The Shape of the Universe

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Abstract

In reference to a recently formulated idea of LANCZOS a special solution of the MAXWELL equations is presented, describing a metric wave field which is the reason for all relativistic effects and gravity. Gravity can be lead back to this special electromagnetic field. Interestingly enough, the properties of this field are similar to those, the recently postulated HIGGS-field should have, to avoid violations of already secured perceptions and observations. Based on this solution, an alternative vacuum propagation function for EM-waves is developed, which describes all effects like cosmologic red-shift and the unexpected results of the SN-Ia-cosmology-experiment, completely without dark matter etc. A complete section is dedicated to the results and interpretation of the SN-Ia-cosmology-experiment. The dependencies between the fundamental physical constants, which not all are real constants are enlightened. Thus, an expression for the calculation of the Hubble-parameter only from locally accessible physical constants can be worked out. Due to the alternative propagation function, there is a special investigation of the question "Is the course of the Planck's radiation-function the result of the existence of an upper cut-off frequency of the vacuum?"in the annex. No standard model, no inflation, no dark matter, exact cosmology. Questions and suggestions via gerdpommerenke@arcor.de. Version 4 has been strongly revised, mainly the section entropy, Planck's radiation rule and redshift. Deutsche Version siehe viXra:1906.0321

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1. Author-seminar paper

Primary purpose of this work was to determine, if it is possible to specify the HUBBLE-parameter with other methods than astronomic ones and if necessary even to calculate it. Until now, the determination was possible only by extensive astronomic observations, with which precision leaves to be desired indeed. With the improved technical methods, like e.g. the HUBBLE-Space-Telescope, it now succeeds to advance into space farther and farther obtaining new, more exact data. It becomes visibly with it, that it will be imperative more and more to have an exact model of the universe as whole in order to interpret these data correctly because the farther one advances into the universe and with it, into the depths of time, the more effects appear, that can be hardly interpreted with the contemporary models or not at all.

Object of this work now is to construct such a model, using data that is in the local area, which is accessible with the present-day technical methods particularly. These would be the universal fundamental physical constants and their relations to each other as well as the electron charge, -mass and similar values and the known physical rules. For this as fundamentals serves a cosmologic model basing on a lecture, delivered in German language by Prof. Cornelius LANCZOS on the occasion of the EINSTEIN-Symposium 1965 in Berlin. Except for [1] this lecture does not have been published furthermore (and never in English) according to my knowledge. Therefore, I put the English translation in front of this work declared as quotation. That even facilitates the evaluation of, in what extent the present work figures an expansion of his theory.

In his model LANCZOS postulates the existence of a strictly agitated wave-field, which generally should be, according to his opinion, the real cause of the qualities of space-time and relativistic effects. For more details please read the lecture itself, which has got only seven pages overall. Because this idea is fascinating me and since LANCZOS has sketched his model even only in coarse outlines, I have tried to put an authentic model on the basis of the known facts and phenomenons, both fitting LANCZOS' demands and nevertheless not colliding with the yet accepted reality.

Since LANCZOS' model is already quite unconventional itself, I too had to turn some unconventional bases on start. The most important is the existence of a specific conductivity of the vacuum different from zero, additionally to the influence- and dielectric constant, as cause of the expansion of the universe, which does not have discovered yet, since we have arranged well with the classic MAXWELL-equations. In the course of the work we will see, that the real wave propagation in the vacuum might be take place a little bit more complicated. Even the specific conductivity turns out to be the »missing link« in the system of universal nature-constants.

With the help of this assumption a special explicit solution of the MAXWELL equations has been found, which fits on the one side the demands of LANCZOS' model, on the other side disposes of the properties the recently postulated HIGGS-field must have, if it should not violate already secured perceptions and observations. If both fields are identical remains to be seen at first. The solution presented in this work is designated as metric wave field. On the basis of this solution, finally a line-element (vacuum-solution) can be constituted describing explicitly the qualities of space-time even with stronger gravitational-fields and coincides with the usual EINSTEIN- respectively classic relationships in case of weaker fields. The contemplation will be continued up to the determination of the particular curvature tensors, the energy-impulse-tensor as well as the geometry. Since all these solutions are explicit, the application of the variation-calculus could have been renounced completely.

An alternative vacuum propagation function for EM-waves – under consideration of the above mentioned metric wave field – is presented, describing effects like the cosmologic red-shift and the unexpected results of the SN-cosmology-experiment, completely without dark matter etc. Different from the generic interpretation they are caused by an additional parametric attenuation, that results directly from the expansion of the universe, being disregarded by the standard solution of the MAXWELL equations. A complete section is dedicated to the results and interpretation of the SN-cosmology-experiment.

Furthermore the dominance of normal matter opposite to antimatter, the real meaning of PLANCK'S smallest increment as the real potential of gravitational-field will be explained as well as the meaning of SOMMERFELD's fine-structure-constant.

At the end of the work an equation is presented, allowing to calculate the HUBBLE-parameter from locally accessible physical values and there is taken up a comparison with the values obtained from this work and with the actual astronomic values. Even if many questions are answered overall, the present work is no complete cosmology however.

The theoretical electrotechnics custom notation is used in the work (j instead of i). Even SI-units are used consistently, since I believe that the preset of constants to 1 (e.g. light-speed), as usual in the RT, are leaving to a cover-up of as yet unknown interdependences at all. Since this work is strongly interdisciplinary I tried to present the stuff in such a manner, that it can be understood even by non-specialists.

I ask for your understanding, that the concept MINKOVSKIan line-element is not being used in the sense of its real meaning in the beginning of the work. The reason is that I simply could not find another name for the physical object (MLE) that I want to describe with. Moreover there is constantly talked about a MINKOVSKIan line-element in LANCZOS' lecture, even if it is only approximately MINKOVSKIan.

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3. Cosmologic model

3.1. Fundamentals and hypotheses

3.1.1. Starting point of the work

Starting point of all contemplations is the lecture [1] delivered by Professor Cornelius LANCZOS on the occasion of the EINSTEIN-symposium 1965 in Berlin. On this occasion open questions, how for example the expansion, the existence and isotropy of the cosmic background radiation should be clarified in the course of the work. Furthermore it will be examined, whether it is possible to determine the HUBBLE-constant from the universal nature-constants and other measurable dimensions mathematically.

3.1.2. Tetrades-formalism and definite space-time-structure (quotation)

»…EINSTEIN has turned away the empiric of MACH's school in his later years completely and the adoration of the „sense data“ (i.e. the immediate sensations) mocks of the something takes for pure coin, what is only the consequence of a much complicated situation. There are for example the pressure and the temperature of a gas - two observable numbers - which aren't however no more than macroscopic median values of an infinitely complicated process, of which we can grasp only statistically. Would it not be possible that could apply somewhat such also on the MINKOVSKIan line-element? There are now these g_{ik}, which should assume virtually constant values in the vacuum. Yes, however we know from certain quantum theoretical experiences, — like for example the so-called vacuum-polarization, or the zero-point energy, — that the vacuum can play in no way a so passive role, that would be characterized with a smooth quasi-euklidic geometry. In the forties I have permitted myself the thought that there happens somewhat much more dynamic, namely, that there exists a strongly agitated wave-field, which only therefore doesn't appear explicitly, since the frequencies are extremely high and the inertia of the matter reacts only to statistical median values, as similar as the pressure of a gas. In the last years, I have developed this somewhat vague picture by the assumption that one possibly not has to look with the solution of the geometrical field-equations for sphere-symmetrical solutions,—but after solutions, which are *periodic*, in all four coordinates. Then one gets a crystal-like structure for the metric plateau, that underlies the world-geometry. The constant g_{ik} of the MINKOVSKIan line-element would be only median values, caused by the extreme small lattice-constant. Indeed, one gets from the three dimensioned world-constants speed of light, gravitational-constant, PLANCK's constant a fundamentally-length of the magnitude 10^{-32}cm, just an extremely small length, opposite to that the atomic dimensions are still macroscopic. Therefore it doesn't and can be considered to be a priori impossible to equate this fundamentally-length to the lattice constant. (I it would like to add here that I only found out by professor TREDERS works, that PLANCK itself already has recognized this length as fundamentally-length and has discussed this matter in his lectures about heat-radiation. In the English translation, I could not find any hint relating to this.)

Now I have discussed the idea of such a wave-background in its more primitive version with EINSTEIN more often, and he does not have probably discarded the idea a priori, but his main objection was that a preferred frame of reference would be introduced by a so agitated background, which stands in contradiction with the fact of the LORENTZ-transformation. This objection is absolutely legitimate coming from EINSTEIN, who has celebrated so terrific triumph based on the non-existence of a preferred coordinate-system, that he could not avoid to consider this thought as final and irrefutable.

And however one can argue also differently. We know the crystals of the so-called cubic symmetry-group, that absolutely behave macroscopically isotropic, although they are characterized by three well-distinctive orthogonal main-axes. The three main-axes are however macroscopically equivalent, which leads into the consequence of an apparent isotropy in as well as elastically like optical sense. If one transfers this contemplation into the four-dimensional, so one comes to the knowledge that a microscopically preferred coordinate-system nevertheless can fake the equivalence of all LORENTZ frames of reference macroscopically.

Let's employ us something in detail with the main-axes of such a crystalline lattice. In his incomparably beautiful examinations over bent surfaces GAUSS has introduced two fundamental quadratic differential-forms, the first and second fundamentally-form. With help of these two forms, the two main-curvature-directions of surface can be defined invariantly in each point. In a pure RIEMANN geometry, however only the first fundamentally-form is existing, and the question after the main-axes remains unanswered for the moment. Now, however there is just a second Tensor, namely the curvature tensor R_{ik} – or also the matter tensor T_{ik} – which is in accordance with our assumptions now in no way equal to zero. Therefore one has the two fundamentally-forms

$$\mathrm{ds}^2 = g_{ik}\mathrm{dx}^i\mathrm{dx}^k \quad \text{and} \tag{0.1}$$
$$\mathrm{d}\sigma^2 = R_{ik}\mathrm{dx}^i\mathrm{dx}^k \tag{0.2}$$

and accordingly the main-curvature-directions by the vectorial eigenvalue-problem

$$R_{i\alpha}h^\alpha - \lambda g_{i\alpha}h^\alpha = 0 \tag{0.3}$$

can be defined. In order to not overburden the frequently used symbol of λ we will rather mark the four eigenvalues with $\sigma_{1\ldots}\sigma_4$ so that the main-axis-problem can be written in the form

$$R_{i\alpha}h^{\alpha^k} - \sigma_k g_{i\alpha}h^{\alpha^k} = 0 \tag{0.4}$$

The first index of the quantities h^{ik} is a genuine contra-variant index, while the second one only is used for numbering, to distinguish the four main-vectors h^i as first, second, third, fourth vector.

Therefore the quantities of h^{ik} aren't to be understood as Tensor but as four vectors with altogether 16 components. Purely algebraically it follows these relationships

$$\begin{aligned} h_{ia} &= h^{\alpha a}g_{i\alpha} \\ g_{ik} &= h_{ia}\,h_{ka} \\ g^{ik} &= h^{ia}h^{ka} \\ h^{ia}h_{ka} &= h^{ai}h_{ak} = \delta^i_k \end{aligned} \tag{0.5}$$

Interestingly these are exactly the relationships EINSTEIN has introduced in his theory of „distance-parallelism“ in 1928. It was this exactly the year, in which I was assigned as his co-worker to Berlin. He was made happy by the new ideas very much, whereas I could not find the right enthusiasm for the new theory, since it appeared artificially to me wanting to graft something on the RIEMANN geometry, that does not stand with it in any organic relationship. And however EINSTEIN's theory seems to be very captivate and attractive. After all the possibility was given to add here another anti-symmetrical element to the 10 symmetrical g_{ik} characterized by 6 quantities, that would be to be assigned so well to the anti-symmetrical field tensor of the electromagnetic field-strength. Now let's have a look at our main-axis-definition, we can see that these EINSTEIN h^{ia} quantities adjust themselves quite casually without taking reference on a distance-parallelism anyway. Naturally, these four vectors now have a quite different meaning. They install into each point a tetrade of four perpendicular vectors which are capable, to characterize our metric lattice. In addition, they yield not only the g_{ik} in algebraic form but also the R_{ik} according to the equation

$$R_{ik} = \sigma_a h_{ia}\,h_{ka} \tag{0.6}$$

or even

$$R^{ik} = \sigma_a h^{ia} h^{ka}. \tag{0.7}$$

That now has its particular advantages, if the question is to lay down an action-principle, from which the field-equations should be derived for the geometry of the world. The EINSTEIN variation-principle makes use of scalary curvature

$$R = R_{ik} g^{ik} = \sigma_1 +_{\dots} + \sigma_4 \ , \tag{0.8}$$

and the action-integral becomes here

$$W = \int (\sigma_1 +_{\dots} + \sigma_4) h dx^1 \dots dx^4 \ , \tag{0.9}$$

where h means the determinant of the h_{ia} quantities. On the other hand if one works with a quadratic action-principle, to satisfy the calibration invariant, so the LAGRANGE-function of our action-principle now becomes

$$L_0 = \frac{1}{2}[\sigma_1^2 + \dots + \sigma_4^2 - C(\sigma_1 + \dots + \sigma_4)^2]h \tag{0.10}$$

where C is an a priori uncertain numerical constant. We see therefore that the difference between the different action-principles is not so big at all, if one operates with the h_{ia} as fundamentally-quantities. Of course there already supervenes as additional-condition that the R_{ik} 's are given by a quite certain differential-operator, so that the complete action-principle is characterized by the LAGRANGE-function

$$L = L_0 - p^{ik} [\sigma_a h_{ia} h_{ka} - D(h_{ia} h_{ka})]h \tag{0.11}$$

where I have marked with $D(h_{ik})$ the known differential-expression of second order in the g_{ik} symbolically. To the luck, the second derivatives of the g_{ik} occur only *linearly* in it, so that one can immediately get rid of the second derivatives by partial integration and yields a LAGRANGE-function containing only the first derivatives of the action-quantities. The action-quantities, which are varied freely, are given as follows at this:

$16 h_{ia}$, $4\, \sigma_i$, $10 p^{ik}$, altogether 30 quantities.

Of course I would not like to get involved in arithmetical details, my object is only to outline the train of thought and to register the results.

The mentioned metric lattice is not yet the end. Rather it corresponds to the empty space only so far, what is translated with the MINKOVSKIan line-element usually. Instead, we now have our periodic lattice with the microscopic metric waves. The material particles are superponed to this lattice as modified solutions of the field-equations, to which the periodic margin-conditions are no longer applied. Once let's leave aside the question of the structure of these particles. What happens in a point of the world, that is far from material particles, just in the vacuum? This situation is similar to, as if we would take a crystal bending it. The inflection of the lattice just comes about by the action of distant masses and charges.

Therefore we have a mathematical interference-problem to hand and we are forced to look for the interference on the LAGRANGE-function. Since we have gone out from an actual solution of the field-equations (because we assume that the metric lattice represents a possible, although not the only possible solution of the field-equations), so it depends on the second variation $\sigma^2 L$ depending on the varied action-quantities quadratically. Just there are the quantities δh_{ia} of special interest and the linear field-equations, that must be found for.

Let's think of our main-axis-problem now. A deformation of the main-axes can be split into two parts, namely a bare spin and an elastic deformation. We can suspect with EINSTEIN that the elastic deformation will correspond to gravity, the rotation to the electromagnetic field. What however is the cause that the electromagnetic fields overtop the gravitational-fields so strongly?

To this point is the following to say. We know that the so-called „cosmologic equations“

$$R_{ik} = \lambda g_{ik} \tag{0.12}$$

fill the field-equations of the quadratic action-principle precisely. With this solution, all four eigenvalues become the same:

$$\sigma_i = \lambda \tag{0.13}$$

and the direction of the main-axes remains uncertain. So the smallest interference can have the consequence of a whatever strong rotation of the main-axes. This case of degeneration won't be of interest for us. Probably however, we can assume that we are *close* to that case, i.e. that

$$\sigma_i = \lambda + \varepsilon_i \tag{0.14}$$

applies, where the ε_i are small opposite to the large constant λ. Then we have certain main-axis-directions, but the preference of these directions is weak, so that a rotation especially easily comes into existence with an interference, while the metric alteration remains only small. So the outstanding strength of the electric actions opposite to the gravitational ones can be explained therefore.

The variation of δh_{ia} just can be attributed to a true tensor F_{ik} by setting

$$\delta h_{ia} = F_i^{\mu} h_{\mu a} \tag{0.15}$$

This tensor doesn't appear with EINSTEIN. He presupposes the Euclidean values for the fundamental field,

$$\delta h_{ia} = \delta_{ia} \tag{0.16}$$

since he assumes the MINKOVSKIan line-element for the non-interfered field. Then applies

$$\delta h_{ia} = F_{ia} \tag{0.17}$$

whereas the tensor F_{ik} is to separate strictly from the four vectors δh_{ia} in our case. Now one can show, that in case of a bare *rotation* of the main-axes the tensor F_{ik} becomes anti-symmetrical and can be traced to a vector φ_i according to the equation

$$F_{ik} = \varphi_{i,k} - \varphi_{k,i}\,. \tag{0.18}$$

Regarding to the LAGRANGE-function of the superimposition-field we can already make certain quite definite prognoses out of the structure of the problem. We foresee that $L'=\delta^2 L$ d2L will depend on the effect-quantities quadratically, as similar as at the mechanical oscillations of a solid around the equilibrium, wherever the LAGRANGE-function starts with the quadratic members (the linear members disappear, since we have gone out from an equilibrium), while the higher members can be neglected because of the smallness of the oscillations. We just have the quantities F_{ik}^2, and that must come in with certain coefficients, that become dependent from the lattice-structure somewhere. It is plausible to assume that the four scalars σ_i, – the eigenvalues of the main-axis-problem – will be suitable particularly. In (0.14) we have accepted these σ_i as virtually constant that only differ from the big constants λ by the small quantities ε. Therefore, we will expect an expression for the coefficients, which depends on that ε_i linearly in first approximation. The constant part must disappear however, because if all ε_i are zero, that's just the degenerate case (0.12) in which even a finite rotation doesn't generate any metric alteration and therefore L'=0 applies. So it can be only an homogeneous linear function of the ε_i as factor of F_{ik}^2, which must be symmetrically in *i* and *k* furthermore. The most natural is to assume $\varepsilon_i+\varepsilon_k$ as a factor. However with the help of universal principles it's possible to demonstrate that a modification of all ε_i by the same constant must not generate any modification in L'. Just we have to correct $\varepsilon_i+\varepsilon_k$ as follows:

$$\varepsilon_i + \varepsilon_k - \frac{1}{2}(\varepsilon_1 + \varepsilon_2 + \varepsilon_3 + \varepsilon_4) \tag{0.19}$$

with the result

$$L' = \beta\left[\varepsilon_i + \varepsilon_k - \frac{1}{2}(\varepsilon_1 + \varepsilon_2 + \varepsilon_3 + \varepsilon_4)\right] F_{ik}^2 \quad , \tag{0.20}$$

where β is a bare constant. This is the expression indeed, that yields the detailed calculation for $L' = \sigma^2 L$.

This result immediately has the following consequence. The 6 terms, that appear in L', are reduced to only 3 terms immediately, since only the combinations

$$F_{12}^2 - F_{34}^2, \qquad F_{23}^2 - F_{14}^2, \qquad F_{31}^2 - F_{24}^2 \tag{0.21}$$

appears, i.e., immediately we see that the electric and magnetic quantities appear with *inverse* sign in the action-principle. Let our metric lattice be only macroscopically isotropic concerning x_1, x_2, x_3, x_4, then we will get the usual invariant of the electromagnetic field immediately

$$E^2 - H^2, \tag{0.22}$$

from which the MAXWELL equations can be derived as you know. The particular negative sign usually derived from the MINKOVSKIan imaginary signature $x_4 = ict$ here comes about in a quite natural manner as macroscopic superimposition-appearance because of a weak interference on the metric lattice, evoked by an infinitesimal rotation of the fundamental four-leg.

The alteration of a purely RIEMANN metrics to a metrics, in which Pythagoras's theorem appears in the form of

$$s^2 = x^2 + y^2 + z^2 - c^2t^2 \tag{0.23}$$

mostly is been accepted as more or less self-evident without big discussion.. For EINSTEIN was the + + + – signature of the line-element an incomprehensible mystery, that one quite accepts, simply because it so *is*, without comprehending why it *must* be so however. In the implementations discussed here, the situation is quite different. We have gone out from a real, pure RIEMANN geometry, which is positively definite (without this demand we could not at all guarantee the existence of real eigenvalues of the main-axis-problem generally). So, just from the beginning we are able to work with a rational geometry, in which the conditions of each rational metrics:

$$\begin{aligned} &\overline{AB} = \overline{BA} \\ &\overline{AB} = 0 \quad \text{heißt} \quad A = B \\ &\overline{AC} \le \overline{AB} + \overline{BC} \end{aligned} \tag{0.24}$$

are fulfilled (in case of the MINKOVSKIan signature the second and third condition gets lost). Furthermore we have taken as a basis an action-principle, that is quadratic in the curvature-components, which satisfies the demand of the calibration invariance therefore. Therefore, we install a philosophy of maximum rationality. Nevertheless, it succeeds, for *the macroscopic experience-space* (whom all physically measurable quantities belong to) to derive a metrics, that behaves in a MINKOVSKIan manner avouching the usual propagation of all physically measurable quantities with speed of light. Namely the interference of the fundamental metric lattice yields a LAGRANGE-function having to interpret in a MINKOVSKIan manner, if one interprets it as *primary* and if one negates the fundamental lattice, from which it follows.

Does we have the right to consider a theory of this kind as a natural development of EINSTEIN's ideas? The majority of my colleagues will probably negate this question, while I believe to may answer with a yes. In any deep academic discovery, quite one may distinguish essential and irrelevant elements. The incredibly large of the discovery of EINSTEIN was the geometry of the nature to be recognized as bent and to understand the physical „matter“ as a curvature-condition of the space-time-world, on reason of the equation

$$R_{ik} - \frac{1}{2} R g_{ik} = T_{ik} \tag{0.25}$$

what may possibly be put as the biggest achievement of all times in the area of abstract thinking. Furthermore, it was EINSTEIN's endeavor to describe the interdependence between matter and field by field-equations. The equation $R_{ik}=0$ expresses the disappearance of the matter tensor, what only can have macroscopic value, without solving the actual problem of the matter, how that was probably known by EINSTEIN. But even assumed, that we have the right field-equations, so it still remains a problem to take the right selection from an infinite variety of possible solutions. EINSTEIN makes two assumptions from empirical reasons here. He searches for spherical-symmetrical solutions, and he assumes as margin-condition that the line-element in the vacuum, distant from matter, becomes virtually MINKOVSKIan. These two assumptions forced by empiricism (and therefore only macroscopic proven) I would consider as the accidental of EINSTEIN's theory, all the more, as EINSTEIN himself has not regarded the MINKOVSKIan signature of the line-element as the last word.

In the theory sketched here, one doesn't search for spherical-symmetrical solutions but for *periodic* ones (fourfold periodic) of the fundamental equations, by which a lattice-like structure of the space-time-world is caused about. A fundamentally-length immediately appears with it, namely the lattice constant of this crystal-like metrics. A second fundamentally-length, that is assigned to the cosmologic constant λ, immediately comes together with it. The reasons are 1st: the cosmologic equations are exact solutions of the field-equations and 2nd: the cosmologic constant in this theory becomes a calibration quantity of the microcosm (and not of the macrocosm). Just there are two independent fundamental lengths, well harmonizing with the so different magnitudes of HEISENBERG's and PLANCK's fundamentally-length, namely on the one hand 10^{-13}, on the other hand 10^{-32} cm. In addition, the theory succeeds in deriving the MAXWELL equations on the basis of an infinitesimal interference of the lattice. About the possibility, to regard the different subatomic particles as stimulated inherent-solutions of the field-equations, nothing yet can be stated in this approximation. However it's not excluded to link the lattice-oscillations with HEISENBERG's uncertainty principle. Relating to this however it is possibly not uninteresting to refer to the following. For the measurement of any physical quantity (i.e. a lattice overlaid one) only such lattice-points come into consideration, that lie congruently regarding the fundamentally-cell. Because only then you will measure the one on which it depends, without being disturbed by the metric oscillations of the lattice. Like this, a seemingly granulated structure of the space comes about just practically, with the lattice constant as smallest possible length. On the other hand, the HEISENBERG uncertainty principle yields,—according to a remark of professor TREDER,—that smaller lengths as PLANCK's fundamentally-length (interpreted as lattice constant in this case) basically aren't measurable.

I would like to close with a remark of universal type. As you know, the invariance opposite to LORENTZ-transformations is committed to the MINKOVSKIan line-element, just tradition-like to a space with vanishing curvature. Now one cannot assume definitely at the fields representing the material particles, that the RIEMANN curvature remains small, because in these areas of the space-time-world, the matter tensor must become very considerable, and it is impossible to postulate that the line-element still virtually has the MINKOVSKIan normal-form. And however the strange paradox exists that the symmetry-qualities of the LORENTZ-cluster are of basic meaning for the physical qualities of subatomic particles. It looks just like as if the special relativity-theory would be more important for the structure of the matter than the universal one. How can this strange contradiction be annulled?

Now let's consider the problem of the theory outlined here. Certainly, the material particles lead to strong curvatures and can't be described by means of a virtually MINKOVSKIan line-element anyway. But compared with the enormously strong sub-microscopic curvatures of the fundamental lattice even these curvatures are still very weak. Compared with the very strong lattice-field even the atomic fields are yet to be understood as relatively weak interferences, having the consequence that the influence of the lattice is not essentially different, just as much whether the macroscopic action on the vacuum (MAXWELL'S equations) or on the inside of the particle is calculated (HEISENBERG's „smallest length" of 10^{-13} is just very small, but still very big opposite to 10^{-32} cm).). So the normally incomprehensible paradox dissolves in this way.

In the discussion Mister MØLLER (Copenhagen) inquired the one the geometry of the macroscopic field should be determined by. We can reply: the LAGRANGE-function of the macroscopic field contains all consequences referring to the field implicitly. If e.g. one gave a mathematician the LAGRANGE-function of EINSTEIN's gravitational-equations without mentioning anything about the RIEMANN-geometry so he would be able to develop all consequences of EINSTEIN's theory from this function, indifferently, whether he now interprets the tensor g_{ik} as RIEMANN-line-element or not. The decisiveness are the invariance-qualities of the LAGRANGE-function. If e.g. this function remains invariant opposite to all LORENTZ-transformations, so this observation would lead to a later introduction of a MINKOVSKIan metrics. It can be just very well, that the macroscopic metrics nothing has to do with the real metrics but is presented solely as mathematical construction to the interpretation of certain invariance-qualities of the LAGRANGE-function.«

*** End of quotation ***

Translation by Dipl. Ing. Gerd Pommerenke

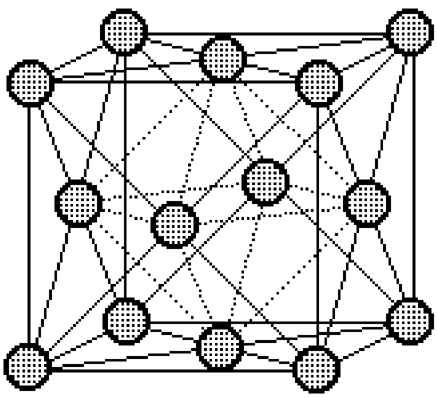


Figure 1
Cubic face-centered crystal lattice

$\mathbf{N = {}^8/_8 + {}^6/_2 = 4}$

3.2. Specification of the model

In this lecture, it is just assumed that the metrics is built like a cubic (regular) space-lattice of MINKOVSKIan line-elements periodically in all directions, and we want to assume too, that it would be actually so. For mathematicians, however, these only exist on paper, while LANCZOS regards them more as physical objects. Thus we want to abbreviate them with MLE only.

Object of the further contemplations should be the question, how such a MINKOVSKIan line-element is built, how it „works“, how the single line-elements are arranged, how they interact together and how the electromagnetic waves propagate in such a metrics. Then, still open questions should be answered, like the one for the expansion of the universe and its causes, the existence and origin of the cosmic background radiation as well as its isotropy also at sources, that cannot have any causal connection on reason of their big distance from each other. The existence of this radiation could not yet be taken into account in the above-mentioned lecture, since it had been discovered first in the year the lecture was held. The structure of the physical matter is not object of this work, since it represents, according to [1], autonomous sphere-symmetrical solutions of the field-equations. In a separate chapter however we will deal with the peculiarities and the interaction of matter and metrics. Now we want to establish the first hypothesis the model is based on:

> *I. On the level of the metric space-lattice apply the legalities of the classic physics. The relativistic effects result from the existence of this lattice and its structure.*

How the relativistic effects arise, will be considered in a later chapter. In the progression, we will apply just only the legalities of the classic physics.

As first, we assume that the MINKOVSKIan line-elements (MLE), we want to examine here, are arranged in a (regular) cubic face-centered space-lattice (picture 1). Such a system behaves isotropically.

Simply let's go out from the MAXWELL equations, that even beside the known methods according to [1], in fact should be to derive on the basis of an infinitesimal interference on the lattice. Now, at first we want to consider these equations less mathematically but more according to their content.

$$\operatorname{div} \mathbf{B} = 0 \qquad \operatorname{div} \mathbf{D} = \rho$$
$$\operatorname{curl} \mathbf{E} = -\dot{\mathbf{B}} \qquad \operatorname{curl} \mathbf{H} = \mathbf{i} + \dot{\mathbf{D}} \tag{1}$$

As well for the electric as for the magnetic field-strength the operator curl for rotation appears. Let's assume that a rotation would really take place here. Thereto we look at the model figured in figure 2 that is to imagine three-dimensional however.

3.3. Forces in the model

A ball-capacitor (figure 2) with the radius r_c and the charge of q_0 moves on an orbit with the angular frequency ω_0, the radius r_0 and the velocity c=const (speed of light). The capacity results in $C_0 = 4\pi\varepsilon_0 r_C$. the energy stored in this capacitor in

$$W_0 = \frac{1}{2}\frac{q_0^2}{C_0} = \frac{q_0^2}{8\pi\varepsilon_0 r_C} \tag{2}$$

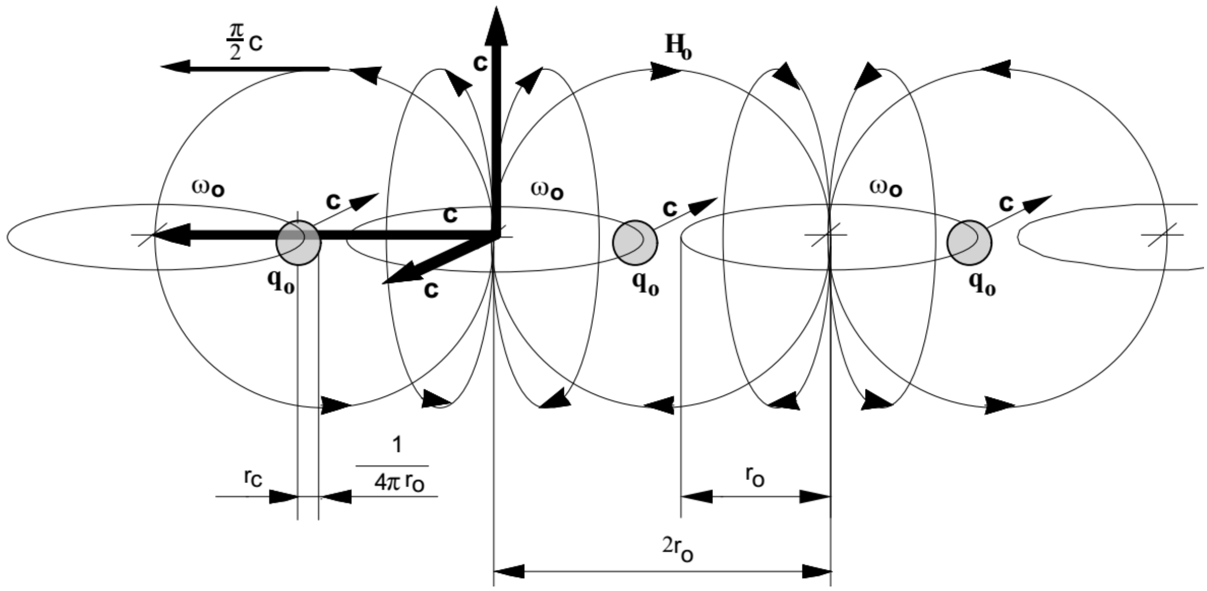


Figure 2
MINKOVSKIan line-elements
Physical dimensions and mutual coupling

and with $r_0 = 4\pi r_c$ and $C_0 = \varepsilon_0 r_0$

$$W_0 = \frac{q_0^2}{2\varepsilon_0 r_0} \tag{3}$$

Furthermore this energy even should have a mass m_0. Since this mass is rotating its mass-moment of inertia results in

$$J_0 = mr_0^2 \qquad \text{(point-mass)} \tag{4}$$

According to our formulation, applies $\omega_0 = c/r_0$ and we receive for the kinetic energy, that should be equal to the electric one,

$$W_0 = \frac{1}{2} J_0 \omega_0^2 = \frac{1}{2} m_0 c^2 \tag{5}$$

Since the capacitor does not have any mass itself, the mass m_0 of the charge is given by

$$m_0 = \frac{q_0^2}{\varepsilon_0 c^2 r_0} = \frac{\mu_0 q_0^2}{r_0} \tag{6}$$

The 2nd expression of (6) we get from the known relationship

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \quad , \tag{7}$$

having a strong similarity with the formula for the resonance-frequency of a loss-free oscillatory circuit on the first look

$$\omega = \frac{1}{\sqrt{LC}} \quad . \tag{8}$$

Then for the centrifugal force (amount) $F_Z = m_0 r_0 \omega_0^2$ applies:

$$F_Z = \frac{\omega_0^2 q_0^2}{\varepsilon_0 c^2} = \mu_0 \omega_0^2 q_0^2 = \frac{q_0^2}{\varepsilon_0 r_0^2} \tag{9}$$

F_Z is directed outwardly. Expression (9;3) represents with the exception of a factor $1/4\pi$ the COULOMB law (repulsion), only that there is no second charge, that could wield a repelling force, here. Centrifugal force and COULOMB-force would just be of same magnitude. To guarantee, that mo doesn't vanish in the infinite, a force is required, able to eliminate the appearing centrifugal force. Thereto it must be invert and of same quantity.

Since we are concerned with the circular motion of a charge here, we can even talk about a current $i_0 = \omega_0 q_0$. This current generates a magnetic field at which point even an inductivity occurs (1 turn). Simplifying, we now assume, that the inductivity should be $L_0 = \mu_0 r_0$. That agrees with the equation for a coil with one turn as well:

$$L = \mu_0 r \left\lfloor \ln \frac{8r}{r'} - \frac{7}{4} \right\rfloor , \tag{10}$$

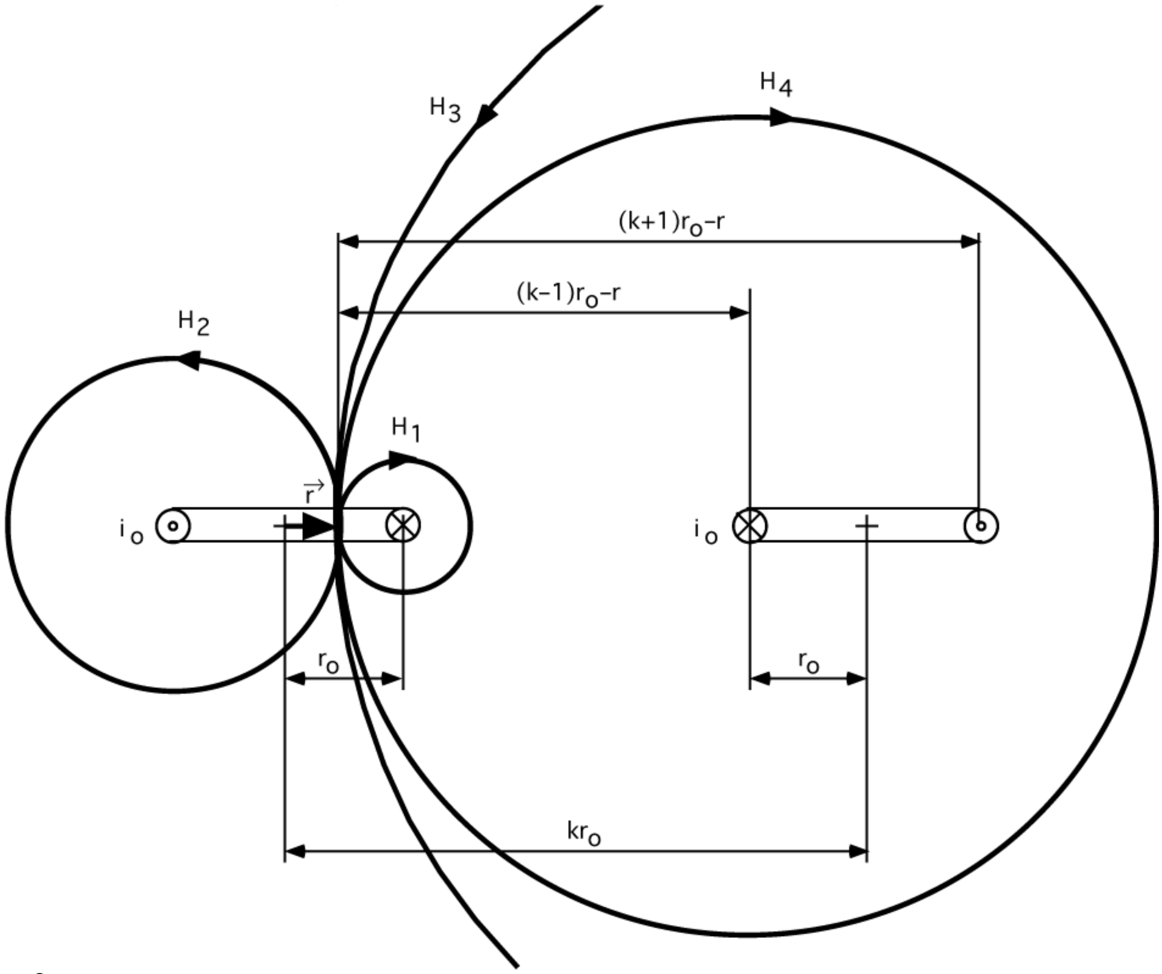


Figure 3
Magnetic field-strength in one and
in several conductor loops

in which r represents the inside-radius, r′ the wire-radius of one single short-circuited turn (μ_r=1). If r′=0.5114 r applies, the bracket-expression yields 1 and we get the aforementioned expression. This is, as said, only a model, since our coil doesn't consist of wire. Rather one should imagine the charge and current something like „spreaded“ across the space. According to [20] the magnetic field-strength $\mathbf{H_0}$ (in future always figured as vector, H is the HUBBLE-constant) in the centre of the conductor loop (left) amounts to

$$\mathbf{H_0} = -\frac{i_0}{2 r_0}\mathbf{e_r} \tag{11}$$

$\mathbf{e_r}$ is the unit-vector. The negative sign results from the definition of the field-strength as difference between zero-potential (r=∞) and potential in the distance R. The field-strength-share of a current-element $i_0$ds in the distance r of the centre (figure 3) calculates according to [20] as follows

$$d\mathbf{H_0} = d\frac{q_0 c\mathbf{e_r}}{4\pi\,(r_0 - r^2)} = \frac{i_0\mathbf{e_r}ds}{4\pi\,(r_0 - r^2)} \tag{12}$$

Here the potential in the distance r_0 takes the place of the zero-potential. For the field-strength H_0 in this point the following applies

$$\mathbf{H_0} = \oint d\mathbf{H} = \oint \frac{i_0\mathbf{e_r}ds}{4\pi(r_0 - r^2)} \tag{13}$$

To solve this integral, we better divide d**H** into the two shares $\mathbf{H_1}$ (right) and $\mathbf{H_2}$ (left), d**H** results from the sum of both shares then. The integration-limits lie at 0 and π.

$$\mathbf{H_0} = \frac{i_0\mathbf{e_r}}{4\pi}\left(\frac{1}{r_0 - r} + \frac{1}{r_0 + r}\right)\int_0^\pi d\varphi = \frac{i_0\mathbf{e_r}}{2}\frac{r_0}{r_0^2 - r^2} \tag{14}$$

Then in the centre the field strength prevails denoted in (11). That value is related to one isolated, single MLE only. In order to determine the real field strength, we must consider the adjacent line elements additively. Let’s have a look to the effect of *one* adjacent MLE (figure 3 right) in x-direction. To that purpose we can transform expression (14) in the following manner:

$$\mathbf{H_1} = \frac{i_0\mathbf{e_r}}{4\pi}\left[\frac{1}{(k-1)r_0 - r} + \frac{1}{(k+1)r_0 - r}\right]\int_0^\pi d\varphi = \frac{i_0\mathbf{e_r}}{2}\frac{r_0}{r_0^2(k^2-1) - 2\pi r_0 r + r^2} \tag{15}$$

Since the single line-elements are arranged in a cubic-face-centered space-lattice (figure 1), altogether four line-elements are arranged along a field-line in fact in the manner depicted in figure 4. On this occasion, I already have jumped in ahead of coming findings by figuring the single tracks not as circles but as eight-shaped graph (eight-curve). This is necessary in order to figure the phase-relations. So far, we have considered even only one special-case, namely that one, at which q and **H** have its effective-values. One must assume however that it is about an oscillatable system overall (L and C) and there the single values will vary after an approximately sine-shaped function. A track-graph with a positive charge at one end and a negative charge at the other end however figures a dipole, that lines up in space according to a certain mode (vector $\mathbf{E_0}$).

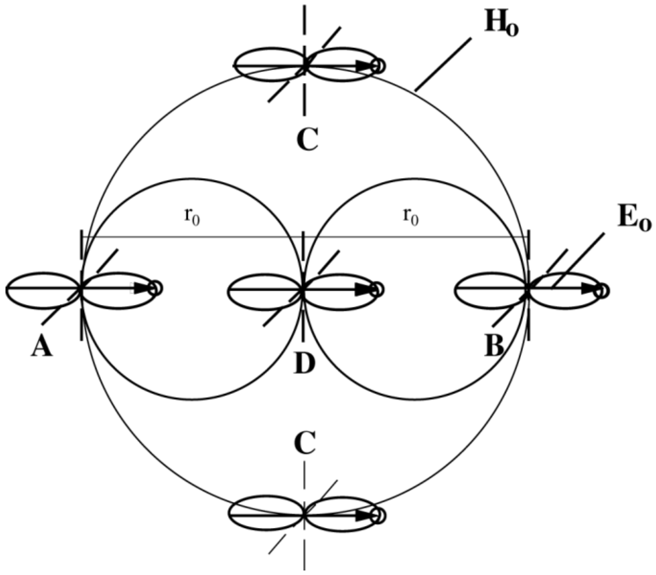


Figure 4
Collocation of the MLE's at a field-line in x-direction
at a cubic face-centered lattice

Let's look at figure 4 now, so we first see the point A. This is the MLE, we are examining. In the point D there is the second MLE, whose influence we have determined in (15). There is also a connection with the point B. The field line intersects the two elements C with an angle of 0°, i.e. not at all, so that it doesn't come into effect in x-direction. But with an interference (e.g. along the z-axis) they can change their orientation such, that they come into effect too or even take the place of A and B. Then the propagation takes place in z-direction. Under consideration of the four adjacent MLEs we obtain the following expression for $\mathbf{H_0}$:

$$\mathbf{H}_0 \approx \frac{i_0 r_0 \mathbf{e_r}}{2}\left[\frac{1}{r_0^2 - r^2} + \frac{4}{r_0^2(k^2-1) - 2\pi r_0 r + r^2}\right] \tag{16}$$

What interests now is the question of the actual size of k. Placing the values 1, 2 and π, we obtain the course depicted in figure 5 in x-direction.

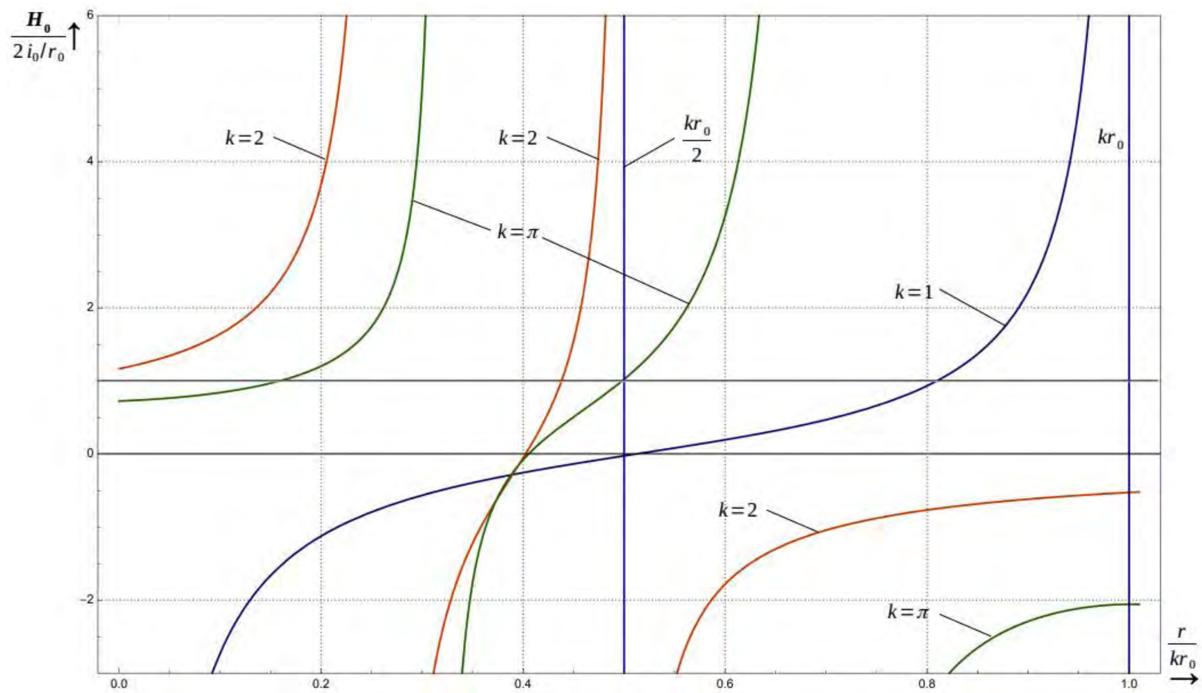


Figure 5
Course of the magnetic field strength depending on
the radius r and various lattice constants

For k=1 we can see, that there is a zero transit of $\mathbf{H_0}$ at $r = r_0/2$, the average value of the distance A-D. Thus, the magnetic field at this point is equal to zero. That means, the charge q_0 of D has taken on its maximum. Hence, there is a phase-shift of 90° between both points, exactly as with a resonance coupling. Differently with k=2, that would be connection A-B. Here the magnetic field has its maximum. Thus, one MLE always communicates with the next but one MLE via the magnetic field.

But there are any more MLEs in the fc-lattice. Even the ones on face and farther away are interacting with A. But we considered the four adjacent MLEs only. But since a cube with the edge length r_0 also contains 4 MLEs, we can assume, that (16) applies to the average value of all influences too. With it, we can define a so called e*ffective lattice constant*. So we are looking for the value of k, at which expression (16) becomes equal to 1 in half the distance and therefore (17) applies. As we can see in figure 5, that's the case at $k=\pi$. Herewith, the e*ffective lattice constant* has the value πr_0, while the r*eal lattice constant* is equal to r_0. For $\mathbf{H_0}$ applies:

$$\mathbf{H_0} = -\frac{i_0}{r_0}\mathbf{e_r} \tag{17}$$

and for the magnetic induction

$$\mathbf{B_0} = \mu_0\mathbf{H_0} = \frac{\mu_0\omega_0 q_0\mathbf{e_r}}{r_0} = \frac{\mu_0 c q_0\mathbf{e_r}}{r_0^2} \tag{18}$$

Simultaneously, we are concerned with a moved charge in the magnetic field. So, a LORENTZ-force $\mathbf{F}_m = q_0(\mathbf{c}\times\mathbf{B_0})$ will apply. It is directed inside. For the simplification, we want to look at the system along the x-axis again. Therefore, we can set for the amount of the attractive force $F_m = -q_0 c B_0$. We get using

$$F_m = -\frac{\mu_0 c^2 q_0^2}{r_0^2} = -\frac{q_0^2}{\varepsilon_0 r_0^2} \tag{19}$$

Expression (9), just with inverse signs. Centrifugal force and LORENTZ-force cancel each other. Now, we can determine even the rest-mass of the magnetic field:

$$W_0 = \frac{1}{2}i_0^2 L_0 = \frac{1}{2}\omega_0^2 q_0^2\mu_0 r_0 = \frac{1}{2}m_0 c^2 \tag{20}$$

$$m_0 = \frac{\mu_0 q_0^2}{r_0} \tag{21}$$

As it can be proven easily, this expression is identical to (6). Now, we want to determine the gravitative attraction of the magnetic and the electric rest mass (we imagine it as point-masses in the centre of the orbit). We can write on reason of the mass-equality

$$F_g = -G\frac{m_0^2}{r_0^2} = -G\frac{\mu_0^2 q_0^4}{r_0^4}. \tag{22}$$

We now look at the energy stored in C_0 once again (3). Since this represents only the half of the total-energy of the MLE, we can write

$$W_0 = \frac{q_0^2}{2\varepsilon_0 r_0} = \frac{1}{2}\hbar\omega_0 \tag{23}$$

Then, following expression arises for the charge:

$$q_0 = \sqrt{\hbar c\varepsilon_0} = \sqrt{\frac{\hbar}{Z_0}} \tag{24}$$

In this connection, Z_0 stands for the vacuum wave-propagation impedance $Z_0 = \sqrt{\mu_0/\varepsilon_0}$. This represents because of equation (7) a similarly invariable quantity like c. Herewith we have already »linked the lattice-oscillations with HEISENBERG's uncertainty principle« by the way, as it LANCZOS demands in his lecture. From (22) and (24) we get:

$$F_g = -G\frac{\hbar c\varepsilon_0\mu_0^2 q_0^2}{r_0^4} = -\frac{G\hbar}{c}\frac{q_0^2\mu_0}{r_0^4} \qquad (25)$$

and after expansion with c^2

$$F_g = -\frac{G\hbar}{c^3}\frac{q_0^2}{\varepsilon_0 r_0^4} \qquad (26)$$

Now let's have a look at the first fraction $G\hbar/c^3$ somewhat more exactly, so it represents, with the exception of a factor of $1/2\pi$, exactly the square of the PLANCK's elementary-length, how we already know it from other models. If we now fix that

$$r_0 = \sqrt{\frac{G\hbar}{c^3}} \qquad (27)$$

should be, we also get for the gravitational-force expression (19) as well as (9)

$$F_g = -\frac{q_0^2}{\varepsilon_0 r_0^2} \qquad (28)$$

Now, the value of PLANCK's elementary-length is not $G\hbar/c^3$ however but actually Gh/c^3 The difference of $1/2\pi$ can be attributed to the fact, that it’s easier to count with the second expression with some models. In the course of the development of quantum mechanics it has also been shown that $\hbar$ is the more practical natural unit than the h chosen by PLANCK. Then, the same applies even to the derivations. But from a physical point of view always the same result turns out at the end, even if the factors possibly looks a little bit bulky. We decide on $G\hbar/c^3$, because it’s better for our model. Further we get for the other PLANCK's elementary-expressions:

$$\omega_0 = \sqrt{\frac{c^5}{G\hbar}} \qquad W_0 = \sqrt{\frac{\hbar c^5}{G}} \qquad m_0 = \sqrt{\frac{\hbar c}{G}} \qquad (29)$$

The value for ω_0 amounts to about $1.8551 \cdot 10^{43} s^{-1}$. We were able to trace back centrifugal, COULOMB-, LORENTZ- and gravitational-force to a single expression. Interestingly the value of r_0 is insignificant with the electromagnetic contemplation (MAXWELL equations). If however the gravitational-force is coming into play then for the value of r_0 only equation (27) may apply. Incidentally MAXWELL shall has gone out from a similar model we are discussing here, however without expansion.

Another important point of view is the propagation-velocity of an interference in our model. If we postulate that the angular frequency ω_0 of the electric dipole and ω_0 of the magnetic induction and field-strength are equally large, so an interference must spread in phase and/or amplitude with the velocity of $\pi c/2$ along the field-line $\mathbf{H_0}$. That means, the interference propagates along a straight line AB (not figured in figure 4) exactly with the speed of light. The same is applied even to the propagation in other, optional directions. So, there are also distances of $\pi\sqrt{2} \ldots \pi\sqrt{3}$ available in the space-lattice. Now we must imagine the radial-velocity upon the field-line proportionally to the distance, so that the axial-velocity is always c. If we regard the system L_0C_0 as a parallel-oscillatory circuit, so we get for the resonance-frequency:

$$\omega_0 = \frac{1}{\sqrt{L_0 C_0}} = \frac{1}{r_0 \sqrt{\mu_0 \varepsilon_0}} = \frac{c}{r_0} \tag{30}$$

and without r_0

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \tag{31}$$

exactly expression (7). For the total-energy W_0 of a MLE, that results from the *sum* of electric and magnetic energy, then we get

$$W_0 = \frac{q_0^2}{\varepsilon_0 r_0} = \frac{m_0}{2} c^2 + \frac{m_0}{2} c^2 = m_0 c^2 \tag{32}$$

For this reason, the energy of the mass of electromagnetic radiation amounts to m_0c^2 and not to $m_0c^2/2$. We get the same value here by solving the following equation (energy in the gravitational-field)

$$W_0 = \int F_m dr_0 = -\frac{q_0^2}{\varepsilon_0} \int \frac{dr_0}{r_0^2} = \frac{q_0^2}{\varepsilon_0 r_0} \tag{33}$$

That is already the total-energy, since both masses are involved in it. Furthermore, the relationship $W_0 = \hbar\omega_0$ applies of course. We get more important relationships for the magnetic flux φ_0, if we equate electric and magnetic energy

$$W_0 = \frac{1}{2}\frac{q_0^2}{C_0} = \frac{1}{2}\frac{\varphi_0^2}{L_0} \tag{34}$$

$$\frac{\varphi_0}{q_0} = \sqrt{\frac{L_0}{C_0}} = \sqrt{\frac{\mu_0}{\varepsilon_0}} = Z_0 \tag{35}$$

$$\varphi_0 = q_0 Z_0 = \sqrt{\hbar \mu_0 c} = \sqrt{\hbar Z_0} \tag{36}$$

$$\varphi_0 q_0 = \hbar \tag{37}$$

The last expression throws a marking light on the meaning of PLANCK's quantity of action and we have already realized the suggestion of [1] : »…to link the lattice-oscillations with HEISENBERG's uncertainty principle«. For the energy, one can also write $W_0 = \varphi_0 q_0 \omega_0$ or $W_0 = \varphi_0 i_0$ as well as $W_0 = q_0 u_0$ (everything effective-values). One sees, almost all quantities can be attributed to simplest expressions.

3.4. The MINKOVSKIan line-element as oscillatory circuit

Having considered so far only the case of electric and magnetic mass which are equally large — charge and flux φ_0 would have its effective-values and m_0 would describe an orbit in this case — the MLE doesn't behave quite so simply. So it suffices however to assume an orbit for later contemplations. As already more above suggested, there is an oscillatable system with a capacitor and a coil available, that shall (in the moment) be interconnected via a loss-free medium, namely the vacuum. So, we can make even an equivalent circuit for it (figure 6), the one of an undamped parallel-oscillatory circuit:

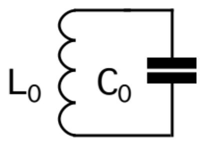


Figure 6
Equivalent circuit
of a static MLE

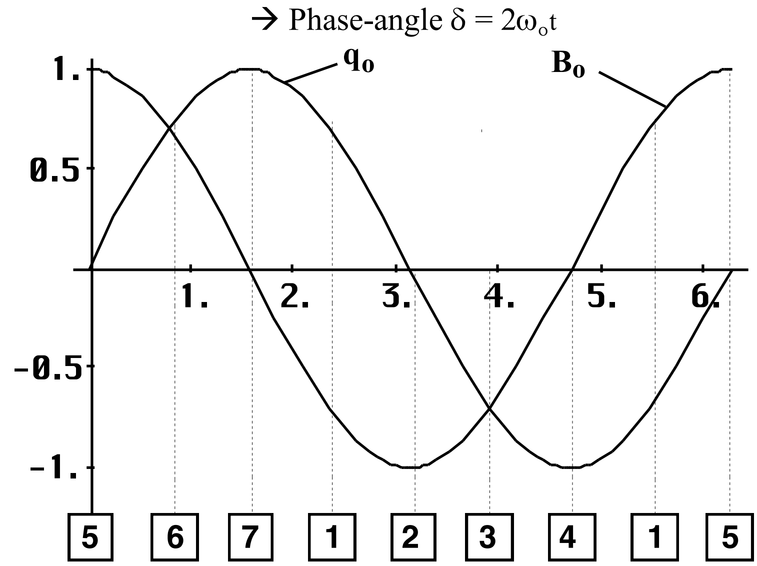


Figure 7
Courses of charge and induction
with labeling of the track-points

We already have specified the equation for the resonance-frequency in (30). If L_0 and C_0 behave like a parallel-oscillatory circuit however, even all values like q_0, φ_0, H_0, etc. have to change time wise according to harmonic functions. The same even is valid for the distance r_0. The temporal course of q_0 and B_0 (H_0) in detail of the marked track-points is figured in figure 7. The exact track-function arises from (33), (35) and (37) using the following formulation:

$$W_0 = \hbar\omega_0 = \frac{q_0^2}{\varepsilon_0 r_0} \sin^2 2\omega_0 t \qquad (38)$$

Rearranged to r_0 by neglecting the fixe phase-angle $\pi/2$ with $\delta = 2\omega_0 t$:

$$r(\omega_0 t) = \frac{q_0}{2\,\varepsilon_0\varphi_0\omega_0}\left(1+\cos\left(\frac{\pi}{2}+4\omega_0 t\right)\right) \Rightarrow \frac{c}{2\omega_0}\left(1+\cos 4\omega_0 t\right) \qquad (39)$$

$$r(\delta) = \frac{r_0}{2}\left(1+\cos 2\delta\right) \qquad \text{or in x and y to} \qquad (40)$$

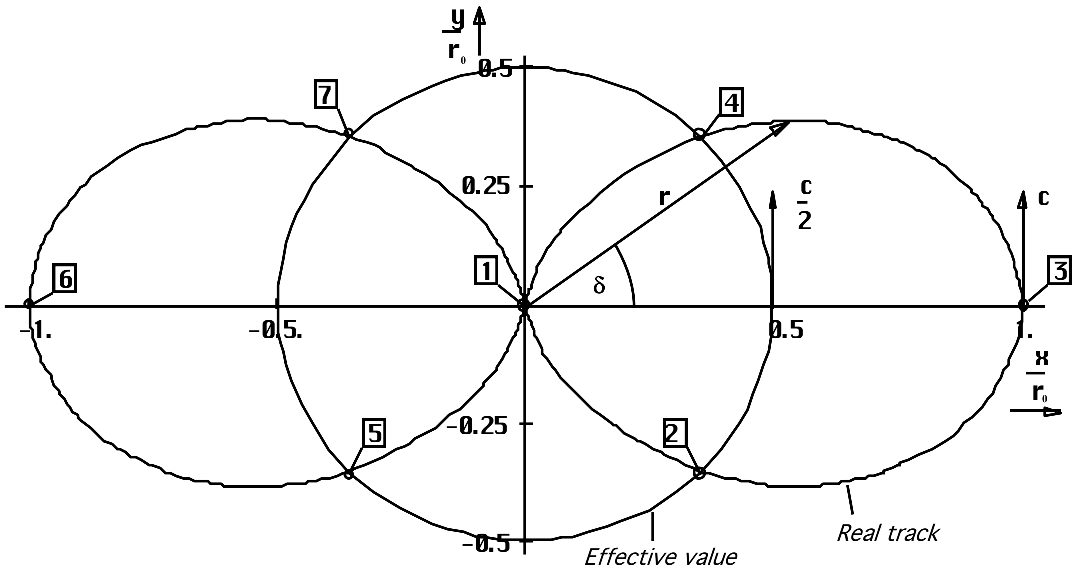


Figure 8
Real track-course in the xy-plane

$$x(\delta) = \frac{r_0}{2}\left(1+\cos 2\delta\right)\cos\delta \qquad (41)$$

$$y(\delta) = \frac{r_0}{2}(1 + \cos 2\delta)\sin\delta \tag{42}$$

The exact course is figured in figure 8. In the xy-plane it corresponds exactly to the course of the envelope of the POINTING-vector **S** (like r) of a HERTZian dipole [24].

For most further examinations, it suffices to go out from an orbit simplifying by consideration of effective-values only.

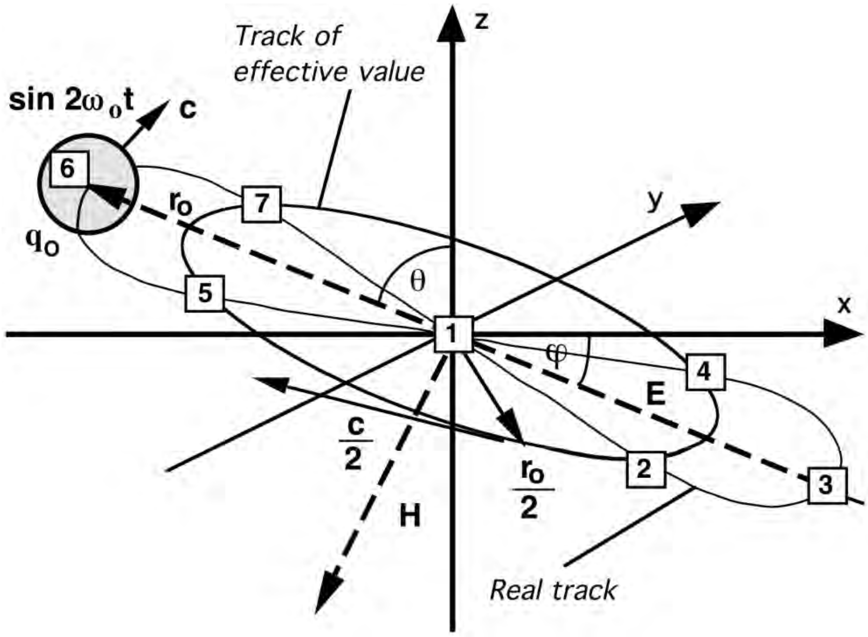


Figure 9
Idealized and real track of
the MLE in three-dimensional presentation

Significant is the shape of a dipole (vector $\mathbf{E_0}$) by the true track-course (figure 8 and 9), since the charge q_0 is equally large at the respective bend points of the track however affected with opposite sign. This dipole can be oriented in all three directions at will.

An eventual expansion of this of model is achieved by the temporal increase of r_0. The model however is only valid, if the expansion-velocity of r_0 is smaller than c/2. If it is larger, so there is no more rotation anyway. The motion proceeds rectilinear as well as curvilinear then. It has no more exact track-function declared. That would be also rather pointless, as we will still see later.

3.5. Disadvantages of the static model

With the described static model, we have realized case (0.13) and »the direction of the main-axes remains uncertain. The smallest interference here can have the consequence of an at will strong rotation of the main-axes.« The cause is following: With L_0 and C_0, it is a matter of ideal components. That means, the Q-factor Q_0 of such an oscillatory circuit would be infinite with it, the bandwidth zero. The resonance-super-elevation is also infinitely with an infinite Q-factor however (voltage u_0 and current i_0). Therefore it has no exact phase and amplitude declared. This is just identical to the uncertainty of the main-axe's position however.

Another disadvantage is that the model doesn't change time wise. That means, all median values including r_0 remain constant forever. Now it is a known fact however, that the cosmos is expanding and the same should happen with the metrics too. Maybe, this is even the cause of expansion? We use this supposition as base and formulate our second hypothesis with it.

> *II. The expansion of the cosmos is evoked by the expansion of the metric lattice/ radiation-field.*

Furthermore, the question of origin and isotropy of the cosmic background radiation remains unanswered. In order to avoid these disadvantages, we want to make dynamic the model.

4. Dynamic model

4.1. Further contemplations

If we want to achieve an expansion of the metrics, so we must see to take away energy from the MLE. Now one assumes yet the vacuum as loss-free, since the propagation-velocity of electromagnetic radiation is independent from the frequency. Let's introduce the conductivity $\kappa_0=1/\rho_0$, so for the complex wave-propagation-impedance (j is the imaginary unit, as used in the electrotechnics) applies

$$\underline{Z} = \sqrt{\frac{j\omega\mu_0}{\kappa_0 + j\omega\varepsilon_0}} \tag{43}$$

and on reason of (30) for $\underline{c}$

$$\underline{c} = \sqrt{\frac{j\omega}{\mu_0(\kappa_0 + j\omega\varepsilon_0)}} \tag{44}$$

Two extreme-cases result from it. While (44) passes into equation (31) for a non-conductor, we get for an ideal conductor

$$\underline{c} = \sqrt{\frac{j\omega}{\mu_0\kappa_0}} \tag{45}$$

Therefore generally applies: in a loss-affected medium, the wave-propagation-impedance becomes complex and with it $\underline{c}$ too. Since $\underline{c}$ determines the propagation rate $\underline{\gamma} = \alpha + j\beta = j\omega/\underline{c}$, the attenuation rate α would become unequal to zero and even moreover frequency-dependent with the appearance of an imaginary part of $\underline{c}$. It applies

$$\alpha = \frac{\omega}{c}\sqrt{\frac{1}{2}\left(\sqrt{1+\left(\frac{\kappa_0}{\omega\varepsilon_0}\right)^2}-1\right)} = \frac{\omega}{c}\sinh\left(\frac{1}{2}\operatorname{ar\,sinh}\frac{\kappa_0}{\omega\varepsilon_0}\right) \tag{46}$$

That means, additionally to the geometrically caused damping an additional damping $e^{-\alpha x}$ would appear and one could define a lower cut-off frequency for the space (–3dB/λ). Only if the conductivity is zero, that wouldn't be the situation. All this does neither has been observed in the vacuum and the wave-propagation occurs with light speed for all frequencies. The vacuum just acts like an ideal non-conductor [20].

Nevertheless, we want to try to find a solution, taking all these facts into account. At first we extend our equivalent circuit by the loss-resistor RoR (figure 10), index R stands here for a series connection of circuits, as well as by the shunt-resistor R_0.

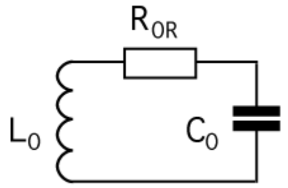


Figure 10
Equivalent circuit with
series-resistor

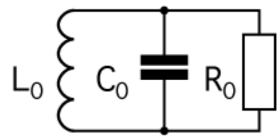


Figure 11
Equivalent circuit with
shunt-resistor

With our further contemplations, now we have to decide in favor of one of both equivalent circuits. For the conversion of both impedances applies

$$R_0 = \frac{Z_0^2}{R_{0R}} \tag{47}$$

We decide in favor of the second model, since a very large loss-impedance is the best approach to a non-conductor. Starting with figure 10 we first define the loss-impedance R_{0R} which must be obviously very small in this case, in reference to a cube with the edge length r_0 to

$$R_{0R} = \frac{1}{\kappa_0}\frac{r}{A} \qquad A = r^2 \qquad R_{0R} = \frac{1}{\kappa_0 r} \tag{48}$$

From it we obtain for R_0

$$R_0 = \kappa_0 r_0 Z_0^2 \tag{49}$$

Evidently, our MLE is a system of second order. By introduction of R_0, we can now define even two time constants, namely

$$\tau_0 = \sqrt{L_0 C_0} \qquad \text{and} \qquad \tau_1 = R_0 C_0 \tag{50}$$

With τ_0, a time-constant of second order, it is with largest probability a matter of the reciprocal of the angular frequency of our MLE. Which value in the nature then now that τ_1 can be assigned to? An additional temporal damping of electromagnetic waves doesn't appear as you know. Since R_0 has to be very large, then the same is applied to τ_1. We now assume that τ_1 can be identified with the reciprocal of the HUBBLE-parameter H. This hypothesis is substantiated by the fact that H is a time-constant of first order, whatever is valid for τ_1 too. We can write then

$$H = \frac{\dot{r}_0}{r_0} = \frac{1}{R_0 C_0} = \frac{1}{\kappa_0 \mu_0 r_0^2} = \frac{\varepsilon_0}{\kappa_0}\frac{1}{L_0 C_0} = \frac{\varepsilon_0 \omega_0^2}{\kappa_0}. \tag{51}$$

Furthermore generally applies $H = n/t$; n is a constant factor which depends on the used model (radiation-/dust-cosmos), t is the time and equates with the age here. Next we want to define the Q-factor of the oscillatory circuit according to [5]

$$Q_0 = \frac{W_0 \omega_0}{P_0} = \frac{\hbar \omega_0^2 R_0}{u_0^2} \tag{52}$$

and because of $u_0 = -\omega_0 \varphi_0$ as well as (36)

$$Q_0 = \frac{\hbar R_0}{\varphi_0^2} = \kappa_0 r_0 Z_0 = \frac{R_0}{Z_0} = \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{53}$$

The numerical value is about $1.041\cdot 10^{61}$. If we go out from the last expression of (51), we can even write for H

$$H = \frac{\varepsilon_0\omega_0^2}{\kappa_0} = \frac{\varepsilon_0 c\omega_0}{\kappa_0 r_0} = \frac{\omega_0}{\kappa_0 r_0 Z_0} = \frac{\omega_0}{Q_0} \tag{54}$$

Now we could think, up to the determination of H it is far no more. Unfortunately, the value of κ_0 is unknown however. But it can be received from the astronomically determined value of H approximatively

$$\kappa_0 = \frac{c^3}{\mu_0 G\hbar H} \tag{55}$$

with $1.710\cdot 10^{93}$ $AV^{-1}m^{-1}$. In this connection a value of 55 $kms^{-1}Mpc^{-1}$, has been set up for H, that is $1.7824\cdot 10^{-18}s^{-1}$. Possibly, this value is rather not up-to-date anymore. One recognizes the magnitude of κ_0 however. Furthermore applies $G\hbar H$ = const.

Now that further on our model. Using the relationship H = n/t and the third expression of (51) we are already able to determine the time-function of r_0

$$r_0 = \sqrt{\frac{t}{n\kappa_0\mu_0}} \quad \text{and} \tag{56}$$

$$\dot{r}_0 = \frac{1}{2}\sqrt{\frac{1}{n\kappa_0\mu_0 t}} \tag{57}$$

with it we get for the HUBBLE-parameter H

$$H = \frac{\dot{r}_0}{r_0} = \frac{1}{2t} \quad \text{and} \quad q = -\frac{r_0\ddot{r}_0}{\dot{r}_0^2} = 1 \tag{58}$$

just the relationship for a radiation-cosmos. This is nor further remarkable, since we have assumed the MAXWELL equations however. q is the dilatory-parameter (do not mix-up with the charge). It follows n=1/2 and we can write

$$r_0 = \sqrt{\frac{2t}{\kappa_0\mu_0}} \quad \text{und} \quad \dot{r}_0 = \frac{1}{\sqrt{2\kappa_0\mu_0 t}} \tag{59}$$

$$t = \frac{R_0 C_0}{2} = \frac{\kappa_0\mu_0 r_0^2}{2} \tag{60}$$

With these relationships, we can now set about to put a differential equation for our oscillatory circuit. Let's look at it figure 12 for that purpose.

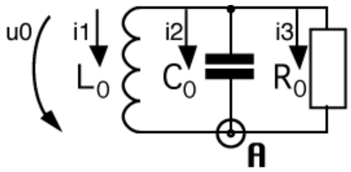


Figure 12
Voltages and currents
in the oscillatory circuit

4.2. Differential equation and solutions

4.2.1. Specification of the differential equation

We have a parallel-oscillatory circuit with the inductivity L_0, the capacity C_0 and the loss-resistor R_0 on hand. Furthermore, the voltage u_0 is connected to all components simultaneously. In the node **A** the three currents i_1, i_2 and i_3 unify. The KIRCHHOFF's first law applies:

$$i_1 + i_2 + i_3 = 0 \tag{61}$$

Furthermore applies because of $u_0 = d\varphi_0/dt$ and $\varphi_0 = i_1 L_0$

$$u_0 = \frac{d(i_1 L_0)}{dt} \qquad \text{(I)}$$

$$u_0 = \frac{1}{C_0}\int i_2 dt \qquad \text{(II)}$$

$$u_0 = i_3 R_0 \qquad \text{(III)}$$

Now equation (I) can be resolved as follows

$$u_0 = \frac{d(i_1 L_0)}{dt} = L_0 \frac{di_1}{dt} + i_1 \frac{dL_0}{dt} \tag{62}$$

and we get the following differential equation

$$\dot{i}_1 + \frac{\dot{L}_0}{L_0} i_1 = \frac{u_0}{L_0} \quad \text{oder} \tag{63}$$

$$y' + f(t)y = g(t) \tag{64}$$

$$M(t) = e^{\int f(t)dt} = e^{\int \frac{dL_0}{L_0 dt} dt} = e^{\int \frac{dL_0}{L_0}} = L_0 . \tag{65}$$

Now, we are able to resolve for i_1 [21]

$$i_1 = \frac{1}{M(t)}\left[\int g(t) M(t)\, dt + C\right] \tag{66}$$

With C=0 we get then

$$i_1 \quad = \quad \frac{1}{L_0}\int \frac{u_0}{L_0} L_0 dt \quad = \quad \frac{1}{L_0} \int u_0 dt \quad . \tag{67}$$

Now, we rearrange equ. (II) for i_2:

$$i_2 \quad = \quad \frac{d(u_0 C_0)}{dt} \quad = \quad C_0 \frac{du_0}{dt} + u_0 \frac{dC_0}{dt} \tag{68}$$

We receive the value of i_3 directly by rearrangement of (III) so that we can write

$$i_1 = \frac{1}{L_0} \int u_0 dt \tag{I}$$

$$i_2 = C_0 \frac{du_0}{dt} + u_0 \frac{dC_0}{dt} \tag{II}$$

$$i_3 = \frac{u_0}{R_0} \tag{III}$$

Put into (61) we obtain

$$\frac{1}{L_0} \int u_0 dt + C_0 \frac{du_0}{dt} + u_0 \left(\frac{dC_0}{dt} + \frac{1}{R_0} \right) = 0 \quad . \tag{69}$$

Since $u_0 = \dot{\varphi}_0$ equ. (69) changes into

$$C_0 \ddot{\varphi}_0 + \left(\dot{C}_0 + \frac{1}{R_0} \right) \dot{\varphi}_0 + \frac{1}{L_0} \varphi_0 = 0 \tag{70}$$

and after division by C_0

$$\ddot{\varphi}_0 + \left(\frac{\dot{C}_0}{C_0} + \frac{1}{R_0 C_0} \right) \dot{\varphi}_0 + \frac{1}{L_0 C_0} \varphi_0 = 0 \quad . \tag{71}$$

This is the differential equation of a parametric amplifier. But on reason of the definition of $C_0 = \varepsilon_0 r_0$ we also can write

$$\ddot{\varphi}_0 + \left(\frac{\dot{r}_0}{r_0} + \frac{1}{R_0 C_0} \right) \dot{\varphi}_0 + \frac{1}{L_0 C_0} \varphi_0 = 0 \quad . \tag{72}$$

Of course it is somewhat difficult to imagine, that the capacitor quasi shall grow with the metrics. But considering C_0 as a basic quality of space, whereat its size depend on the dimensions of the MLE, it should be somewhat less difficult however. If we now assume, that no expansion would take place anyway, equ. (72) would change into the normal differential equation for a loss-affected oscillatory circuit with shunt-resistor with the well known solution:

$$\omega_0 = \sqrt{\frac{1}{L_0C_0} - \left(\frac{1}{2R_0C_0}\right)^2} \quad . \tag{73}$$

Then however, we would get for the speed of light:

$$c = \sqrt{\frac{1}{\mu_0\varepsilon_0} - \left(\frac{1}{2\mu_0\kappa_0 r_0^2}\right)^2} \quad , \tag{74}$$

That would even mean that the (maximum-)speed of light is not constant. The constancy of the light speed however is a basic statement, that we may not negate. To the luck our metrics is expanding and the first partial factor of φ_0 in equation (72), namely H is $\neq 0$. According to (51) furthermore both augmenters are identically and we can write

$$\ddot{\varphi}_0 + \frac{2}{R_0C_0}\dot{\varphi}_0 + \frac{1}{L_0C_0}\varphi_0 = 0 \qquad \text{or} \tag{75}$$

$$\ddot{\varphi}_0 + 2H_0\dot{\varphi}_0 + \omega_0^2\varphi_0 = 0 \quad . \tag{76}$$

Equation (76) is very interesting. If we want to determine the time-function of φ_0 however, we now have to insert (53, 54):

$$\ddot{\varphi} + \frac{1}{t}\dot{\varphi}_0 + \frac{\kappa_0}{2\varepsilon_0 t}\varphi_0 = 0 \qquad \text{or} \tag{77}$$

$$\ddot{\varphi}_0 t + \dot{\varphi}_0 + \frac{1}{2}\frac{\kappa_0}{\varepsilon_0}\varphi_0 = 0 \quad . \tag{78}$$

With it we have laid down the differential equation for our model. It deals with a very rare hyper-geometrical differential equation, that we want to solve in the next section.

4.2.2. Universal solution of the differential equation

During literature-study, this type of differential equation has not been found and the POOLE's equation [17] did not succeed anyway. To solve the equation therefore only comes into question the integration of power series approach [21]. We look at the following equation for that purpose:

$$y''x + Ay' + By = 0 \tag{79}$$

We first rearrange this equation to y

$$y = -\frac{1}{B}\left(y''x + Ay'\right) \tag{80}$$

Then we expand y into a power series

$$y = a_0x^0 + a_1x^1 + a_2x^2 + a_3x^3 + a_4x^4 + \ldots + a_nx^n \tag{81}$$

$$y' = 0a_0x^{-1} + 1a_1x^0 + 2a_2x^1 + 3a_3x^2 + 4a_4x^3 + \ldots + na_nx^{n-1} \tag{82}$$

$$y'' = 0(-1)a_0x^{-2} + 1(0)a_1x^{-1} + 2\cdot 1a_2x^0 + 3\cdot 2a_3x^1 + 4\cdot 3a_4x^2 + \ldots + n(n-1)a_nx^{n-2} \tag{83}$$

In cumulative notation:

$$y = \sum_{n=0}^{\infty} a_n x^n \tag{84}$$

$$Ay' = \sum_{n=1}^{\infty} Ana_n x^{n-1} = \sum_{n=1}^{\infty} Ana_n x^{n-1} = \sum_{n=0}^{\infty} A(n+1)a_{n+1}x^n \tag{85}$$

$$y''x = \sum_{n=0}^{\infty} n(n-1)a_n x^{n-1} = \sum_{n=1}^{\infty} n(n-1)a_n x^{n-1} = \sum_{n=0}^{\infty} n(n+1)a_{n+1}x^n \tag{86}$$

Now, inserting the last column's expressions into (80) we get:

$$\sum_{n=0}^{\infty} a_n x^n = -\frac{1}{B}\sum_{n=0}^{\infty}(A+n)(1+n)a_{n+1}x^n \tag{87}$$

With it we can already specify the recurrence formula for the discrete coefficients of y:

$$\boxed{a_{n+1} = -\frac{B}{(A+n)(1+n)}a_n} \tag{88}$$

It results in the following coefficients then:

$$a_1 = -\frac{B}{(A+0)(1+0)}a_0 = -\frac{B^1}{(A+0)(1+0)}a_0 \tag{89}$$

$$a_2 = -\frac{B}{(A+1)(1+1)}a_1 = \frac{B^2}{(A+0)(A+1)(1+0)(1+1)}a_0 \tag{90}$$

$$a_3 = -\frac{B}{(A+2)(1+2)}a_2 = -\frac{B^3}{(A+0)(A+1)(A+2)(1+0)(1+1)(1+2)}a_0 \tag{91}$$

$$\ldots \qquad \ldots$$

$$a_n = -\frac{B}{(A+n-1)(1+n-1)}a_{n-1} \tag{92}$$

$$a_n = (-1)^n \frac{B^n}{(A+0)(A+1)(A+2)\ldots(A+n-1)(1+0)(1+1)(1+2)\ldots(1+n-1)}a_0 \tag{93}$$

Another notation would be

$$a_n = a_o(-1)^n B^n \prod_{k=0}^{\infty}\frac{1}{(1+k)(A+k)} \tag{94}$$

and with $(z)_n = (z+0)(z+1)\ldots(z+n-1)$

$$a_n = a_o(-1)^n B^n \frac{1}{(1)_n(A)_n} = a_o(-1)^n B^n \frac{1}{n!(A)_n} \tag{95}$$

$$y = a_0 \sum_{n=0}^{\infty}\frac{1}{n!(A)_n}(-Bx)^n \tag{96}$$

This is the general hypergeometric function ${}_0F_1(;A;-Bx)$ however.

$$y = a_0\, {}_0F_1(;A;-Bx) \tag{97}$$

Herewith we have found a special solution of our differential equation. Now we must see just, if we can express the result by a more simple analytic function. Whether it's possible or not, depends on the parameter A however. Before we return to our model then, we still want to examine the behavior of the universal solution (91). We look at two special cases thereto.

4.2.3. Specific solutions

4.2.3.1. The harmonic solution (A=1/2)

We start with equ. (97) inserting the value 1/2 for A:

$$y = a_0\, {}_0F_1\left(;\frac{1}{2};-Bx\right) \tag{98}$$

This yields by setting the expansion-part $\dot{r}_0/r_0$ in (72) to zero as a solution of the differential equation $\ddot{\varphi}_0 t + 1/2 \cdot \dot{\varphi}_0 + \kappa_0/2\varepsilon_0 \cdot \varphi_0 = 0$ (model without expansion). According to [12] applies:

$${}_0F_1\left(;\frac{1}{2};-\frac{1}{4}z^2\right) = \cos z \qquad \text{also} \tag{99}$$

$$-\frac{1}{4}z^2 = -\,Bx \qquad \text{or} \tag{100}$$

$$z = \sqrt{4Bx} \tag{101}$$

$$y = a_0 \cos\sqrt{4Bx} \qquad \text{with} \quad a_0 = \hat{\varphi}_0 \quad B = \frac{1}{2}\frac{\kappa_0}{\varepsilon_0} \quad x = t \tag{102}$$

$$\varphi_0 = \hat{\varphi}_0 \cos\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad \varphi_0 = \hat{\varphi}_0 \cos Q_0 \tag{103}$$

$$\varphi_0 = \hat{\varphi}_0 \cos 2\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\; t \tag{104}$$

Considering the root-expression of equ. (104) more exactly, so it would have to correspond to the angular frequency ω_0 and would be time-dependent.

$$\omega_0 = \sqrt{\frac{\kappa_0}{2\varepsilon_0 t}} \qquad \hat{\varphi}_0 = \sqrt{2\hbar Z_0} \tag{105}$$

$$\varphi_0 = \sqrt{2\hbar Z_0}\cos 2\omega_0 t \tag{106}$$

Since it deals with a differential equation of second order, the universal solution had to be then:

$$\varphi_0 = \sqrt{\hbar Z_0}\,(c_1 \cos 2\omega_0 t + c_2 \sin 2\omega_0 t) \tag{107}$$

Since c_2 can be even imaginary or complex, the universal solution also can be understood as the sum of the exponential-functions $e^{j2\omega_0 t}$ und $e^{-j2\omega_0 t}$. These also figure two possible independent solutions. Equation (107) is then:

$$\varphi_0 = \sqrt{\hbar Z_0}\,(e^{j2\omega_0 t} + e^{-j2\omega_0 t}) \tag{108}$$

We would have found a solution with constant amplitude with it. MAXWELL uses this solution as base for the solution of the equations designated to him. The factor 2 should be neglected here once. The solution is not applicable for our model however, since we want to put a model with expansion being A always larger than 1/2 (78).

4.2.3.2. The Bessel solution (A=1)

This solution corresponds to our model.

$$y = a_0\, {}_0F_1(;1\,;-Bx) \tag{109}$$

According to [17] applies

$${}_0F_1(;b;\,x) = \Gamma(b)(jx)^{b-1} J_{b-1}\left(2jx^{\frac{1}{2}}\right) \tag{110}$$

J_n is the Bessel function of n'th order, just

$${}_0F_1(;1;-Bx) = \Gamma(1)(jBx)^0 J_0\left(\sqrt{4Bx}\right) \tag{111}$$

$$y = a_0 J_0\left(\sqrt{4Bx}\right) \quad \text{with} \quad a_0 = \hat{\varphi}_i/2 \quad B = \frac{1}{2}\frac{\kappa_0}{\varepsilon_0} \quad x = t \tag{112}$$

$$\varphi_0 = a_0 J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) = a_0 J_0(Q_0) \tag{113}$$

$$\varphi_0 = a_0 J_0\left(2\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\,t\right) \quad \text{with} \quad \omega_0 = \sqrt{\frac{\kappa_0}{2\varepsilon_0 t}} \tag{114}$$

Since it´s about a differential equation of second order and the degree of the Bessel function is integer, the universal solution is:

$$\varphi_0 = \hat{\varphi}_i(c_1 J_0(2\omega_0 t) + c_2 Y_0(2\omega_0 t)) \tag{115}$$

Even in this case c_1 and c_2 can be imaginary or complex. According to [22] it's often opportune to consider the two functions (Hankel functions)

$$H_0^{(1)}(x) = J_0(x) + j\, Y_0(x) \quad \text{and} \tag{116}$$

$$H_0^{(2)}(x) = J_0(x) - j\, Y_0(x) \tag{117}$$

as linearly independent solutions forming the universal solution

$$y(x) = c_1 H_0^{(1)}(x) + c_2 H_0^{(2)}(x) \tag{118}$$

with it. The universal solution (115) reads then:

$$\varphi_0 = \hat{\varphi}_i\left(H_0^{(1)}(2\omega_0 t) + H_0^{(2)}(2\omega_0 t)\right) \tag{119}$$

An analogy exists between equation (108) and (119). For our further examinations, we set c_1 and c_2 in (119) equal to 1 for the moment. Then we get as specific solution:

$$\varphi_0 = \hat{\varphi}_i J_0(2\omega_0 t) \qquad \varphi_0 = \hat{\varphi}_i J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \tag{120}$$

Even a formulation with the Bessel-Y-function would be possible however. With the exception of an infinite initially-value no more differences arise then. Later, we will make use of the sum of both (Hankel function). With it, the discussion, whether a finite or infinite initially-value is on hand, will have been proven as useless.

4.2.3.3. Behaviour of solutions

Depending on the coefficient A there is the following behaviour of solutions:

$A < 0.5$	ascending amplitude
$A = 0.5$	static amplitude
$A > 0.5$	descending amplitude

4.2.3.4. Consequences for the model

We have got a solution with non constant amplitude (descending). With it the magnetic flux starts with a *finite* value however (gainful). Two problems result from it:

1. *It has no frequency defined in the real sense.*
2. *The amount of the Planck's quantity of action is not constant.*

The first problem is relatively easy to solve by studying the asymptotic behaviour of our function (120). Even from (76) can be concluded on a frequency ω_0, that depends on the age i.e. the HUBBLE-parameter H. The second problem has extensive effects on nearly all physical laws and processes, that should be discussed in the course of this work in detail. Furthermore the gravitational-constant is also a variable quantity, which is being denied today by almost nobody more however.

4.2.4. Asymptotic expansion

On presence of following conditions: $t \gg 0$, $Re(x) \gg 0$, $Re(n) > -1/2$ accordingly to [23] applies:

$$J_n(x) \approx \sqrt{\frac{2}{\pi x}} \cos\left(x - \frac{n\pi}{2} - \frac{\pi}{4}\right) \tag{121}$$

and for J_0 and its derivative, that we require even later, (we use the equality sign from now on):

$$J_0(x) = \sqrt{\frac{2}{\pi x}} \cos\left(x - \frac{\pi}{4}\right) \quad = \quad \frac{1}{\sqrt{\pi x}} (\cos x + \sin x) \tag{122}$$

$$J_1(x) = \sqrt{\frac{2}{\pi x}} \cos\left(x - \frac{3\pi}{4}\right) \quad = -\frac{1}{\sqrt{\pi x}} (\cos x - \sin x) \tag{123}$$

For ω_0 we can write

$$\omega_0 = \sqrt{\frac{\kappa_0}{2\varepsilon_0 t}} \tag{124}$$

For φ_0 applies then (approximation):

$$\varphi_0 = \frac{\hat{\varphi}_i}{\sqrt{2\pi\omega_0 t}} (\cos 2\omega_0 t + \sin 2\omega_0 t) \tag{125}$$

With the exception of one factor and a different phase-angle then we get an expression equal to the harmonic solution (107). As more exact examinations show, equ. (123) fulfills the requests of an approximation function for the area $t > 2\tau_1$ (figure 13) indeed. But a better approximation is given by following equation:

$$\varphi_0 = \frac{\hat{\varphi}_i}{\sqrt{\pi(1 + 2\omega_0 t)}} (\cos 2\omega_0 t + \sin 2\omega_0 t) \tag{126}$$

With the effective value

$$\varphi_{0eff} = \frac{\hat{\varphi}_i}{\sqrt{2\pi(1 + 2\omega_0 t)}} \tag{127}$$

or more exact

$$\varphi_{0eff} = \frac{\hat{\varphi}_i}{\sqrt{2\pi(1 + 2\omega_0 t)}} \left(1 + \frac{1 - \sqrt{2/\pi}}{\sqrt{2\pi(1 + 2\omega_0 t)}}\right) \tag{128}$$

The latter expression is only of theoretical value however, since it stands for the effective value which is only defined across at least one period. Within the first period ($t < 2\tau_1$) and for the calculation of the PLANCK's quantity of action, it would be favourable therefore, to operate with the (multiplied with the factor $1/\sqrt{2}$) exact envelope function (Addition theorem of Bessel functions → Modulus of the Hankel function). It applies precisely to Bessel functions (J and Y) of zeroth order and, with very good approximation, to Bessel functions of any order (real) and of course even to larger values of t:

$$\hat{\varphi}_0 = \hat{\varphi}_i \sqrt{J_0^2(2\omega_0 t) + Y_0^2(2\omega_0 t)} \qquad \text{Envelope curve} \qquad (129a)$$

which starts in the infinite however. The value $\hat{\varphi}_i$ then is defined at the point of time, in which the envelope takes on the value of 1. The exact course of φ_0 as well as the approximation function (127) for the envelope is shown in figure 13.

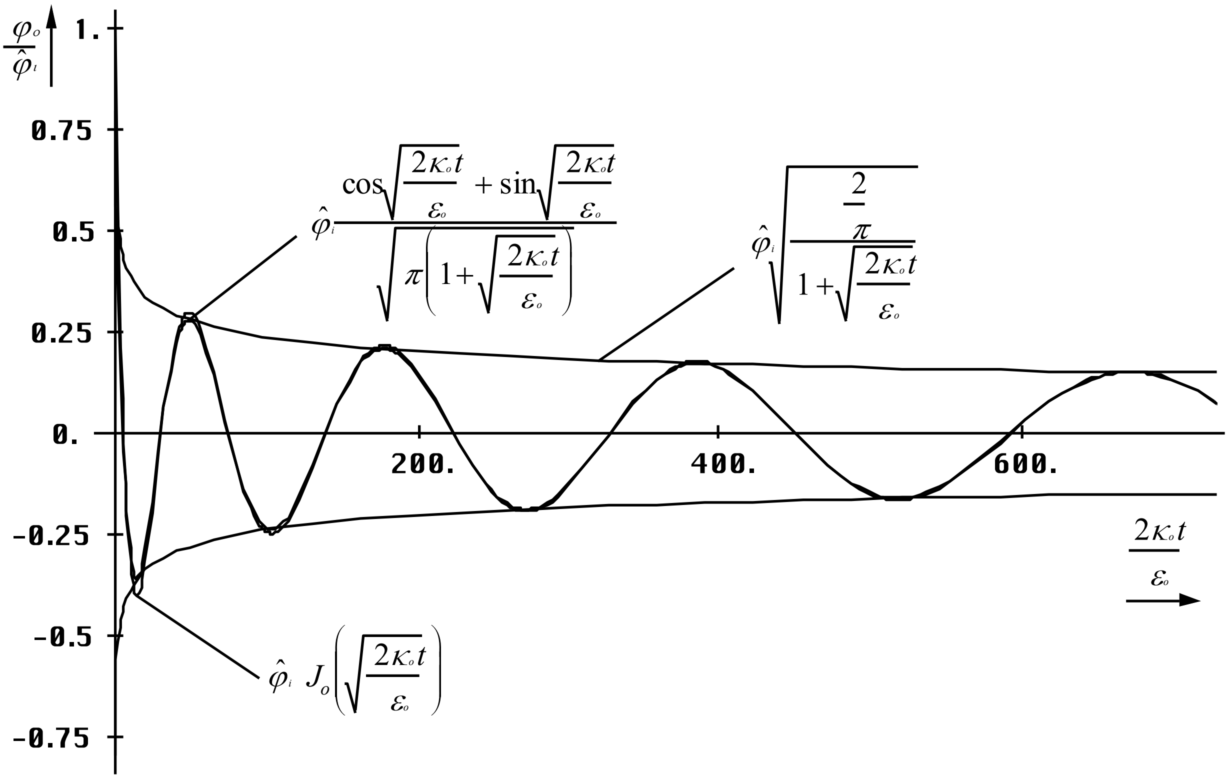


Figure 13
Course of magnetic flux as well as of approximation- and envelope-function (127) during a longer time period

The exact course of φ_0 during the first period as well as the course of the exact envelope-function and of the first and second approximation shows figure 14. Even the course of q_0 is figured (1st derivative). The envelope-functions are applied equally to φ_0 and q_0 and are been important for the determination of effective-values.

Contrary to the ordinary Bessel function, which starts similarly like a cosine-function, the time-function of the magnetic flux rather has a course like an RC-gate within the first part of first period (1st order). With ascending Q-factor $Q_0=2\omega_0 t$ the function passes into an approximately harmonic function. The envelope-function of the charge of q_0 doesn't fit right quite precisely the real function during the first period (1st derivative). The reason is the square root inside the argument of the Bessel functions. In case of hardship, one should make use of the root of the sum of squares of the Bessel function of 1st order (129).

A much better and even easier function for the envelope curve I found later on (not presented), which additionally avoids the ugly „hump“ in the negative domain of the first period in figure 13. It's given by the function:

$$\hat{\varphi}_0 = \sqrt{\frac{2}{\pi}} \frac{\hat{\varphi}_i}{\sqrt{2\omega_0 t}} \qquad \text{Envelope curve} \qquad (129b)$$

$$\varphi_0 = \frac{\varphi_1}{\sqrt{2\omega_0 t}} \qquad \varphi_0 \sim q_0 \sim Q_0^{-\frac{1}{2}} \qquad \text{Effective value} \qquad (129c)$$

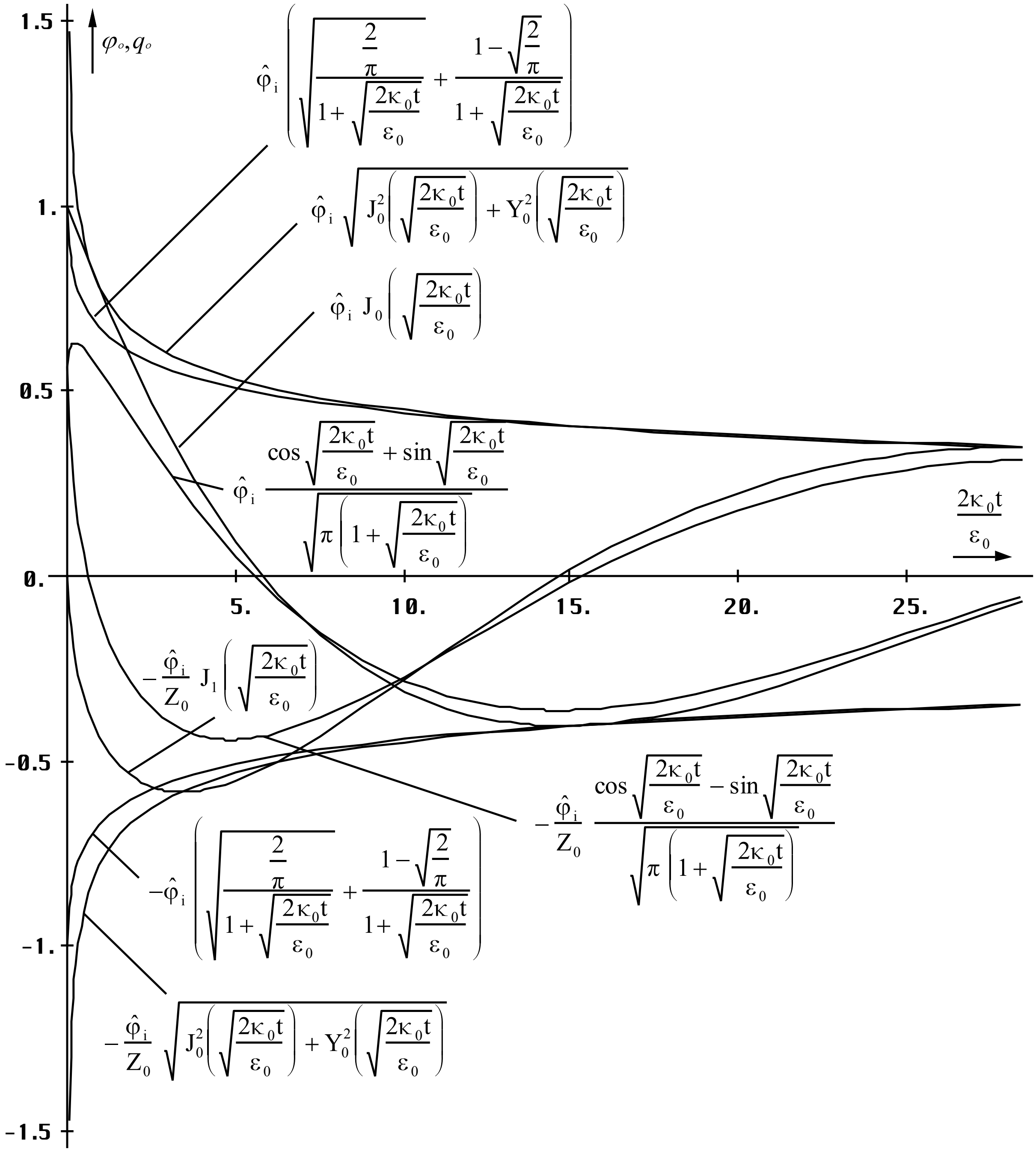


Figure 14
Course of flux and charge as well as of the approximation- and envelope-function (129) near the singularity

4.3. Laplace-transform

4.3.1. Time domain

How does the solution-behavior of equ. (115) actually look like? $J_0(\sqrt{x})$ is defined for real arguments $-\infty<x<\infty$. For positive x arises the course already figured many times. The ambiguity of the root doesn't have any effect. To the negative region, a real solution submits in form of the modified Bessel function $I_0(\sqrt{x})$. This one manifests a course similar to cosh going towards infinite. In contrast, $J_1(\sqrt{-x})$ and the charge $q_0 = -j\, I_1(\sqrt{x})$ becomes imaginary and shows a course like j $\sinh(\sqrt{x})$.

For t<0 don't arise any physically meaningful solutions therefore. A charge is not defined. The point of time t=0 is just the beginning of the expansion of the universe. What was before, cannot be said, probably »NOTHING«. In such a case, the application of the LAPLACE-transformation offers itself in order to get more information.

4.3.2. Figure function

LAPLACE-transformation: This is suitable even to the solution of differential equation (78), provided, the re-transformation is possible. We just go out from (78):

$$\ddot{\varphi}_0 t + \dot{\varphi}_0 + \frac{1}{2}\frac{\kappa_0}{\varepsilon_0}\varphi_0 = 0 \qquad \text{or} \qquad (130)$$

$$y''x \;+\; y' \;+\; a\,y \;=\; 0 \qquad (131)$$

According to the differentiation-rule [22] applies:

$$\mathscr{L}\{y'\} = p\,y(p) - f_0^{(0)} \qquad \text{with} \quad f_0^{(\nu)} = \lim_{t\to+0}\frac{d^\nu f(t)}{dt^\nu} \qquad (132)$$

Fortunately we have already solved the differential equation and know the initial values for t=0. It applies therefore:

$$\mathscr{L}\{y'\} = p\,y(p) - 1 \qquad . \qquad (133)$$

We get for the second derivative:

$$\mathscr{L}\{y''\} = p^2 y(p) - p\,f_0^{(0)} - f_0^{(1)} \qquad \text{with the initial values 1 and 0} \qquad (134)$$

$$\mathscr{L}\{y''\} = p^2 y(p) - p \qquad (135)$$

We require the LAPLACE transform for the product of y″ and T however. According to the multiplication-rule and (133) applies:

$$\mathscr{L}\{t^n f(t)\} = (-1)^n F^{(n)}(p) \qquad (136)$$

$$\frac{dy''(p)}{dp} = 2p\,y(p) + p^2 y'(p) - 2p\,y(p) \qquad (137)$$

$$\mathscr{L}\{y''t\} = 1 - p^2 y' \quad (p) - 2p\,y(p) \qquad (138)$$

Substitution in (131) results in:

$$y'(p) + \frac{a-p}{p^2}\,y(p) = 0 \qquad \text{with the solution} \qquad (139)$$

$$y(p) = e^{-\int\frac{a-p}{p^2}dp} = C_1\,p\,e^{\frac{a}{p}} = \frac{C}{a}\,p\,e^{\frac{a}{p}} \qquad (140)$$

C_1 is in the form of a time-constant. The source-function is a differential equation of second order with a time-constant: $\tau_1 = 1/a = 2\varepsilon_0/\kappa_0$. This appears twice with it and we does not come into the embarrassment to examine which time-constant to be substitute at which position. The value arising from H (astronomically) has a magnitude of $1.035 \cdot 10^{-102}$ s. In the figure domain applies for the magnetic flux then:

$$\varphi_o(p) = \hat{\varphi}_i p\tau_1 \, e^{\frac{1}{p\tau_1}+C} \qquad (141)$$

For signals with a duration of $t \gg \tau_1$ it's about an ideal D-gate (differentiating circuit). Unfortunately this something out of common use figure-function cannot be found in any reference work making a retransformation into the time domain nearly impossible. So far, I did not have succeeded in finding a solution for the integral of retransformation. Since we already know the solution however this is not quite so bad. It would be interesting in that sense however, as the type of function, which the model was activated with at the point of time $t = 0$, could be found out on this way. Comparative contemplations lead to the conclusion that it could have been a DIRAC-impulse $\sigma(t)$ with the LAPLACE transform $\mathscr{L}\{\sigma(t)\} = 1$ which even agrees with the model of big bang in the best manner. To the multiplication in the figure domain, the convolution corresponds in the time domain:

$$\varphi_o = \hat{\varphi}_i \cdot \sigma(t) * J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \qquad (142)$$

At the beginning, there was the »NOTHING« with the physical qualities μ_0, ε_0 and κ_0. Then, something was there suddenly (magnetic DIRAC-impulse). The DIRAC-impulse is an impulse with infinite amplitude and a duration of $t \to 0$. The integral below this impulse is equal to 1. This would speak in behalf of a finite initial value (Bessel-J). The response of the model (overswinging with a median value of 0) can also be observed on electronic systems of second order using a DIRAC-like agitation (needle-impulse) but not using a jump- or ramp-function. The DIRAC-impulse is already known for a long time. Using technical methods however it won't be to realize whether at present nor in future. So far, there were even no parallels in the nature, only in form of an approximation as needle-impulse. This way, another mathematical function would have found its exact correspondence in the nature. In any case, it's about a forced process.

On the assumption, that it was actually a DIRAC-impulse, we get promptly for the transfer-function G(p):

$$G(p) = p\,\tau_1 \, e^{\frac{1}{p\tau_1}+C} \qquad (143)$$

The course of transfer-functions for the magnetic flux and of the charge q_0 (first derivative) is depicted in figure 15 by setting $C=0$ at first, since it has only an influence on the scale of the y-axis. Both functions point out a polus at the position $p=+0$, a null with $p=-0$ and a minimum at the point of time τ_1 respectively $\tau_1/2$. For longer impulses, the function changes into the one of an ideal D-gate (high pass $\to$ contradiction?).

The PN-diagram doesn't need to be figured separately (polus at $p=+0$, null at $p=-0$). The number of polus is equal to the number of the nulls (realizability-condition). There are no polus in the left half-plane (stability-condition). Since the polus is located in the point of 0, the system is loss-free anyway but still a „passive component“ however. With polus in the left half-plane, the system could come into an oscillation by itself. With polus in the right half-plane at $p>0$, losses appear, so that the oscillation grinds to a halt after a certain time — contrary to reality, where the oscillation whether hasn't yet faded away even today nor probably in the future. The null in the origin (-0) points on a blocking of lower frequencies.

It is seen about a high pass physically. Since the null is in the left half-plane, it's still about a minimum-phase-system. Systems of this category have, according to [26], the quality of attenuation and phase being associated by the HILBERT-transformation.

Since there are no conjugate complex polus available, even no resonance-effects appear. The minimum at τ_1 points out a phase-transition.

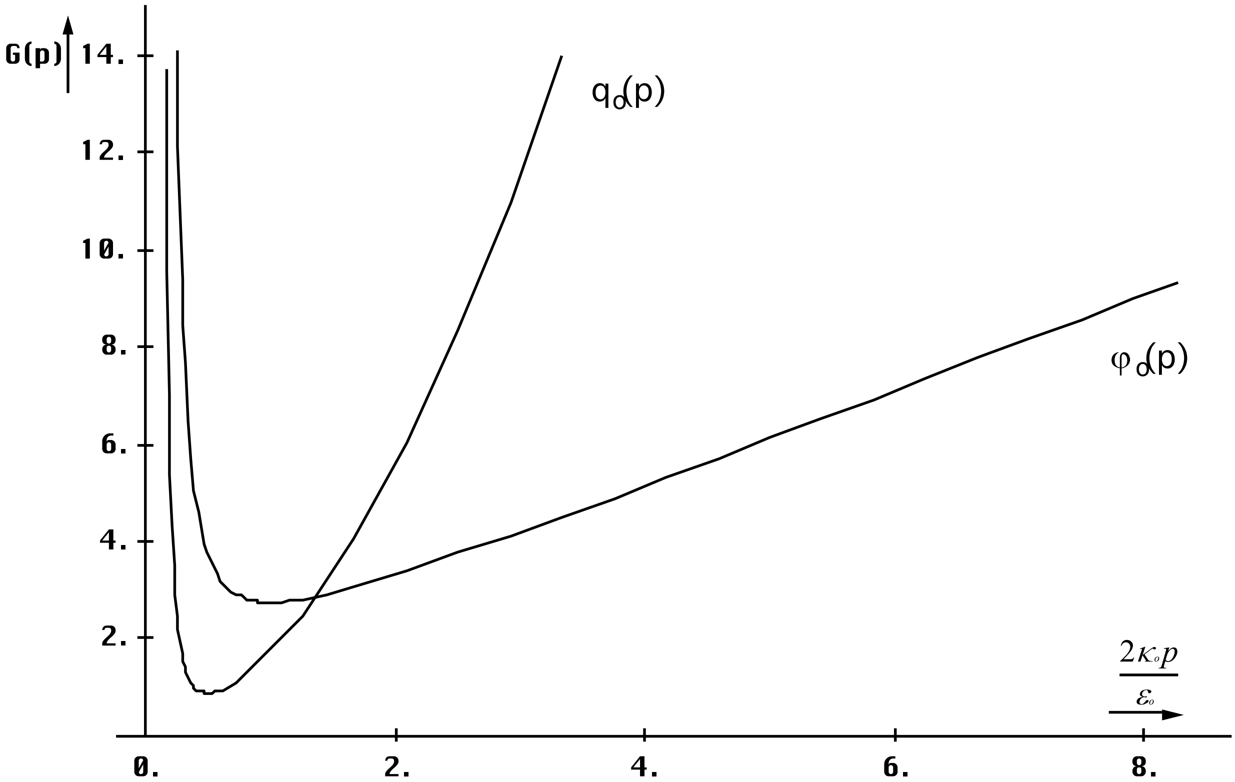


Figure 15
Transfer-functions (figure domain)
for magnetic flux and charge (C=0)

From the figure-function we have read that it deals with a high pass of 2nd order. In general, such a system has a frequency-dependent attenuation. This stands in contradiction to the observations however, resulting in a constant frequency response across all (technically observable) frequencies. To the calculation of the complex frequency response of our model we goes out from equation (143), in that we replace: $p=\sigma+j\omega$. A substitution $p=j\omega$ doesn't emerge any useful result, since the system still is oscillating and, with it, the associated Fourier integral never converge. The convergence is forced with the term of σ. The frequency response of the magnetic flux gives also information about wave-propagation in the vacuum, since the discrete dipoles (MLE) are interconnected across the magnetic field (resonance-coupling). We obtain the value of σ from the halve of the inverse of right factor of (77).

$$G(\sigma+j\omega) = (\sigma+j\omega)\,\tau_1\, e^{\frac{1}{(\sigma+j\omega)\tau_1}+C} \qquad (144)$$

With $\sigma=1/(2\tau_1)=\omega_1=1/(2t_1)=\frac{\kappa_0}{\varepsilon_0}$ and $\omega=0$ ($G(j\omega)=1$) we get for $C=-1$. Then applies:

$$G(j\omega) = \frac{\omega_1+j\omega}{\omega_1}\, e^{\frac{-j\omega}{\omega_1+j\omega}} \quad . \qquad (145)$$

With $\Omega=\omega/\omega_1$ the following expression (complex frequency response) turns out:

$$G(j\omega) = \left[\left(\Omega \sin\frac{\Omega}{1+\Omega^2} + \cos\frac{\Omega}{1+\Omega^2}\right) - j\left(\sin\frac{\Omega}{1+\Omega^2} - \Omega\cos\frac{\Omega}{1+\Omega^2}\right)\right] e^{-\frac{\Omega^2}{1+\Omega^2}} \qquad (146)$$

Since the locus curve of frequency response doesn't cut the y-axis, there is no aperiodic borderline case in this system.

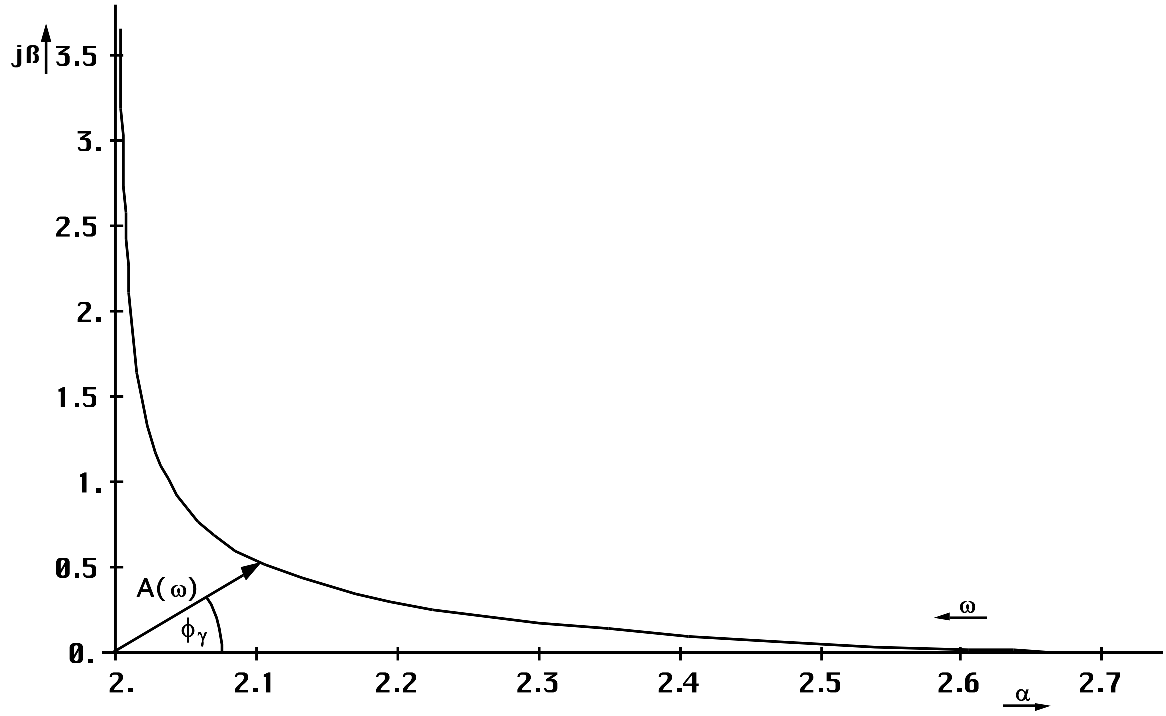


Figure 16
Frequency response locus curve

For frequency and phase response further we get with $\theta = \frac{\Omega}{1+\Omega^2}$

$$A(\omega) = \sqrt{1+\Omega^2}\; e^{-\frac{\Omega^2}{1+\Omega^2}} \qquad (147)$$

$$B(\omega) = \arctan\frac{\Omega\cos\theta - \sin\theta}{\Omega\cos\theta + \sin\theta} = \varphi_\gamma \qquad (148)$$

The expression for the phase response can still be simplified. Both functions (BODE-diagram) are shown in figure 17. The attenuation-course (–6 dB/decade) shows that it's about a system of 2nd order.

Interesting is the cosine of the phase response $\cos B(\omega) = \cos\varphi_\gamma$ as well. This value is used e.g. in the electrotechnics for the calculation of efficiency (power). It figures the measure of a coupling-factor of the discrete MLE's mutually. The calculation of this value by substitution of $\cos(\arctan x) = (1+x^2)^{-1/2}$ even leads to a simplified expression for (148):

$$\cos\varphi_\gamma = \cos\left(\arctan\Omega - \frac{\Omega}{1+\Omega^2}\right) \qquad \text{und} \qquad \varphi_\gamma = \arctan\Omega - \frac{\Omega}{1+\Omega^2} \qquad (149)$$

Then equation (146) simplifies to

$$G(j\omega) = (\cos\varphi_\gamma + j\sin\varphi_\gamma)\sqrt{1+\Omega^2}\, e^{-\frac{\Omega^2}{1+\Omega^2}} = e^{-\frac{\Omega^2}{1+\Omega^2}+\frac{1}{2}\ln(1+\Omega^2)+j\varphi_\gamma} \qquad (150)$$

The course of $\cos\varphi_\gamma$ is figured in figure 18. An appraisal takes place in 4.3.4. Still, even the course of the second term is to be seen in φ_γ. One sees that it only comes to the validity at frequencies near ω_1.

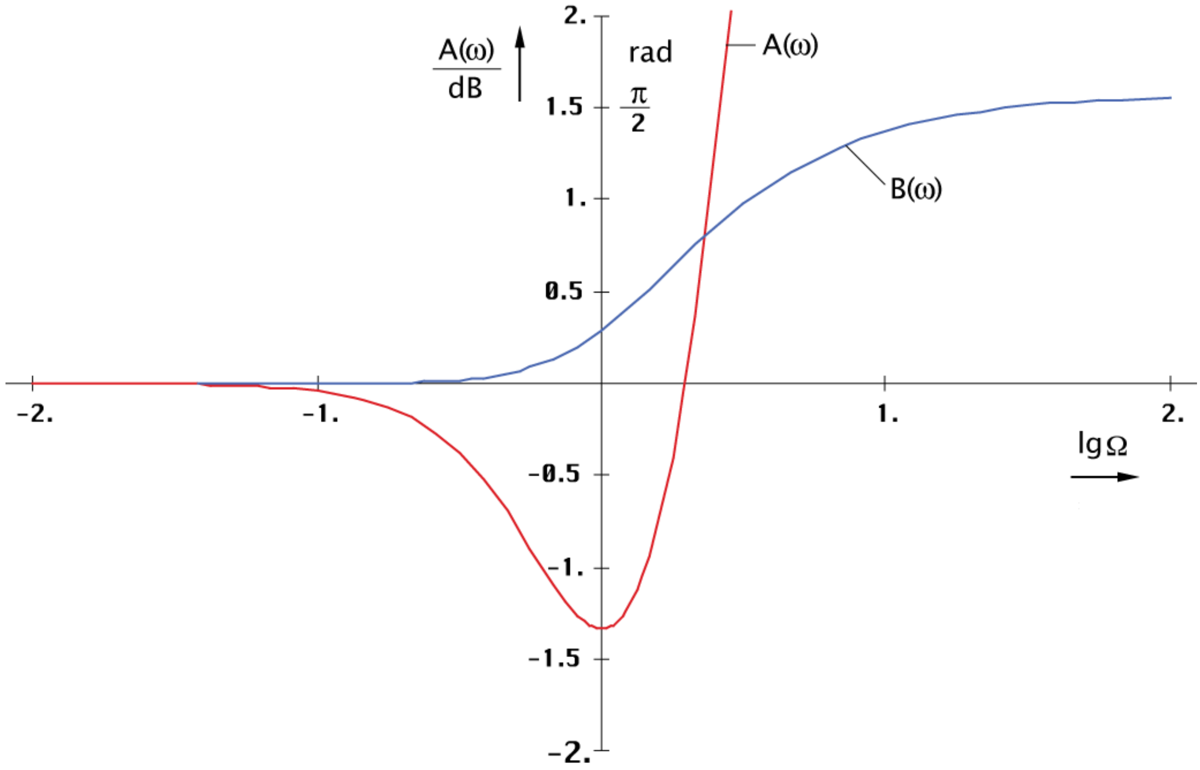


Figure 17
BODE-diagram: Frequency response A(ω)
and phase response B(ω) of the system

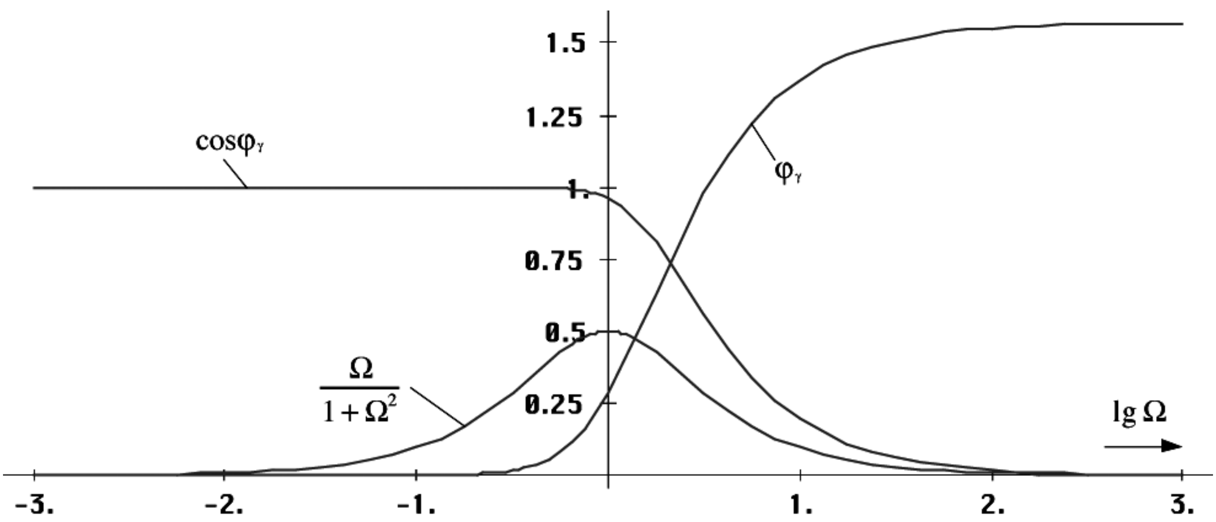


Figure 18
Course of phase angle,
cos φ and of the expression θ

Finally, the phase- and group delay in dependence of the frequency should be examined. Both functions are depicted in figure 19. The phase delay is defined as:

$$T_{Ph} = \frac{B(\omega)}{\omega} = \frac{1}{\omega}(\arctan\Omega - \frac{\Omega}{1+\Omega^2}) \quad (151)$$

For the group delay we get:

$$T_{Gr} = \frac{dB(\omega)}{d\omega} = 2\frac{\theta^2}{\omega_1} = \frac{2}{\omega_1}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \quad (152)$$

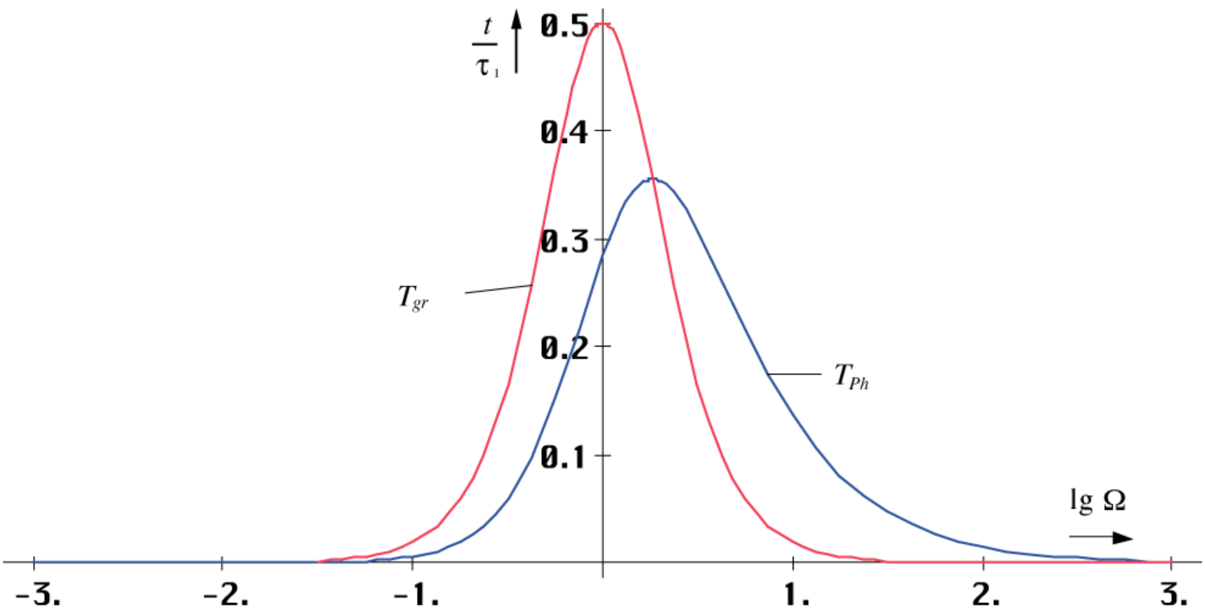


Figure 19
Group- and phase delay

4.3.3. Properties of the model

The following statements are applied only to one discrete MLE. More exact statements for wave-propagation as such are worked out later. One sees here quite clearly that frequency- and phase response are proceeding approximately exact linearly (0 dB) and phase-true until one third of the frequency $\omega_1 \approx 10^{104}s^{-1}$. A noticeable attenuation and phase-shift does not occur until approximate one tenth of ω_1. Since the amount of ω_1 is so extreme (the supreme measured frequency, cosmic radiation is about $10^{42}s^{-1}$), this effect does not have been observed so far however.

The amplitude is ascending strongly above ω_1 and it actually turns out a high pass-behavior, the wave-propagation at $\omega < \omega_0$ here just actually happens in the attenuation-zone. Since the value of $\cos\varphi_\gamma$ is declining strongly from $\omega_1/2$ on however, and with it the coupling coefficient of each discrete MLE mutually, a wave-propagation is impossible above ω_1. Hypercritical photons cannot exist much longer than τ_1 therefore.

The frequency response across two MLE's with the coupling coefficient $k=\cos\varphi_\gamma$ is shown in figure 20. It is about a group-delay-corrected low pass of 2nd order (2 MLE's that means 2 circuits, therefore the square). The expression $1+\Omega^2$ even occurs in the filter-theory and corresponds to the form-factor of a calibrated equally-tuned dual-circuit filter with identical attenuation-course [26].

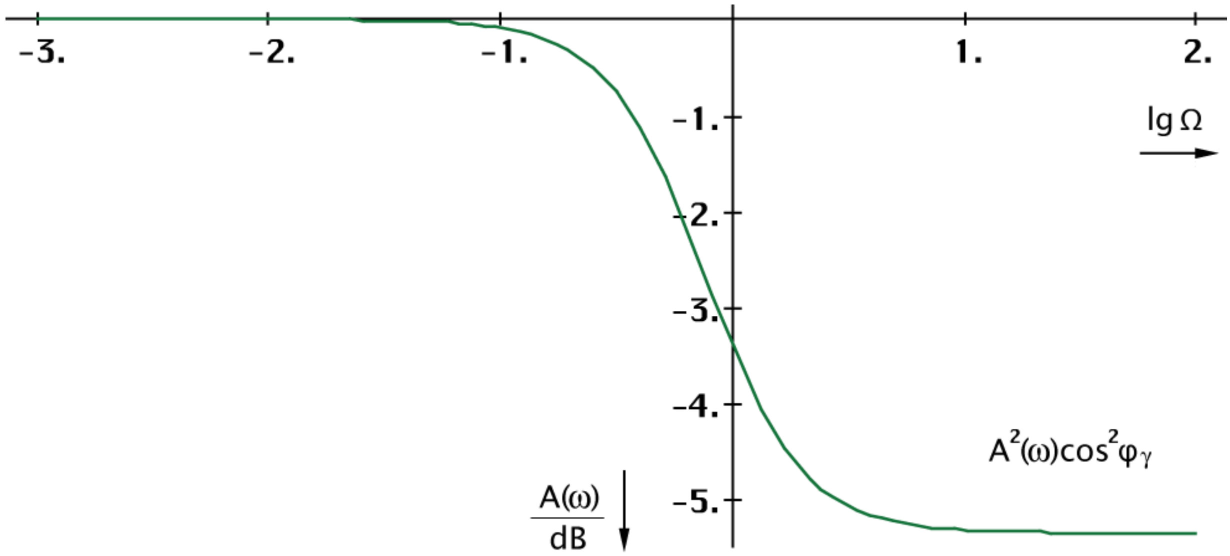


Figure 20
Frequency response for the transfer
to the adjacent MLE

In reference to the sampling-theorem we expect, that only frequencies below $\omega_0/2$ are transferred. The previous statements apply strictly speaking only to the universal wave-field in accordance with [1]. The propagation of radio waves or photons, as we understand, in reality takes place as propagation of interferences of this wave-field. Since the MLE's figure non-linear systems, several side frequencies occur. Important is only the sum- and difference-frequency $\omega_0 \pm \omega$. With the other frequencies, no power-conversion is achieved (property of a non-linear circuit). For the cut-off frequency of overlaid signals, even only the summary frequency is relevant. Because the overlaid signals are more red-shifted than the universal wave-field, the „relative cut-off frequency“, i.e. the spacing between the overlaid frequency ω and the cut-off frequency $\omega_0/2$, ascends with rising age continuously.

The course of group delay shows that the „processing“ of changes of the magnetic induction of lower frequencies actually takes place „instantaneously“. The transfer to the adjacent MLE takes place on the basis of a resonance-coupling with a phase-shift of $\pi/2=\omega_0 t_v$. For the delay time of t_v, one gets the following expression then: $t_v=\pi/(2\omega_0)=\pi\, r_0/(2c)$. For the transfer rate of c (the radius of the field-line of the vector $\mathbf{H_0}$ proceeding through the centre of the track graphs of both MLE's is equal to the half of lattice constant, just $\pi r_0/2$), we receive in accordance with figure 2 an amount of

$$c = \frac{\pi}{2}\frac{r_0}{t_v} = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = c \qquad (153)$$

With it, the wave-propagation-velocity of the vacuum results directly from the phase-shift $\pi/2$, that appears with magnetic resonance-coupling of two oscillatory circuits. This effect even can be observed macroscopically with discrete components which is figured in [26] extensively. On frequencies near ω_1, to t_v the phase delay of T_{Ph}, multiplied with 2π, has to be added. An accurate formula for $\underline{c}$ for this case (critical photons) however cannot be declared here because of considering the discrete MLE only. We will work out an exact expression for wave-propagation-velocity in section 4.3.4.4.5. being valid near t=0 as well.

Furthermore we can say that the propagation-velocity c decreases the more approaching to ω_1 This value however exactly corresponds to that point, in which the track-curve (figure 8) is no longer defined. A phase-transition occurs, the rotation finishes. There is only the rectilinear expansion.

With it the phase-shift to the adjacent MLE also adds up and achieves a value of π, a destructive interference appears, a wave-propagation isn't possible at all (coupling-factor k=cos(π/2)=0). Furthermore, c̲ and even the wave impedance Z̲ become complex, leading real- and imaginary-part to achieve same value. This corresponds to the case of an electrically conductive medium.

All that arises from the going smaller and smaller value of R_0, resulting from descending r_0, and the Q-factor. That means, the impedance achieves the magnitude of the complex impedances X_C and X_L short-circuiting them more and more. Above ω_0, R_0 only determines the behavior of the system then (electric conductor). However this is not applied to the wave-field as such. Reverse behavior appears here. Near t=0 as well as $\omega=\omega_0$, the field-wave impedance behaves like a non-conductor. First at larger distance, the behavior approaches the one of an ideal conductor, as we will still see later. Decisive for it is the mutual coupling-factor of the MLE's however.

Now a wave-propagation-velocity different from c does not contradict our primary assumption c=const and nor the SRT for so long, while its value is smaller or equal to c. This is always guaranteed even with frequencies near ω_1 respectively in the time just after the big bang. The previous results don't just stand in contradiction to prevailing discoveries.

4.3.4. Propagation-function

First we want to pass in review the classic theory of MAXWELL's equations once again, in order to work out, with the help of analogies, an alternative solution, fitting the requests of our model. The equation-system (1) is under-determined, so that there is more than one solution filling these equations.

4.3.4.1. Classic solution for a loss-free medium

In accordance with the previous discoveries, the cosmic vacuum seems to be a loss-free medium. It applies ρ=0 (space-charge-density) as well as κ=0. To the reminiscence here the MAXWELL equations once again:

$$\text{div } \mathbf{B} = 0 \qquad \text{div } \mathbf{D} = \rho$$
$$\text{curl } \mathbf{E} = -\dot{\mathbf{B}} \qquad \text{curl } \mathbf{H} = \mathbf{i} + \dot{\mathbf{D}} \tag{154}$$

Furthermore applies:

$$\mathbf{D} = \varepsilon\, \mathbf{E} \qquad \mathbf{B} = \mu\, \mathbf{H} \qquad \mathbf{i} = \kappa\, \mathbf{E} \tag{155}$$

Put into (154) we get (partial derivatives for x, y and z):

$$\text{div } \mathbf{H} = 0 \qquad \text{div } \mathbf{E} = 0$$
$$\text{curl } \mathbf{E} = -\mu\, \dot{\mathbf{H}} \qquad \text{curl } \mathbf{H} = \varepsilon\, \dot{\mathbf{E}} \tag{156}$$
$$\text{curl } \mathbf{E} = -\mu\, \frac{\partial \mathbf{H}}{\partial t} \qquad \text{curl } \mathbf{H} = \varepsilon\, \frac{\partial \mathbf{E}}{\partial t}$$

Reapplication of the rotation-operation on (156) and substitution of the expression for curl **H** results in:

$$\text{curl curl } \mathbf{E} = -\mu\ \text{curl} \frac{\partial \mathbf{H}}{\partial t} = -\mu \frac{\partial (\text{curl}\, \mathbf{H})}{\partial t} = -\mu\varepsilon \frac{\partial^2 \mathbf{E}}{\partial t^2} \tag{157}$$

Still formal-mathematically applies and due to div **E** = 0, (Δ is the LAPLACE-operator):

$$\text{curl curl } \mathbf{E} = \text{grad div } \mathbf{E} - \Delta\mathbf{E} = -\Delta\mathbf{E} \qquad (158)$$

Analogously applies for **H:**

$$\text{curl curl } \mathbf{H} = \varepsilon \text{ curl} \frac{\partial \mathbf{E}}{\partial t} = \varepsilon \frac{\partial(\text{curl}\,\mathbf{E})}{\partial t} = -\mu\varepsilon \frac{\partial^2 \mathbf{H}}{\partial t^2} \qquad (159)$$

Just as because of div **H** = 0:

$$\text{curl curl } \mathbf{H} = \text{grad div } \mathbf{H} - \Delta\mathbf{H} = -\Delta\mathbf{H} \qquad (160)$$

Then for $\mu_r = \varepsilon_r = 1$ (vacuum) can be applied:

$$\Delta\mathbf{E} = \mu_0\varepsilon_0 \frac{\partial^2 \mathbf{E}}{\partial t^2} = \frac{1}{c^2}\frac{\partial^2 \mathbf{E}}{\partial t^2} \qquad \Delta\mathbf{H} = \mu_0\varepsilon_0 \frac{\partial^2 \mathbf{H}}{\partial t^2} = \frac{1}{c^2}\frac{\partial^2 \mathbf{H}}{\partial t^2} \qquad (161)$$

The Laplace-operator Δ is nothing other than the vector of the second directional-derivatives however: $\Delta = (\partial^2/\partial x^2, \partial^2/\partial y^2, \partial^2/\partial z^2)$. With propagation only into x-direction, the partial derivatives for y and z become zero, and we can write too:

$$\frac{d^2\mathbf{E}}{dx^2} = \mu_0\varepsilon_0 \frac{d^2\mathbf{E}}{dt^2} \qquad \frac{d^2\mathbf{H}}{dx^2} = \mu_0\varepsilon_0 \frac{d^2\mathbf{H}}{dt^2} \qquad (162)$$

After division by $d^2\mathbf{E}$ respectively $d^2\mathbf{H}$, multiplication with dx^2, division by $\mu_0\varepsilon_0$ and subsequent extraction of the square-root, we will receive the known expressions for the wave-propagation-velocity $\underline{c}$ (phase- and group velocity) as well as the field-wave impedance $\underline{Z}_F = \mu_0\underline{c}$:

$$\underline{c} = \frac{dx}{dt} = \frac{1}{\sqrt{\mu_o\varepsilon_o}} = c \qquad \underline{Z}_F = \sqrt{\frac{\mu_0}{\varepsilon_o}} = Z_0 \qquad (163)$$

The underlining stand for complex values. Since the product $\mu_r\varepsilon_r$ is always larger than 1, the maximum wave-propagation-velocity is equal to c. It has an all-pass-behavior on hand, no lower cut-off frequency exists and the wave-propagation-velocity is independent from the frequency. For the propagation rate $\underline{\gamma}$ applies:

$$\underline{\gamma} = \alpha + j\beta = \pm j\omega/\underline{c} = \pm j\omega\sqrt{\mu_o\varepsilon_o} \qquad (164)$$

In this connection is α the attenuation rate (α=0) and β the phase-rate. Except for the geometrical attenuation ($\mathbf{S} \sim r^{-2}$) in this case just no additional attenuation appears. Then, for the propagation-function (into x-direction) we get (analogously for $\underline{\mathbf{H}}$):

$$\underline{\mathbf{E}} = \mathbf{E}\, e^{j\omega\left(t - \frac{x}{c}\right)} = \mathbf{E}\, e^{j\omega t - \gamma x} \qquad (165)$$

This solution suffices the cases appearing most frequently in the nature. If the medium is not loss-free, it fails however. Even, the cosmologic red-shift cannot be explained so.

4.3.4.2. Classic solution for a loss-affected medium

At a loss-affected medium (e.g. water) ρ=0 applies as well as κ>0. **E** and **H** are understood as complex time-functions (underlined). Equation (156) is then:

$$\text{curl } \underline{\mathbf{E}} = -\mu \frac{\partial \underline{\mathbf{H}}}{\partial t} \qquad \text{curl } \underline{\mathbf{H}} = \left(\kappa + \varepsilon \frac{\partial}{\partial t}\right) \underline{\mathbf{E}} \tag{166}$$

To the solution of the equations, MAXWELL works with the following ansatz:

$$\underline{\mathbf{E}} = \mathbf{E}\, e^{j\omega t} \qquad \underline{\mathbf{H}} = \mathbf{H}\, e^{j\omega t} \tag{167}$$

In this connection, the real-part corresponds to an orientation of the vector in y-, the imaginary-part to the one in z-direction, x is the propagation direction. This ansatz matches, except for the factor 2, the first term of equation (108) $e^{j\omega t}$ i.e. the harmonic solution with static amplitude (static model without expansion). However, equation (108) does not treat the magnetic (or even electric) field-strength but the charge as well as the flux. To the conversion, a coupling-length r_k, is required, depending from the model in use. At both MAXWELL solutions, the value can be chosen absolutely free. But it should be essentially smaller than the wavelength. The best choice would be PLANCK's elementary-length r_0 indeed. The magnetic field-strength submits to $\mathbf{H} = \varphi\, \mathbf{e_r}/(\mu r_k^2)$ then.

Now it is comprehensible enough, that MAXWELL first attempts to find an harmonic solution, this nevertheless corresponds to the long-time experiences (harmonic wave-functions) and even to the current approaching in solving equation-systems. Furthermore, he achieved a solution, that agrees to the greatest extent with observations and experiments, delivering even technically applicable results, as well. The cosmologic red-shift however cannot be explained with it. It applies further:

$$\frac{\partial \underline{\mathbf{E}}}{\partial t} = j\omega\, \mathbf{E}\, e^{j\omega t} = j\omega\, \underline{\mathbf{E}} \qquad \frac{\partial \underline{\mathbf{H}}}{\partial t} = j\omega\, \mathbf{H}\, e^{j\omega t} = j\omega\, \underline{\mathbf{H}} \tag{168}$$

We get for the second derivatives:

$$\frac{\partial^2 \underline{\mathbf{E}}}{\partial t^2} = -\omega^2 \mathbf{E}\, e^{j\omega t} = -\omega^2 \underline{\mathbf{E}} \qquad \frac{\partial^2 \underline{\mathbf{H}}}{\partial t^2} = -\omega^2 \mathbf{H}\, e^{j\omega t} = -\omega^2 \underline{\mathbf{H}} \tag{169}$$

Further applies:

$$\text{curl } \underline{\mathbf{E}} = -\mu \frac{\partial \underline{\mathbf{H}}}{\partial t} = -j\omega\mu \underline{\mathbf{H}} \qquad \text{curl } \underline{\mathbf{H}} = \left(\kappa + \varepsilon \frac{\partial}{\partial t}\right) \underline{\mathbf{E}} = (\kappa + j\omega\varepsilon)\, \underline{\mathbf{E}} \tag{170}$$

We apply the rotation-operation to both sides again:

$$\text{curl curl } \underline{\mathbf{E}} = \text{curl } (-j\omega\mu \underline{\mathbf{H}}) = -j\omega\mu \text{ curl } \underline{\mathbf{H}} = -j\omega\mu(\kappa + j\omega\varepsilon)\, \underline{\mathbf{E}} = -\Delta \underline{\mathbf{E}} \tag{171}$$

$$\text{curl curl } \underline{\mathbf{H}} = \text{curl}((\kappa + j\omega\varepsilon)\underline{\mathbf{E}})) = (\kappa + j\omega\varepsilon) \text{ curl } \underline{\mathbf{E}} = -j\omega\mu(\kappa + j\omega\varepsilon)\, \underline{\mathbf{H}} = -\Delta \underline{\mathbf{H}} \tag{172}$$

Furthermore applies:

$$\Delta \underline{\mathbf{E}} = j\omega\mu(\kappa + j\omega\varepsilon)\, \underline{\mathbf{E}} = -\omega^2\left(\mu\left(\frac{\omega\varepsilon - j\kappa}{\omega}\right)\right) \underline{\mathbf{E}} = \left(\mu\left(\frac{\omega\varepsilon - j\kappa}{\omega}\right)\right)\left(-\omega^2 \underline{\mathbf{E}}\right) \tag{173}$$

$$\Delta \underline{\mathbf{H}} = j\omega\mu(\kappa + j\omega\varepsilon)\, \underline{\mathbf{H}} = -\omega^2\left(\mu\left(\frac{\omega\varepsilon - j\kappa}{\omega}\right)\right) \underline{\mathbf{H}} = \left(\mu\left(\frac{\omega\varepsilon - j\kappa}{\omega}\right)\right)\left(-\omega^2 \underline{\mathbf{H}}\right) \tag{174}$$

On propagation in x-direction only, the partial derivatives for y and z become zero again and it applies $\Delta = d^2/dx^2$. Because of (169) one can also write:

$$\frac{d^2\underline{\mathbf{E}}}{dx^2} = \left(\mu\left(\frac{\omega\varepsilon - j\kappa}{\omega}\right)\right)\frac{d^2\underline{\mathbf{E}}}{dt^2} \qquad \frac{d^2\underline{\mathbf{H}}}{dx^2} = \left(\mu\left(\frac{\omega\varepsilon - j\kappa}{\omega}\right)\right)\frac{d^2\underline{\mathbf{H}}}{dt^2} \tag{175}$$

For $\mu_r = \varepsilon_r = 1$, we get after division by $d^2\underline{\mathbf{E}}$ as well as $d^2\underline{\mathbf{H}}$, multiplication with dx^2, division by the double bracketed expression, de-parenthesizing of $-j$ and extraction of the root the known expressions for the propagation-velocity $\underline{c} = dx/dt$ and the field-wave impedance $\underline{Z}_F$:

$$\underline{c} = \sqrt{\frac{j\omega}{\mu_o(\kappa + j\omega\varepsilon_o)}} \qquad \underline{Z}_F = \sqrt{\frac{j\omega\mu_o}{\kappa + j\omega\varepsilon_o}} \tag{176}$$

Or resolved for real and imaginary part:

$$\underline{c} = \frac{c}{\sqrt{2}}\left(\sqrt{\sqrt{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}+1} + j\sqrt{\sqrt{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}-1}\right)\frac{1}{\sqrt{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}} \tag{177}$$

$$\underline{c} = \frac{c}{\sqrt[4]{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}}\left(\cos\frac{1}{2}\arctan\frac{\kappa}{\omega\varepsilon_0} + j\ \sin\frac{1}{2}\arctan\frac{\kappa}{\omega\varepsilon_0}\right) \quad \text{as well as} \tag{178}$$

$$\underline{c} = \frac{c}{\sqrt{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}}\left(\cosh\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0} + j\ \sinh\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0}\right) \tag{179}$$

The root-expression in (177) even is the absolute value simultaneously. For the attenuation rate α and the phase-rate β one finally gets:

$$\alpha = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}-1\right)} = \frac{\omega}{c}\sinh\left(\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0}\right) \tag{180}$$

$$\beta = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\left(\frac{\kappa}{\omega\varepsilon_0}\right)^2}+1\right)} = \frac{\omega}{c}\cosh\left(\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0}\right) \tag{181}$$

The propagation-function is the same like (164) however with the variant values for α and β (180, 181). For $\kappa = 0$ this solution passes into case 4.3.4.1. The propagation-velocity is dependent on κ and ω and amounts to c at most There is a lower cut-off frequency. Since $\alpha \neq 0$, an additional attenuation of the electromagnetic field-strength (POINTING-vector) appears to the geometrical one. With extreme values of κ, nonlinear distortions occur because of different group- and phase velocity. This solution describes wave-propagation in a medium of whatever qualities and a space-charge-density of 0. It doesn't explain cosmologic red-shift.

4.3.4.3. Alternative solution for a loss-affected medium with expansion

4.3.4.3.1. Solution

We start with the same formulation as in the previous case: $\rho = 0$ as well as $\kappa_o > 0$. **E** and **H** are understood as complex time-functions again (underlined). Since in the time just after big bang there is a pure radiation-cosmos and because we are considering the MLE, just the empty space, here the vacuum solution only can be of interest anyway. Equation (156) reads then:

$$\text{curl } \underline{\mathbf{E}} = -\mu_0 \frac{\partial \underline{\mathbf{H}}}{\partial t} \qquad \text{curl } \underline{\mathbf{H}} = \left(\kappa_0 + \varepsilon_0 \frac{\partial}{\partial t}\right) \underline{\mathbf{E}} \tag{182}$$

In contrast to MAXWELL, who made use of the first term of equation (108) $e^{j\omega t}$ as base, we now choose the first term of equation (119), which we have obtained as an independent solution of the differential equation (78). The coupling-length of r_k cannot be chosen here freely. Because the imaginary-part of the Hankel function is coming from the infinite the initial value of φ is defined at the point $2\omega_0 t = Q_0 = 1$. The coupling-length at this point is r_1.

$$\underline{\mathbf{E}} = \mathbf{E}\ H_0^{(1)}(2\omega_0 t) \qquad \underline{\mathbf{H}} = \mathbf{H}\ H_0^{(1)}(2\omega_0 t) \tag{183}$$

In this connection again, the real-part corresponds to the vector's orientation in y, the imaginary-part to the one in z-direction, while x is the propagation direction. As already noticed, an analogy exists among the exponential-function $e^{j2\omega t}$ and the Hankel function. Both are transcendent complex functions being periodic respectively nearly periodic. In the following, we want to find out, whether this base leads to a solution of the MAXWELL equations too. It is however to mark that ω_0 is time-dependent in this case. Therefore we will first work with the correct time-functions:

$$\underline{\mathbf{E}} = \mathbf{E}\ H_0^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad \underline{\mathbf{H}} = \mathbf{H}\ H_0^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{184}$$

Let's proceed now like in 4.3.4.2. (analogously for $\underline{\mathbf{H}}$):

$$\frac{\partial \underline{\mathbf{E}}}{\partial t} = -\frac{2\kappa_0}{2\varepsilon_0}\sqrt{\frac{\varepsilon_0}{2\kappa_0 t}}\ \mathbf{E}\ H_1^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} = -\sqrt{\frac{\kappa_o}{2\varepsilon_o t}}\ \mathbf{E}\ H_1^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{185}$$

The minus sign is caused by the derivative of the Hankel-function. Furthermore applies, according to the calculating rules for cylinder-functions [22]:

$$\frac{\partial \underline{\mathbf{E}}}{\partial t} = -\omega_o\ \mathbf{E}\ H_1^{(1)}(2\omega_0 t) = -\omega_0^2 t\ \mathbf{E}\ \left(H_0^{(1)}(2\omega_0 t) + H_2^{(1)}(2\omega_0 t)\right) \tag{186}$$

$$\frac{\partial \underline{\mathbf{H}}}{\partial t} = -\omega_o\ \mathbf{H}\ H_1^{(1)}(2\omega_0 t) = -\omega_0^2 t\ \mathbf{H}\ \left(H_0^{(1)}(2\omega_0 t) + H_2^{(1)}(2\omega_0 t)\right) \tag{187}$$

As next, we de-parenthesize the expression for the Hankel function of zero order so we can write, because of (183), for the first derivative as expression of the original-function:

$$\frac{\partial \underline{\mathbf{E}}}{\partial t} = -\omega_0^2 t\left(1 + \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{E}} \qquad \frac{\partial \underline{\mathbf{H}}}{\partial t} = -\omega_0^2 t\left(1 + \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{H}} \tag{188}$$

We require the second derivatives as well. These we determine to the best, in that we differentiate the right expression of (185) once again (analogously for $\underline{\mathbf{H}}$):

$$\frac{\partial^2 \underline{\mathbf{E}}}{\partial t^2} = -\frac{\partial}{\partial t}\left(\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\,.\,H_1^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right)\mathbf{E} = -(\dot{u}v + u\dot{v})\mathbf{E} \tag{189}$$

For u and v, we get following expressions:

$$u = \omega_0 \qquad \dot{u} = -\frac{\omega_0}{2t} \tag{190}$$

$$v = H_1^{(1)}\ 2\omega_0 t \qquad = \omega_0 t\ \ H_0^{(1)}\ 2\omega_0 t\ + H_2^{(1)}\ 2\omega_0 t \tag{191}$$

$$\dot{v} = \omega_0\, H_2^{(1)}\ 2\omega_0 t\ - \frac{1}{2t} H_1^{(1)}\ 2\omega_0 t \qquad = -\frac{\omega_0}{2}\ H_0^{(1)}\ 2\omega_0 t\ - H_2^{(1)}\ 2\omega_0 t \tag{192}$$

Replacement of the second expression of(189) results in:

$$\frac{\partial^2 \underline{\mathbf{E}}}{\partial t^2} = \omega_0^2\, H_0^{(1)}(2\omega_0 t)\ \mathbf{E} \qquad = \omega_0^2\ \underline{\mathbf{E}} \tag{193}$$

$$\frac{\partial^2 \underline{\mathbf{H}}}{\partial t^2} = \omega_0^2\, H_0^{(1)}(2\omega_0 t)\ \mathbf{H} \qquad = \omega_0^2\ \underline{\mathbf{H}} \tag{194}$$

Now, we put (188) into (182) getting:

$$\text{curl}\ \underline{\mathbf{H}} = \left(\kappa_0 + \varepsilon_0 \frac{\partial}{\partial t}\right) \underline{\mathbf{E}} = \left(\kappa_0 - \varepsilon_0 \omega_0^2 t \left(1 + \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\right) \underline{\mathbf{E}} \tag{195}$$

Expression (195) even can be written more simple:

$$\text{curl}\ \underline{\mathbf{H}} = \varepsilon_0 \omega_0^2 t \left(\frac{\kappa_0}{\varepsilon_0 \omega_0^2 t} - \left(1 + \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\right) \underline{\mathbf{E}} \tag{196}$$

$$\text{curl}\ \underline{\mathbf{H}} = \varepsilon_0 \omega_0^2 t \left(2 - \left(1 + \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\right) \underline{\mathbf{E}} \tag{197}$$

$$\text{curl}\ \underline{\mathbf{H}} = \varepsilon_0 \omega_0^2 t \left(1 - \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right) \underline{\mathbf{E}} \tag{198}$$

For $\text{curl}\underline{\mathbf{E}} = -\mu_0 \frac{\partial \underline{\mathbf{H}}}{\partial t}$ we obtain immediately by substitution :

$$\text{curl}\ \underline{\mathbf{E}} = \mu_0 \omega_0^2 t \left(1 + \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\ \underline{\mathbf{H}} \tag{199}$$

We apply the rotation-operation to both sides again:

$$\text{curl curl}\ \underline{\mathbf{H}} = \text{curl}\left(\varepsilon_0 \omega_0^2 t \left(1 - \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right) \underline{\mathbf{E}}\right) = \varepsilon_0 \omega_0^2 t \left(1 - \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right) \text{curl}\ \underline{\mathbf{E}} \tag{200}$$

$$\text{curl curl } \underline{\mathbf{H}} = \mu_0\varepsilon_0\omega_0^4 t^2 \left(1-\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{H}} = -\Delta\underline{\mathbf{H}} \tag{201}$$

$$\text{curl curl } \underline{\mathbf{H}} = \frac{\omega_0^2}{c^2}\omega_0^2 t^2 \left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\underline{\mathbf{H}} = -\Delta\underline{\mathbf{H}} \tag{202}$$

The result for $\underline{\mathbf{E}}$ is analogous. We continue like in section 4.3.4.2.:

$$\Delta\underline{\mathbf{E}} = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\left(\omega_0^2\underline{\mathbf{E}}\right) = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\frac{\partial^2\underline{\mathbf{E}}}{\partial t^2} \tag{203}$$

$$\Delta\underline{\mathbf{H}} = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\left(\omega_0^2\underline{\mathbf{H}}\right) = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\frac{\partial^2\underline{\mathbf{H}}}{\partial t^2} \tag{204}$$

With propagation only into x-direction, the partial derivatives for y and z will be zero again and it applies $\Delta = d^2/dx^2$ (analogously for $\underline{\mathbf{H}}$):

$$\frac{\partial^2\underline{\mathbf{E}}}{\partial x^2} = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\frac{\partial^2\underline{\mathbf{E}}}{\partial t^2} \tag{205}$$

After rearrangement, we finally get for the wave-propagation-velocity $\underline{c}$ and field-wave-impedance $\underline{Z}_F$:

$$\underline{c} = \frac{c}{j\omega_0 t}\frac{1}{\sqrt{1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2}} \qquad \text{with} \qquad \Theta = \frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)} \tag{206}$$

$$\underline{c} = \frac{c}{j\omega_0 t}\frac{1}{\sqrt{1-\Theta^2}} \qquad \underline{Z}_F = \frac{Z_0}{j\omega_0 t}\frac{1}{\sqrt{1-\Theta^2}} \tag{207}$$

One sees that the propagation-velocity converges to zero for large t. The same is applied to the field-wave impedance too. We have to do it with a quasi-stationary wave-field (standing wave) filling very well the requests on a metrics. The propagation-velocity is complex again. A decomposition into real- and imaginary-part works out quite difficult, but it's mathematically possible however. The solution for $\underline{c}$ reads:

$$\underline{c} = -\frac{\sqrt{2}}{\rho_0}\frac{c}{2\omega_0 t}\left(\sqrt{1-\frac{1}{\sqrt{1+\theta^2}}} - j\sqrt{1+\frac{1}{\sqrt{1+\theta^2}}}\right) \qquad \text{Ambiguous!} \qquad \text{with} \tag{208}$$

$$A = \frac{J_0(2\omega_0 t)J_2(2\omega_0 t) + Y_0(2\omega_0 t)Y_2(2\omega_0 t)}{J_0^2(2\omega_0 t) + Y_0^2(2\omega_0 t)} \qquad \rho_0 = \sqrt[4]{\left(1-A^2+B^2\right)^2 + \left(2AB\right)^2}$$

$$B = \frac{J_2(2\omega_0 t)Y_0(2\omega_0 t) - J_0(2\omega_0 t)Y_2(2\omega_0 t)}{J_0^2(2\omega_0 t) + Y_0^2(2\omega_0 t)} \qquad \theta = \frac{2AB}{1-A^2+B^2} \tag{209}$$

An all together quite complex expression turns out, that can still be simplified someway however (210). A starts at $+\infty$ converging to -1. The course resembles the function $1/A^2-1$ approximately, which cannot be used well as approximation however. B has a course like $1/B^2$ and is converging to zero. The same is applied even to θ then. The bracketed expression converges to 1 with it. $1/\rho_0$ is the value-function converging to $1/\sqrt{2}$.

$$\underline{c} = -\frac{2}{\rho_0}\frac{c}{2\omega_0 t}\left(\sin\frac{1}{2}\arctan\theta + j\cos\frac{1}{2}\arctan\theta\right) = \frac{2}{\rho_0}\frac{c}{2\omega_0 t}e^{-j\frac{1}{2}(\arctan\theta+\pi)} \tag{210}$$

Unfortunately (210) cannot be transformed into an expression similar to (179) with area-functions, so that the ambiguity of the arctan-function leads to a partially wrong result. We should better calculate with the following substitution therefore:

$$\arctan\theta = \arg\left(\left(1 - A^2 + B^2\right) + j2AB\right) \qquad \arg\underline{c} = \frac{1}{2}\operatorname{arccot}\theta - \frac{\pi}{4} \tag{211}$$

While the real-part of $\underline{c}$ is defined as the velocity in propagation direction, the imaginary-part can be interpreted as a velocity rectangular thereto. The appearance of an imaginary part in $\underline{c}$ means also that there is an attenuation anywhere (refer to figure 23). A numerical handling of (206) even can be processed with »Mathematica« resulting in the course figured in figure 21. Since the Hankel functions, with larger arguments, can be expressed well by other analytic functions, we will try to declare approximative solutions later.

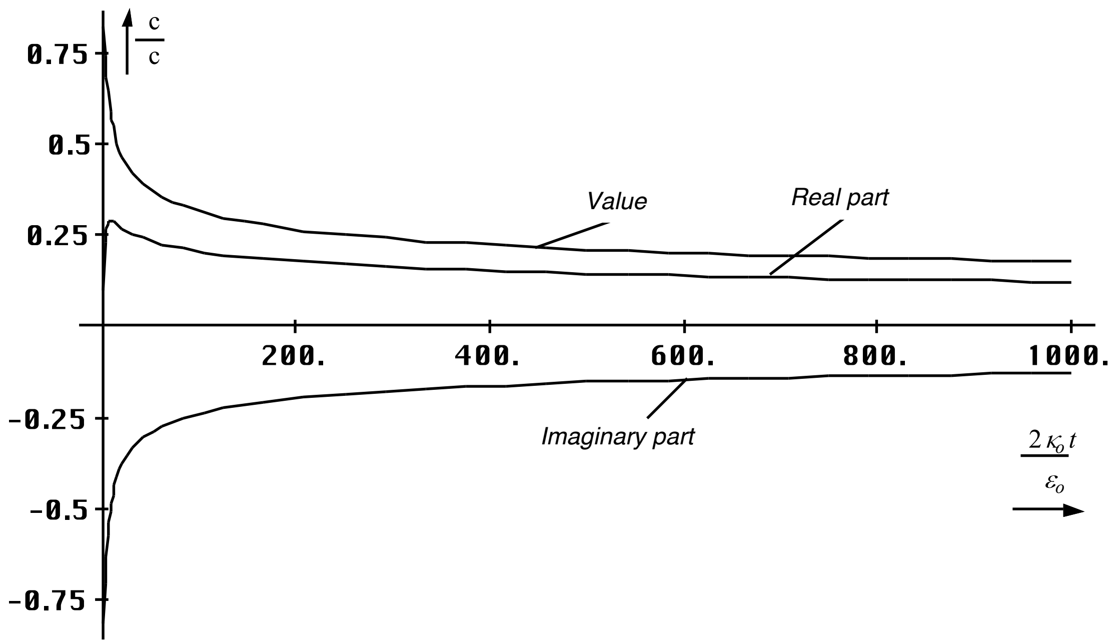


Figure 21
Propagation-velocity
in dependence of time (linear time-scale)

In the coarse, the propagation-velocity behaves proportionally to $t^{-1/4}$, as we will still see later. Overall, figure 21 strongly reminds to the smooth curve of a discrete MLE (figure 13). Near t=0 it looks somewhat differently however. A logarithmic scale helps on in this case (figure 22). As exact examination emerged, have real- and imaginary-part of $\underline{c}$ the same amount from $20\kappa_0 t/\varepsilon_0$ on approximately. We must pay attention to this with the specification of an approximation function.

We have to do with a case of inversion here. This manifests by the fact that the propagation-velocity ascends from zero to an amount of 0.851661c (with $0.748514\,t_1$) first in order to descend asymptotically to zero again.

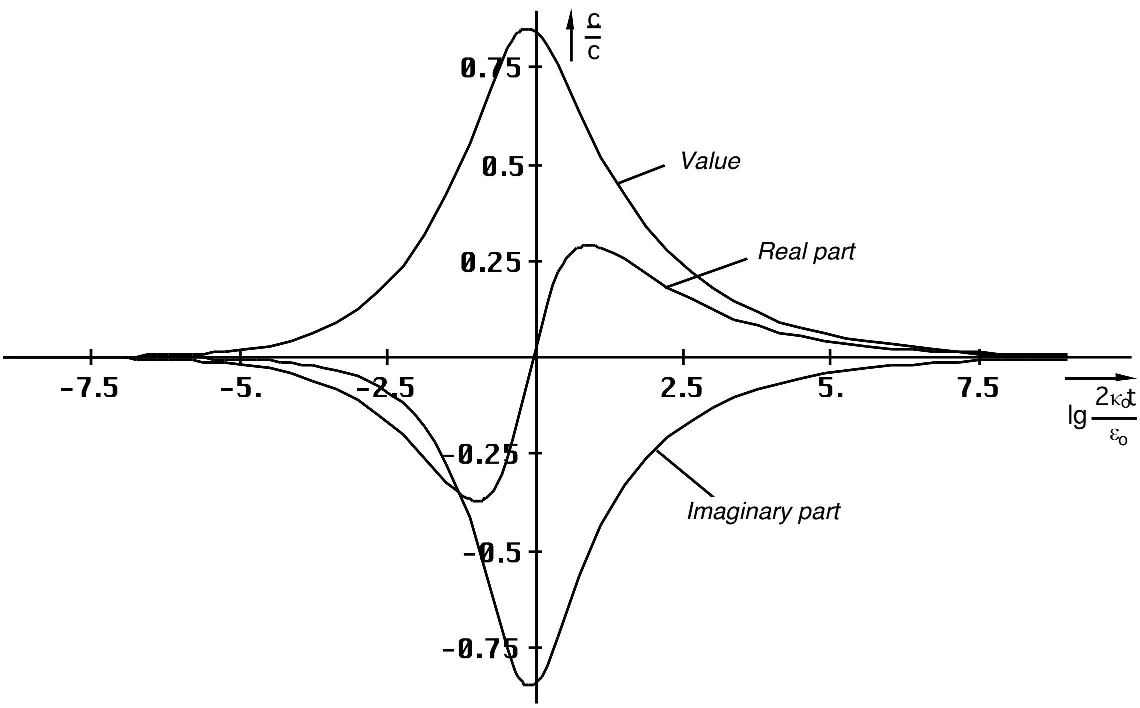


Figure 22
Propagation-velocity
in dependence of time (logarithmic time-scale)

With it, the world-radius (wave-front) of this model doesn't expand with c but only with 0.851661c which figures no violation of the SRT anyway. With it happens also that later transmitted wave-sections pass the wave-front quasi. Since the proportion of real- and imaginary-part is different in this case, it doesn't take place on the same track-curve - the wave-fronts rather cross each other.

To specify the propagation-function, let's have a look at the classic solutions (165), (212) once again and at our primary function (183) too.

$$\underline{E} = \mathbf{E}\, e^{j\omega\left(t-\frac{x}{\underline{c}}\right)} = \mathbf{E}\, e^{j\omega t-\gamma x} = \mathbf{E}\, e^{j\left(\omega t+j\underline{\gamma} x\right)} \qquad (212)$$

Contrary to (165) the argument in the case with expansion is real. Strictly speaking, namely it's not the Hankel function but the modified Hankel function $M_0^{(2)} = I_0(z) - jK_0(z)$ being the $_0$(z)=J$_0$(jz) however only for pure imaginary arguments. With complex arguments, the real part cannot be drawn to a position ahead of the Hankel function as usual with the exponential-function, since the power rules aren't applied to Hankel functions anyway. It's possible first with larger arguments z. In general the modified Hankel function isn't used however. Therefore, we use for the base the „ordinary“ Hankel function adapting the propagation-function accordingly. To avoid contradictions with the classic definition of propagation rate, real-part equals attenuation rate, imaginary-part equals phase-rate, the propagation-function should read as follows then (analogously for $\underline{\mathbf{H}}$):

$$\underline{E} = \mathbf{E}\, H_0^{(1)}\left(2\omega_0\left(t-\frac{x}{\underline{c}}\right)\right) = \mathbf{E}\, H_0^{(1)}\left(2\omega_0 t - j\underline{\gamma} x\right) \qquad (213)$$

This is not quite the classic expression for a propagation-function. Attention should be paid to the factor 2 which can be assigned both to the frequency, as well as the time-constant. With the definition of propagation rate $\underline{\gamma} = \alpha + j\beta$ it obviously belongs to the frequency since

$\underline{\gamma}$ depends on phase velocity dx/dt, but not on the half of dx/(2dt). By equating both arguments of (213) one gets then:

$$\underline{\gamma} = -\frac{2\omega_0}{\underline{c}} \quad = \quad j\kappa_0 Z_0 \sqrt{1-\Theta^2} \tag{214}$$

From (210) the reciprocal of $\underline{c}$ can be determined very easily. Due to (164) we get for $\underline{\gamma}$:

$$\frac{1}{\underline{c}} = -\frac{\omega_0 t \rho_0}{c}\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{215}$$

$$\underline{\gamma} = \alpha + j\beta = -2\omega_0/\underline{c} = \frac{2\omega_0^2 t \rho_0}{c}\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{216}$$

$$\underline{\gamma} = \rho_0 \kappa_0 Z_0 \left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{217}$$

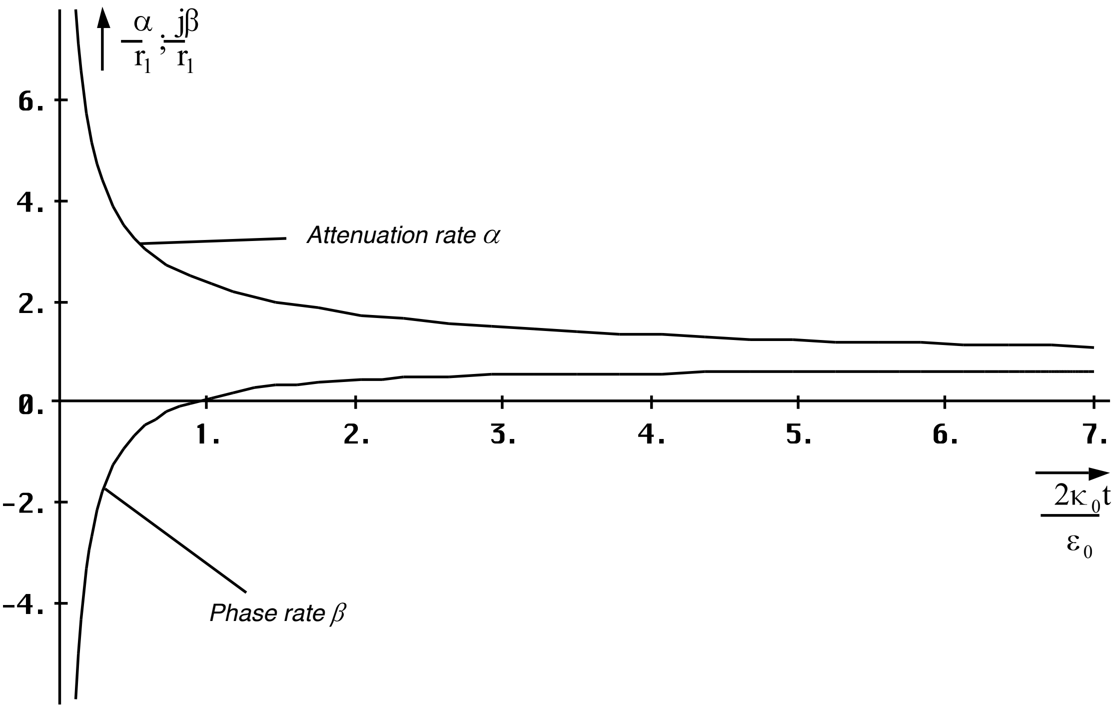


Figure 23
Phase-rate and attenuation rate
in dependence of time (linear scale)

With accurate contemplation one recognizes that α and β, evaluated by its action, are exchanged in fact (α = phase-rate, β = attenuation rate). This is caused thereby that a rotation of about 90° (j) occurs during propagation (figure 26). x turns into y and y into –x. The attenuation α, starting at the point of time t=0, starting off infinity, is decreasing exponentially. To the present point of time, one can say that there is basically no attenuation anyway. This doesn't apply however considering cosmologic time periods.

At the point of time $0.897\,t_1$ ($Q = 0.947$), the function β has a zero-passage. This supplies the somewhat particular course in logarithmic presentation (figure 24). It's about a phase-jump of 180° in this case. Possibly, this is even that point, in which the wave-front, sent at the point of time t=0, is passed by the faster, later transmitted. Furthermore, even the formation of the crystalline structure of space takes place approximately to this point of time (folding of parable into rotation). Up to this point of time, the space is closed, after it open. From the point of time $100\,t_1$ on we are able to declare, referring to figure 24, the following approximation:

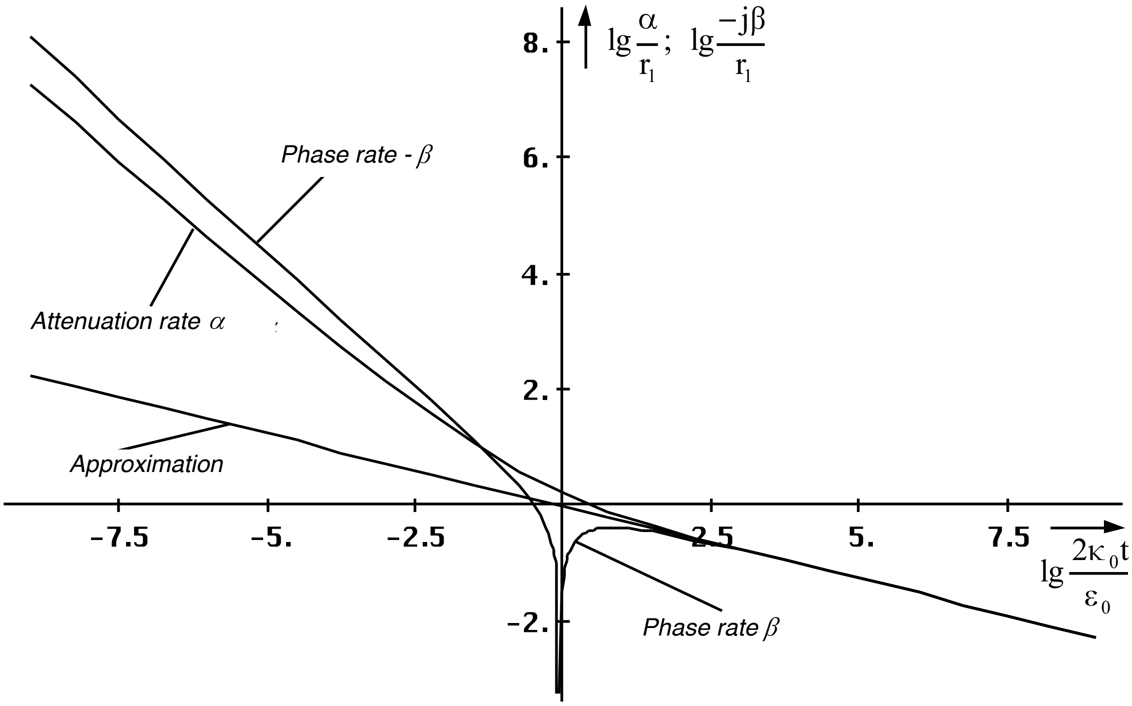


Figure 24
Phase rate and attenuation rate
in dependence of time (logarithmic)

$$\underline{\gamma} \approx (1+j)\,\kappa_0 Z_0 \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad\qquad \underline{\gamma} \approx (1+j)\,\frac{\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{218}$$

These relationships can be derived as well graphically from figure 24, as explicitly using (214) by application of (223). However, it's necessary to multiply (214) with j, in order to take account of the 90° turning (figure 26). Then, to the approximation $\underline{\gamma}=2\omega_0/\underline{c}$ is applied. The factor $\kappa_0 Z_0$ is the reciprocal of our r_0 with a Q-factor of 1, marked with $1/r_1$. Phase rate and attenuation rate are the same from 100 t_1 on approximately. This is the behavior of an ideal conductor. Possibly a lot of known physical effects like e.g. superconductivity and electron conductivity of the vacuum are basing hereupon.

Even interesting is the similarity of the course of the absolute propagation-velocity of metrics with the group delay specified in section 4.3.2. on transit of an interference through the discrete MLE. While the propagation-velocity of metrics is increasing near the singularity, the propagation-velocity of an overlaid wave is decreasing simultaneously, with the result of total-velocity remaining constant = c.

At the world-radius, the universe expands with the maximum velocity of 0.851661c, in the inside with a velocity decreasing more and more. Since the wave count in the interior of a sphere with defined radius r(c,t) is decreasing, the deficit is balanced by an increase of wavelength. Outside K, the wave count ascends continuously due to propagation.

Now, some problems appear, at which we want quickly have a look here, as well. Initially, the cosmos would not show the same physical qualities anyplace. We would have to do it with a weakened cosmologic principle then:

III.	*The cosmos offers the same sight to the same point of time.*

This statement needs the interpretation: The universe is expanding into an even Euclidean space without time-definition. The calendar begins with the transit of the wave-front first. Therefore, the universe has a different age at different positions. The local time is always meant. To equations, that refer to the expansion-centre, the time is applied at this point, just the total-age. There is no universal world-time in this model, what agrees with the statements of the SRT very well. With it, the local age is a function of the distance to the centre, which can be determined by measurement of the local physical quantities, at least theoretically. The HUBBLE-constant turns into a local quantity. With it, we even would have solved the time-scale-problem, which would have been appeared here otherwise. There are just both areas being younger and such being older than the area, in which we are located (every time seen from the observer). If one moves in space, so one moves in time simultaneously. Thus the expression »space-time« is uniquely defined.

The space outside K would be equipped with the basic physical qualities ε_0, μ_0 and κ_0, allowing even a wave-propagation in accordance with the classic MAXWELL theory for the vacuum. The metric wave-field is just not required for wave-propagation anyway. In what extent matter can exist outside, should not be examined here further. Debatable in any case is the question, where this, respectively any other electromagnetic radiation should come from. We once assume that there is none. If this should be the case but yet, **no** possibility exists to cross the singularity at the world-radius K, neither into the one, nor into the other direction.

We have the real- and imaginary-part of $\underline{c}$ assigned to propagation in x- and y-direction. Let's have a look at the propagation of the wave-front now, transmitted at the point of time t = 0. If we figure it two-dimensionally, we will get the following track-curve (figure 25):

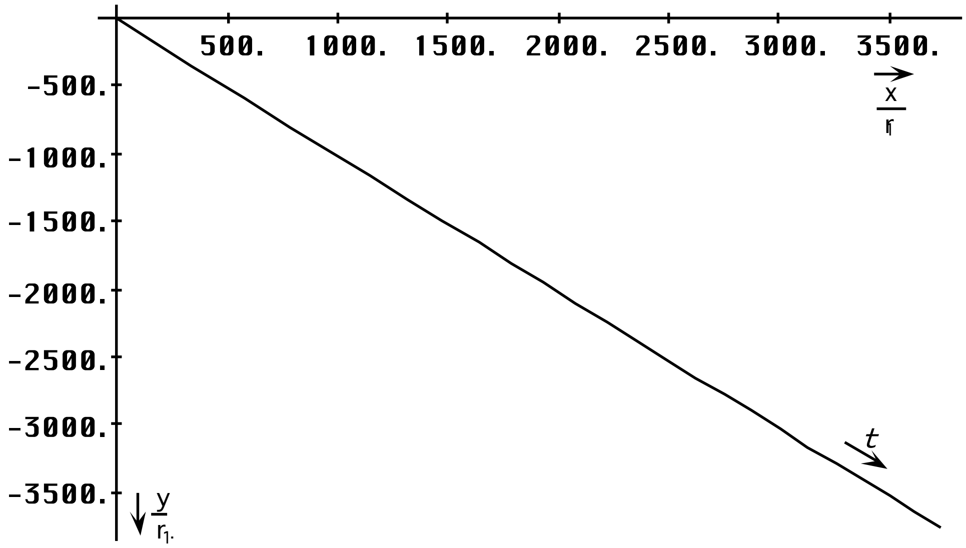


Figure 25
Track-curve for larger values of t
in dependence of time

For larger t, the expansion of the wave-front proceeds approximately rectilinear. The behavior looks somewhat differently near the singularity. In figure 26 is figured the course of the track-curve of a discrete section of the wave-front near the singularity. One discovers a sort of parable, with larger t a hyperbole. A rotation of an angle of 90° appears in the propagation direction. Figure 27 shows the function of the absolute distance to the centre.

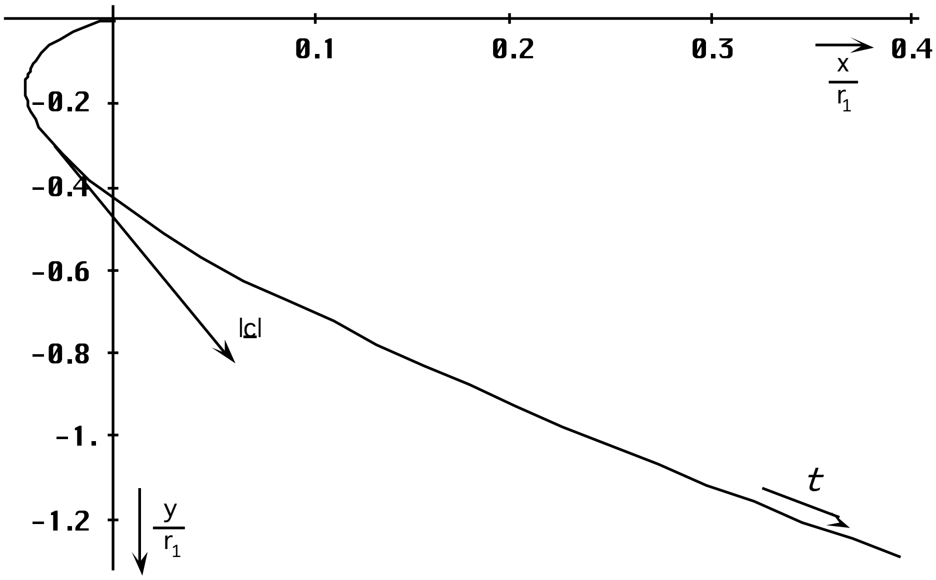


Figure 26
Track-curve near the singularity
in dependence of time

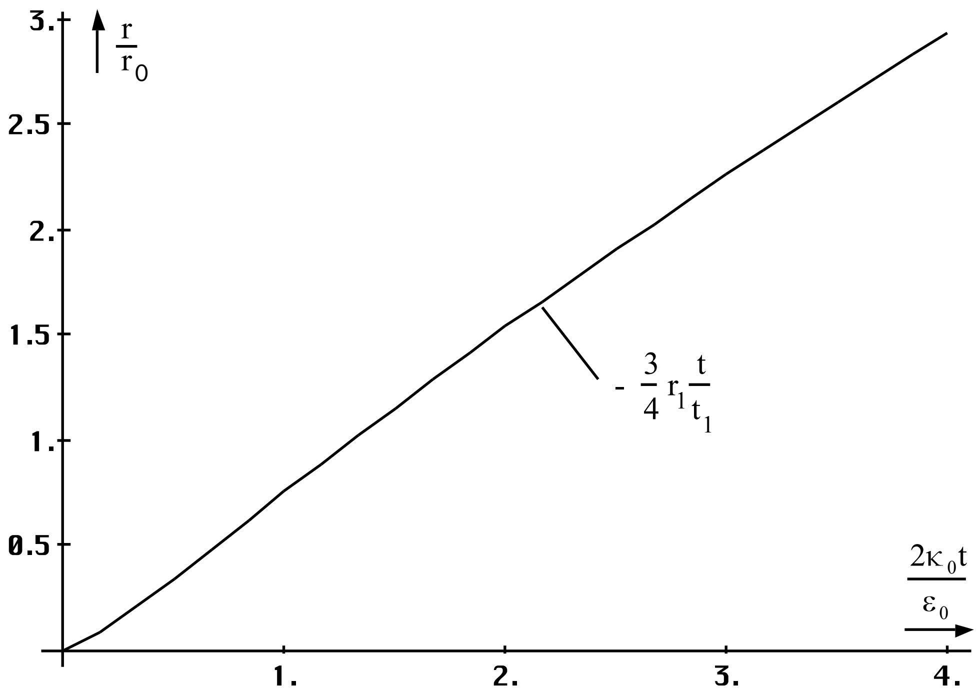


Figure 27
Radius r as the absolute distance to the centre
in dependence of time for smaller values of t

The function has been calculated and figured with the help of »Mathematica« by numerical integration on the following way:

```
Hankel1=Function[BesselJ[#1,#2]+I BesselY[#1,#2]];
Cd=Function[-2*I/Sqrt[#]/Sqrt[1-(Hankel1[2,Sqrt[#]]/Hankel1[0,Sqrt[#]])^2]];
CdI=Function[NIntegrate[Cd[a],{a,0,#}]];

Plot[Abs[CdI[t]],{t,0,1}, AspectRatio->1]
```

(219)

The locus curve of the field-wave impedance is declared in figure 28. The value for t»0 is of particular interest. Contrary to overlaid interferences of inferior frequency, to which $\underline{Z}_F = Z_0$ is applied, this value virtually becomes zero for the metrics on the other hand. Thus (virtually) no propagation-losses appear anyway. This „virtually" could be the reason for the cosmologic red-shift. This idea should be examined in the following section. First however, we want to deal with the approximative solutions for larger t once again.

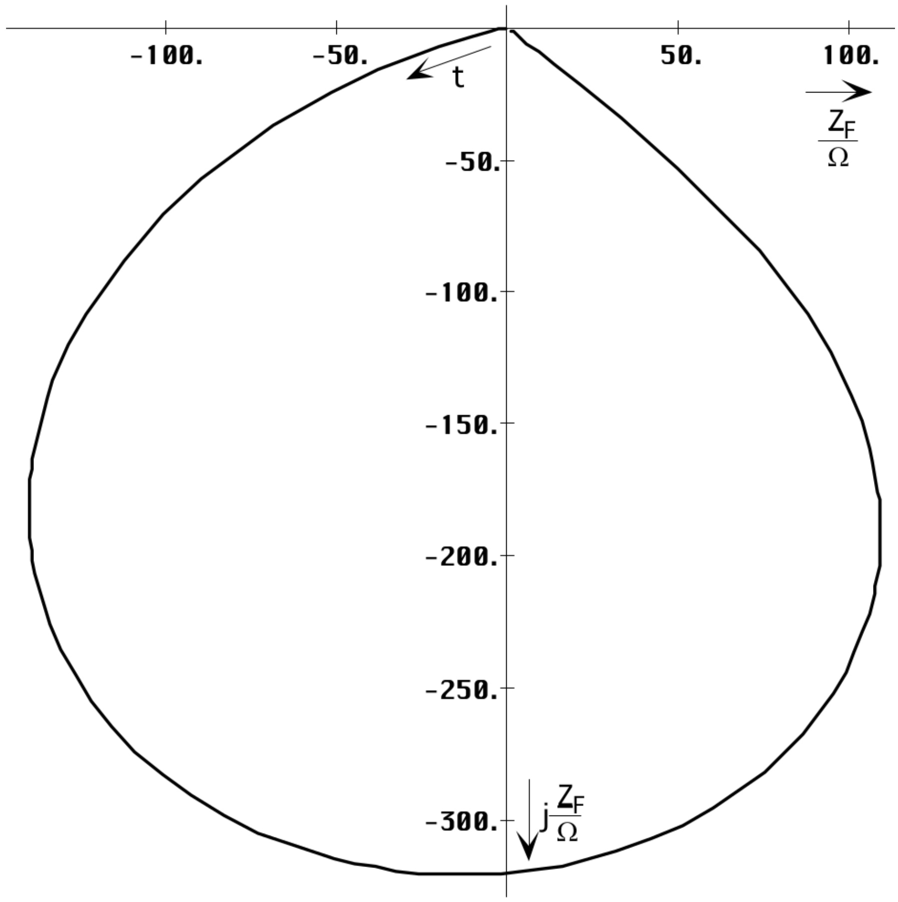


Figure 28
Locus curve of the
field-wave impedance

4.3.4.3.2. Approximative solutions

In [23] is an asymptotic formula for the Hankel function declared. It reads:

$$H_\nu^{(1)}(z) = \sqrt{\frac{2}{\pi z}}\; e^{j\left(z - \frac{\pi}{2}\nu - \frac{\pi}{4}\right)} \left[1 + O\left(z^{-1}\right)\right] \qquad \text{for } 0 < z < \infty \tag{220}$$

Put into (206), one sees that nearly all expressions can be reduced. The root-expression converges to a value of:

$$R = \sqrt{1 - \left(\frac{\left[1 + O_2\left(t^{-1/2}\right)\right]}{\left[1 + O_0\left(t^{-1/2}\right)\right]}\right)^2} \qquad \text{or} \tag{221}$$

By expanding with $[1 - O_0(z^{-1})]$ and suppression of the quadratic terms we get:

$$R = \sqrt{1 - [1 + O_2(t^{-1/2}) - O_0(t^{-1/2})]^2} \approx \sqrt{2O_2(t^{-1/2}) - 2O_0(t^{-1/2})} \tag{222}$$

The root-expression is just only dependent on the remainder terms which is tending to zero as well. Therefore, this base is not suitable for our purposes.

For $\underline{\gamma}$, we have already found an approximation, still remain $\underline{c}$ and $\underline{Z}_F$. In figure 22 we have already figured the course of $\underline{c}$. To the graphic determination of an approximation, we require the logarithmic representation however (figure 29). To be considered, it is the fact that the imaginary part is actually negative.

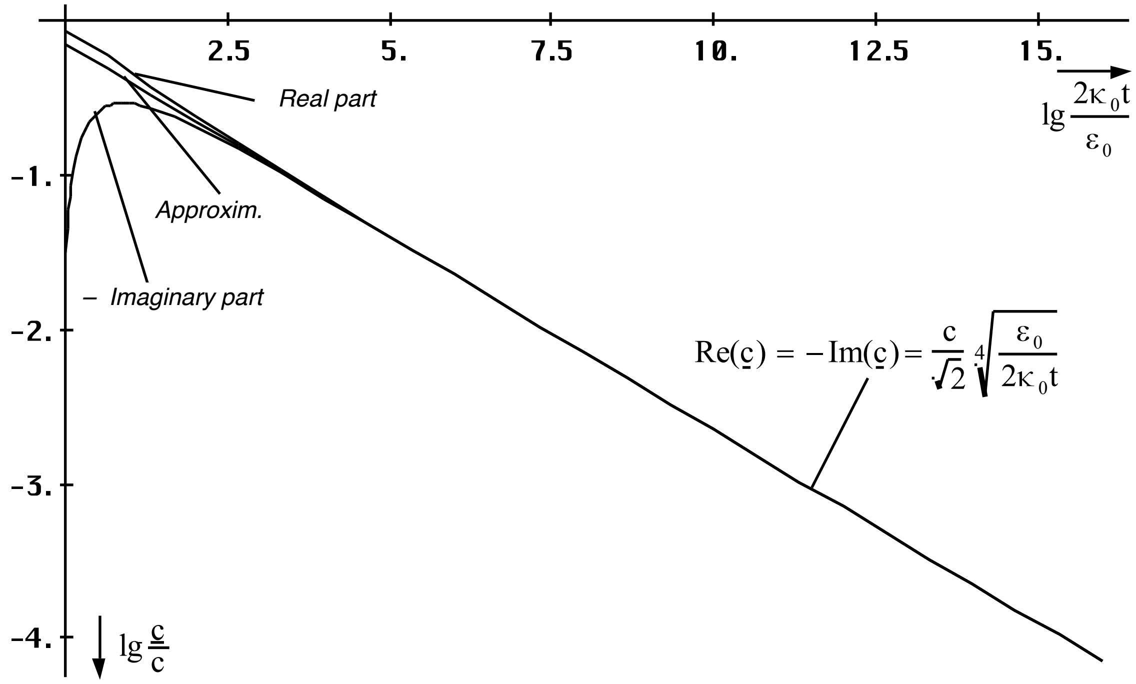


Figure 29
Propagation-velocity
in dependence of time (logarithmic)

$$\underline{c} = \frac{1-j}{\sqrt{2}}\, c \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad \underline{c} = \frac{1-j}{2}\, \frac{c}{\sqrt{\omega_0 t}} \tag{223}$$

$$|\underline{c}| = c \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad |\underline{c}| = \frac{c}{\sqrt{2\omega_0 t}} \quad (1.0916 \cdot 10^{-22}\ \mathrm{ms}^{-1}) \tag{224}$$

$$\underline{Z}_F = \frac{1-j}{\sqrt{2}}\, Z_0 \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad \underline{Z}_F = \frac{1-j}{2}\, \frac{Z_0}{\sqrt{\omega_0 t}} \tag{225}$$

4.3.4.3.3. Propagation-function

First we want to put an approximation of the propagation-function. One can work with very large precision using the approximation equations with it. For larger arguments, we achieve by application of (220) the essentially more simply manageable expressions (analogously for H):

$$\underline{\mathbf{E}} = \mathbf{E} \sqrt{\frac{2}{\pi \,|\, 2\omega_0 t + j\underline{\gamma} x \,|}}\; e^{j(2\omega_0 t - \frac{\pi}{4}) - \underline{\gamma} x} \tag{226}$$

The value-function appears here in the root-expression, since character phasing is determined by the exponential-function only, as one can discover in figure 13 and 14 very well. The phase-angle π/4 is of subordinate interest for the approximation so that it can be omitted therefore:

$$\underline{\mathbf{E}} = \mathbf{E} \sqrt{\frac{2}{\pi \left| 2\omega_0 t + j\underline{\gamma} x \right|}} \; e^{j2\omega_0 t - \underline{\gamma} x} \tag{227}$$

Substituting the approximations for $\underline{\gamma}$ (218) we determine both ω_0 , as well as $\underline{\gamma}$ being functions of time. It's no further critical for $2\omega_0 t$, since it will be multiplied with t anyway. Differently with $\underline{\gamma}$, it should depend on x only. To the substitution of t, we require the phase velocity v_{ph}. It applies $t=x/v_{ph}$ then. On the basis of the factor 2 the phase velocity is defined as follows:

$$v_{ph} = \frac{2\omega_0}{\beta} = \frac{2c}{\sqrt{2\omega_0 t}} = 2 \left| \underline{c} \right| \qquad \text{for } t \gg 0 \tag{228}$$

The phase velocity is equal to the double absolute amount of propagation-velocity. This is caused by the factor 2 on the other hand, since character phasing propagates with double frequency even with double velocity. As a matter of interest, the group velocity should be declared here as well:

$$v_{gr} = \frac{1}{d\beta / d\omega_0} = -2 \left| \underline{c} \right| \qquad \text{for } t \gg 0 \tag{229}$$

Both results are equal with the exception of sign. That means, propagation takes place distortion-free. By substitution of $t=x/v_{ph}$ in (218) we get with $t^3=\kappa_0\varepsilon_0\mu_0^2 x^4/4$ and the product $\underline{\gamma} x$ the following expressions for $\underline{\gamma}$:

$$\underline{\gamma} = \frac{1}{2}(1+j)\sqrt[3]{\frac{4\kappa_0^2 Z_0^2}{x}} = (1+j)\,\kappa_0 Z_0 \sqrt[3]{\frac{r_1}{2x}} \tag{230}$$

$$\underline{\gamma} x = \frac{1}{2}(1+j)\sqrt[3]{4\kappa_0^2 Z_0^2 x^2} = \frac{1}{2}(1+j)\sqrt[3]{\frac{4x^2}{r_1^2}} \tag{231}$$

The result is stunning. $\underline{\gamma}$ is proportional $x^{-1/3}$ and the time t can be eliminated totally. Unfortunately, one can declare $\underline{\gamma}(x)$ explicitly only in the approximation. With the exact function (217) a separation, especially of t, is absolutely impossible. Other solution-procedures must be applied here. A simple base arises as follows:

In figure 27 we have proven that the radius ascends linearly with smaller arguments. With it, the dependences figured in (230) and (231) are valid even for small arguments, however not in x but in r. For larger arguments it is not of interest, whether one reckons with x or with r anyway. However then, it's necessary to multiply both, $\underline{\gamma}$ as well as x with $\sqrt{2}$ because of ($r=x\sqrt{2}$), since propagation takes place as well into x, as into y-direction. The rotation θ is defined by the imaginary part. It applies:

$$\underline{\gamma} r \mathrel{\hat{=}} \sqrt{(j2\omega_0 t)^3} \qquad \text{or rearranged} \qquad 2\omega_0 t \mathrel{\hat{=}} \sqrt[3]{j\left(\underline{\gamma} r\right)^2} \tag{232}$$

Since it's the phase velocity which is important for the propagation-function only, being real and having always the same direction like propagation direction, even only the value-function is required:

$$\left| \underline{\gamma} r \right| \mathrel{\hat{=}} \sqrt{(2\omega_0 t)^3} \qquad \text{or rearranged} \qquad 2\omega_0 t \mathrel{\hat{=}} \sqrt[3]{\left| \underline{\gamma} r \right|^2} \tag{233}$$

With it, an approximative solution $\underline{\gamma}(r)$ would be valid until down to t=0 precisely. However, the rotation about the angle θ remains unconsidered then. Now however, we have a case on hand in which α and β are containing as well attenuation- as phase-information. With it, we are unable to make a reasonable propagation-function. In the case $t \gg t_1$ phase rate and attenuation rate are having the same value overall. Our model behaves similarly like a metal with it. Propagation within a metal takes place about π/4 warped to the entry-direction, α doesn't just actually stand for an attenuation but for the rotation. Since the material-qualities of the metal don't change in general, deviation adds up as long as a value of π is achieved with vertical incidence so that the wave after minimal penetration leaves the metal in reverse direction again. The penetration depth is dependent on material-qualities, wavelength and the incidence-angle. Therefore, electromagnetic waves are reflected by metallic surfaces in general. In the case of our model, the material-qualities aren't constant, $\underline{\gamma}$ is decreasing by time. Therefore it suffices only to one rotation of 90° here and the wave remains in the medium (vacuum). An attenuation doesn't appear ($t \gg t_1$).

In order to take that into account, we take up a rotation about π/4 of the coordinate-system. This corresponds to the multiplication of (231) with $\sqrt{j}$. Also our $\sqrt{2}$ comes into play here and we get a purely imaginary solution: (234) and (235) left side. With it applies α=0 as well as $\underline{\gamma}=j\beta$ and there is no exponentially caused attenuation anyway. Nevertheless, the amplitude of **E** and **H** is decreasing continuously. This is caused by the Hankel function only, as one can discover in the approximation (227) very well (root-expression). Amplitude and phase are coupled closely together with it (minimum-phase-system). The rotatory angle in space now is equal to θ+π/4.

The Hankel function is singular at the point x=0. Therefore, this point is not suitable as origin for a space-temporal coordinate-system, that we require, in order to figure the simultaneous dependence of space and time. Therefore, we will use the „nearest" situated point $r_1/2$. This is the smallest distance at all, with which a space-temporal coordinate-system is possible. Also, we have taken up coupling of φ_0 and **E** at this point. Another reason for the choice of this point is formulated in section 4.6.3. It is this the existence of an inner SCHWARZSCHILD-radius. So even a largest value $\underline{\gamma}_1$ exists, that cannot be exceeded. We consider this by the substitution $r^2 \rightarrow r^2 - r_1^2/4$ (the quadratic action-principle is applied). We finally get:

$$\underline{\gamma} = \quad j\sqrt{2}\kappa_0 Z_0 \sqrt[3]{\frac{r_1}{2r}} \quad \rightarrow \quad -\underline{\gamma} = \frac{j}{r}\sqrt[3]{1-\frac{4r^2}{r_1^2}} \tag{234}$$

$$\underline{\gamma}r = \quad j\sqrt[3]{\frac{4r^2}{r_1^2}} \quad \rightarrow \quad -\underline{\gamma}r = j\sqrt[3]{1-\frac{4r^2}{r_1^2}} \tag{235}$$

Equation (234) and (235) are actually referred to the expansion-centre ($r_1/2$). It is however useful to find a function being based on another point as centre. The best-suited point in this case is the point, at which we are being. The substitution $t \rightarrow T+t'$ leads, due to $r_0=r_1Q_0$ (The tilde stands for the initial value at the point t=0, it's just about a constant), to $r_1 \rightarrow r_0$ and:

$$2\omega_0 t = \widetilde{Q}_0\sqrt{1+\frac{t'}{\widetilde{T}}} \qquad \text{und} \qquad -\beta r = \sqrt[3]{\widetilde{Q}_0\left(1-\frac{4r^2}{\widetilde{r}_0^2}\right)} \tag{236}$$

If we reckon with the radius r, we will make use of β only, in future So a mix-up of the different values $\underline{\gamma}(x)$ and $\underline{\gamma}(r)$ is being avoided as well. Since α=0, the propagation-function simplifies once again:

$$\underline{\underline{\mathbf{E}}} = \hat{\mathbf{E}}_i \sqrt{\frac{2}{\pi(2\omega_0 t - \beta r)}}\, e^{j(2\omega_0 t - \beta r)} \tag{237}$$

With r_0, we have already found one elementary-length. LANCZOS already speaks of a second one however [1]. This is the wavelength of the metric wave-field $\lambda_0 = 2\pi/\beta$. In the approximation of λ_0, it's necessary to divide by $\sqrt{2}$ in order to re-cancel the rotation of the coordinate-system. To the comparison here the expression for r_0 once again. One gets:

$$\lambda_0 = \frac{2\pi}{\rho_0(2\omega_0 t)\kappa_0 Z_0} \operatorname{cosec} \frac{1}{2} \arctan \theta(2\omega_0 t) \tag{238}$$

$$\lambda_0 = \frac{\sqrt{2}\pi}{\kappa_0 Z_0} \sqrt[4]{\frac{2\kappa_0 t}{\varepsilon_0}} = \frac{\sqrt{2}\pi}{\kappa_0 Z_0} \sqrt{2\omega_0 t} \qquad \text{for } \omega_0 t \gg 0 \tag{239}$$

$$r_0 = \frac{1}{\kappa_0 Z_0} \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} = \frac{2\omega_0 t}{\kappa_0 Z_0} = \sqrt{\frac{2t}{\kappa_0 \mu_0}} \tag{240}$$

However is λ_0 smaller than r_0 and with it different from HEISENBERG's elementary-length. λ_0 is in the magnitude of 10^{-68}m. LANCZOS just errs in this point. It has been even only a supposition for his part however. It is rather about the wavelength of the wave-function, that forms our metric lattice itself. (238) till (240) are figuring the time-functions only. The functions of time and locus are as follows.

$$\lambda_0 = \frac{2\pi}{\rho_0(2\omega_0 t - \underline{\gamma} r)\kappa_0 Z_0} \operatorname{cosec} \frac{1}{2} \arctan \theta(2\omega_0 t - \underline{\gamma} r) \tag{241}$$

$$\lambda_0 = \sqrt{2}\pi r_1 \sqrt{\tilde{Q}_0 \sqrt{1 + \frac{t}{\tilde{\tilde{T}}}} + \sqrt[3]{\tilde{Q}_0 \left(1 - \frac{4r^2}{\tilde{r}_0^2}\right)}} \qquad = \frac{\sqrt{2}\pi}{\kappa_0 Z_0} \sqrt{2\omega_0 t - \beta r} \tag{242}$$

$$r_0 = r_1 \left(\tilde{Q}_0 \sqrt{1 + \frac{t}{\tilde{\tilde{T}}}} + \sqrt[3]{\tilde{Q}_0 \left(1 - \frac{4r^2}{\tilde{r}_0^2}\right)} \right) \qquad = \frac{2\omega_0 t - \beta r}{\kappa_0 Z_0} \tag{243}$$

All time/locus-functions are defined for $0<t<\infty$ and for $-r_1/2<x<\infty$. Analogously, time/locus-functions of all other quantities can be determined. The precise and approximative temporal courses of λ_0 (r=0), just as the one of r_0(r=0) are figured in figure 30 and 31.

Figure 31 is somewhat misleading. It looks like, as is r_0 smaller than λ_0. In reality, the graph of r_0 cuts the one of λ_0 at an argument of 450.592 with 21.2271 r_1. The phase-jump, just to be recognized in figure 31, appears with an argument of 0.8968.

Also of interest is the (total-)world-radius K. It arises from the relationship $2\omega_0 A = \beta K$ (A is the total-age) to:

$$K = \frac{\sqrt{1 + 2\omega_0 A}^{\,3}}{\kappa_0 Z_0} \approx \frac{2\omega_0 A^{\frac{3}{2}}}{\kappa_0 Z_0} = \frac{1}{\kappa_0 Z_0} \sqrt[4]{\left(\frac{2\kappa_0 A}{\varepsilon_0}\right)^3} \tag{244}$$

It is this the radius, that one „measures“ moving along the expansion-(world-)line. One cannot determine the exact value and the distance to the centre of expansion however, since we don't know real age anyway.

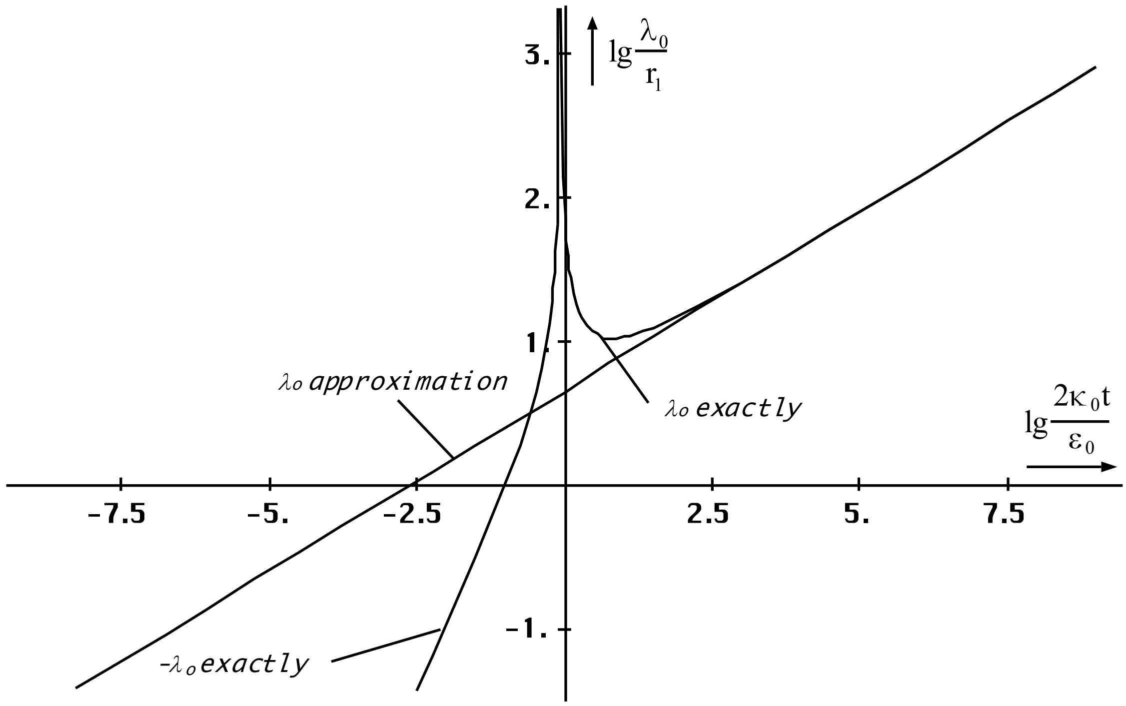


Figure 30
Exact course of λ_0 logarithmic scale

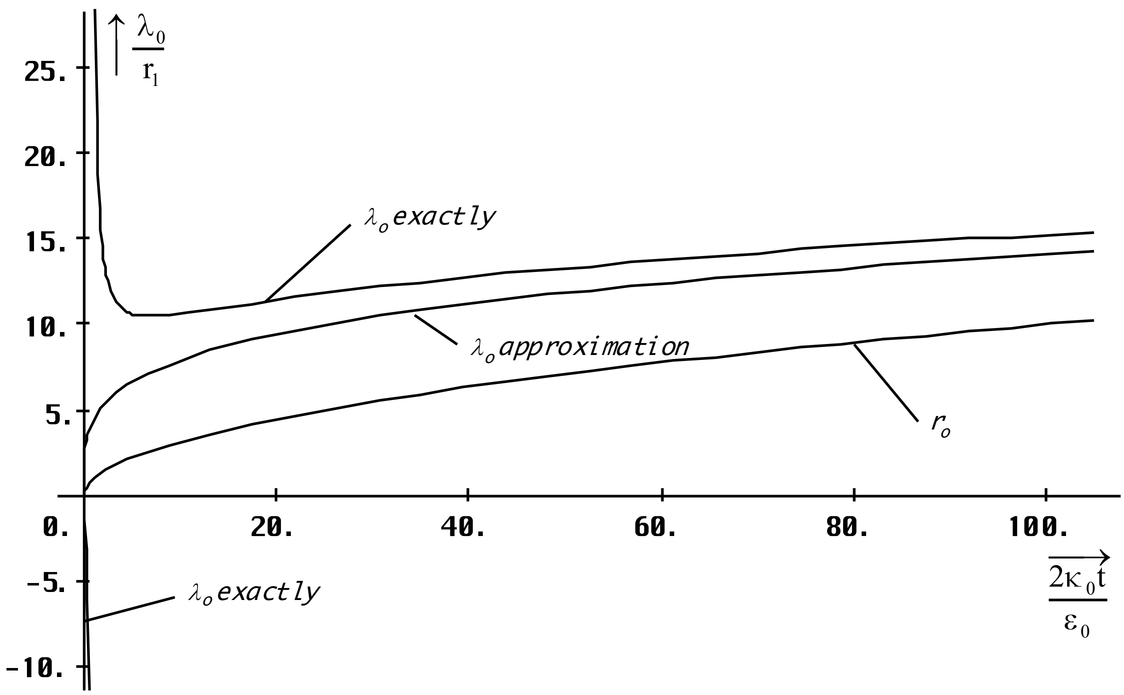


Figure 31
Course of λ_0 exact and approximated
as well as the one of r_0 linear scale

We only now local age T, that results from the local HUBBLE-parameter (245). It quasi-figures the temporal distance to the expansion-centre. It's however possible, to determine the spatial distance to the (local) world-radius R. This one figures a spatial singularity with it. The value of results from the base (246):

$$2\omega_0 t - \beta_0 r = \frac{\omega_0(H)}{H} \qquad \text{bei} \quad r = 0 \qquad T = \frac{1}{2H} \qquad (245)$$

$$2\omega_0 t - \beta_0 r = \frac{\omega_0(H)}{H} \qquad \text{with } 2\omega_0 t = 0 \tag{246}$$

$$R = -\frac{\omega_0(H)}{\beta_0 H} = -\frac{\omega_0 r_0}{H} = -2ct \qquad \text{with} \tag{247}$$

$$\beta_0 = \kappa_0 Z_0 \sqrt[4]{\frac{\varepsilon_0 H}{\kappa_0}} = \sqrt{\frac{c^3}{G\hbar}} = \frac{1}{r_0} \tag{248}$$

We received the value of β_0 from (218) in that we replaced time with the HUBBLE-parameter. The phase rate is just equal to the reciprocal of r_0. The expression for R is:

$$R = -\frac{c}{H} = -1.682\cdot 10^{26}\text{m} = -1.778\cdot 10^{10}\text{Ly} = -5.451\text{ Gpc} \tag{249}$$

The value is roughly 17 billion light-years. Local age amounts to only the half of time, namely 8.8 billion years, according to this model. Trying to calculate total-age A as well as total-world-radius K one recognizes that it won't work. The reason is that present data don't suffice because the equation-system arising from is under-determined anyway. It however applies:

$$\frac{R^4}{K^4} = \frac{1}{H^3 A^3} \qquad \text{and} \qquad HR = -c \tag{250}$$

With the exception of these two we have clearly determined all functions now. And there is no contradiction to already existing theories. But we could still not yet explain cosmologic red-shift.

The examined wave-field forms the metrics of the universe however (empty space), just the MLE. We can already declare it here, further contemplations are reserved to a separate chapter. We go out from (0.23) in it's differential form substituting the common speed of light c with our propagation-velocity c of the metric wave-field:

$$ds^2 = dx^2 + dy^2 + dz^2 - \underline{c}^2 dt^2 \qquad \text{or} \tag{251}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta \; d\varphi^2) - \underline{c}^2 dt^2 \tag{252}$$

Here immediately becomes clear, which physical meaning is assigned to the MLE. For the exact formula, we apply polar-coordinates usefully. We now substitute the exact expression for $\underline{c}$ (r=0):

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) - \frac{c^2 dt^2}{\omega_0^2 t^2 \rho_0^2 (2\omega_0 t - \underline{\gamma} r)} (\sin\frac{1}{2}\arctan\theta(2\omega_0 t - \underline{\gamma} r) - j\cos\ldots)^2 \tag{253}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2 dt^2}{\omega_0^2 t^2 \rho_0^2 (2\omega_0 t - \underline{\gamma} r)} (\cos\arctan\theta(2\omega_0 t - \underline{\gamma} r) + j\sin\ldots) \tag{254}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2 dt^2}{\omega_0^2 t^2 \rho_0^2 (2\omega_0 t - \underline{\gamma} r)} \frac{1 + j\theta(2\omega_0 t - \underline{\gamma} r)}{\sqrt{1 + \theta^2(2\omega_0 t - \underline{\gamma} r)}} \tag{255}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2dt^2}{\omega_0^2 t^2(1 - A^2(\phi) + B^2(\phi))(1 - j\theta(\phi))} \tag{256}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{4\dot{r}_0^2 dt^2}{1 - (A(\phi) - jB(\phi))^2} \tag{257}$$

with $\phi = 2\omega_0 t - \underline{\gamma} r$. Interesting is the reversal of sign. The beam turns into a ball. The previous beam is however still applied to overlaid signals propagating always with speed of light. It adds up the local propagation-velocity (not expansion-velocity!). $A(\phi)$ and $B(\phi)$ determine rotation near the singularity. The reciprocal of the expression in the denominator shows a behavior like $t^{1/2}$ according to the absolute value. Now still the approximation (equation (260) is an anticipation of later results):

$$ds^2 = dx^2 + dy^2 + dz^2 + \frac{c^2dt^2}{2\omega_0 t - \underline{\gamma}\sqrt{x^2 + y^2 + z^2}} \tag{258}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta\ d\varphi^2) + \frac{c^2dt^2}{2\omega_0 t - \beta_0 r} \tag{259}$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta\ d\varphi^2) + \underline{\tilde{c}}^2 dt^2\left(\left(1 + \frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^{-1} \tag{260}$$

Moving only in time and not in space, no spatial curvature appears. This motion-type is called time-like world-line (e.g. photons). With it, a curvature is to be equated with the motion of a mass. This must first be accelerated for this purpose. One names this motion-type space-like world-line then. If you use the expansion-centre as origin of coordinate-system, so there is only a temporal dependence. Directly at the point $r = 0$ there are no space-like world-lines possible, however closely alongside. These are directed outside the singularity, the time-like ones inwards then. A body would be repelled by the singularity. It's about a particle-horizon therefore. Another example for this type of singularity are white holes (if existing) and the local world-radius R. Latter one can be passed through by e.g. photons therefore.

The non-existence of space-like world-lines at this point as well is a reason for the fact that there is no universal spatial coordinate-system defined. Such one, if existing, needs to be valid at *each* point anyplace. If there is only one single point, at which it doesn't apply, there is no universal spatial coordinate-system anyway. Contrary to it only space-like world-lines at the total-world-radius K exist. It's about a temporal singularity therefore (event-horizon) that cannot be passed through by photons. With it, there is even no universal time defined, exactly like in the SRT. The time-like world-lines in the vicinity are defined outwards, the space-like ones inwards the singularity. A body would be attracted by the singularity and could even penetrate it. Examples here are e.g. black holes.

Thinkable would be an universe, with the observer always located in the centre, both singularities equally far away, being quasi „connected“ outside space. This is strengthened by the fact that the product HR exactly fits the speed of light, there is just an infinite curvature at both ends and even by the symmetry of the propagation-velocity-time-function (figure 22). Crossing the point, where the phase-jump appears, you will come out at the „other end of the world“. Such a model would be expanding speaking in behalf of a big bang.

Looking at the second expression of (236) one realizes that it describes exactly the just proposed model. For an observer, there is only his local frame of reference. That a motion in space means even a motion in time, we have already determined yet. Expression (236) however clearly shows, that it doesn't matter, into which direction one moves, temporal direction is always the same, opposite to the natural time-direction (because of r^2). This however still means something else: Each observer has the impression that he is standing in the centre of the universe every time. Since the natural time-vector is always larger than that caused by motion, the observer is always moving in the natural time-direction nevertheless (except one flies faster than c). Although, with a relative-motion ($\beta r = \text{const}$) as well as acceleration ($\beta r \neq \text{const}$) a time-reduction appears. This, once again agrees with the statements of the SRT very well.

4.3.4.4. Solution for a loss-affected medium with expansion and overlaid wave

4.3.4.4.1. Model

We assumed, that the vacuum is not loss-free by introduction of a specific conductance κ_0. With it, we could find a maximally rational solution of the MAXWELL equations, which fills the requests to a metrics, being not in contradiction to Special Relativity. According to [1], the propagation of photons happens as an interference of this wave-field. Furthermore we had determined, that this takes place exactly with speed of light. That agrees with the observations and experiments very well. Solution 4.3.4.1. (Classic solution for a loss-less medium) very well describes the propagation-behaviour of photons *without* metrics, but the cosmologic red-shift cannot be explained however. To do so, we are forced to favour another solution. For this, solution 4.3.4.2. (Classic solution for a loss-affected medium) at first comes into question.

If we simply equate $\kappa=\kappa_0$, we will obtain a solution with a wave-propagation-velocity close to zero, which doesn't agree with reality quite obviously. Solution 4.3.4.2. even only describes wave-propagation *in absence of* a metrics. In section 4.6.5.4.1. will be analyzed , how such a wave would behave. The wave persists in the aperiodic borderline case state, it does not really propagates. There is only an expansion, and it survives even only the first periods.

However other circumstances are on hand with a propagation as an interference of a metric wave-field according to 4.3.4.3. Solution 4.3.4.2. as you know, can be obtained even as solution of equation (72) without expansion, which bases on the equivalent circuit figure 11, when $R_0 \to \infty$. With solution 4.3.4.3. R_0 depends on place and time and is also close to infinite. Doing a reverse-calculation with the base $\kappa=\kappa_0$ we get a value, which is close to zero. In order to come again in correspondence with reality, we are just forced to use another model.

In section 4.3.2. we had determined that the MLE as per figure 11 behaves like a low pass of 2nd order for overlaid signals. Therefore, we want to transform the equivalent circuit of the MLE into a low pass. The exact procedure is presented in figure 32. We first of all disconnect the circuit at the marked position elevating the coil L_0. Thus, the proper low pass (centre right) is ready. Although, the therein contained loss-resistor R_0 characterizes only the losses within the MLE. If we now want to model wave-propagation, we must daisy-chain a lot of these elements (figure 33).

We consider the coupling of two line-elements in the interval πr_0, at which point the coupling-factor should be equal to 1. The coupling itself takes place across the magnetic field (figure 4). And exactly with this coupling there's going to be more losses, which are not characterized by the impedance R_0. It's possible to interpret it as exclusive losses of the capacity C_0, For the coupling-losses, we now introduce another impedance R_{0R}, which we already know from figure 10, and assign it to the inductivity L_0. It are about losses with the inductive transfer indeed. The value of R_{0R} calculates generally by analogy with (48). The interesting is now, that all these values R_0, R_{0R}, L_0, C_0 and G_0 change over time, but only very slowly, so that we speak of a quasistatic process. But quasistatic changes can be neglected with the solution of differential equations, describing the real wave propagation ($E(t,r)$). Nevertheless they have an effect all in all, as we will see later.

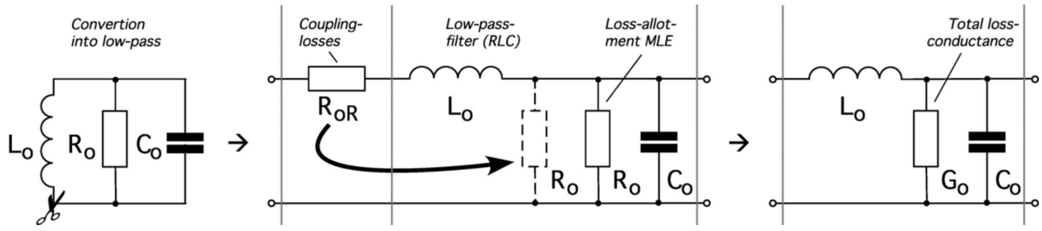


Figure 32
Conversion of the equivalent-circuit of the MLE into a low-pass under consideration of the additional coupling losses

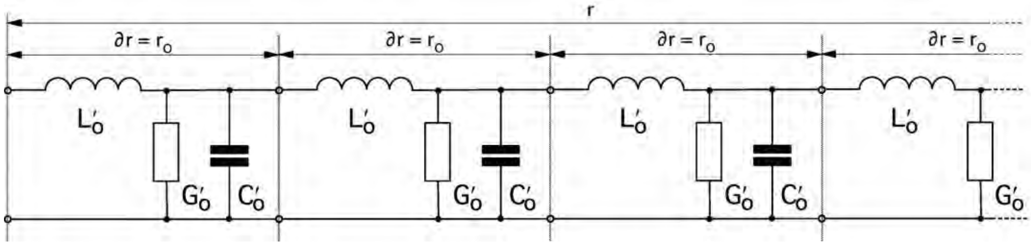


Figure 33
Line-equivalent-circuit with shunt-resistor

Thus we use the model of a conduction to the description of wave propagation in the vacuum. As a result, we hope to find a propagation function similar to that, we found by application of the classic solution for a loss-free medium (□=0), which is not in contradiction to the observations.

At least, we already transform the impedance R_{0R} into an a second parallel loss-resistor R_0, with the help of (47), bunching both together to the total-loss-conductance G_0 with which $G_0=2/R_0$ applies. Figure 32 centre and right are equivalent.

4.3.4.4.2. Approximative solution

First we want to check, whether we cannot use solution 4.3.4.2., if we apply a substitution to κ_0. This is the case indeed. But we don't get a constant in this case, since R_0 is not static. We introduce a substitutive value κ_{0R} to it. With the help of (53), (59), (218) and (247) we obtain:

$$R_{0R} = \frac{1}{\kappa_0 \, r_0} \qquad r_1 = \frac{1}{\kappa_0 \, Z_0} \qquad r_0 = r_1 Q_0 = \sqrt{\frac{2t}{\kappa_0 \mu_0}} \qquad R_{0R} = \sqrt{\frac{\mu_0}{2\kappa_0 t}} \tag{261}$$

$$R_0 = \frac{Z_0^2}{R_{0R}} = Z_0 Q_0 \qquad G_0 = \frac{2}{R_0} = \frac{2}{Z_0 Q_0} = \kappa_{0R} \frac{r_0^2}{r_0} = \kappa_{0R} r_0 \tag{262}$$

$$\kappa_{0R} = \frac{2}{Z_0 Q_0 r_0} = \frac{2}{Z_0 R} = \frac{2}{Z_0 2ct} = \frac{\varepsilon_0}{t} \qquad \kappa_{0R} = 2\varepsilon_0 H = \frac{2\kappa_0}{Q_0^2} \tag{263}$$

R is the world-radius 2ct. Then, inserting (263) into (176) we obtain for the complex propagation-velocity $\underline{c}$ and the field-wave-impedance $\underline{Z}_F$:

$$\underline{c} = c \sqrt{\frac{j\omega t}{1 + j\omega t}} \qquad \underline{Z}_F = Z_0 \sqrt{\frac{j\omega t}{1 + j\omega t}} \tag{264}$$

Now light speed is achieved in infinite time only. Nevertheless, the propagation-velocity is *close* to c. The remainder is filled up by the propagation-velocity $\underline{c}_M$ of the metrics so that the total-velocity is equal to c in turn, which was a basic assumption of this work. The same result we get by solving the telegraph equation [5] (265) for the transient state ($c_1=0$) using the values for C_0, L_0, G_0 as well as $R_0=0$. Figure 33 shows the associated equivalent circuit. In addition we still derive with respect to ∂r, i.e. each low pass-gate now represents the properties of a conducting-section of the length ∂r. The discrete components turn into the capacity, inductivity and conductance covering C'_0, L'_0 and G'_0. Since the vacuum in this model has a finite structure with the smallest increment r_0, applies $\partial r \to r_0$. Fortunately r_0 is sufficiently small, so that we can work with the difference-quotient. Then, we get $C'_0 = C_0/r_0 = \varepsilon_0$, $L'_0 = L_0/r_0 = \mu_0$ and $G'_0 = \varepsilon_0/t = \kappa_{0R}$ for the coverings. With it, the fundamental physical constants ε_0, μ_0 and the substitutive value κ_{0R} are identical to the capacity, inductivity and conductance covering of our „conduction", i.e. the vacuum.

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial r^2} + c_1 \frac{\partial u}{\partial r} + c_2 \frac{\partial u}{\partial t} + c_3 u \qquad \text{with} \qquad (265)$$

$$c = \frac{1}{\sqrt{L'_0 C'_0}} \qquad c_1 = 0 \qquad c_2 = -\frac{R'_0}{L'_0} - \frac{G'_0}{C'_0} \qquad c_3 = -\frac{G'_0 R'_0}{L'_0 C'_0} \qquad R'_0 = 0$$

$$\frac{\partial^2 u}{\partial r^2} - L'_0 C'_0 \frac{\partial^2 u}{\partial t^2} - (C'_0 R'_0 + G'_0 L'_0)\frac{\partial u}{\partial t} - G'_0 R'_0 u = 0 \qquad \text{analogously for i} \qquad (266)$$

$$-\frac{\partial u}{\partial r} = R'_0 i + L'_0 \frac{\partial i}{\partial t} \qquad\qquad -\frac{\partial i}{\partial r} = G'_0 u + C'_0 \frac{\partial u}{\partial t} \qquad (267)$$

$$-\frac{\partial u}{\partial r} = \mu_0 \frac{\partial i}{\partial t} \qquad\qquad -\frac{\partial i}{\partial r} = \frac{\varepsilon_0}{t} u + \varepsilon_0 \frac{\partial u}{\partial t} \qquad (268)$$

This corresponds to a loss-affected line in general. Because of $\mathbf{E}=-\mathbf{u}/r_0$ as well as $\mathbf{H}=-\mathbf{i}/r_0$ we obtain after division by r_0:

$$\frac{\partial \mathbf{E}}{\partial r} = \mu_0 \frac{\partial \mathbf{H}}{\partial t} \;\hat{=}\; \operatorname{curl}\mathbf{E} \qquad\qquad \frac{\partial \mathbf{H}}{\partial r} = \left(\kappa_{0R} + \varepsilon_0 \frac{\partial}{\partial t}\right)\mathbf{E} \;\hat{=}\; \operatorname{curl}\mathbf{H} \qquad (269)$$

In this way the MAXWELL equations can be derived directly. Unlike 4.3.4.2. the parameter κ_{0R} however decreases steadily in this case. The solution itself is not loss-free. An attenuation-factor, different from zero, which can be attributed to the variable parameter κ_{0R} Therefore, it is also named parametric attenuation. Starting with (266), we get for the line-/field-wave-impedance ($\underline{Z}_L = \underline{Z}_F$):

$$\underline{Z}_L = \sqrt{\frac{R'_0 + j\omega L'_0}{G'_0 + j\omega C'_0}} = \sqrt{\frac{j\omega\mu_0}{\varepsilon_0/t + j\omega\varepsilon_0}} = Z_0 \sqrt{\frac{j\omega t}{1 + j\omega t}} \qquad (270)$$

That's the same solution as (264). Because of $Z_0=\mu_0 c$, even the expression for $\underline{c}$ applies. Altogether it's about an autonomous solution with different properties as the hitherto introduced ones. Since no discrete components are involved, the attenuation takes place completely free of noise. The solution is distortion-free. Even no scatter occurs with it. Because of the currently low value of κ_{0R} ($2.1779 \cdot 10^{-29}\,\mathrm{Sm}^{-1}$), the attenuation is not detectable nowadays. Thus, it seems, that wave-propagation would proceed according to the classic loss-less solution. But strictly speaking, it applies only in a universe without expansion ($\kappa_0 = \kappa_{0R} = 0$) and figures a special-case of the solution introduced here. Now, let's have a look at the propagation-velocity $\underline{c}$ in detail.

> *IV. The metric wave-field behaves for overlaid electromagnetic radiation-fields like a conduction with variable coefficients. This conduction behaves in the first approximation like the classic loss-less vacuum solution of MAXWELL's equations.*

$$\underline{c} = \underline{c}_M + \underline{c}_\lambda \qquad\qquad \underline{c} = c\left(\sqrt{\frac{1}{j2\omega_0 t}} + \sqrt{\frac{j\omega t}{1+j\omega t}}\right) \tag{271}$$

Now let's have a look at the value-function:

$$c^2 = c_M^2 + c_\lambda^2 \qquad\qquad c^2 = c^2\left(\frac{1}{2\omega_0 t} + \frac{1}{\sqrt{1+\left(\frac{1}{\omega t}\right)^2}}\right) \tag{272}$$

This expression is even achieved from the MLE (259) after division by dt^2 with $c^2=ds^2/dt^2$. c_M is the propagation-velocity of the metrics. With it, the overlaid wave is moving always rectangular to the metrics with exact c (figure 34). After rearrangement of (271) we get:

$$\omega t = \frac{1}{\sqrt{\left(\frac{1}{1-\frac{1}{2\omega_0 t}}\right)^2 - 1}} \qquad\qquad \omega = \frac{2H}{\sqrt{\left(\frac{1}{1-\frac{1}{2\omega_0 t}}\right)^2 - 1}} \tag{273}$$

Since with expression (273) it's about an approximative solution, we want to try, whether it already can be simplified. With $y=1/(2\omega_0 t)$ we get for $2\omega_0 t \gg 1$:

$$\omega = \frac{2H}{\sqrt{\frac{2y-y^2}{1-2y+y^2}}} \quad\approx\quad 2H\sqrt{\frac{1-2y}{2y}} \quad=\quad 2H\sqrt{\frac{1}{2y}-1} \tag{274}$$

We finally receive after substitution:

$$\omega = 2H\sqrt{\omega_0 t - 1} \quad\approx\quad \sqrt{2}H\sqrt{2\omega_0 t} \tag{275}$$

Because of $H=1/2t$ the frequency is decreasing according to $\omega \sim t^{-3/4}$. We are particularly interested in the wavelength $\lambda=\sqrt{2}\pi/\beta=\sqrt{2}\pi c/\omega$. The sign of (250) has been neglected. The factor $\sqrt{2}$ stands here instead of 2, as even already with λ_0, to cancel rotation around $\pi/4$ of the coordinate-system up taken with the definition of the approximative formula of $\underline{\gamma}(r)$. Then we get the following result:

$$\lambda = \pi\frac{c}{H}\frac{1}{\sqrt{2\omega_0 t}} = \frac{\pi R}{\sqrt{2\omega_0 t}} \qquad\qquad \lambda \sim t^{3/4} \tag{276}$$

To this we must remark that we have assumed, for the previous contemplation, the expansion-centre as basis of the coordinate-system, at which no length is actually defined. More essential qualities result from it for the two singular points.

> *For the* spatial singularity *(expansion-centre) applies: Each length, measured from this point, always has the quantity $r_1/2$. Each period, measured at this point, always has the amount T, each frequency 2H. It's about an event-horizon. It's a drain of the electromagnetic field.* *To the approximation applies $r=\infty$, $t=0$.*

> *For the* temporal singularity *(wave-front) applies: Each length, measured from this point, always has the quantity R/2. Each period, measured at this point, always has the amount t_1, each frequency $2\omega_1$. It's about a particle-horizon. It's a source of the electromagnetic field.* *To the approximation applies r=0, t=∞.*

The spatial singularity only is suitable as basis of a space-independent temporal, the temporal singularity as basis of a time-independent spatial coordinate-system. As basis of a four-dimensional space-temporal coordinate-system, both singularities are equally inappropriate. Seen from the spatial singularity, all time-like vectors have an equal frequency and wavelength. We must pay attention to this on a coordinate-transformation to our local coordinates. It applies for t=T+t′ and for the wavelength λ:

$$\lambda = \frac{2\pi Cc}{\sqrt{\tilde{Q}_0}} \frac{\left(\tilde{T}+t'\right)}{\sqrt[4]{1+\frac{t'}{\tilde{T}}}} = \frac{\pi \tilde{R} C}{\sqrt{\tilde{Q}_0}} \left(1+\frac{t'}{\tilde{T}}\right)^{\frac{3}{4}} \tag{277}$$

$$\lambda = \tilde{\lambda} \left(1+\frac{t'}{\tilde{T}}\right)^{\frac{3}{4}} = \tilde{\lambda} \left(\sqrt{1+\frac{t'}{\tilde{T}}}\right)^{\frac{3}{2}} \tag{278}$$

C is an arbitrary constant, it disappears on a retransformation. Expression (278) represents the temporal dependence. To the determination of spatial dependence, we must visualize that this case differs from the preceding λ_0 and r_0.

Having to do until now with a wave-field which shows different conditions at different places (quantity of r_0, propagation-velocity etc.—therefore different dependences of space and time), the circumstances are deviating in this case. It is about a purely time-like vector, which propagates everywhere with the same velocity, namely c. The dependence of space and time is identical to it, following the same function. Even R/2 expands time-like with a constant velocity of c. Just only, we have to replace t by r. Therefore we expand the fraction in (278) with 2c obtaining:

$$\lambda = \tilde{\lambda} \left(1+\frac{2ct'}{2c\tilde{T}}\right)^{\frac{3}{4}} = \tilde{\lambda} \left(1+\frac{2r}{\tilde{R}}\right)^{\frac{3}{4}} \tag{279}$$

With it, the overlaid wave doesn't behave like the metrics r_0 as well as λ_0 concerning wavelength and frequency. But differences exist also between r_0 and λ_0. There are even more differences then again. So, the distance, the light covers from the source to the observer, is different from the distance, a material body must cover. Latter one amounts to R/2 maximally, while theoretically whatever large distances are possible in the first case. This is clearly the behaviour of a particle-horizon. We call the first one time-like, that second one as space-like distance (see also section 7.5.2.). The conversion takes place in the following manner:

$$r_T = -\frac{r_R}{\sqrt{1-\frac{4r_R^2}{R^2}}} \qquad r_R = -\frac{r_T}{\sqrt{1+\frac{4r_T^2}{R^2}}} \tag{280}$$

We got both expressions, in that we have taken up a bond at the SRT with c=R/(2t) and v=r/t. With help from (279) we can also find a substitution for the expression β, that is applied to signals, which are overlaid the metrics. In contrast to (236) that applies to the metrics itself, we get for the phase rate β of the overlaid wave (not equal to the phase rate of the metrics β_0) because of $\lambda=2\pi c/\omega=2\pi/\beta$:

$$\beta = \frac{\tilde{\omega}}{c}\left(1+\frac{2r}{\tilde{R}}\right)^{-\frac{3}{4}} = \frac{\tilde{\omega}}{c}\Xi(r) \quad \text{with} \quad \Xi(r)=\left(1+\frac{2r}{\tilde{R}}\right)^{-\frac{3}{4}} \quad \Xi(t)=\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{3}{4}} \tag{281}$$

We introduce the two right functions to the better presentation. With the propagation of overlaid waves, β is not identical to α obviously. We obtain α and β from (180, 181) by replacement of κ_0 with κ_{0R}

$$\alpha = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\left(\frac{1}{\omega t}\right)^2}-1\right)} = \frac{\omega}{c}\sinh\left(\frac{1}{2}\operatorname{arsinh}\frac{1}{\omega t}\right) \tag{282}$$

$$\beta = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\left(\frac{1}{\omega t}\right)^2}+1\right)} = \frac{\omega}{c}\cosh\left(\frac{1}{2}\operatorname{arsinh}\frac{1}{\omega t}\right) \tag{283}$$

For $\omega t \gg 1$ outside the near field of a beaming dipole (inside other relationships apply anyway), with help of the approximations arsinh $\varepsilon\approx\varepsilon$, sinh $\varepsilon\approx\varepsilon$, cosh $\varepsilon\approx 1+\varepsilon^2/2$ follows:

$$\alpha = \frac{1}{R} \qquad\qquad \beta = \frac{\omega}{c} = \pm\omega\sqrt{\mu_0\varepsilon_0} \tag{284}$$

Here, we get for the phase rate β a deviant result, namely the same, as with the classic solution for a loss-free medium. The cosmologic red-shift is not just caused by the electric qualities of the line as well as the space but by the line itself. Just once imagine the following: A line is flowed through by an alternating current. A certain wavelength appears. If this line is manufactured from an ideally elastic material now and one pulls at an end, so the line is stretched. Simultaneously, also an enlargement of the wavelength occurs with simultaneous diminution of the conducting-velocity (c in sum).

Since $\alpha\neq 0$, even an attenuation of the amplitude appears. It is however so small, that it becomes effective only in cosmologic time periods. For the electric and magnetic field-strength applies (amplitude response):

$$A = 20\ \lg e^{-\frac{r}{R}} = -8.686\frac{r}{R}\ \text{dB} \tag{285}$$

$$A = 20\ \lg e^{-\frac{t}{2T}} = -4.343\frac{t}{T}\ \text{dB} \tag{286}$$

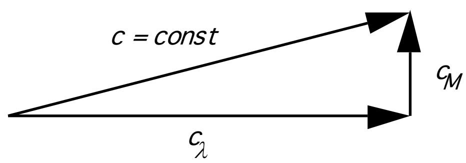


Figure 34
Propagation velocity of the metrics and of an overlaid electromagnetic wave

or $A'=-1\text{Np}/R$. Because of $c=\text{const}$, both expressions are equivalent. With it, the half-life period (–6dB) is about 1.382T, the half-life width about 0.691R. The attenuation is just so small, that it can be neglected mainly, it is far below the geometrical attenuation however. It obviously also appears with the metrics included. With it, it is unattached from the metrics indeed, as one easily can realize in (270). The influence of the metrics is given by r_0 and, as one sees, all r_0 cancel each other. With it, our solution completely emulates wave-propagation and -attenuation admittedly, but not the cosmologic red-shift. Therefore, we divide the portion β (the attenuation rate α is not affected) by the bracketed expression of (279) obtaining our substitute-$\underline{\gamma}$, $\underline{c}$ and $\underline{Z}_L$, it applies $R=r_0Q_0$:

$$\underline{\gamma} = \frac{\tilde{H}}{c} + j\frac{\tilde{\omega}}{c}\Xi(r) \qquad \underline{c}=c \qquad \underline{Z}_L=Z_0 \tag{287}$$

Expression (287) is the propagation rate for signals, that are overlaid the metrics, ($\underline{\gamma}=\alpha+j\beta$). The geometrical attenuation of course still appears. It cannot be neglected, but it's not figured here. The solution is applied to the entire domain $r \gg r_0$, however not in the proximity of the (of a) temporal singularity and with very strong gravitational-fields (black holes). We require the complete solution 4.3.4.4.4 to it.

4.3.4.4.3. Propagation-function

We assume the solution of the telegraph equation for the transient state [5]. The equation-system is also known as conducting-equations.

$$\begin{aligned} &\underline{u}_2 \cosh \underline{\gamma} r + \underline{i}_2 \underline{Z}_L \sinh \underline{\gamma} r = \underline{u}_1 \\ &\frac{\underline{u}_2}{\underline{Z}_L} \sinh \underline{\gamma} r + \underline{i}_2 \cosh \underline{\gamma} r \quad = \underline{i}_1 \end{aligned} \tag{288}$$

In this connection, the index means the input-signal 1, the index 2 the output-signal. We now replace in the following manner:

$$\underline{\mathbf{E}}_1 = -\frac{\hat{u}_1}{r_0}\mathbf{e}_r\, e^{j\omega t} = \mathbf{E}_1\, e^{j\omega t} \qquad \underline{\mathbf{H}}_1 = -\frac{\hat{i}_1}{r_0}\mathbf{e}_r\, e^{j\omega t} = \mathbf{H}_1\, e^{j\omega t} \tag{289}$$

$\mathbf{e_r}$ is the unit-vector. Furthermore, $\underline{Z}_L \approx Z_0$ applies (transient state) and $\underline{u}=\underline{i}Z_0$. Then we get as solution of (288):

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1\, e^{j\omega t - \underline{\gamma} r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1\, e^{j\omega t - \underline{\gamma} r} \qquad \omega = \tilde{\omega}\, \Xi(t) \tag{290}$$

This solution is identical to (165) but it considers the cosmologic red-shift only for $\underline{\gamma}$ (287). We also must notice the temporal dependence of the expression $j\omega t$, i.e. at the source of the signal. The right expression of (290) is used for it. With it, we have found a solution explaining as well the propagation as the cosmologic red-shift of electromagnetic waves.

4.3.4.4.4. Complete solution

If we want to find a solution, being valid even in the proximity of very strong gravitational fields and/or of the temporal singularity, we are forced to calculate with the complete formula. In section 4.3.2. we had noticed that the space owns also an upper cut-off frequency. Solution (290) shows all-pass behavior and doesn't reflect the real circumstances anyway, but it's adequate for more than 99% of all cases. A solution with consideration of the cut-off frequency (downward the frequency is really restricted by the age only) must be a complete solution. Therefore, let's try to find first an approach for a complete solution with and without consideration of the cut-off frequency. We go out from (271), however using the correct expression for the propagation-velocity $\underline{c}_M$ of the metrics (210):

$$\underline{c} = \underline{c}_M + \underline{c}_\lambda = c \qquad \underline{c} = c\left(\frac{e^{-j\frac{1}{2}\arctan\theta}}{j\rho_0\omega_0 t} + \sqrt{\frac{j\omega t}{1+j\omega t}}\right) \tag{291}$$

We look at the value-function again, at which point it's however necessary to pay attention to the fact, that the angle α, depending also on θ, may be unequal to $\pi/2$ (figure 96). Therefore, the cosine-rule applies:

$$c^2 = c_M^2 + c_\lambda^2 - 2c_M c_\lambda \cos\alpha \qquad\qquad \frac{1}{\rho_0\omega_0 t} = \frac{c_M}{c} \tag{292}$$

$$\frac{1}{\sqrt{1+\left(\frac{1}{\omega t}\right)^2}} - 2\frac{\cos\alpha}{\rho_0\omega_0 t\sqrt[4]{1+\left(\frac{1}{\omega t}\right)^2}} + \left(\frac{1}{\rho_0^2\omega_0^2 t^2} - 1\right) = 0 \tag{293}$$

analogously for $Z_0=\mu_0 c$. After reiterated substitution, we get the following solutions:

$$\omega = 2H\sqrt{\frac{y^4}{1-y^4}} \qquad \text{with}^{1} \qquad y = \beta_x^{-1} = \frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha} \tag{294}$$

The second solution is applied to space-like photons. Similarities exist obviously with the reciprocal of (274). The value of y tends to 1 for $Q_0 \gg 1$. Since the real transfer-function is independent from the metrics, (284) is also applied to the complete solution in the far field $\omega t \gg 1$. We continue as in 4.3.5.4.2. To that purpose we first transform:

$$\omega = \frac{2H}{\sqrt{\frac{1}{y^4}-1}} = \frac{2H}{\sqrt{\left(\frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right)^{-4} - 1}} \tag{295}$$

The transition from the exact solution to the approximation will be descripted more exactly in section 5.3.1. The factor 2 turns out by itself with it, that means, with the exact solution the rotation of the coordinate-system is automatically done by the function. We are interested in the wavelength $\lambda=2\pi/\beta=2\pi c/\omega$ once again:

$$\lambda = \pi R\sqrt{\left(\frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right)^{-4} - 1} \tag{296}$$

$$\lambda = C\, R(Q)\sqrt{\beta_x^4 - 1} \qquad\qquad Q = \tilde{Q}_0\left(1+\frac{r}{c\tilde{T}}\right)^{\frac{1}{2}} = \left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \tag{297}$$

C is that arbitrary constant to the conversion upon the R^4-coordinate system once more. The function R(r) describes the *exact* dependence of R concerning the phase-angle/Q-factor Q. The definition of A and B can be taken from (209). We were already able to set $R(t)=1+t/T$ in the approximation. With the complete solution it is unfortunately impossible, because R is propagating and expanding at the same time (see section 6.2.2.1). The relation $R=r_1Q_0^2$ exactly applies only for $Q_0 \gg 1$. The spatial and temporary dependence of R for zero-vectors is given by the right expression of (297). Furthermore $\tilde{Q}=\tilde{Q}_0$ and $R(\tilde{Q})=\tilde{R}$ applies. Finally, we get for the wavelength and frequency:

$$\lambda = \tilde{\lambda}\,\frac{R(Q)}{R(\tilde{Q})}\sqrt{\frac{\beta_x^4-1}{\tilde{\beta}_x^4-1}} \qquad\qquad \omega = \tilde{\omega}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_x^4-1}{\beta_x^4-1}} \tag{298}$$

All values except c and ω are a function of the phase-angle/Q-factor $Q_0=2\omega_0 t$. For just two kinds of photons and neutrinos we define the eight functions[2] $\Xi_x(r)$ and $\Xi_x(t)$:

$$\Xi_\gamma(r) = \Xi_\gamma(t) = \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_\gamma^4-1}{\beta_\gamma^4-1}} \qquad\qquad \Xi_{\bar{\gamma}}(r) = \Xi_{\bar{\gamma}}(t) = \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\gamma}}^4-1}{\beta_{\bar{\gamma}}^4-1}}$$

$$\Xi_\nu(r) = \Xi_\nu(t) = \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_\nu^4-1}{\beta_\nu^4-1}} \qquad\qquad \Xi_{\bar{\nu}}(r) = \Xi_{\bar{\nu}}(t) = \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\nu}}^4-1}{\beta_{\bar{\nu}}^4-1}} \tag{299}$$

---

[1] See (621) relativistic dilatation factor β with $v=c_M$, see also section 5.3.
[2] Siehe Abschnitt 5.3.1.

Responsible for the insertion of the right relationships (substitution r=ct) is the reader himself. But the function is explicitly calculable yet. (287) and (290) are applied. This is the complete transfer-function without consideration of the cut-off frequency. It is valid even in strong gravitational fields and at the „edge" of the universe.

4.3.4.4.5. The cut-off frequency

In section 4.3.2. we have worked out the transfer-function of a discrete MLE of the size r_0 The solution has been applied to the metric wave-field itself. But it's valid even for overlaid waves however, if we understand the overlaid wave as an interference of the differential equation (76). In this case, we have to use $2\omega_0$ for σ in (144) instead of $2\omega_1$, it applies $\Omega=0.5\omega/\omega_0$. First, let's have a look at the part of the total attenuation factor α, caused by ω_g, which can be calculated from the amplitude response $A(\omega)$. Only the real part is being transferred. In connection with the phase-angle ϕ_γ in reference to the length $r_0=c/\omega_0$ applies:

$$\Psi(\omega) = \ln \mathrm{Re}(A(j\omega)) = \ln(A(\omega)\cos\phi_\gamma) \tag{300}$$

$$\Psi(\omega) = \ln\left(\sqrt{1+\Omega^2}\; e^{-\frac{\Omega^2}{1+\Omega^2}} \cos\left(\arctan\Omega - \frac{\Omega}{1+\Omega^2}\right)\right) \quad \text{with} \quad \Omega = \frac{1}{2}\frac{\tilde{\omega}}{\tilde{\omega}_0}\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{1}{2}} \Xi(r) \tag{301}$$

$$\Psi(\omega) = \frac{1}{2}\ln\left(1+\Omega^2\right) - \frac{\Omega^2}{1+\Omega^2} + \ln\cos\left(\arctan\Omega - \frac{\Omega}{1+\Omega^2}\right) \tag{302}$$

$$\alpha = \frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c}\Psi(\omega) \qquad \Psi(\omega) = 0 \quad \text{for } \omega \ll \omega_0 \tag{303}$$

By the way, the part $\Psi(\omega)$ here depends on space and time, since it depends on Ω, the ratio of two frequencies, changing both according to different functions ($\omega \sim t^{-3/4}$, $\omega_0 \sim t^{-1/2}$). So the change don't cancels out. $\Omega \sim t^{-1/4}$ applies in the approximation.

But the cut-off frequency has even effects on the phase rate β. The more approaching the cut-off frequency, all the more the phase-shift ϕ_γ (149) is making noticeable, caused by the ascending phase delay T_{Ph} (151) during transfer of one MLE to the other ($t_1 \rightarrow t_0$). Since the phase-defects add up, there's going to be a retardation of the overall phase-shift $\Phi(\omega)$. This causes a ramp down of the propagation-velocity onto values smaller than c (permitted), remaining ω unchanged, declining λ on the other hand. The smaller value of $|\underline{c}|$ is affecting α and β in the same manner. With the now manageable frequencies, the phase-defect is practically equal to zero however. Before calculating on, we must already convert the phase-shift $\Phi(\omega)$ into units of wavelength however. It applies $\Phi(\omega)=1+T_{Ph}/T_\omega$, where T_ω is the period of ω:

$$\Phi(\omega) = \left(1+\frac{1}{2\pi}\left(\arctan\Omega - \frac{\Omega}{1+\Omega^2}\right)\right) \qquad \Phi(\omega) = 1 \quad \text{for } \omega \ll \omega_0 \tag{304}$$

With it, we can declare the following universal propagation-function for the vacuum:

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1\; e^{j\omega t - \underline{\gamma} r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1\; e^{j\omega t - \underline{\gamma} r} \qquad \omega = \tilde{\omega}\; \Xi(t) \tag{305}$$

$$\underline{\gamma} = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c}\Psi(\omega)\right) + j\frac{\tilde{\omega}}{c}\Xi(r)\right)\Phi(\omega) \qquad |\underline{c}| \le c \qquad |\underline{Z}_L| \le Z_0 \tag{306}$$

The complete solution with frequency response is not required in most cases. With later contemplations we will work further with (306) however. In that cases, in which the cut-off frequency plays no role, applies $\Phi(\omega)=1$.

One quality of the universal propagation-function is that electromagnetic waves with critical frequency, i.e. with a frequency near ω_0, have only a small-scale reach, since with approach to ω_0 both, the phase- and group velocity are degrading with different value. This is however synonymous with the appearance of non-linear distortions, finally causing a total destructive interference to the wave. The behaviour resembles the one of the wave-propagation in an ionized plasma. The signal factually dissolves in noise, an effect, as it everyone knows, who has been observed or executed radio-traffic on shortwave before now.

Theoretically, waves would be possible with hypercritical frequency as well. For these applies the same, said in the preceding paragraph. Even a propagation without aid of the metrics doesn't work across longer distances because of the giant conductivity κ_0. If you should be interested, please look up in section 4.6.5.

4.3.4.4.6. The cosmologic red-shift

From (279) an expression for the cosmologic red-shift can be derived directly:

$$\lambda = \tilde{\lambda}\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{3}{4}} \qquad z = \frac{\lambda-\tilde{\lambda}}{\tilde{\lambda}} = \frac{\lambda}{\tilde{\lambda}}-1 \tag{307}$$

$$\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{3}{4}} = z+1 \qquad \frac{2r}{\tilde{R}} = (z+1)^{\frac{4}{3}}-1 \tag{308}$$

$$r = \frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) \qquad v^{\uparrow} = c\left((z+1)^{\frac{4}{3}}-1\right) \tag{309a}$$

v is the escape velocity. Now one often claims in the literature that this could be also larger than c. But this is not the case. Reason for the wrong claim is a cardinal-mistake that is liked to do even by experts again and again and, I don't want to exclude myself here, in the first edition also by myself. One simply substitutes $\tilde{R}$ with the current value at the observer, obtaining escape-velocities larger c then.

As further wrong conclusion arises that signals with $z>1.28$ should have come from areas behind the event-horizon $\tilde{R}=2c\tilde{T}$ or better, they should have covered a distance longer than $\tilde{R}$. This stands in contradiction to the observations indeed.

While the options of observation were restricted to smaller z-values, it has not been attracted attention to. Meanwhile, already objects with a red-shift of $z=6$ have been found and the red-shift of the cosmic background-radiation has even a value of $z=(2Q_0)^{3/2}\approx 10^{90}$, as described in section 4.6.4.2.3. Now, the reason for such giant values of z is not an universe which is, in reality, much larger than assumed — even if it would be so, there could not exist zero-vectors with a length larger than $\tilde{R}=2c\tilde{T}$, because they would return to their starting point after this distance, i.e. they are closed in itself.

The real mistake is the misinterpretation of (309a). The expressions are namely based on the propagation-function (290) and this is always being related to the starting point of the wave, the signal-source. So it applies to outgoing vectors only. Therefore, we must always substitute $\tilde{R}$ with the value at the source to the point of time of radiation, and all distances and the velocity $v^{\uparrow}$ are always been referred to the source then. The expansion of the universe since the point of time of radiation is namely already included in the exponent 4/3, as one easily can recognize with the help from (277) . By the way, this is applied also to calculations according to the classic model of cosmology, even if the exponent can differ from 4/3 there. For this reason, I have marked both values with the upward-arrow ↑ for outgoing vectors. It reminds something to the wiring sign of a transmitting aerial, which may serve as mnemonic device.

Now we don't know the exact value of $\tilde{R}^{\uparrow}$ indeed, which is associated with the distance between the source and the observer, the value we want to determine originally. What we however know, is the value $\tilde{R}^{\downarrow}$. Since the distances $r^{\uparrow}$ and $r^{\downarrow}$ as well as the velocities $c^{\uparrow}$ and $c^{\downarrow}$ are equal, a simple relationship, that works with the value $\tilde{R}^{\downarrow}$ at the observer, can be found. We do the following approach:

$$r = \frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) = c\left(\tilde{T}^{\downarrow}-t\right)\left((z+1)^{\frac{4}{3}}-1\right) = c\left(\tilde{T}^{\downarrow}-\frac{r}{c}\right)\left((z+1)^{\frac{4}{3}}-1\right) \qquad (309b)$$

$$r = \left(\frac{\tilde{R}^{\downarrow}}{2}-r\right)\left((z+1)^{\frac{4}{3}}-1\right) = \frac{\tilde{R}^{\downarrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right)-r\left((z+1)^{\frac{4}{3}}-1\right) \qquad (309c)$$

After reducing to r, we get the following expressions for r and v:

$$r = \frac{\tilde{R}^{\downarrow}}{2}\left(1-(z+1)^{-\frac{4}{3}}\right) \qquad v^{\downarrow} = c\left(1-(z+1)^{-\frac{4}{3}}\right) \qquad (309d)$$

The expressions (309a) and (309d) yield the same result when substituting the right values. The contradiction has been solved with it. But it is not yet the whole thing. What applies to the value r, applies also to $\tilde{R}$, $\tilde{r}_0$, $\tilde{H}$, $\tilde{\omega}_0$ and $\tilde{\omega}$ in the propagation-function, i.e. if we are working with $\tilde{R}^{\downarrow}$, also these values must be corrected. One always only reckons either with the values at the source or with those at the observer. In more final case, the expressions $\underline{\gamma}$ and ω must be multiplied with a correction-factor. For the world-radius R applies:

$$\tilde{R}^{\uparrow} = 2c\,(\tilde{T}^{\downarrow}-t) = 2c\left(\tilde{T}^{\downarrow}-\frac{r}{c}\right) = \tilde{R}^{\downarrow}-2r = \tilde{R}^{\downarrow}-\tilde{R}^{\downarrow}\left(1-(z+1)^{-\frac{4}{3}}\right) \qquad (309e)$$

$$\tilde{R}^{\uparrow} = \tilde{R}^{\downarrow}\frac{1}{(z+1)^{\frac{4}{3}}} \qquad \tilde{R}^{\downarrow} = \tilde{R}^{\uparrow}(z+1)^{\frac{4}{3}} \qquad \tilde{H}^{\uparrow} = \tilde{H}^{\downarrow}(z+1)^{\frac{4}{3}} \qquad \tilde{H}^{\downarrow} = \tilde{H}^{\uparrow}\frac{1}{(z+1)^{\frac{4}{3}}} \qquad (309f)$$

By using of (308) can be shown that the expression (z+1) is corresponding to the relativistic dilatation factor β. Then further $(z+1)^{2/3}\sim\beta^{2/3}\sim Q_0^{-1}$ applies and on the basis of table 5:

$$\tilde{r}_0^{\uparrow} = \tilde{r}_0^{\downarrow}\frac{1}{(z+1)^{\frac{2}{3}}} \qquad \tilde{r}_0^{\downarrow} = \tilde{r}_0^{\uparrow}(z+1)^{\frac{2}{3}} \qquad \tilde{\omega}_0^{\uparrow} = \tilde{\omega}_0^{\downarrow}(z+1)^{\frac{2}{3}} \qquad \tilde{\omega}_0^{\downarrow} = \tilde{\omega}_0^{\uparrow}\frac{1}{(z+1)^{\frac{2}{3}}} \qquad (309g)$$

$$r_1^{\uparrow} = r_1^{\downarrow} = \frac{1}{\kappa_0 Z_0} \sim (z+1)^{\frac{0}{3}} = \text{const} \qquad \omega_1^{\uparrow} = \omega_1^{\downarrow} = \frac{\kappa_0}{\varepsilon_0} \sim (z+1)^{\frac{0}{3}} = \text{const} \qquad (309h)$$

An exception forms the frequency ω. In contrast to $H\sim Q_0^{-2}$ resp. $\omega_0\sim Q_0^{-1}$ applies $\omega\sim Q_0^{-3/2}$:

$$\tilde{\lambda}^{\uparrow} = \tilde{\lambda}^{\downarrow}\frac{1}{(z+1)} \qquad \tilde{\lambda}^{\downarrow} = \tilde{\lambda}^{\uparrow}(z+1) \qquad \tilde{\omega}^{\uparrow} = \tilde{\omega}^{\downarrow}(z+1) \qquad \tilde{\omega}^{\downarrow} = \tilde{\omega}^{\uparrow}\frac{1}{(z+1)} \qquad (309i)$$

To the correction of $\underline{\gamma}$ and ω, we next consider the product αr:

$$\frac{\tilde{H}}{c}r = \frac{1}{\tilde{R}^{\uparrow}}\frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) = \frac{1}{\tilde{R}^{\downarrow}}\frac{1}{(z+1)^{-\frac{4}{3}}}\frac{\tilde{R}^{\downarrow}}{2}\left(1-(z+1)^{-\frac{4}{3}}\right) = \frac{1}{2}\left((z+1)^{\frac{4}{3}}-1\right) \qquad (309j)$$

$$\frac{\tilde{\omega}_0}{c}r = \frac{1}{\tilde{r}_0^{\uparrow}}\frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) = \frac{1}{\tilde{r}_0^{\downarrow}}\frac{1}{(z+1)^{-\frac{2}{3}}}\frac{\tilde{r}_0^{\downarrow}\tilde{Q}_0^{\uparrow}}{2}\frac{\left(1-(z+1)^{-\frac{4}{3}}\right)}{(z+1)^{-\frac{2}{3}}} = \frac{\tilde{Q}_0^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) \qquad (309k)$$

With it, the parametric attenuation is really unattached from the frame of reference, exactly, as determined by the solution of the telegraph equation. The remaining quantities depend on the respective frame of reference however. With it, we can define the universal propagation-function using the values at the observer. At first however once again correctly with arrows for the values at the source:

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1 \ e^{j\omega t - \underline{\gamma} r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1 \ e^{j\omega t - \underline{\gamma} r} \qquad \omega = \tilde{\omega}^{\uparrow}\, \Xi(t) \tag{309l}$$

$$\underline{\gamma} = \left(\left(\frac{\tilde{H}^{\uparrow}}{c} + \frac{\tilde{\omega}_0^{\uparrow}}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}^{\uparrow}}{c} \Xi(r) \right) \Phi(\omega) \qquad |\underline{c}| \le c \qquad |\underline{Z}_L| \le Z_0 \tag{309m}$$

These expressions are even applied to passing through signals, that are followed up into future. In this case, one inserts the values of the observer instead those of the source, doing just so, as if the observer would be the source. The distance r indeed is defined in reference to the observer then. The same applies even to z. At the place of the observer applies z=0, which is not favorable straightaway, since z is defined absolutely in general, namely on the basis of the red-shift of the absorption-lines of stars. Therefore, a propagation-function, using the values of the observer, with which r and z are however defined in reference to the source, would be suitable better. This arises to:

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1 \ e^{j\omega t - \underline{\gamma} r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1 \ e^{j\omega t - \underline{\gamma} r} \qquad \omega = \tilde{\omega}^{\downarrow}(z+1)\, \Xi(t) \tag{309n}$$

$$\underline{\gamma} = \left(\left(\frac{\tilde{H}^{\downarrow}}{c}(z+1)^{\frac{4}{3}} + \frac{\tilde{\omega}_0^{\downarrow}}{c}(z+1)^{\frac{2}{3}} \Psi(\omega) \right) + j \frac{\tilde{\omega}^{\downarrow}}{c}(z+1)\, \Xi(r) \right) \Phi(\omega) \qquad \ldots \tag{309o}$$

After having figured the real relations extensively once again, it was simply necessary, we now come to the real topic. In table 1, which has been gathered from [27] in excerpts, some quasi-stellar radio-sources are figured with distance-information. The values marked with an * have been taken from the original, the rest has been calculated.

* Source	* z	Escape velocity [v/c]↑	Escape velocity [v/c]↓	* Distance photo-metric [Gpc] ↑	Distance [Gpc] Eq.(309a)↑ [H=76]	Distance [Gpc] Eq.(309a)↑ [H=55]	* Distance geometric [Gpc]↓	Distance [Gpc] Eq. (309d)↓ [H=76]
3C 273B	0.158	0.108	0.089	0.470	0.427	0.588	0.420	0.484
3C 48	0.367	0.259	0.170	1.100	1.023	1.408	0.800	0.928
3C 47	0.425	0.302	0.188	1.270	1.194	1.644	0.900	1.025
3C 279	0.536	0.386	0.218	1.610	1.528	2.103	1.070	1.187
3C 147	0.545	0.393	0.220	1.630	1.555	2.141	1.090	1.198
3C 254	0.734	0.542	0.260	2.200	2.143	2.950	1.310	1.416
3C 138	0.759	0.562	0.265	2.280	2.222	3.059	1.340	1.441
3C 196	0.871	0.655	0.283	2.610	2.583	3.555	1.450	1.542
3C 245	1.028	0.783	0.305	3.080	3.100	4.267	1.590	1.662
CTA 102	1.037	0.791	0.306	3.110	3.130	4.308	1.600	1.668
3C 287	1.055	0.806	0.309	3.160	3.190	4.391	1.620	1.681
3C 208	1.109	0.852	0.315	3.320	3.372	4.642	1.660	1.716
3C 446	1.404	1.110	0.345	4.200	4.392	6.046	1.870	1.877
3C 298	1.436	1.139	0.347	4.300	4.506	6.202	1.890	1.892
3C 270,1	1.519	1.214	0.354	4.550	4.802	6.610	1.940	1.929
3C 191	1.946	1.612	0.382	5.830	6.376	8.777	2.160	2.078
3C 9	2.012	1.675	0.385	6.030	6.627	9.122	2.190	2.097

Table 1: Some quasi-stellar radio sources

For the interpretation of the measuring results, the author used, willy-nilly, the classic model of cosmology with several parameters (parabolic and elliptical). Since the elliptical model with *q*=1 has the best fit with my model, the elliptical values have been taken over. Therefore, one must not expect an exact agreement with the values calculated by me. In order to document the mistake in the first edition more exactly, in column 3 have been figured the escape-velocities >c calculated with the wrong value of $\tilde{R}$. Column 4 is containing the right values.

Column 7 shows the incorrectly calculated distances according to (309a) for a value of H=55 kms^{-1}Mpc^{-1}. One can see, that the values are too high, H has been estimated too low. One furthermore sees, that the author of [27] has committed the same cardinal-mistake obviously. Indeed, the values are only shifted in reference to the photometric distance in the logarithmic representation (figure 35), which corresponds to a multiplication. The corresponding factor has been determined with statistical methods. It amounts to 1.38±0.08. That results in a probable value of the HUBBLE-parameter of 75.9±4.4 kms^{-1}Mpc^{-1} (column 6). The correlation-coefficient to the photometric values is 0.792. The value of H is within the limits determined with modern methods. Obviously, one can achieve right results even with wrong data comparing two wrong results…

All results of table 1 are visualized in figure 35. One sees that the values, calculated correctly according to expression (309d) with H=75.9 kms^{-1}Mpc^{-1} also fit well the geometrical distance (light-way) calculated by the author of [27]. The correlation-coefficient between this two data-series amounts to 0.795. This corresponds to the one of the incorrectly calculated values approximately. In the further course of the work, we will use a value of the HUBBLE-parameter of H=75.9 kms^{-1}Mpc^{-1} therefore. This will be specified in section 7.5. once again.

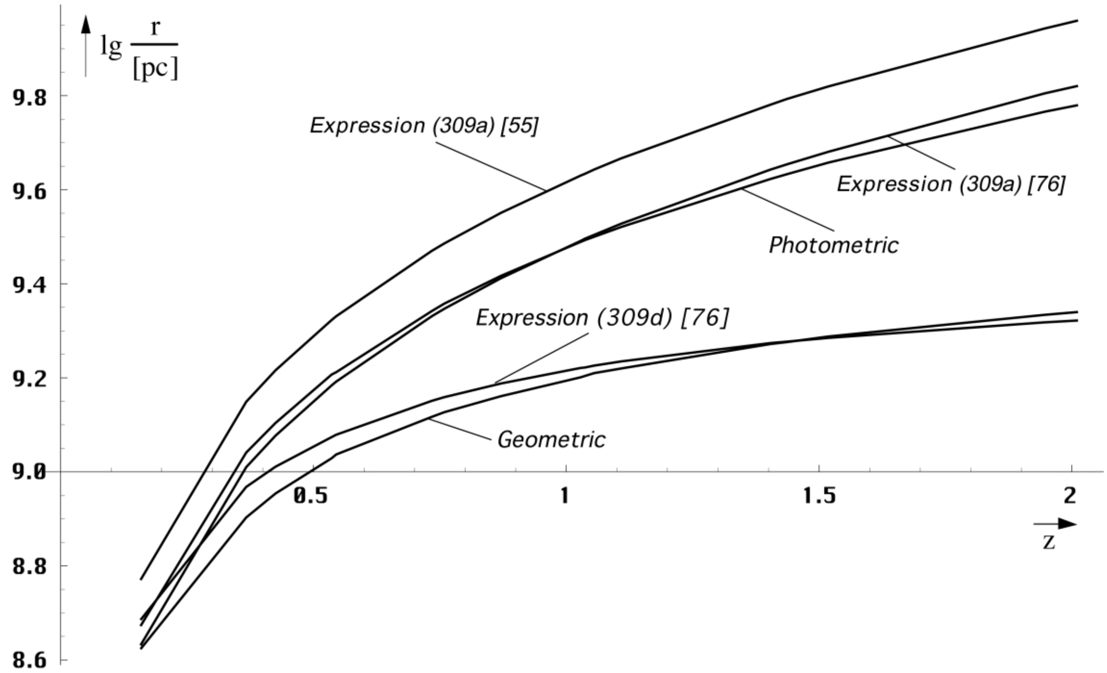


Figure 35
Distance in dependence of the
red-shift for elliptical models (q=1)

The difference in the ascend of both pairs of curves is to be attributed to the application of the classic model of cosmology.

4.3.4.4.7. The HERTZian dipole

In the section 4.3.4.4.2. we have worked out an expression for the line-wave impedance of the vacuum (264). Furthermore we have determined that the spatial singularity behaves like a HERTZian dipole. The HERTZian dipole is the interface between an electronic system and the vacuum. Both can be figured also as a four-terminal network. We just expect circumstances analogical as with a voltage divider. From [20] we understand the legalities in the near field of a beaming HERTZian dipole. The coordinate-system is descripted in figure 36.

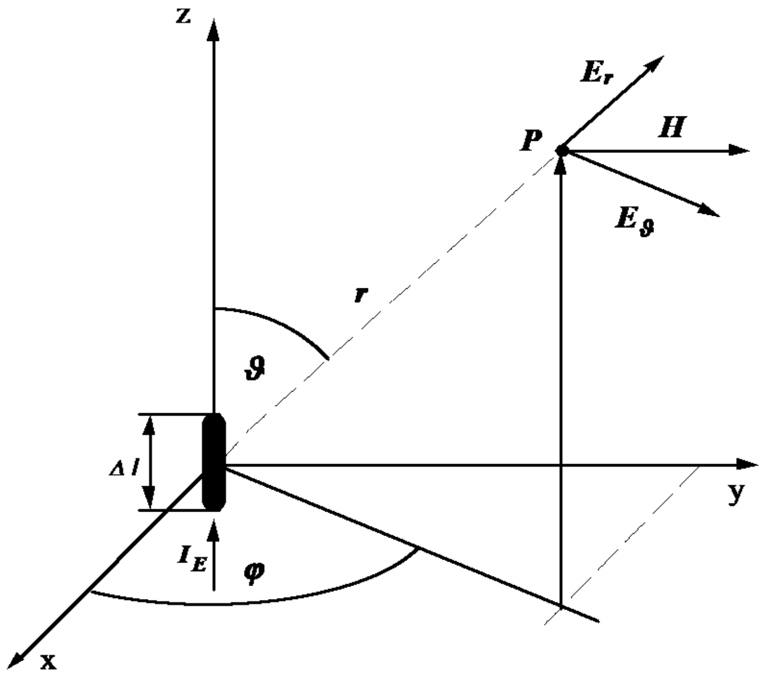
HERTZian field-equations (complex) → radiation-field in the point P:

$$\underline{\mathbf{H}} = \underbrace{\frac{I_E \Delta l}{4\pi}}_{\text{PLANE}} \underbrace{\frac{\sin\vartheta}{r^2}\left(1 + j\frac{\omega r}{c}\right)}_{\text{SPACE}} \underbrace{e^{-j\omega\frac{r}{c}}}_{\text{PROPAGATION DIRECTION}} \underbrace{\mathbf{e}_\varphi}_{\text{UNIT VECTOR}} \tag{310}$$

For the two electric field-strength-vectors applies:

$$\underline{\mathbf{E}}_r = \frac{I_E \Delta l}{4\pi} \frac{2\cos\vartheta}{j\omega\varepsilon_0 r^3}\left(1 + j\frac{\omega r}{c}\right) e^{-j\omega\frac{r}{c}} \mathbf{e}_r \tag{311}$$

$$\underline{\mathbf{E}}_\vartheta = \frac{I_E \Delta l}{4\pi} \frac{\sin\vartheta}{j\omega\varepsilon_0 r^3}\left(1 + j\frac{\omega r}{c} - \left(\frac{\omega r}{c}\right)^2\right) e^{-j\omega\frac{r}{c}} \mathbf{e}_\vartheta \tag{312}$$



Δl « λ

Figure 36
The HERTZian dipole

Looking at these equations more exactly, one recognizes that they implicitly contain the expression for the field-wave impedance $\underline{Z}_F$ of the vacuum (264) found by us, namely in the spatial part. We try to depict these equations as a function of $\underline{Z}_F$ without changing the physical content therefore. It applies $\omega r/c = \omega t$ as well as $I = U/Z_0$

$$\underline{\mathbf{H}} = \frac{1}{4\pi} \frac{I_E}{r} \frac{\Delta l}{r} \frac{Z_0^2}{Z_0^2 - \underline{Z}_F^2} \sin\vartheta \; e^{-j\omega t} \mathbf{e}_\varphi \tag{313}$$

$$\underline{\mathbf{E}}_r = \frac{1}{2\pi} \frac{U_E}{r} \frac{\Delta l}{r} \frac{Z_0^2}{\underline{Z}_F^2} \cos\vartheta \; e^{-j\omega t} \mathbf{e}_r \tag{314}$$

$$\underline{\mathbf{E}}_\vartheta = \frac{1}{4\pi} \frac{U_E}{r} \frac{\Delta l}{r} \left(\frac{Z_0^2}{\underline{Z}_F^2} + \frac{\underline{Z}_F^2}{Z_0^2 - \underline{Z}_F^2}\right) \sin\vartheta \; e^{-j\omega t} \mathbf{e}_\vartheta \tag{315}$$

These are the relationships for a HERTZian dipole of the length Δl in the matching-case (Z_0). Actually certain similarities exist with the voltage divider rule with complex impedances. Applying Z_0 (classic loss-free solution) instead of $\underline{Z}_F$, we would get a result, with which the wave seamlessly passes over to space. Because this never has been observed in reality, it is an indication, that wave propagation rather takes place according to the model presented here. In the case of the spatial singularity, on the basis of the particular qualities, becomes Δl = R/2 as well as K/2. It appears due to it, that the dipole shows equal dimensions into all directions, it has been mutated to a ball-emitter. Therefore, the metric wave-field is not polarized anyway.

4.4. Current values of the universal nature-constants

Having updated the value of the HUBBLE-parameter, it is opportune to depict an overview of all dependent and independent universal fundamental »constants« (table 2). Invariables are marked with the symbols (• ◦). One sees that there are actually only five universal fundamental (•) physical *constants* (μ_0, ε_0, κ_0, $\hbar_i$ and k).

The speed of light is also a genuine constant admittedly, however not fundamentally at all, since it can be combined from μ_0 and ε_0, just as r_1, ω_1 and t_1. The initial value of PLANCK's quantity of action $\hbar_i$ as well as some other values will be described later for the first time. These and all other ones are no genuine constants. They can be figured by combination of the five fundamental values as well as the corresponding space-time-coordinates.

Constant	Symbol	C	Value	Unit of measurement
Speed of light	c	◦	$2.99792458 \cdot 10^{8}$	$m\ s^{-1}$
Induction-constant	μ_0	•	$4\pi \cdot 10^{-7}$	$Vs\ A^{-1}m^{-1}$
Influence-constant	ε_0	•	$8.854187817 \cdot 10^{-12}$	$As\ V^{-1}m^{-1}$
Conductivity-constant	κ_0	•	$1.23879 \cdot 10^{93}$	$A\ V^{-1}m^{-1}$
Boltzmann-constant	k	•	$1.380658 \cdot 10^{-23}$	$J\ K^{-1}$
Planck's init. quant. of action	$\hbar_1$	•	$7.95297 \cdot 10^{26}$	J s
Planck's quantity of action	$\hbar$		$1.05457266 \cdot 10^{-34}$	J s
Gravitational-constant (init.)	G_1		$1.55558 \cdot 10^{-193}$	$m^3kg^{-1}s^{-2}$
Gravitational-constant (Nwt.)	G		$6.67259 \cdot 10^{-11}$	$m^3kg^{-1}s^{-2}$
Poynting-vector metrics (init.)	S_1		$3.3907 \cdot 10^{426}$	$W m^{-2}$
Poynting-vector metrics	S_0		$1.38959 \cdot 10^{122}$	$W m^{-2}$
Fine-structure-constant	α		$7.2973530 \cdot 10^{-3}$	1
Q-factor/phase metrics (g_{00}^{-1})	Q_0		$7.5419 \cdot 10^{60}$	1
Planck's mass	m_0		$2.17661 \cdot 10^{-8}$	kg
Planck's energy	W_0		$1.95624 \cdot 10^{9}$	J
Planck's length	r_0		$1.61612 \cdot 10^{-35}$	m
Planck's time-unit	t_0		$2.6954 \cdot 10^{-44}$	s
Circular frequency of metrics	ω_0		$1.85501 \cdot 10^{43}$	s^{-1}
Wave impedance vacuum	Z_0	◦	$376.73 \approx 2\pi \cdot 60$	Ω
Cut-off frequency vacuum	ω_1	◦	$1.3991 \cdot 10^{104}$	s^{-1}
Smallest time-unit vacuum	t_1	◦	$3.57372 \cdot 10^{-105}$	s
Smallest length vacuum	r_1	◦	$2.14127 \cdot 10^{-96}$	m
Hubble parameter	H		75.9 ± 4.4	$km\ s^{-1} Mpc^{-1}$
Hubble parameter	(ω_{-1})		$2.45972 \cdot 10^{-18}$	s^{-1}
Total age	2T		$1.291818 \cdot 10^{10}$	a
Local age	T		$6.45909 \cdot 10^{9}$	a
Local age	(t_{-1})		$2.03275 \cdot 10^{17}$	s
Local world-radius	R		3.9500	Gpc
Local world-radius	(r_{-1})		$1.21881 \cdot 10^{26}$	m

Table 2: Fundamental physical constants

4.5. Complementary contemplations to the metrics

In section 4.3.4.3. we found with (243) an expression for the temporal and spatial dependence of PLANCK's elementary-length, figuring at least locally a scale for the proportions (distance). On this occasion we refer once again to the fact that this is not applied to the size of material bodies itself, which doesn't change, since it's about autonomous ball-symmetrical solutions of the field-equations according to our assumption [1], that are always stationary according to the BIRKHOFF-theoreme. It doesn't mean that these never changing solutions cannot be *observed* with variable size.

Just particularly is this a matter of the distances of material bodies mutually. These follow a function, which depends on the considered distance on the other hand, since quantity and expansion-velocity of PLANCK's elementary-length is changing with ascending distance to the coordinate-origin. Here only distances with its starting-point in the origin should will be considered. Of considerable importance for deeper contemplations is also the number of the MLEs along an imagined line with the length r (wave count vector Λ). We distinguish two cases in this connection: Wave count vector with constant r and r with constant wave count vector. More final case corresponds to the best the existing circumstances, since one can assume that no point is distinguished to other points in the cosmos. The average relative velocity against the metrics at the coordinate-origin is equal to zero. This should be so everywhere then. With it, the expansion of the universe is traced back to the expansion of the metrics only. This corresponds to the case of a constant wave count vector.

4.5.1. Constant distance

Because of the *real lattice constant* r_0 for smaller distances r the wave count vector **Λ** is defined in the following manner:

$$\mathbf{\Lambda} = \frac{1}{\pi}\frac{r}{r_0}\mathbf{e_r} \tag{316}$$

$\mathbf{e_r}$ is the unit-vector. In the following, we consider only the figure Λ however. For larger distances, we have to replace Λ by dΛ and r by dr using the corresponding expression (243) for r_0:

$$d\Lambda = \frac{1}{\tilde{r}_0}\frac{dr}{(1+t')^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \qquad \text{with} \quad t' = \frac{t}{\tilde{T}} \tag{317}$$

To the solution we replace as follows (it applies $\tilde{R}/\tilde{r}_0 = \tilde{Q}_0$):

$$d\Lambda = \frac{3}{2}\frac{\tilde{R}}{\tilde{r}_0}\frac{r'^2}{a^2-r'^2}dr' \qquad \text{mit} \quad r' = \left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}} \quad \text{und} \quad a^2 = (1+t')^{\frac{1}{2}} \tag{318}$$

$$\Lambda = \frac{3}{2}\tilde{Q}_0\int\frac{r'^2}{a^2-r'^2}dr' = \frac{3}{2}\tilde{Q}_0\left(a\,\text{artanh}^{*)}\frac{r'}{a}-r'\right) \qquad \text{*) arcoth for } |r| > ct \text{ (behind the particle horizon)} \tag{319}$$

$$\Lambda = \frac{3}{2}\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}\text{artanh}\frac{\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right) \qquad \text{def}\ \Lambda_0 = \pi\tilde{Q}_0 \tag{320}$$

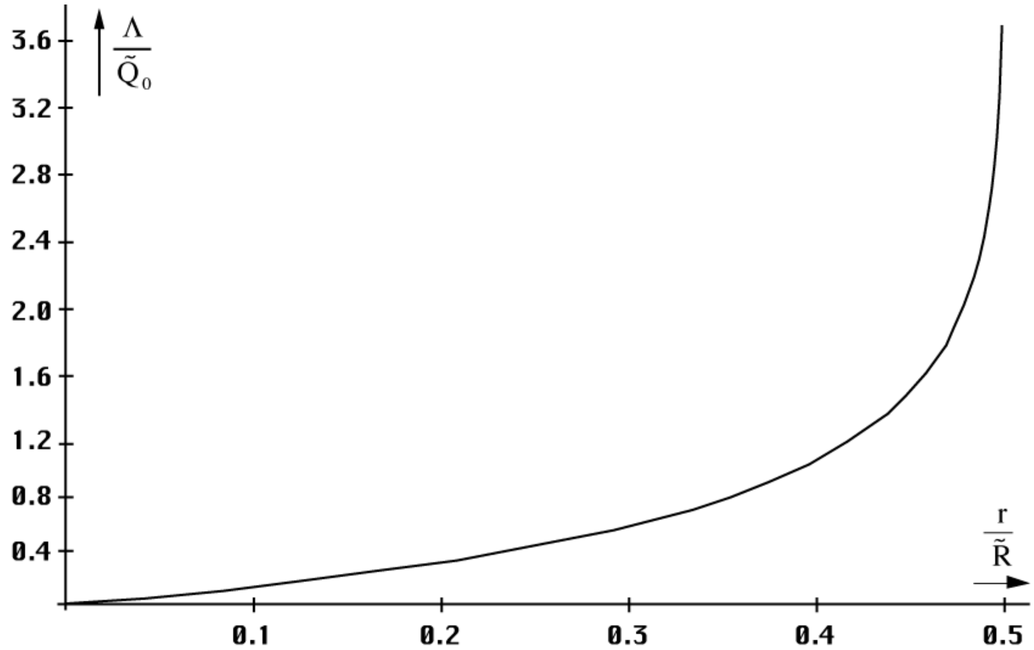


Figure 37
Wave count vector as function
of distance for t=0

The wave count Λ follows the function depicted in figure 37. Approaching to half the world radius (R/2), it seems to be, that Λ strives towards infinity. If we want to define a finite wave count Λ_0, we take only a certain part of the world radius to calculate the wave count for it. We opt for the radius, at which function (320) equals the local Q-factor multiplied with π. The value is 0,49383R, that are 98,7661% of the distance to the particle horizon (cT). In total however an infinite value will not reached, since r_0 is becoming smaller and smaller going to r_1. Out there (Q=1) is the back of beyond, we reached the particle horizon. I guessed the value to $\Lambda_1=Q_0^2$, since even $R=r_1 Q_0^2$ applies. But that's not the case. The little more ambitious calculation for $r = R/2-r_1 \rightarrow 1-10^{-120}$ under application of the power series for $(1-x)^{1/3}$, multiple substitutions up to the transformation of the function artanh→ arsinh→ ln, the result $\Lambda_1 = 3/2\, Q_0 \ln Q_0 \approx 210\ Q_0 = 1{,}58461\cdot 10^{63}$ turns out. For Λ_1 applies $t' \equiv t \equiv 0$ i.e. constant wave count vector. But by expansion and wave propagation „outwards" the phase angle $2\omega_0 T = Q_0$ increases continuously. Because of (53) applies $\Lambda_1(T) = 3/2 \sqrt{bT} \ln \sqrt{bT}$ with $b = 2\kappa_0/\varepsilon_0$.

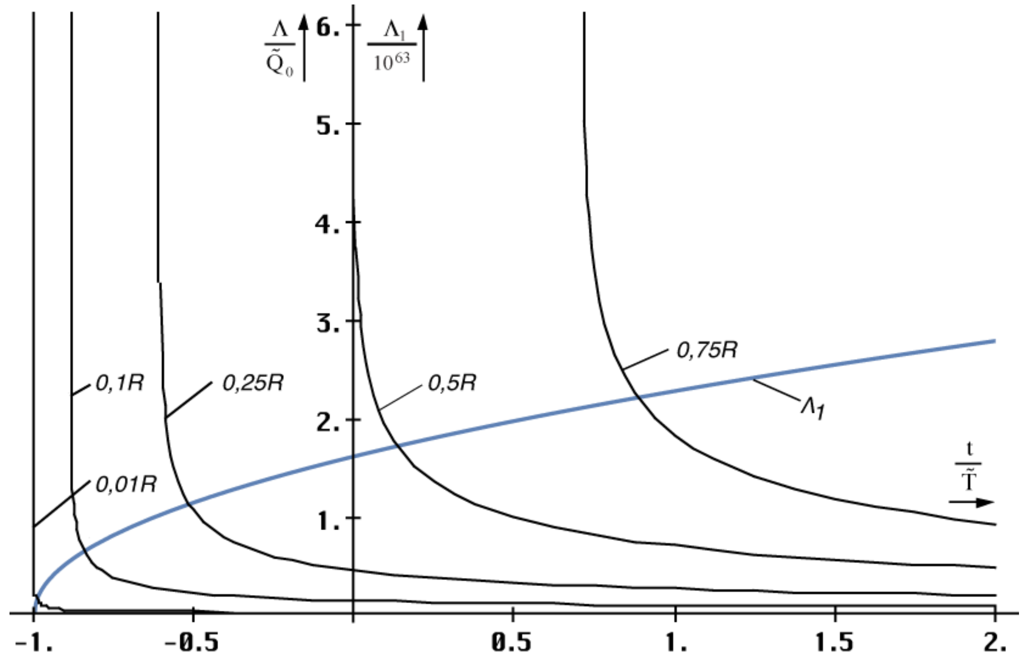


Figure 38
Temporal dependence of the wave count vector
for several distances r

The temporal dependence for several r is shown in figure 38. The larger the considered length, the later the point of time, the wave count vector is defined from on. This is easy to understand, can I however regard a length as existent only then if the world-radius is larger or equal to it. If the world-radius is smaller, so such a length doesn't exist. Therefore, lengths larger than 0.5R aren't defined at present and the function (320) has a real solution not until a value of e.g. t=0.75T, t=0 is the present point of time. Altogether, the wave count decreases. This results from the fact that we are considering a constant length with expanding r_0. So it appears, that MLEs are „scrolled out“ permanently at the „tail“ leading to a degradation of the wave count vector at the same time.

4.5.2. Constant wave count vector

4.5.2.1. Solution

We first assume the right expression of (320) for t=0 (a=1). It declares the quantity of the wave count vector at the present point of time and at each point of time, if we want to assume it as constant. We just look for the function F(a, $\tilde{r}'$) being nothing other as the temporal dependence of a given length $\tilde{r}'$.

$$\Lambda = \frac{3}{2}\frac{\tilde{Q}_0}{\pi}\left(\operatorname{artanh}\tilde{r}' - \tilde{r}'\right) = \frac{3}{2}\frac{\tilde{Q}_0}{\pi}\left(a\ \operatorname{artanh}\frac{\tilde{r}'F}{a} - \tilde{r}'F\right) = \text{const} \qquad (321)$$

An explicit reducing by differentiating and setting to zero (the left expression turns into zero on this occasion) leads to the trivial solution F=0. Otherwise, only an implicit solution can be found as solution of the equation:

$$a\ \operatorname{artanh}\frac{\tilde{r}'F}{a} - \operatorname{artanh}\tilde{r}' - \tilde{r}'(F-1) = 0 \qquad r(t) = \tilde{r}F^3(t) \qquad (322)$$

or in »Mathematica«-notation F1[t,r]:

```
Fa1=Function[a=FindRoot[
#1*ArcTanh[#2/#1*x]-ArcTanh[#2]-#2*(x-1)==0,{x,1},
MaxIterations->30]; (Round[(x/.a)*10^7]/10^7)^3];
F1=Function[Fa1[(1+#1)^.25,(2*#2)^(1/3)]];
```
(323)

In this connection we have to be particular about the method (tangent-method) and the initial value. Equation (322) namely has another second solution. This one, F2[t,r], we get as follows (secant method):

```
Fa2=Function[a=FindRoot[
#1*ArcTanh[#2/#1*x]-ArcTanh[#2]-#2*(x-1)==0,{x,{-30,30}},
MaxIterations->30]; (Round[(x/.a)*10^7]/10^7)^3];
F2=Function[Fa2[(1+#1)^.25,(2*#2)^(1/3)]];
```
(324)

The temporal course of the first solution is figured in figure 39, it's positive. For the first solution, there is only a limited definition-range. This is, on the one hand limited by the spatial singularity (world-radius smaller than considered length), on the other hand by the temporal singularity (the end is now behind the SCHWARZSCHILD-radius). Outside these limits, one gets with (323) the second solution. The larger the considered length all the smaller the definition-area. The second solution but even is defined within the limits of the first one.

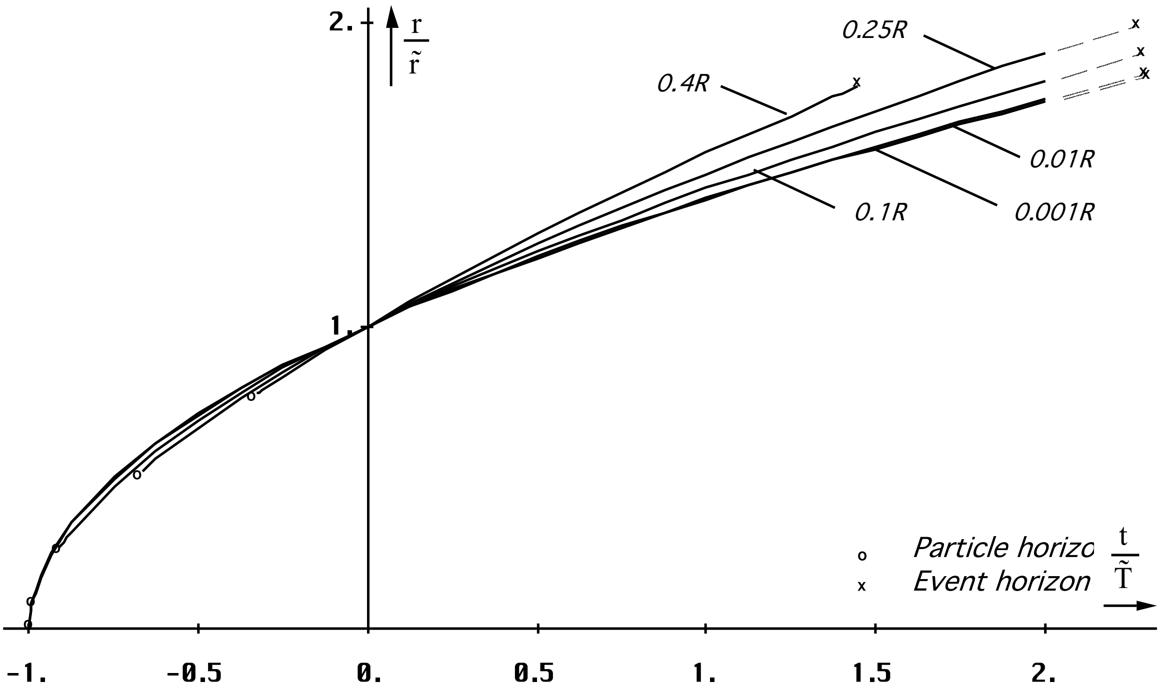


Figure 39
Temporal dependence of a
given distance r (first solution)

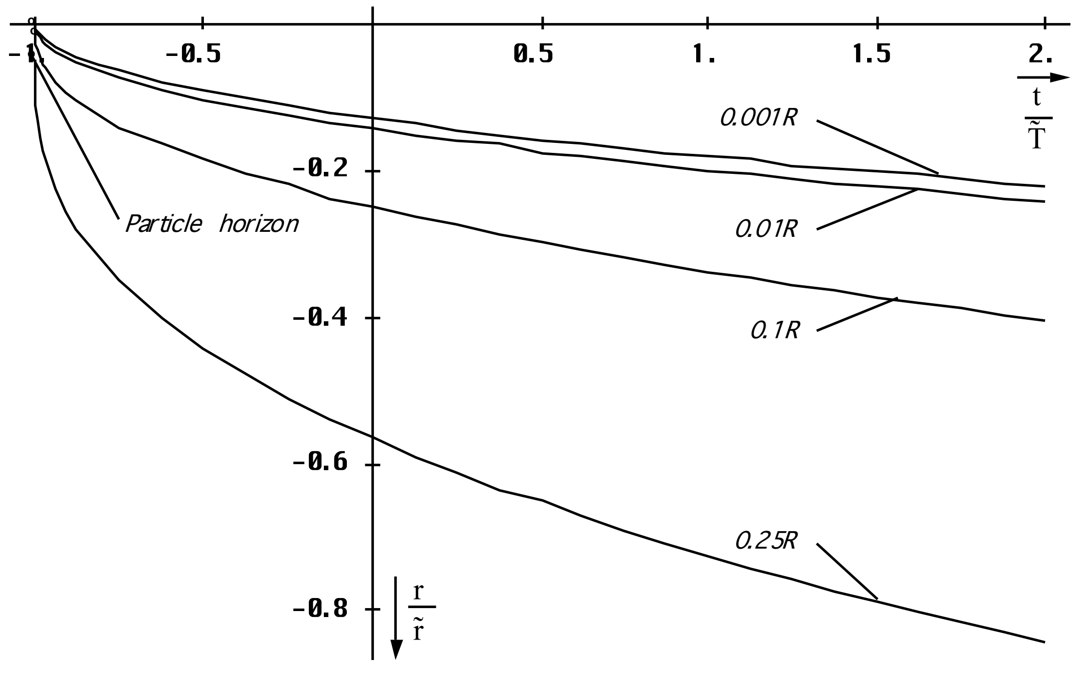


Figure 40
Temporal dependence of a
given distance r (second solution)

The second solution[1] (figure 40), actually a duplicate-solution, is negative. Which physical meaning it has, cannot be said here more exactly. I think that it could be about the solution for time-like vectors like photons coming from the past (negative distance). On the basis of the curvature which is increasing when approaching the local world-radius, our model is closed for space-like vectors. With it, one had to be able to even achieve a certain point when moving into the opposite direction. On the basis of the fact, that the point, we are located, is identical to the coordinate-origin, the question arises then again, what a negative distance actually means.

---

[1] Remark: One obtains the second solution only using Mathematica 1.0. All higher versions display a math error (branch point) during calculation, iteration procedures converge first, but diverge after all. Thus, the existence of a second solution is not deemed to be sure.

For example even another interpretation as distance with motion contrary to the natural time-direction would be possible. For this purpose we would have to move faster than the light then. Does the answer arise here to the question, where and whether one comes out again having fallen into a temporal singularity (black hole) - if one should be still alive? Maybe, someone else knows a valid interpretation. As a support, even the relationship of the second and first solution $-r_2/r_1$ at the point of time t=0 (r_1=r), just today, is declared in figure 41. One recognizes that the second-solution is definitely a space-like vector, since it moves against infinity with R/2.

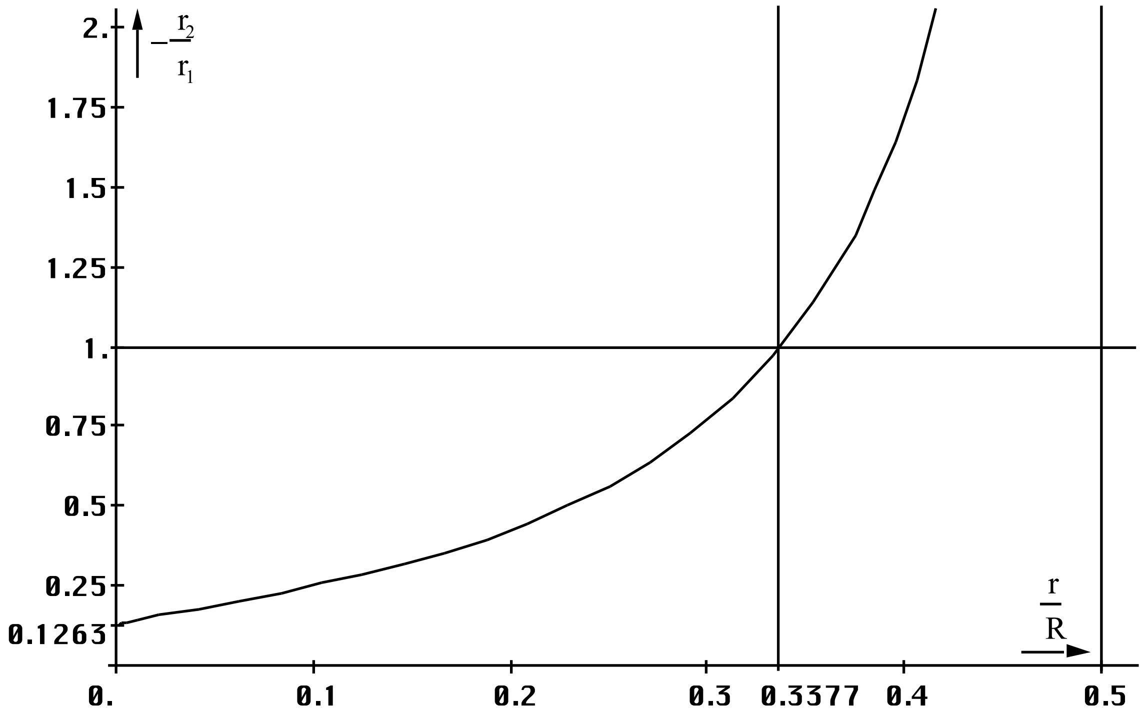


Figure 41
Ratio of second and first solution with t=0

4.5.2.2. Approximative solutions

A simple solution for small r arises explicitly from (322) under application of the two first terms of the TAYLOR series for the function artanh:

$$r \approx \tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} = 2\omega_0 t\,\frac{\tilde{r}}{\tilde{Q}_0} \qquad \text{for } \tilde{r} \le 0.01\,\tilde{R} \qquad (325)$$

This corresponds exactly to the behavior of PLANCK's elementary-length (MLE) and is valid until 0.01R approximately. For larger distances, the ascend is larger too. We first examine the course in the environment of t=0 (figure 42) as well as the ascend $\Delta r/\Delta t$ with $\Delta t=2\cdot10^{-3}$. With root-functions is the ascend (dr/dt) in this point equal to the exponent m in:

$$r = \tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m} \qquad (326)$$

This is shown in figure 43 for both solutions. For the first solution, it is in the range of 1/2…3/4. With the function Fit[] approximative formulas of different precision for the exponent m (first solution) may be found:

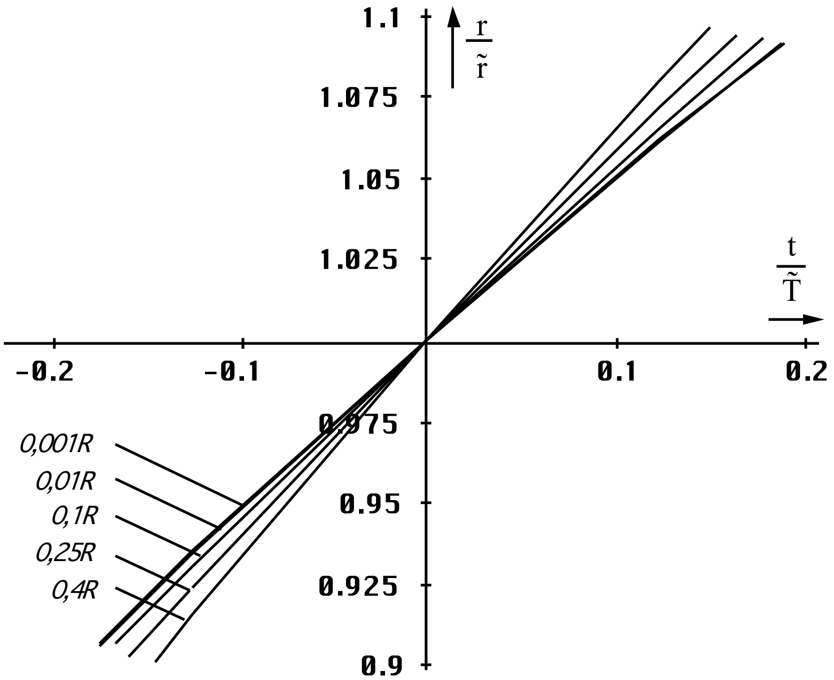


Figure 42
Temporal course of the first Solution near t=0 for different distances r

$$m \approx 0.510614 + 0.180781\frac{r}{\tilde{R}} + 0.52561\frac{r^2}{\tilde{R}^2} \tag{327}$$

$$m \approx 0.5 + 0.545339\frac{r}{\tilde{R}} - 1.39032\frac{r^2}{\tilde{R}^2} + 2.55941\frac{r^3}{\tilde{R}^3} \tag{328}$$

$$m \approx 0.5 + 0.61738\frac{r}{\tilde{R}} - 3.55318\frac{r^2}{\tilde{R}^2} + 18.4405\frac{r^3}{\tilde{R}^3} - 42.6787\frac{r^4}{\tilde{R}^4} + 38.0884\frac{r^5}{\tilde{R}^5} \tag{329}$$

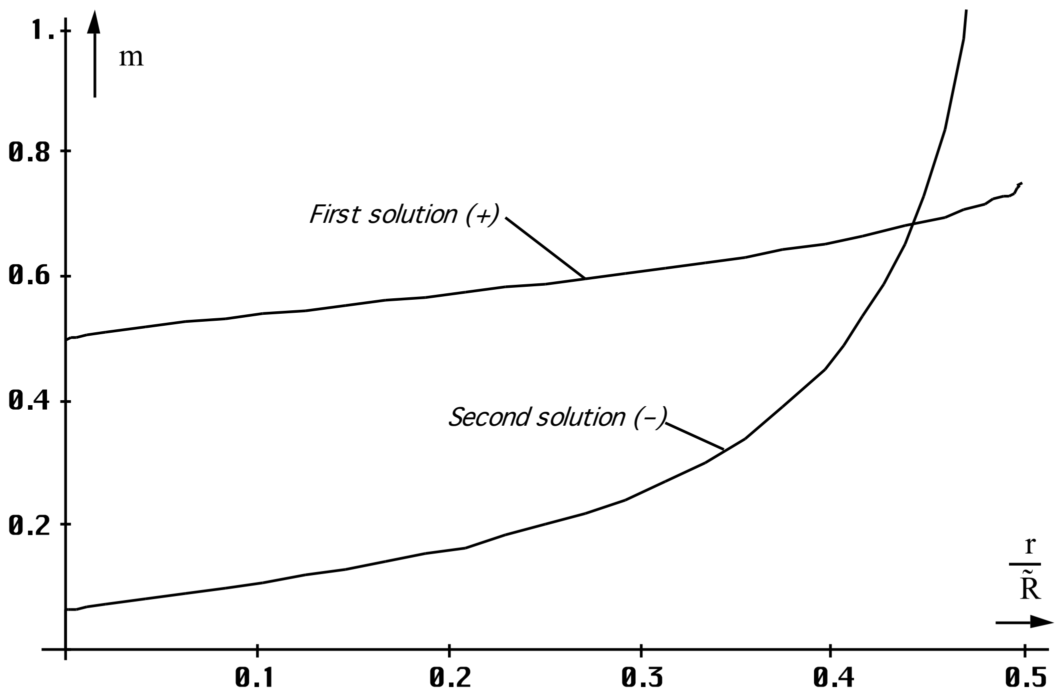


Figure 43
Ascend of both solutions in the proximity of t=0 as a function of the distance r

Equation (329) is very exact and suitable even for calculations with more extreme demands. Indeed, one needs to consider the restricted definition-range, which is not being co emulated automatically by the approximative solution. It is pointed out here once again that the distances and velocities, regarded in this section, are a matter of space-like vectors having nothing to do with the time-like vectors considered in section 4.3.4.4.6. Cosmologic red-shift.

4.5.2.3. The HUBBLE-parameter

Having defined the HUBBLE-parameter only for small lengths and PLANCK's elementary-length (r_0) until now, which are following the relationships for a radiation-cosmos (m=1/2), we have to correct our statements for larger distances. With m=m(r) becomes the HUBBLE-parameter $H = \dot{r}/r$ herewith even a function of the distance:

$$H = \frac{m}{\tilde{T}+t} \qquad H_0 = \frac{m}{\tilde{T}} \tag{330}$$

The course is shown in figure 44. The metrics examined by this model is a non-linear metrics. The question has become unnecessary with it, whether our universe is a radiation- or dust-cosmos. The answer is — as well, as. It's a question of the dimensions of the considered area. For small lengths, the distance behaves like a radiation-cosmos, in the range between zero and 0.5R like a dust-cosmos, with 0.5R like photons overlaid the metrics.

More latter distance is not an area of infinite red-shift however, as in other models. It shows with the dilatory-factor *q* very well The course is figured in figure 45.

$$q = -\frac{r\ddot{r}}{\dot{r}^2} = \frac{1}{m} - 1 \tag{331}$$

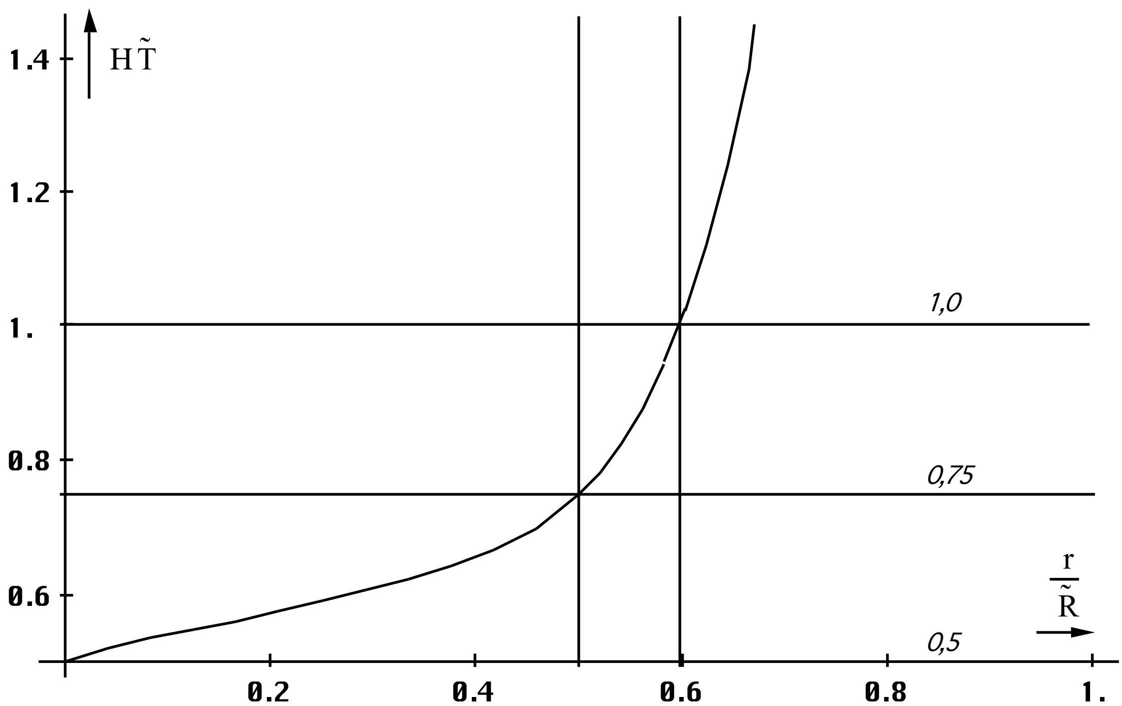


Figure 44
HUBBLE-parameter as a function of the distance for t=0, the values r>0.5R are extrapolated.

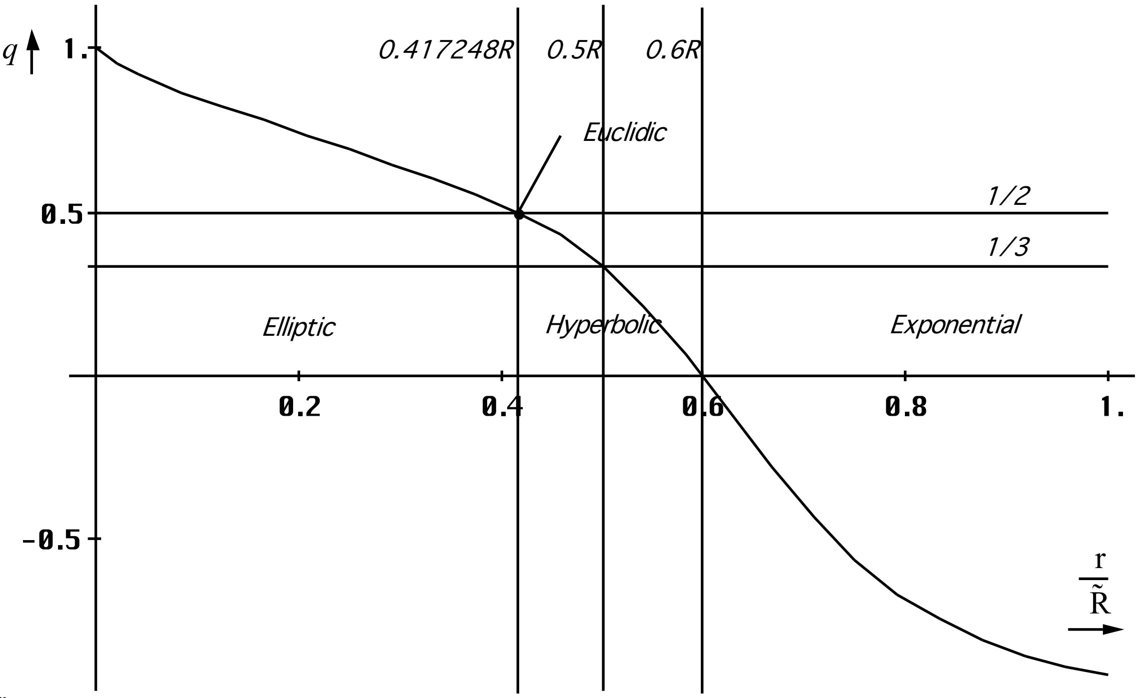


Figure 45
Dilatory-factor as a function of the
distance for t=0, the values r>0.5R are extrapolated.

The expansion-velocity H_0r as a function of the distance is shown in figure 46. The speed of light is already reached in an essentially minor distance as with the standard-models. While the quantity of r_0 is running against zero at 0.5R the expansion-velocity is finite and smaller than c at this point. This has suspected that the entire universe is essentially larger than c, especially since equation (319) allows for r>R with arcoth instead of artanh an extrapolation of Λ. An expansion-velocity of c corresponds to a red-shift of z=0.763301.

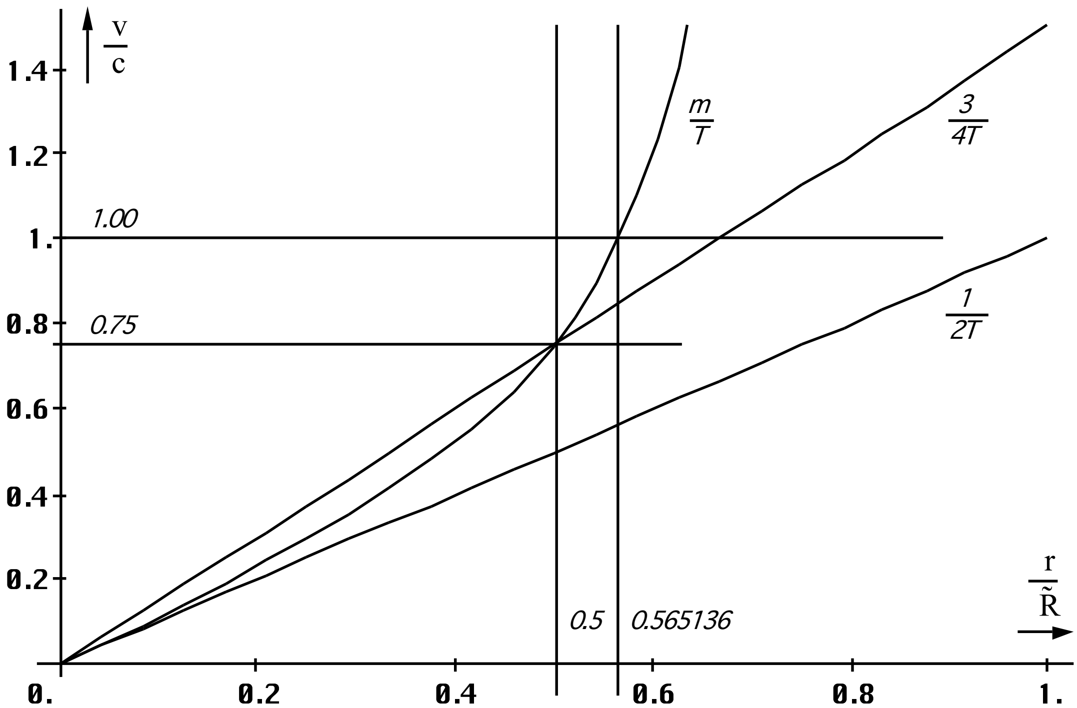


Figure 46
Expansion-velocity as a function of the
distance for t=0, the values r>0.5R are extrapolated.

The cT-limit for space-like vectors is only a consequence of the coordinate-transformation (236) from the spatial singularity (expansion-centre), which is outside our coordinate-system, to our local coordinates. This is applied even to the contradiction between our assumption that the total-universe is expanding with 0.851661c at the wave-front and the values figured in figure 46, which are increasing strongly above R/2. An observer in the vicinity of <0.5R is measuring quite other values for r_0 and T locally. The values at us, seen by this observer, resemble those again, measured by us at the very same observer. For r>0.5R there is no more coordinate-transformation possible anyway, however time-like signals can reach us perfectly well. Overall the universe is open, smaller areas behave like this, as they are closed. This even carries weight for the entropy of the metric field.

4.6. Energy and entropy

4.6.1. Entropy

Now we would like to consider the discrete MLE and our model from the energetic viewpoint. Since entropy is much more important for the thermodynamician than energy, we want to take this into account by examining entropy first. We want to mark entropy with S henceforth. In order to avoid confusions with the POINTING-vector, we will always figure this bold, as vector (**S**) therefore. If we write S, we always mean entropy and with **S** always the POINTING-vector.

Purely statistically seen, the entropy of a system is defined by (332) at which point k is the BOLTZMANN-constant and N the number of the possible inner configurations.

$$S = k \ln N \tag{332}$$

With a single MLE (N=1)) the entropy would be equal to zero theoretically, when applying (332). This is wrong of course, since the statistics necessitates a minimum number of N to be applied at all. With N=1 the result, mathematically seen, can take on a whatever value without offending against the „statistics“. Therefore we want to try to find out, if there is another possibility to determine the entropy of this single MLE.

Exactly considered, with the MLE it's a matter of our ball-capacitor moving in its inherent magnetic field. This has the mass m_0 (29). What happens inside this capacitor, we don't know. It behaves basically like a (primordial) black hole. According to [5] the SCHWARZSCHILD-radius is defined as:

$$r_s = \frac{2mG}{c^2} \tag{333}$$

Let's substitute m with m_0 here now (29), we receive $r_s=2r_0$, substantiating our foregoing assumption. The surface of this black hole yields with it to $A=4\pi r_0^2$. It is interesting that the expression for the SCHWARZSCHILD-radius can be derived even without aid of the SRT or URT. Since the SRT/URT according to this model is only emulated by the metric fundamental lattice, such relationships must be basic qualities of the lattice itself. They apply as well microscopically as macroscopically then.

In [4] is figured a method to determine the entropy of a black hole. It is based on quantum physical considerations fitting our MLE very well. The author assumes the KERR-NEWMAN-solution of the EINSTEIN-vacuum-equations $R_{ik}=0$ with stationary rotating, electrically loaded source and external electromagnetic field (334) with $R\equiv r^2-2mr+a^2$ and $\rho^2\equiv r^2+a^2\cos^2\vartheta$, $M=mGc^{-2}$ and $a=Lm^{-1}c^{-1}$; m is the mass and L the moment of momentum.

$$ds^2 = -\frac{R}{\rho^2}\left[c\,dt - a\sin^2\vartheta d\varphi\right]^2 + \frac{\rho^2}{R}dr^2 + \rho^2 d\vartheta^2 + \frac{\sin^2\vartheta}{\rho^2}\left[\ r^2 + a^2\ d\varphi - a\,dt\right]^2 \qquad (334)$$

We don't want to discuss this here further. The author finally comes to the following statements for the radius $r_\pm$ of the black hole and its surface A:

$$r_\pm = M \pm \sqrt{M^2 - a^2} \qquad\qquad A = 8\pi\left[M^2 \pm M\sqrt{M^2 - a^2}\right] \qquad (335)$$

Let's put in here now $m = m_0$, $L = 0$, so we get with $r_+ = 2r_0$ as well as $A = 4\pi r_0^2$ precisely the same result as in (333). The inner radius coincides with the centre in this case. For $L = \hbar$ we get a solution for an inner SCHWARZSCHILD-radius $r_- = r_0$ as well as $A = \pi r_0^2$. The result is just dependent on the fact, whether the MLE owns a moment of momentum or not.

Furthermore, the author refers to a work of BEKENSTEIN (1973) whereby the entropy of a black hole should be proportionally to its surface. The exact proportionality-factor has been determined by HAWKING (1974) in a quantum physical manner to:

$$S_b = \frac{kc^3}{4G\hbar}A \quad = \quad k\frac{A}{4r_0^2} \quad = \quad k\frac{A}{(4)r_s^2} \qquad (336)$$

k is the BOLTZMANN-constant, the number in bracket is applied to $L = \hbar$. Interestingly enough, this expression contains PLANCK's elementary-length and even with $\hbar$ according to our definition instead of h. If we now insert the values again, so we get:

$$S_b = 4\pi k \quad \text{for } L = 0 \quad \text{as well as} \quad S_b = \pi k \quad \text{for } L = \hbar \qquad (337)$$

Now we want to examine, whether the MLE actually owns a moment of momentum. We are based on our model (effective-value) developed in section 3.3. Generally applies for the moment of momentum **L**:

$$\mathbf{L} \;=\; \mathbf{r}\times\mathbf{p} \;=\; m\cdot(\mathbf{r}\times\mathbf{v}) \qquad (338)$$

With $m = m_0$, $r = r_0$, $v = c$, $c \perp r$ we get after application of (27) and (29) for the amount L:

$$L \;=\; m_0 c r_0 \;=\; \hbar \qquad \text{and because of} \qquad c = \omega_0 r_0 \qquad (339)$$

$$W_0 \;=\; m_0 c^2 \;=\; \hbar\omega_0 \qquad (340)$$

Expression (340) is apparently right. We have explicitly proven with it that the MLE owns a moment of momentum. This one is equal to PLANCK's quantity of action or vice-versa:

> *The PLANCK's quantity of action is defined by the effective-value of the moment of momentum of the MINKOVSKIan line-element. The inherent moment of momentum (spin) is identical to the track moment of momentum.*

The last statement is justified by the fact that it's a matter of effective-value here. In reality, r_0, m_0 and the track- and inherent moment of momentum are temporally variable, nearly periodic functions. PLANCK's quantity of action is the sum of track- and inherent moment of momentum then. This one is equal to $\hbar$, at which point one time the track-, the other time the inherent moment of momentum becomes equal to zero. Such an interdependence even is called dualism. Naturally, PLANCK's quantity of action can be defined not only as moment of momentum. Another possibility is e.g. $q_0\varphi_0$.

Let's go back to entropy. One sees that the BOLTZMANN-constant figures an elementary quality of our metric fundamental lattice, as elementary as ε_0, μ_0 and κ_0. Here, someone will say, this cannot be the matter, since k is a purely statistical constant. One can just answer this interjection: »The BOLTZMANN-constant is so elementary only just because of that it is statistical«. Also π allows to be defined statistically.

We have determined the entropy of one discrete MLE. How does it look with a larger length then again? Since the single-entropy is a multiple of the BOLTZMANN-constant, we can calculate-on with the already known statistical relationships (332). In this connection the (absolute) maximum number of possible inner configurations within a volume with the radius r is given by the number of MLE's contained in this volume. With a cubic-face-centered crystal-lattice, the number of MLE's within a cube with the edge length d is defined as:

$$N = 4\left(\frac{d}{\rho}\right)^3 = 4\left(\frac{d}{r_0}\right)^3 \qquad (341)$$

ρ is the lattice constant in this case. The fc-cube just contains 4 elements in total. Then, within a ball with the diameter $d = \Lambda r_0$ and the volume $\pi/6\,d^3$ there are

$$N = \frac{2}{3}\pi\left(\frac{d}{\rho}\right)^3 = \frac{2}{3}\pi\left(\frac{\Lambda r_0}{r_0}\right)^3 = \frac{2}{3}\pi\Lambda^3 \qquad (342)$$

individual MLE's. As long as ρ is not too large, we can insert (316) for Λ, otherwise (320):

$$N = \pi\tilde{Q}_0^3\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}} \operatorname{artanh}\left(\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{4}}\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right)-\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right)^3 \qquad (343)$$

That's the number of elements within a sphere with the radius r. We obtain a value of $4.23385\cdot10^{183}$ for N_0. Inserting the expression $\Lambda_1 = \frac{3}{2}\,Q_0 \ln Q_0$ into (342), we get even a result for N_1. Here applies $t \equiv 0$ too. The whole universe would contain a total of $N_1 = \frac{9}{4}\,\pi\, Q_0^3 \ln^3 Q_0 = 8.35202\cdot10^{189}$ elements then.

Because of the propagation of the metric wave field even this value is increasing continuously, and that according to $N_1(T) = \frac{9}{4}\,\pi\,(\sqrt{bT})^3 \ln^3 \sqrt{bT}$ with $b = 2\kappa_0/\varepsilon_0$. For information the course of $N_1(T)$ is depicted besides figure 47 right above.

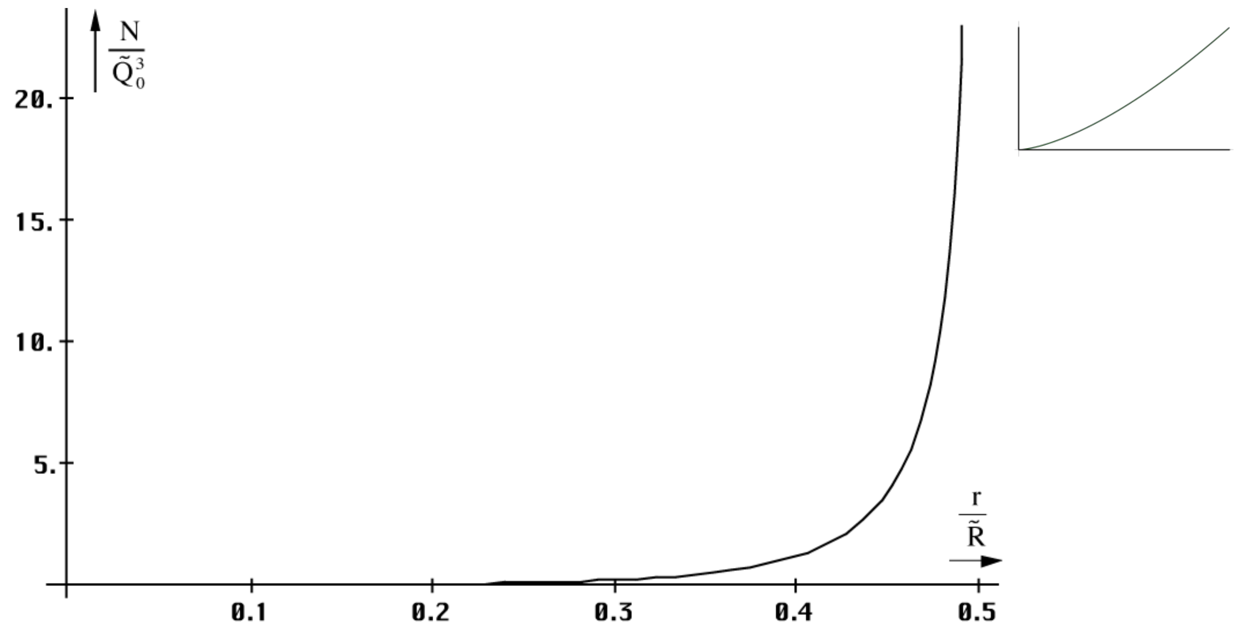


Figure 47
Number of MLE´s in dependence of the radius

The course of N as a function of the radius r at the moment t=0 shows figure 47. There is no anomaly to be seen. If one observes a certain area with the radius r from a frame of reference being moved to it, so no minor entropy-value is measured because of longitudinal-contraction, since r and the world-radius, as well as even t and the age are measured foreshortened in the same manner, so that the respective quotient and with it S doesn't change.

$$S = \pi k \ln\left(\frac{2}{3}\pi\Lambda^3\right) = \pi k \; 0{,}739265 + 3\ln\Lambda \tag{344}$$

In figure 48 you can see the entropy S in dependence of the radius (344). Starting with the value $0{,}739265\,\pi k = 3{,}2065361\cdot10^{-23} JK^{-1}$ at $r=r_0$ entropy ascends continuously, runs through a phase of lower rise and strives with $r\rightarrow cT$ to infinite abruptly. But it doesn't reach this value, since the number of line elements up to the edge is finite (Λ_1).

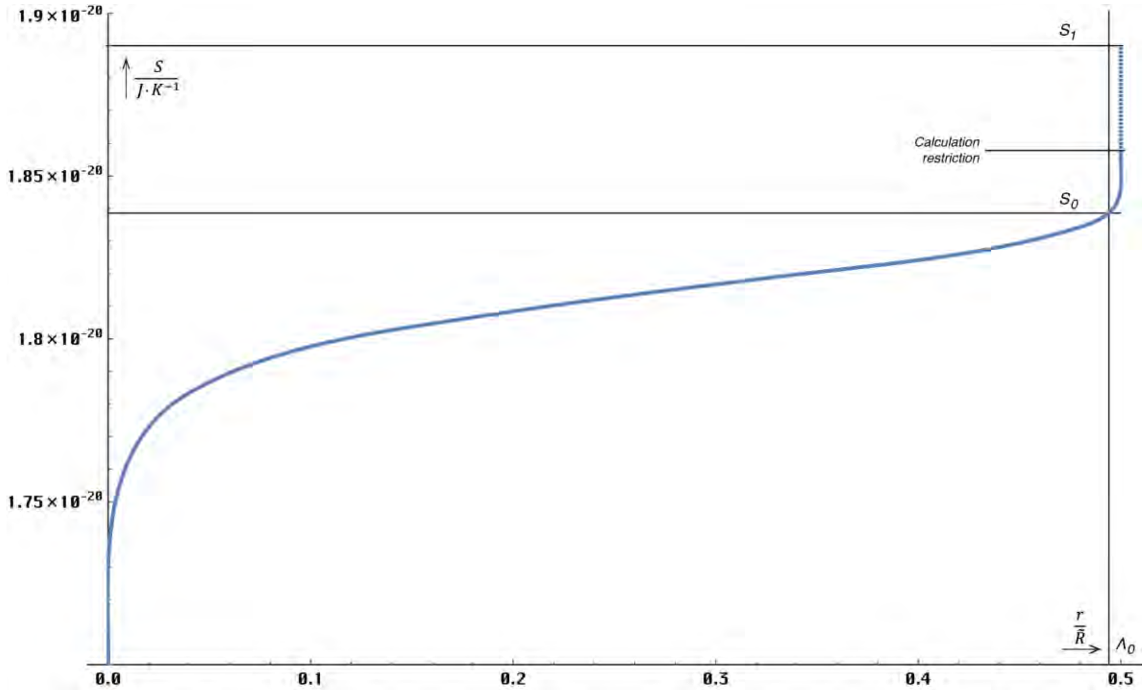


Figure 48
Entropy in dependence of the radius

In the graphics the curve is pictured only up to a certain value, since calculation accuracy is too low— we get a wrong complex solution and the plot stops. I added the missing part until S_1 by hand (dashed line). The plotting problem also occurs in figure 49. Analogously to Λ_0 there is also an entropy S_0:

$$S_0 = \pi k \ln\left(\frac{2}{3}\pi\Lambda_0^3\right) = \pi k \ln\left(\frac{2}{3}\pi^4\tilde{Q}_0^3\right) = 1.8386\cdot10^{-20}\,\mathrm{J\,K^{-1}} \quad \text{(98.7661\%)} \tag{345}$$

We obtain a value of $S_1 = 3\pi k\,(\quad + \ln Q_0 + \ln\ln Q_0) \approx 131\,{}^{2}\pi k = 1{,}89^{7}\cdot 10^{-20}\,\mathrm{J\,K^{-1}}$ for the entropy S_1 of the universe as a whole until the particle horizon. The temporal dependence for the case r=const is shown in figure 49. It applies even to S_0. Interesting is, that the entropy is decreasing for regions with constant dimensions. This could be the „motor“ for the evolution from the inferior to the superior. At the case constant wave count vector the entropy S and also S_0 remains constant over the entire definition range. It is calculated as follows:

$$S = \pi k \ln\left(\pi\tilde{Q}_0^3\left(\operatorname{artanh}\left(\frac{2\tilde{r}}{\tilde{R}}\right)^{\frac{1}{3}} - \left(\frac{2\tilde{r}}{\tilde{R}}\right)^{\frac{1}{3}}\right)\right)^3 \tag{346}$$

In contrast, the value of S_1 increases continuously, because the number of all line elements N_1 grows because of the expansion and wave propagation into the „nothing“. Btw. S_1 is converging towards a value of $1.92\cdot10^{-20}JK^{-1}$. Hence, the universe strives for a thermodynamic equilibrium. But there is still enough "room at the upside". The interpretation I want to delegate to the specialists however. The starting value of S_1 is equal to $\pi k = 4{,}33747\cdot10^{-23}JK^{-1}$.

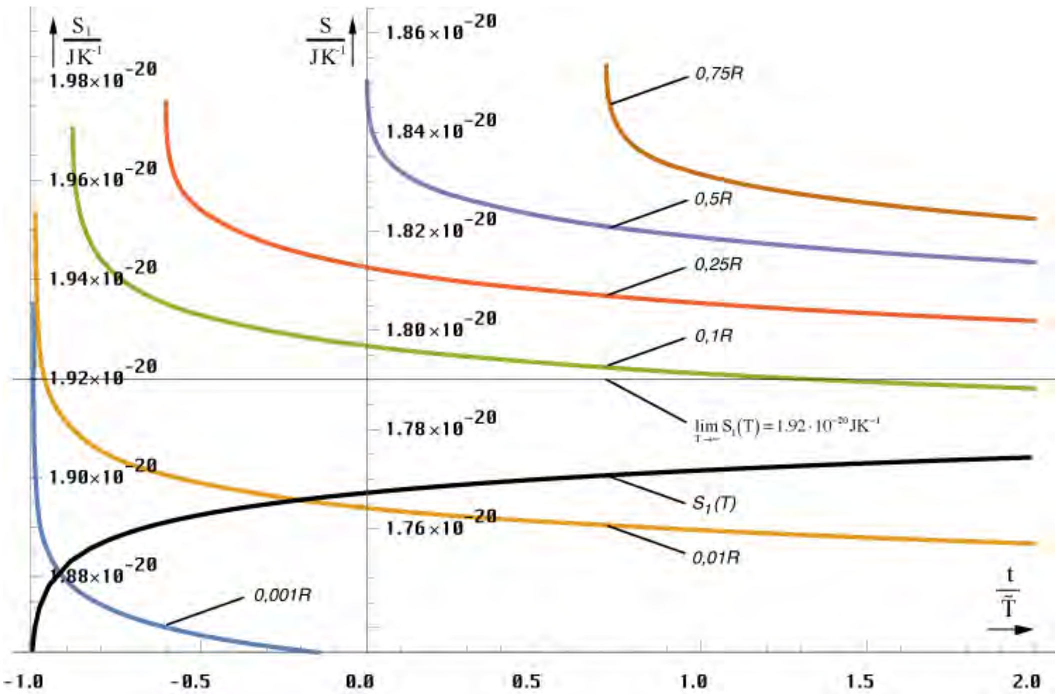


Figure 49
Temporal dependence of entropy
for r=const (linear scale)

But the entropy S with constant wave count vector for several radii isn't defined over all times. That's why certain distances don't exist, until the radius of the expanding universe has reached that extension. Then the start-entropy has exactly the same value as S_1 at this moment, i.e.: The later the entry, the higher the start-entropy. You can see that well in figure 49 despite the plot-calculation problem. If we move up S_1, the curve exactly fits the entry points. Both y-axes are having the same scale and they are just shifted against each other. In reality the entry-values are reaching up to S_1 exactly.

4.6.2. Particle-horizon

We have noticed that there is a singularity in our model in the distance cT. This has the qualities of a particle-horizon. So we have found a good correspondence with other models, which reckon with the same distance, in fact - resulting from the assumption, that the maximum velocity is c. With a „pure“ radiation-cosmos this one had to be at 2cT however. We have to do it with our model with a phenomenon, that I would like to mark as the »2T-problem«. In all possible relationships, the factor appears 2 again and again that is associated with time. It results from the definition of the HUBBLE-Parameter $H = 1/(2T)$. Nevertheless the model behaves, as if there is no such factor at all.

We have already found the solution in the antecedent section. It is this the appearance of an inner SCHWARZSCHILD-radius, well-founded by the fact that the discrete MLE disposes over a moment of momentum (spin) of the size of PLANCK's quantity of action $\hbar$ (spin 2!). On the basis of the relation $R=r_0Q_0$ a particle-horizon exists as well in the macroscopic scale for the local cosmos as whole, as in the sub-microscopic scale with the length r_1 due to the relation $r_1=r_0/Q_0$. This is at $r_1/2$ then. The HUBBLE-parameter $H_0 = \omega_0\, Q_0^{-1}$ has also the character of an angular frequency, exactly as ω_0. Latter one just has the spin 2. It would be no wonder if the universe as a whole would have a spin of the size 2 too ($\hbar_1$). This would explain the phenomenon.

4.6.3. Temperature

Now we want to assign a temperature to the discrete MLE. According to [4] it arises from the GIBBS fundamental equation as well as from (23) and (32) to:

$$T_b dS_b = d(mc^2) - \omega dL \tag{347}$$

$$T_b dS_b = d(m_0 c^2) - d(\hbar\omega_0) = 0 \qquad T_b \equiv 0 \text{ K} \tag{348}$$

because of $\omega_0 \neq$const. This agrees with the observations very well. The famous expression $mc^2=\hbar\omega$ is just nothing other than a special case of the GIBBS fundamental equation for $T_b=0$ on the level of the metric wave-field. This one, thermally seen does not comes into picture — For the case L=0 namely following expression would arise for the temperature:

$$T_b = \frac{\hbar c^3}{8\pi m_0 G k} = \frac{W_0}{8\pi k} \qquad T_b = 5.638 \cdot 10^{30} \text{K} \tag{349}$$

The result (349) deviates from the one which would obtain using the WIEN displacement law, the magnitude is correct however. Indeed this is even only applied to black radiation, while in our case it's about a discrete, very narrow spectral-line. The temperature would be proportional $T_b \sim t^{-1}$. Since this is not the case, it applies:

1. *The temperature of the metric wave-field is equal to zero.*
2. *The discrete MLE owns the moment of momentum of $\hbar$.*
3. *The inner SCHWARZSCHILD-radius of the MLE is equal to $r_0/2$.*
4. *The inner SCHWARZSCHILD-radius of the local universe is equal to cT.*

The PLANCK's quantity of action is also a fundamental quality of the metric wave-field with it. However it is not a constant, so that we will dedicate an individual chapter to it (4.6.4.1.).

Because of the integer spin, the MLE is subject to the BOSE-EINSTEIN-statistics formally. In what extent this is of meaning, cannot be said here. It is *possible* however that effects like e.g. superconductivity are based on the existence of the metric wave-field still owns the MLE a charge, its effective-value is near the electron charge:

$$q_0 = \sqrt{\frac{\hbar}{Z_0}} = 5.288807 \cdot 10^{-19} \text{As} = 3.301378 \text{ e} \tag{350}$$

With the superconductivity, it works around the shape of Cooper-pairs consisting of two electrons with inversely directional spin and FERMI-velocity, just having a charge of 2e and integer spin of zero quantity. They are likewise Bosons with it. So it would be *possible* that such a COOPER-pair occupies the position of the ball-capacitor in our model. On this occasion the charge-difference would amount only approximately 39% of the total-charge of the MLE, so that the electrons can tunnel into the conducting band, how it is the case with semiconductors e.g.. The width of the conducting band results directly from the HEISENBERG's uncertainty principle of energy and time as well as from (23) and (24) to:

$$\Delta W \Delta t \geq \frac{\hbar}{2} \qquad \text{as well as} \qquad \Delta W_0 \Delta \tau_0 \geq \frac{\hbar}{2} \tag{351}$$

$$\Delta q_0 \geq \sqrt{\frac{\hbar}{2Z_0}} = \frac{q_0}{\sqrt{2}} = 2.334427 \text{ e} \tag{352}$$

Then the lower limit of the conducting band amounts to 2.134e so that the charge of the COOPER-pair with 2e is only 4% (q_0) below the conducting band. By the way, the equality-sign in (352) applies only then, when a GAUSSian normal-distribution of the charge is on hand, which is not given for N=1, so we can do well without a tunnel-effect at the worst. Like that, a conduction could take place directly on the level of the metric wave-field, at which point the specific impedance $1/\kappa_0=8.07239\cdot10^{-94}\ \Omega m^2/m$ is so extremely small that it is factually equal to zero. At all, an instrumentational determination of κ_0 in this way would be far outside our technical possibilities.

4.6.4. Energy

Before we do broader contemplations in this direction, we first turn to the PLANCK's quantity of action, since it is joined narrowly with the electromagnetic energy.

4.6.4.1. The PLANCK's quantity of action

4.6.4.1.1. Temporal dependence

We have seen that PLANCK's quantity of action is equal to the product of electric charge and magnetic flux. First, we want to put the time-function for the value of $\hbar$, which is applied to $t \gg 0$, (approximative solution). Because of (122) we can immediately write down for φ_0:

$$\varphi_0 = \frac{\hat{\varphi}_i}{\sqrt{2\pi\omega_0 t}}(\cos 2\omega_0 t + \sin 2\omega_0 t) \tag{353}$$

Furthermore applies: $u_0 = \dot{\varphi}_0$ (self-induction). We assume the exact formula more safely. During differentiation we have to pay attention once again that ω_0 is a time-dependent value. One works just useful using equ. (114)

$$\varphi_0 = \hat{\varphi}_i J_0(2\omega_0 t) \qquad \varphi_0 = \hat{\varphi}_i J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \tag{354}$$

$$\dot{\varphi}_0 = -\frac{\hat{\varphi}_i}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_0 t}}\, J_1\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{355}$$

$$u_0 = -\hat{\varphi}_i\,\omega_0 J_1(2\omega_0 t) \tag{356}$$

For q_0 we obtain because of (123):

$$q_0 = C_0 u_0 = \varepsilon_0 r_0 u_0 \tag{357}$$

$$q_0 = -\varepsilon_0\omega_0 r_0\hat{\varphi}_i J_1(2\omega_0 t) = -\varepsilon_0 c\hat{\varphi}_i J_1(2\omega_0 t) \tag{358}$$

$$q_0 = -\hat{q}_i J_1(2\omega_0 t) \tag{359}$$

$$q_0 = \frac{\hat{q}_i}{\sqrt{2\pi\omega_0 t}}(\cos 2\omega_0 t - \sin 2\omega_0 t) \tag{360}$$

Now, we get for PLANCK's quantity of action:

$$\hbar(t) \;=\; \frac{\hat{\hbar}_i}{2\pi\omega_0 t}(\cos^2 2\omega_0 t - \sin^2 2\omega_0 t) \;=\; \frac{\hat{\hbar}_i}{2\pi\omega_0 t}\cos 4\omega_0 t \qquad (361)$$

$\hat{\hbar}_i = \hat{q}_i\hat{\varphi}_i$ is the amplitude (peak value) of $\hbar$ at the point, at which the time-function of $\hbar$ has the value 1. Now, PLANCK's quantity of action itself is actually not an (almost) periodic time-function but its effective-value, albeit this is on the other hand even a function of time. The effective-value is defined as the quadratic median value across one period:

$$QM \;=\; \sqrt{\frac{1}{t_{k+1} - t_k}\int_{t_k}^{t_{k+1}} F^2(t)\,dt} \qquad (362)$$

For periodic functions, the lower limit is zero in general, the upper limit a multiple of π, mostly 2π. That e.g. leads to an effective-value of $1/\sqrt{2}$ for the sine- and cosine-function. The effective-value of the product of two functions is equal to the quadratic median value of this product or equal to the product of the effective-values of both functions.

Unfortunately, we don't have to do with periodic functions here. Because of the root in the argument frequency is constantly changing and with it the period. Equation (362) is analytically solvable in our case admittedly, even for the Bessel (exact) solution. However we cannot do anything with the result so much, particularly if t is near to zero, since frequency is changing there more quickly than the coverage of median value. That means, in the time immediately after big bang, across the first two or three periods, the PLANCK's quantity of action as such is not defined. Only the exact time-functions apply here. Now it is opportune however, to have a function, which can be applied back up to the point of time t=0, just, in order to determine $\hbar_i$.

Therefore we set the effective-value of charge and magnetic flux to $1/\sqrt{2}$ of the amplitude. This is not quite exact admittedly, at least with small arguments, it's about an approximative solution then again anyway. We get for $t \gg 0$ then:

$$\hbar \;=\; \frac{\hat{\hbar}_i}{4\pi\omega_0 t} \;=\; \frac{\hat{\hbar}_i}{2\pi}\sqrt{\frac{\varepsilon_0}{2\kappa_0 t}} \;=\; \frac{1}{2\pi}\frac{\hat{\hbar}_i}{Q_0} \qquad (363)$$

The quantity of $\hbar_i$ (peak- and effective-value) allows to be determined from it easily:

$$\hat{\hbar}_i \;=\; 2\pi\,\tilde{Q}_0\tilde{\hbar} \;=\; 4.99697\cdot 10^{27}\,\mathrm{Js} \qquad \hbar_i \;=\; \frac{\hat{\hbar}_i}{2} \qquad t_i = \frac{t_1}{4\pi^2} \qquad (364)$$

This value is very much larger than the present. This has enormous effects onto the circumstances in the time just after big bang. We will defer to it in this chapter even near. For flux and charge applies analogously (24) and (36):

$$\varphi_0 = \sqrt{\frac{\hbar_1 Z_0}{2\omega_0 t}} \;=\; \sqrt{\frac{\hbar_1 Z_0}{Q_0}} \qquad \hbar_1 \;=\; \frac{\hat{\hbar}_i}{2\pi} \;=\; 7.95297.10^{26}\,\mathrm{Js} \qquad (365)$$

$$q_0 \;=\; \sqrt{\frac{\hbar_1}{2\omega_0 t Z_0}} \;=\; \sqrt{\frac{\hbar_1}{Q_0 Z_0}} \qquad q_1 \;=\; \sqrt{\frac{\hbar_1}{Z_0}} \;=\; 1.45244.10^{12}\,\mathrm{As} \qquad (366)$$

In future we will use the value $\hbar_1$ instead of $\hbar_i$, since it can be reckoned with it much better. On the basis of the anyway inaccurate value of the HUBBLE-parameter and with it of Q_0 the approximative solution (363) is sufficient for the bulk of all cases.

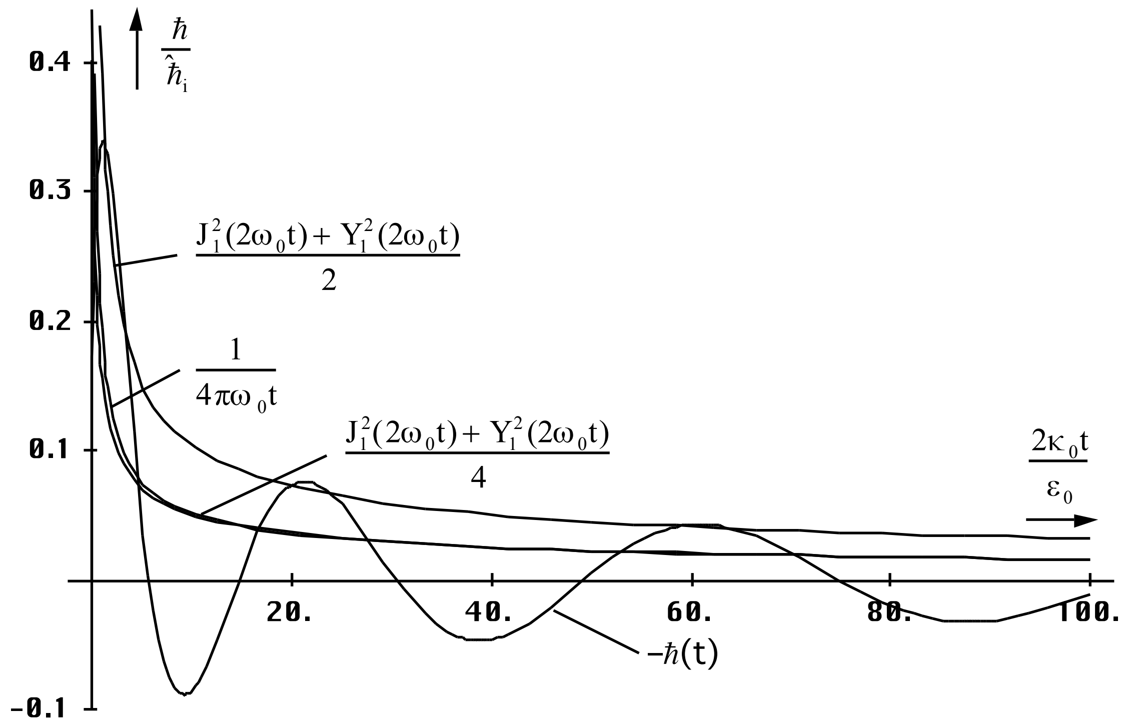


Figure 50
Miscellaneous approximative solutions for
PLANCK's quantity of action, larger scale

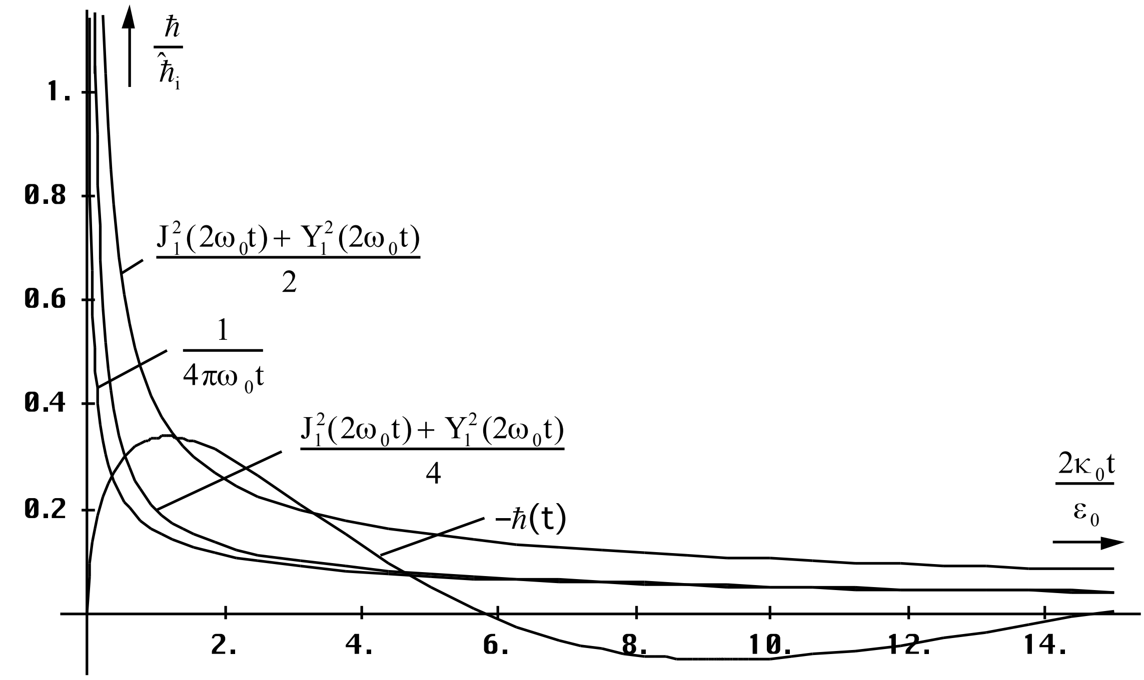


Figure 51
Miscellaneous approximative solutions for
PLANCK's quantity of action, smaller scale

For examinations of the period immediately after big bang it's however opportune to work with the time-function. This is as follows:

$$\hbar = -\hat{\hbar}_i J_0(2\omega_0 t) J_1(2\omega_0 t) \qquad (367)$$

Another expression for the effective-value h can be found with it. Whether this is better than (364), one can see in figure 50 and 51 — the approximation (363) is well almost down to t=0. Even the associated functions are declared. One sees, the application of Bessel functions lead to no increase in precision opposite to (363), rather to the contrary. The Bessel functions of 0th and a mix of 0th and 1st order turn out even more inaccurate solutions. In future we'll therefore only use expression (363) that still has the additional advantage, to be better integrable. Also the dependence of the present values is interesting. We take up the known transformation $2\omega_0 t \rightarrow t/T$ once again obtaining:

$$\hbar = \frac{\hbar_1}{\tilde{Q}_0}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}} = \tilde{\hbar}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}} \tag{368}$$

The temporal dependence of PLANCK's quantity of action has also effects on the value of the electromagnetic energy. That means, beside the cosmologic red-shift, an additional debasement arises by decrease of $\hbar$, so that $W_\gamma \sim t^{-5/4}$ applies.

4.6.4.1.2. Spatial dependence

If PLANCK's quantity of action is a function of time, so it is also a function of the location. This is applied to each local space-temporal coordinate-system. One gets the function, as handled in the preceding sections already several times, by expansion of (368) to:

$$\hbar = \frac{\hbar_1}{\tilde{Q}_0}\frac{1}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} = \frac{\tilde{\hbar}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \tag{369}$$

That is the value of $\hbar$, valid for a process in the distance r of the observer, seen by the observer. According to this definition $\hbar$ can take on even negative values, which corresponds to the appearance of negative energy. At the place of sign-change, there is a spatial singularity with proper certainty. We obtain the course figured in figure 52 which is a function of distance.

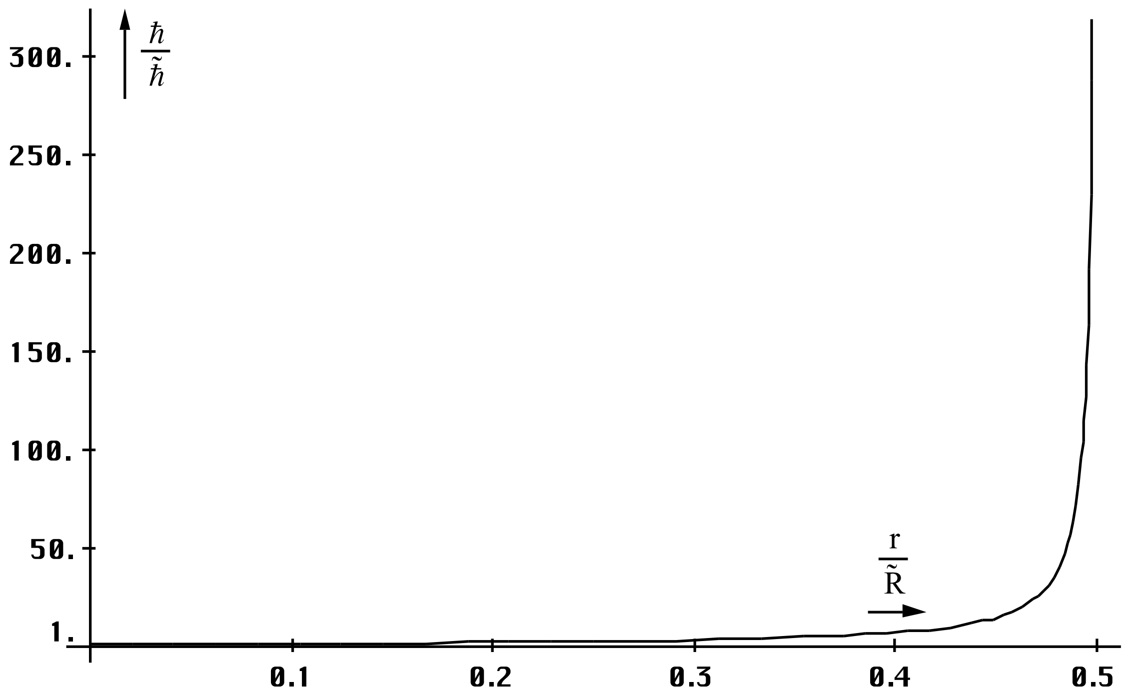


Figure 52
PLANCK's quantity of action
as a function of distance for t=0

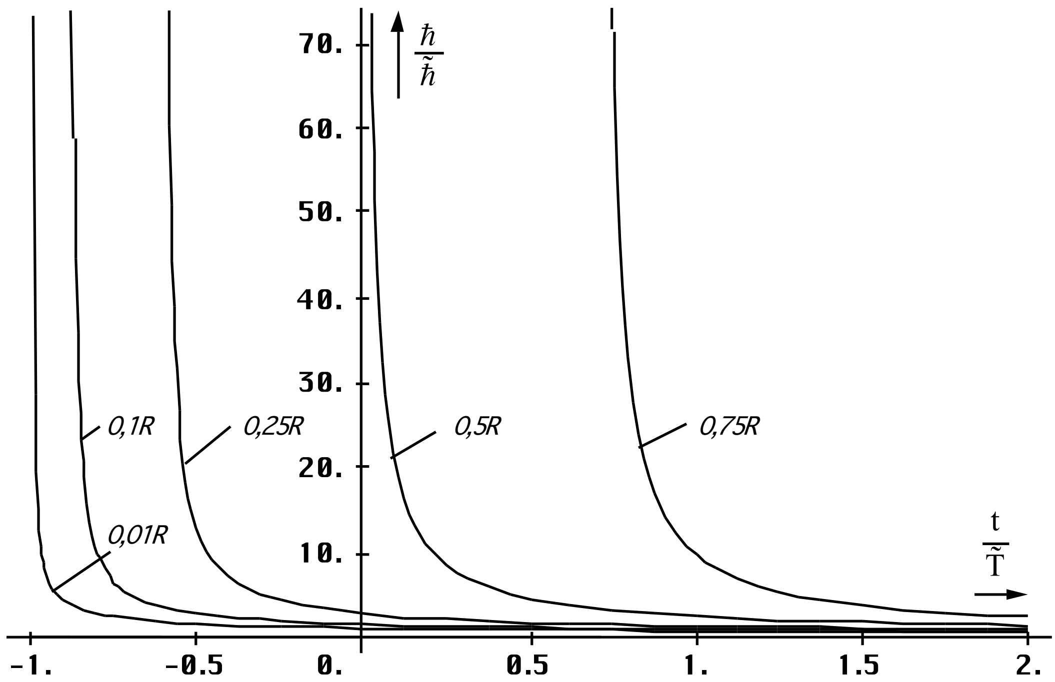


Figure 53
PLANCK's quantity of action
as a function of time for r=const

Near the half world-radius (cT) there's going to be an extreme ascend towards infinite. It is to be considered that the maximum-value by definition as median value is restricted to $\hbar_i$.

With the temporal dependence, the two cases constant distance and constant wave count vector are to be distinguished again. The course for different distances in the case r=const shows figure 53. In the case of constant wave count vector the quantity of PLANCK's quantity of action doesn't remain unchanged however, it's decreasing too. The course is figured in figure 54.

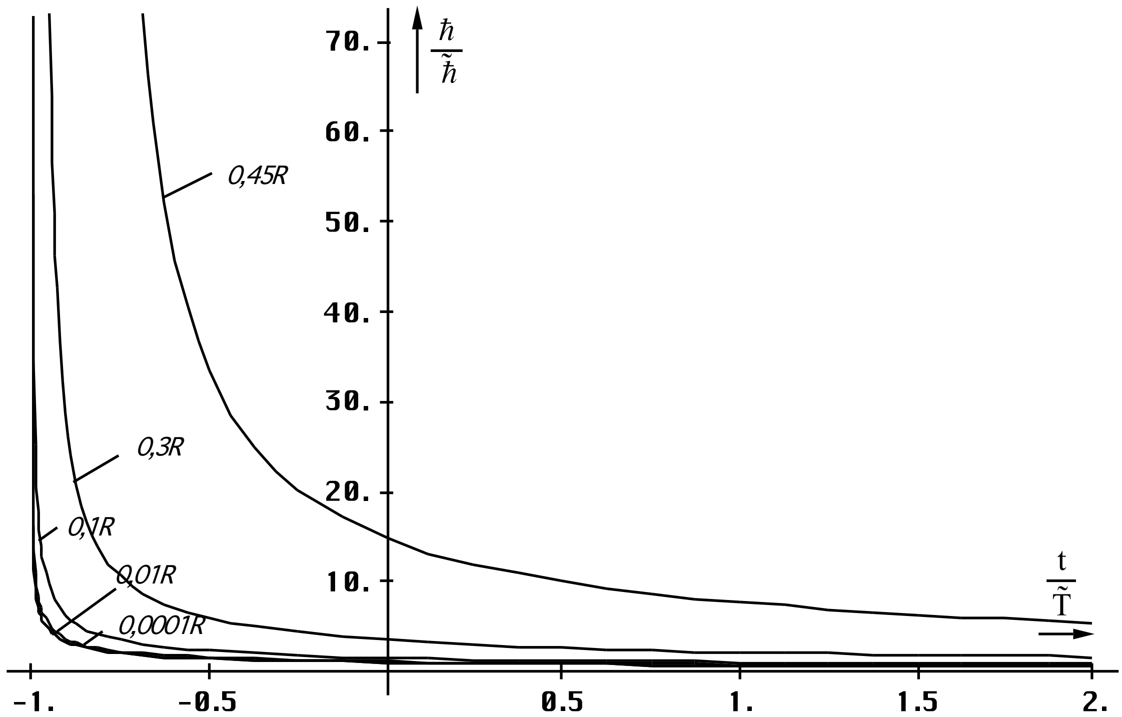


Figure 54
PLANCK's quantity of action as function
of time with constant wave count vector

It will be obtained by application of (326) and (329) without consideration of the restricted definition range by replacement of r (370). However the value of $\hbar$ over a long time period (approximately one age) remains virtually constant (figure 55). With small distances applies (368) as approximation, that means, $\hbar$ depends only on time. For larger distances, the time period $\hbar \approx$ const is shorter admittedly, however the end already soon will be situated behind the particle-horizon, so that $\hbar$ even can be regarded here to be constant over the whole definition range.

$$\hbar = \frac{\hbar_1}{\tilde{Q}_0} \frac{1}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{\tilde{r}}{\tilde{R}}\right)^{\frac{2}{3}} \left(1+\frac{t}{\tilde{T}}\right)^{\frac{2m}{3}}} = \frac{\tilde{\hbar}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{\tilde{r}}{\tilde{R}}\right)^{\frac{2}{3}} \left(1+\frac{t}{\tilde{T}}\right)^{\frac{2m}{3}}} \quad (370)$$

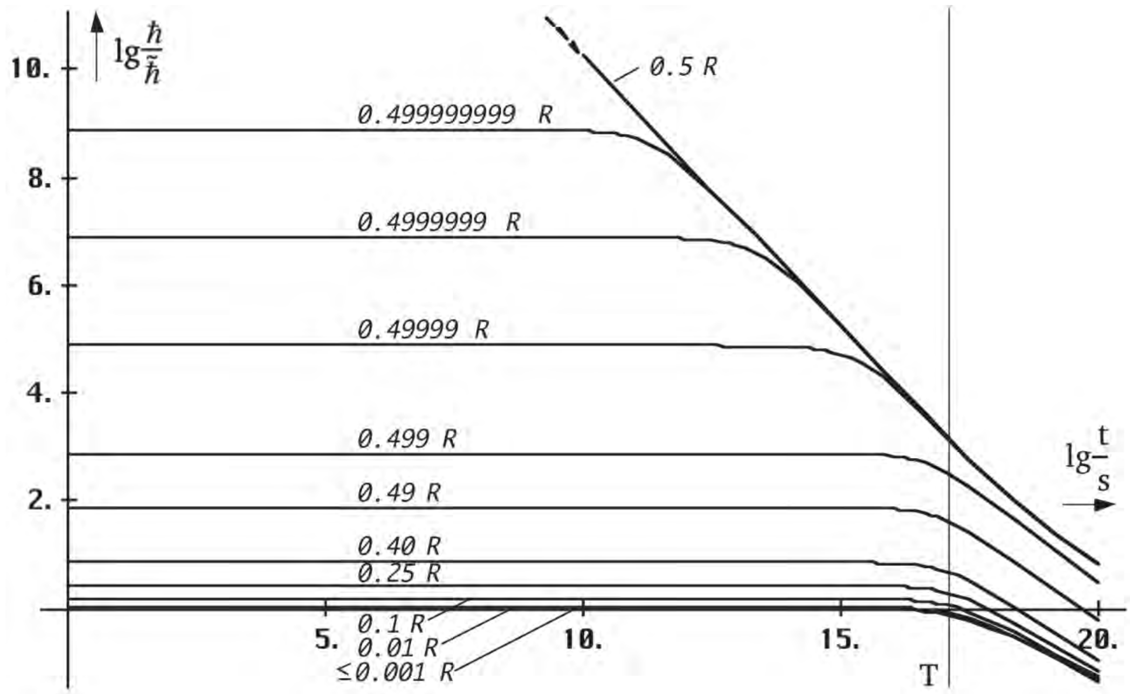


Figure 55
PLANCK's quantity of action with constant wave count vector
for several initially distances (time calculated from nowadays)

Obviously, even a dependence between entropy and PLANCK's quantity of action can be constructed with it. This can take place with help of equation (344) and (369) by substitution of r. Analytically, the problem can be solved only in one direction as function S($\hbar$) however. This dependence does not figure a contradiction. Seen from information theory, entropy is a measure for the disorganizedness of a system. The larger the entropy, all the larger the uncertainty of the inner conditions, even that a previously existing order will be replaced by an accidental order.

The quantity of PLANCK's quantity of action on the other hand determines the limit between micro- and macrocosm on reason of HEISENBERG's uncertainty principle for impulse and place:

$$\Delta p \cdot \Delta x \geq \frac{\hbar}{2} \qquad \Delta(mv) \cdot \Delta x \geq \frac{\hbar}{2} \quad (371)$$

As test-particle, we use the most lightweight subatomic particle with a rest mass different from zero, the electron. Under the assumption, that the maximum velocity is c, we obtain as upper limit for the microcosm Δx:

$$\Delta x = \frac{1}{2}\frac{\hbar}{m_e c} = \frac{1}{4}\frac{\hbar_1}{m_e \omega_0 ct} = \frac{1}{2}\frac{\hbar_1}{m_e c\tilde{Q}_0}\frac{1}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \qquad (372)$$

If the rest mass of the electron doesn't change according to the BIRKHOFF-theorem, a larger value of $\hbar$ means nothing other, than an upward shift of this limit. In the period just after big bang, this limit has been in the magnitude of the entire universe (quantum universe). But even in the proximity of the inner SCHWARZSCHILD-radius of our local universe and near time-like singularities, like black holes, this effect is to be observed or should have to be to be observed.

How can we interpret this? According to the SRT a coordinate-transformation between frames of reference, their relative velocity to each other oversteps c, is impossible. Even with strong gravitational-fields (URT) is this the case. According to the classic theory, is the transition *transformation possible→transformation impossible* abrupt. According to the present theory, this transition is gliding however. The closer we come to the SCHWARZSCHILD-radius with its escape-velocity c, the larger will be spatial curvature, entropy and the value of PLANCK's quantity of action. The limit of the microcosm shifts with it upward and there's going to be the appearance of quantum-effects even with macroscopic bodies (not with time-like vectors!). Then, a simultaneous, exact determination of impulse and place is impossible even for macroscopic bodies. These can be localized only by the electromagnetic radiation sent out by them. Since time-like vectors spreads on different world-lines having another „length“, time-like and space-like coordinates of the source don't coincide and the uncertainty remains.

Near the point cT the uncertainty oversteps the magnitude of distance finally. As a result, each transformation, even if it should be mathematically possible, becomes pointless. Because of the limit of $\hbar$, there is also a maximum-value of uncertainty Δx. For the electron this amounts to :

$$\Delta x_i = \frac{1}{2}\frac{\hbar_i}{m_e c} = 4.57445\cdot 10^{48}\text{m} \gg \tilde{R}\ (1.21881\cdot 10^{26}\text{m}) \qquad (373)$$

This value is for our present frame of reference only of theoretical interest however. In a distance, that amounts to R/2 exactly, actually $(R-r_1)/2$, the uncertainty is so extreme indeed. But only about the classic BOHR's hydrogen-radius ($5.28\cdot 10^{-11}$ m) beside it - the bodies we are considering, doesn't have the diameter zero - the local uncertainty for the very same atom amounts to $3.64\cdot 10^{20}$ m only, as we can easily check using (369) and (372). Also the value of $\hbar$ is essentially lower there. In the distance R/2–1m we obtain for the hydrogen-atom a value of $\Delta x = 1.936\cdot 10^{10}$ m, for a body with the mass 1t (e.g. 1m^3 water = cube with the edge length 1m) only $3.2\cdot 10^{-20}$ m.

For macroscopic bodies, it's just about a rather abrupt transition, not so for microscopic bodies. So, the uncertainty in 1000 km distance for the hydrogen-atom still amounts to $1.936\cdot 10^{4}$ m, for the electron even $3.529\cdot 10^{7}$ m. The uncertainty always refers to our local frame of reference only, just on a very large distance. Quite other, lower values would be applied to an observer being located at the place.

In the time just after big bang, i.e. seen from the spatial singularity as well as in their proximity, the temporal and spatial dependence of PLANCK's quantity of action plays a much more essential role. Moreover it's to be noticed that the spatial singularity, the expansion-centre, is located outside the world-radius determined by our space-time-coordinates . Exactly seen is this point outside each possible space-temporal coordinate-system, since it's inaccessible for space-like vectors.

However this doesn't apply for „intellectual vectors“. If we would have a look at the expansion out of the spatial singularity, so the temporal course of the expansion of the universe as a whole, figured in figure 57, would turn out. The course of the expansion-velocity of the wave-front (figure 56) corresponds, up to the maximum at 0.851661c, to the one in figure 21 and 22. Up to a radius of 1.978 m with 7.747 ns, it's about a quantum universe, after that about a gravitational universe. As border-criterion has been assumed the equality of world-radius and uncertainty Δx for the electron (372;2).

Figure 56
Velocity of the wave-front at the total-world-radius K

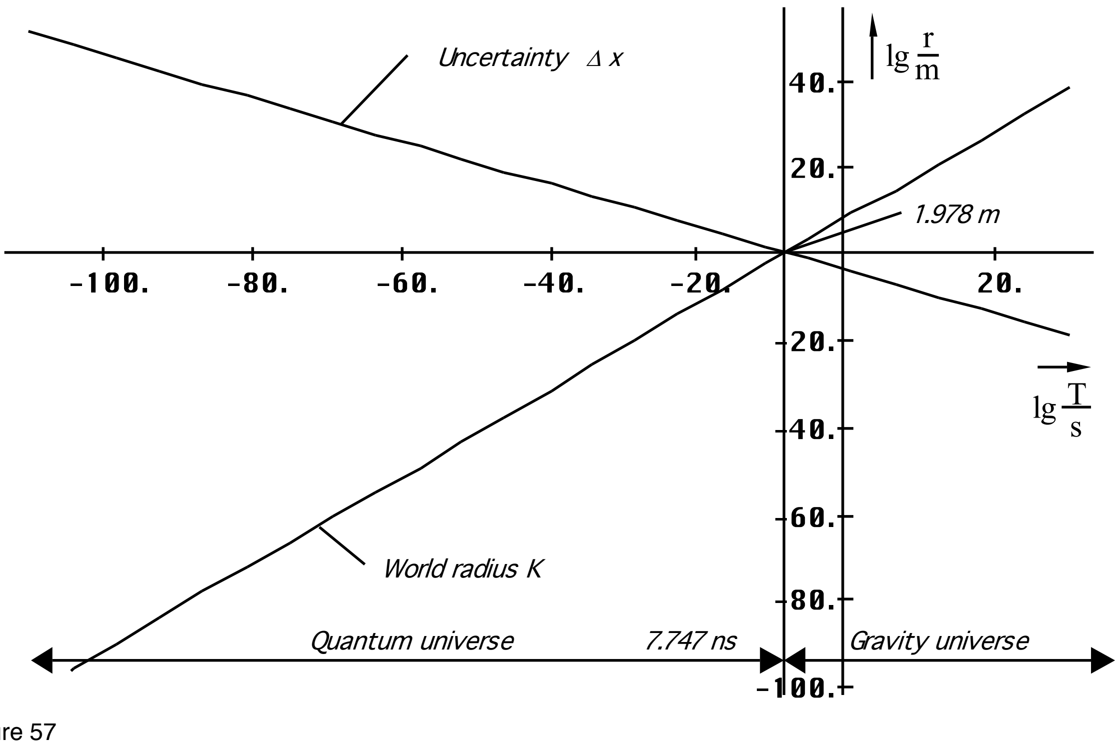


Figure 57
Quantum universe and gravitational universe

4.6.4.2. Energy of the metric wave-field

What happens then now with the energy „consumed" in R_0? In section 4.3.2. we have proven that the MLE is showing a non-adiabatic behavior. It is this an irreversible process, that off-goes by absorption or emission of energy. We will already exclude the first case, energy-absorption, from obvious reasons. The second case, a process, that proceeds under energy-emission, remains. One possibility would be the conversion into mechanical work, another, the conversion into electromagnetic radiation (heat). The first case, conversion into mechanical work, doesn't come into question, since there is no change, neither in temperature, nor in entropy.

Also, there are no material bodies, at which said work could be performed, since we considered empty space only until now. We'll now assume, that the energy doesn't vanish anywhere but it's emitted into space as cosmic background radiation (CMBR) instead:

> *V. The energy released with the expansion of the metrics is emitted as cosmic background-radiation into space..*

It propagates according to the legalities derived in section 4.3.4.4. with light speed as overlaid interference of the metric wave-field. A part of this radiation-energy is transformed in the course of expansion into particles as well as material bodies, that fill our space little by little, so that it is no longer empty. Details are reserved to a later section. This matter however doesn't have a noticeable effect on the metrics as whole, since its mass is far below the mass of the metric wave-field. The interferences of said field, caused by the material bodies, also propagate with speed of light and are cause of the gravitative interaction. According to [24] statement VI is described by the energy-conservation-rule of the MAXWELL equations

$$\dot{w}_0 + \operatorname{div}\mathbf{S} = -\mathbf{i}\,\mathbf{E} \tag{374}$$

In this case $\dot{w}_0$ is the shift of the energy-density, **S** the POYNTING-Vector, **i** the current-density and **E** the electric field-strength. This process should still take place even today then. However, on reason of the extreme Q-factor, the amount of the emitted energy would be so low that it is factually not verifiable then.

4.6.4.2.1. Energy of the MINKOVSKIan line-element (MLE)

Let's have a look at the discrete MLE first. The energy of the electromagnetic radiation is defined as $W_0=\hbar\omega_0$. As well $\hbar$ as ω_0 are functions of time and place. First, we want to figure the temporal dependence. Under application of (363) we obtain:

$$W_0 = \frac{\hat{\hbar}_i}{4\pi t} = \hbar_1 H = \hbar Q_0 H = \hbar\omega_0 \tag{375}$$

Everything in all a very simple expression, that doesn't allow further simplification. This applies, if we assume the expansion-centre as zero of a purely temporal coordinate-system. In the second expression, our lattice constant π appears interestingly enough. The course is figured in figure 58. There is also a maximum-energy (Q=1/2):

$$W_i = \frac{\hat{\hbar}_i}{4\pi t_i} = \frac{\hbar_i\omega_i}{\pi} = 4\,\hbar_1\omega_1 = 4{,}4508\cdot 10^{131}\,\mathrm{Js} \tag{376}$$

No MLE's exist at an earlier point of time. If we want to figure the spatial dependence (figure 59), we have to rearrange (375) a little bit. We replace $\omega_0=c/r_0$:

$$W_0 = \frac{\hbar_1\omega_0}{2\omega_0 t} \Rightarrow \frac{\hbar_1 c}{r_0}\,\frac{1}{2\omega_0 t-\beta r} = \frac{\frac{\tilde{\hbar}c}{\tilde{r}_0}}{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^2} = \frac{\tilde{W}_0}{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^2} \tag{377}$$

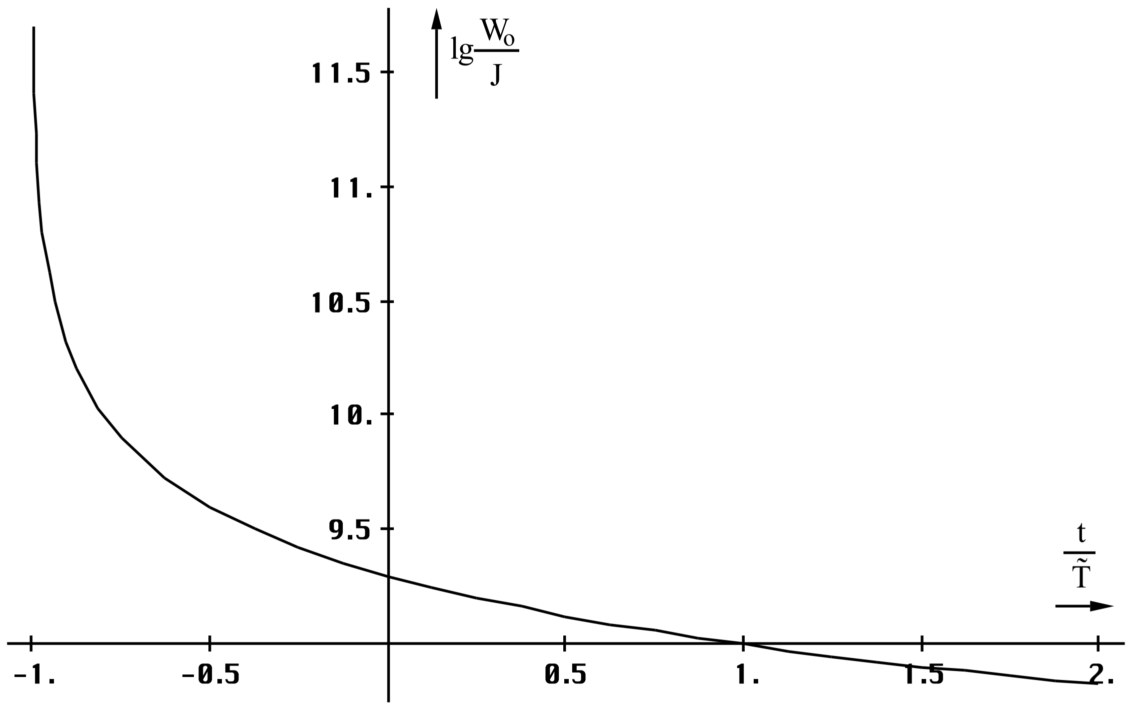


Figure 58
Energy of the MINKOVSKIan line-element
temporal dependence

The third expression in (377) clearly shows that $\hbar$ is also a moment of momentum as well as a part of the definition of mechanical and electromagnetic energy. On the basis of the quadratic expression in the denominator the energy of the MLE is always defined positively, even behind the spatial singularity. The course immediately behind the particle-horizon as well as the one up to the event-horizon is figured in figure 60 and 61.

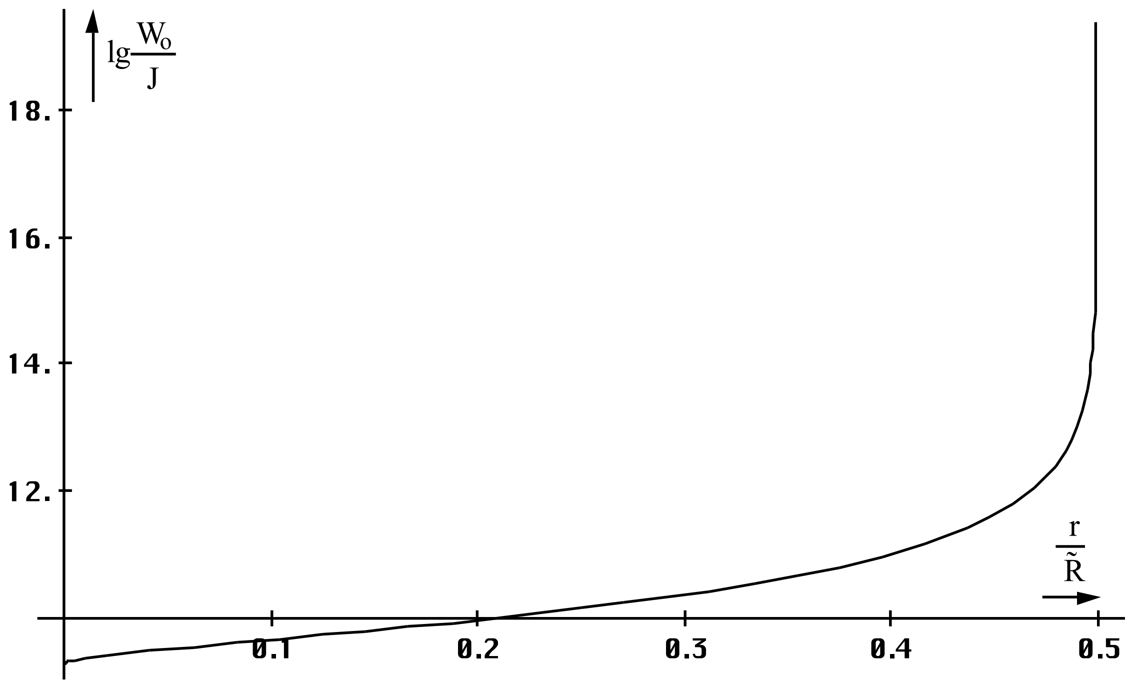


Figure 59
Energy of the MINKOVSKIan line-element
spatial dependence up to the particle-horizon

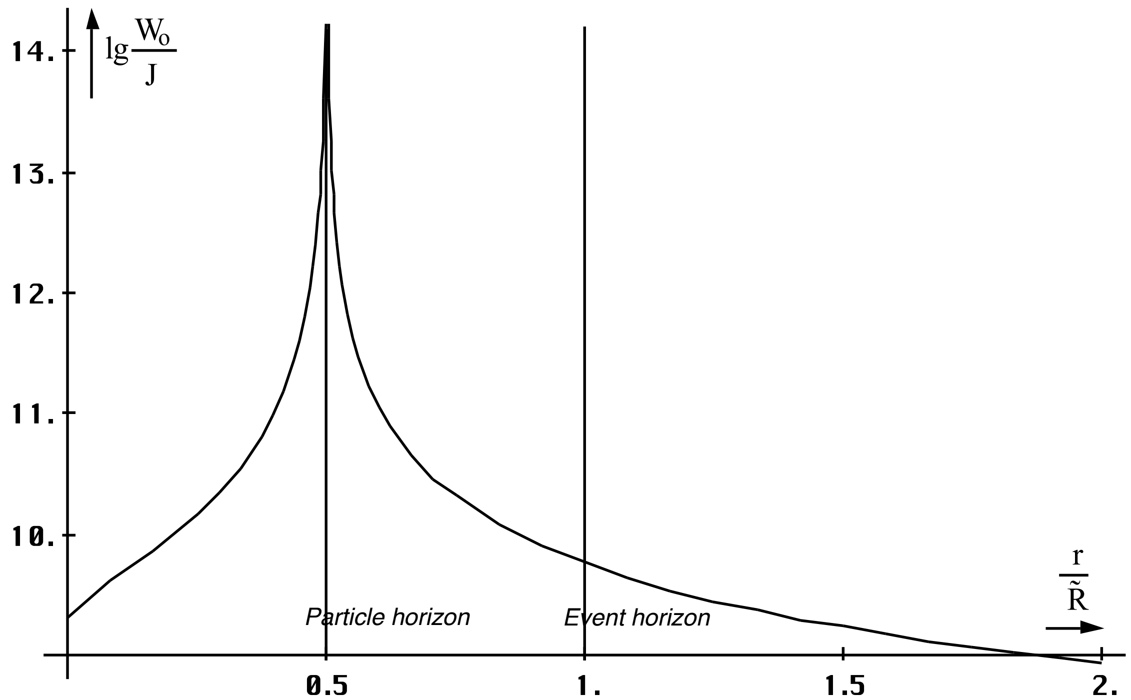


Figure 60
Energy of the MINKOVSKIan line-element
spatial dependence at the particle-horizon

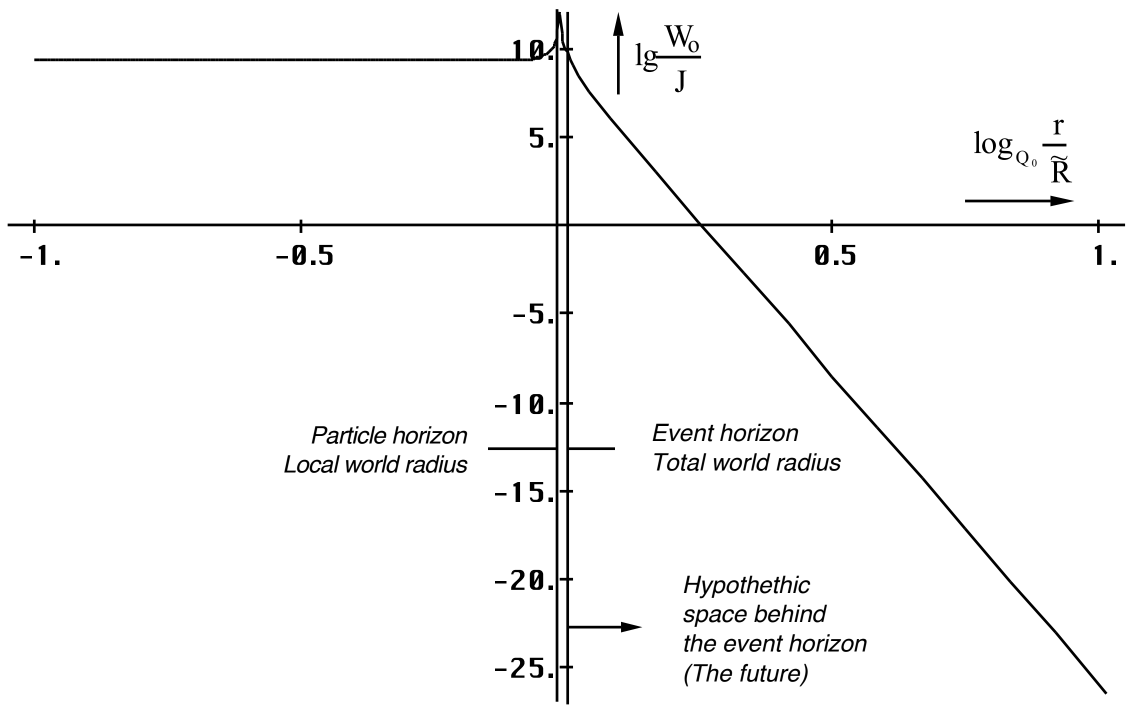


Figure 61
Energy of the MINKOVSKIan line-element
spatial dependence up to the event-horizon

4.6.4.2.2. Power dissipation

According to our model (figure 12) a power dissipation P_V appears at the impedance R_0. This is a function of time again and should be, according to assumption VI., reason for the cosmic background-radiation. Since we don't know exactly, as P_V behaves, whether it suffices, like hitherto, to consider the average value only, we first want to put the exact time-function. It applies:

$$P_v = \frac{u_0^2}{R_0} \qquad u_0 = \frac{q_0}{\varepsilon_0 r_0} = -\frac{c\hat{\varphi}_i}{r_0} J_1(2\omega_0 t) \qquad R_0 = \kappa_0 r_0 Z_0^2 \tag{378}$$

$$P_v = \frac{\hbar_i \omega_0}{t} J_1^2(2\omega_0 t) = \frac{\hbar_i}{t}\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\, J_1^2\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \tag{379}$$

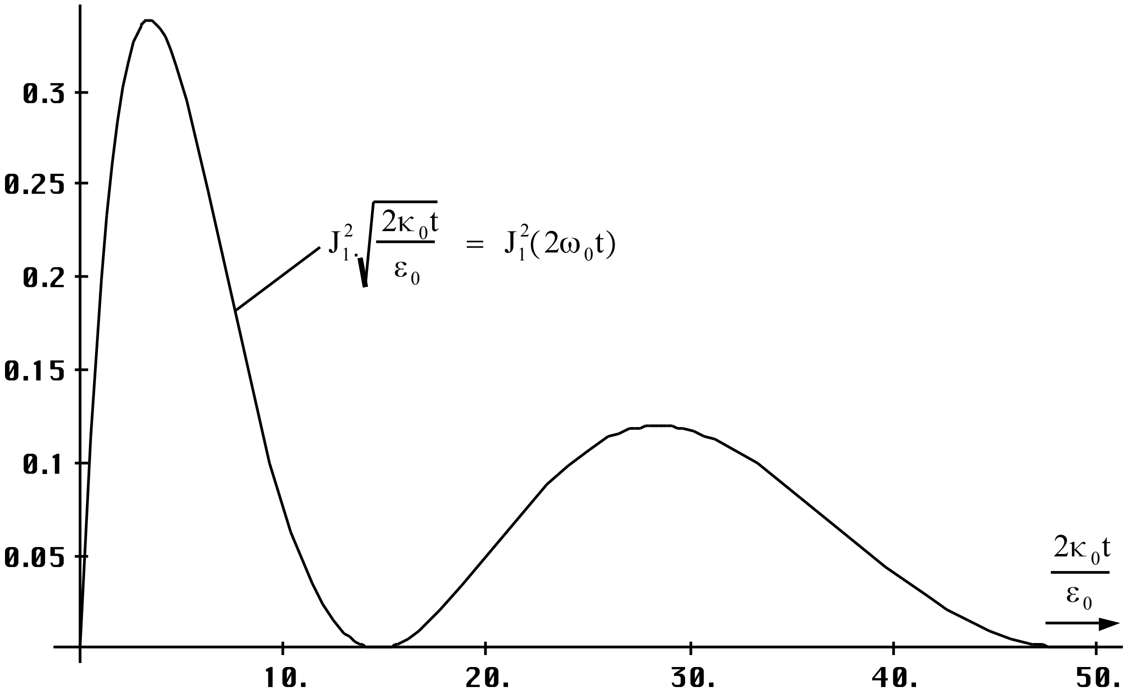


Figure 62
Square of the Bessel function of
1st order during the first period

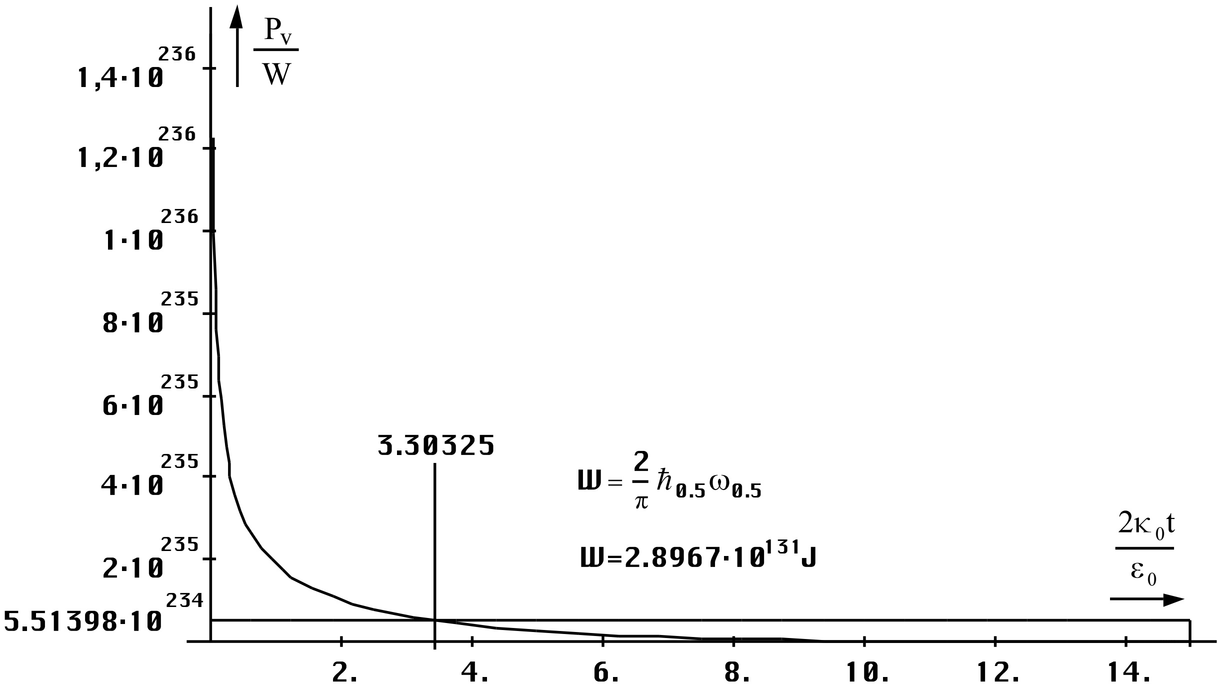


Figure 63
Power dissipation of the MINKOVSKIan
line-element during the first maximum

Minima and maxima are fixed only by the Bessel function. The first two periods are interesting particularly. Therefore, in figure 62 is first figured the course of the Bessel function alone, since, because of the rapid decrease of amplitude, it's impossible to recognize the null in the representation of the entire function (figure 63). The estimation yields 15 t_1 for the first and 50 t_1 for the second null.

Exactly seen with both maxima it's only about the first period, since a frequency duplication is caused by the square. We have to do with a case here, at which it's necessary to calculate with the exact time-function, as already indicated in the previous section. The course of power dissipation during the first maximum is mainly determined by the quotient in front of the Bessel function. No similarities exist with figure 62. The median- and energy-value have been determined by numerical integration using the »Mathematica«-function NIntegrate. There is a problem in that the power dissipation is directed against infinity in the zero point. As attempts with the lower integration-limit emerged, the integral converges to the value stated in figure 63 fortunately.

Before we examine-on the first maximum, let's have a quick look at the second one (figure 64). One can see that as well the power as the energy of this maximum is far below the first one (–21.6dB=1/143). That means: If the cosmic background-radiation is really the action of the power dissipation, accumulating in R_0, so it is (almost) exclusively the first maximum, the qualities of this radiation are defined by. Conceivably, an action of the second maximum can be proven yet with the present-day technical methods.

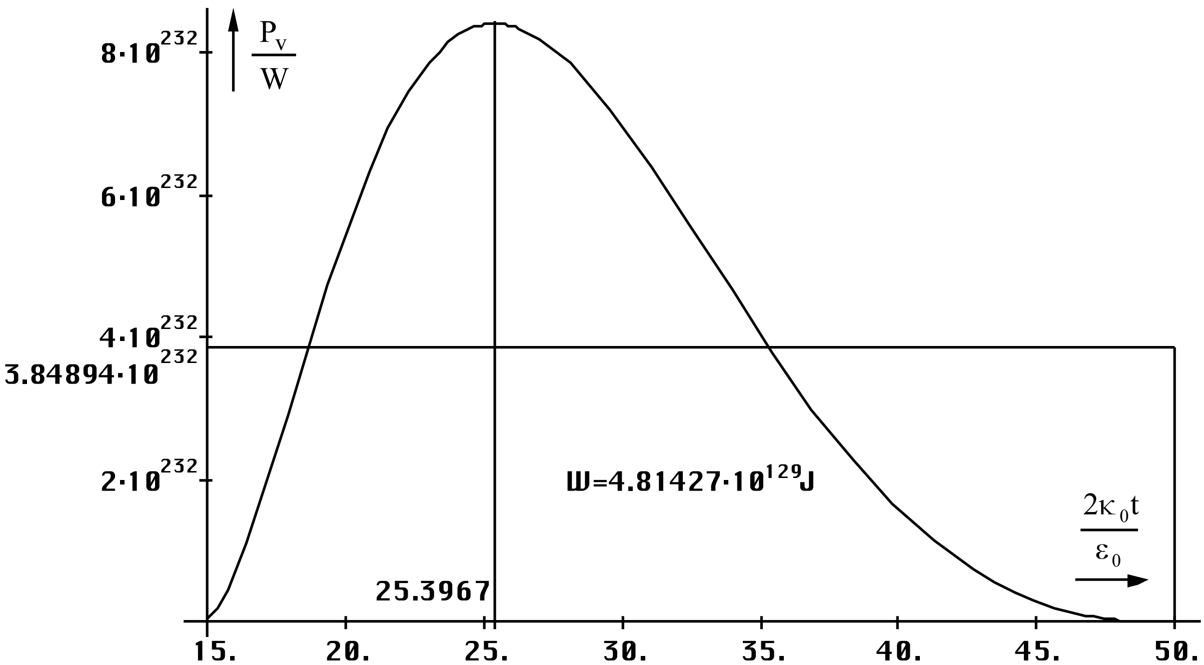


Figure 64
Power dissipation of the MINKOVSKIan
line-element during the second maximum

We want now to examine the first maximum more. It's about a discrete impulse with a defined length T incipient in the point t=0. The LAPLACE-transformation is at the best suitable to it. With it, one first determines the figure-function G(p) as already done in section 4.3.2. Using the transition $p \rightarrow \sigma + j\omega$ we are able to determine the spectrum of our impulse then. With a single-impulse, we get a continuous spectrum. Since we doesn't know the figure-function of (379) and, to the transformation, would have to solve the convolution-integral with (143) first, what works out quite difficult, we will choose another way: We split the function into 64 discreet values calculating the figure-function with help of the Fast-FOURIER-Transformation (FFT). The current FFT-algorithms are been suitable to it, as e.g. the »Mathematica«-function Fourier[{List}]. With it, we must however multiply either the result or the initial-values with the root of 2π, since it's about a LAPLACE-transformation.

As a result, we get a list of 64 complex values in turn, with which the last 32 ones correspond to negative frequencies. The first value corresponds to the DC component and after transition to σ. We want to take up an estimation of bandwidth and Q-factor. We set σ = 1 therefore (resetting). First, we calculate the amounts of the figure-functions however. These are figured in figure 65 and 66 (only positive frequencies $\omega_k=2\pi/T$).

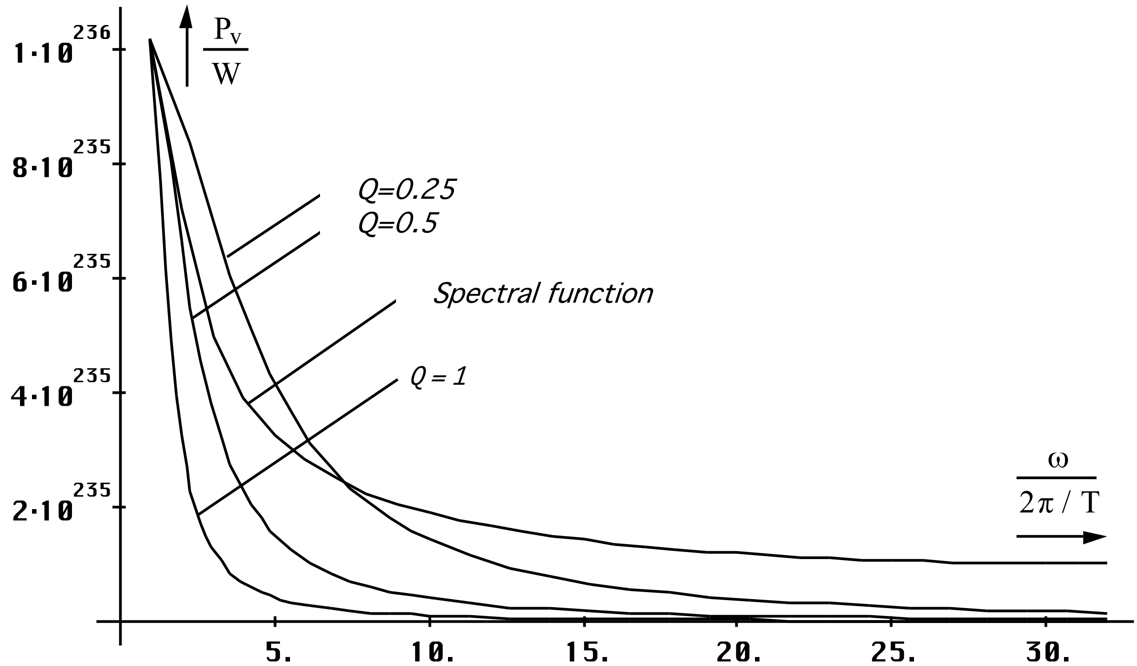


Figure 65
Continuous spectrum (first maximum)

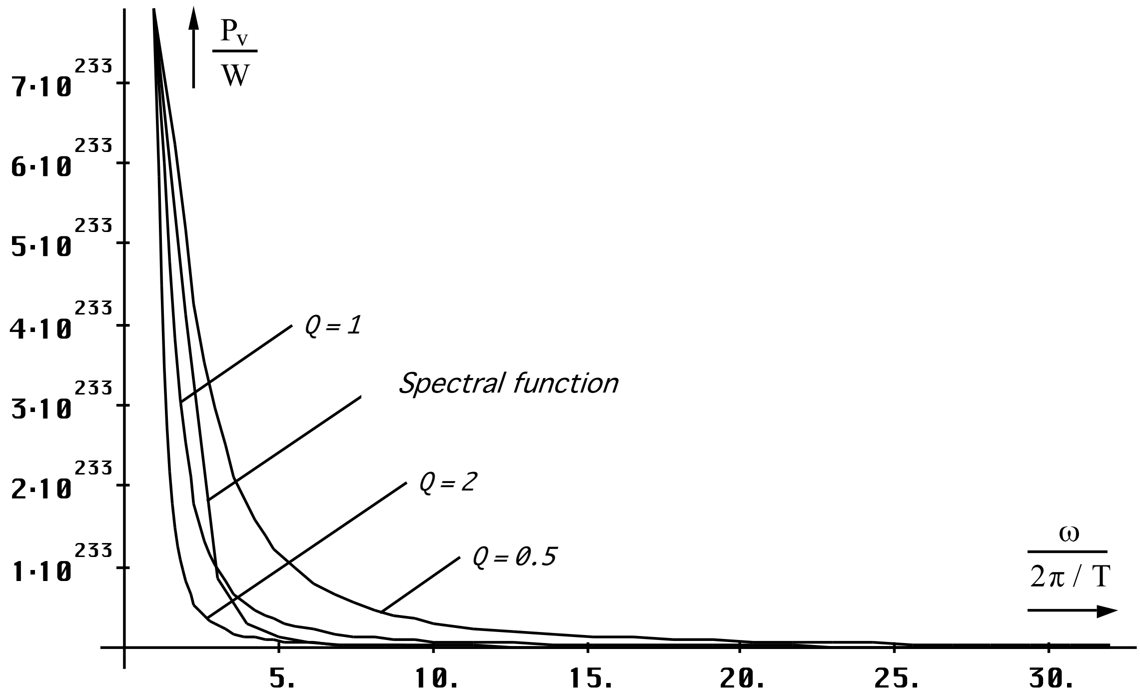


Figure 66
Continuous spectrum (second maximum)

Simultaneously, the transfer-functions of a loss-affected oscillatory circuit of 1st order with different Q-factors are figured. We can take up an estimation of the bandwidth of the cosmic background-radiation with it. For the transfer-function applies:

$$P_v = \frac{P_{max}}{1+v^2Q^2} \qquad v = \frac{\omega}{\omega_0} - \frac{\omega_0}{\omega} \qquad \omega_0 = 1 \qquad (380)$$

v is the discord, Q the Q-factor of the oscillatory circuit. For the first maximum, the Q-factor is at 1/2, with the second maximum at 1. The curves does not quite come to cover. The cause is the low resolution (64 values) on the one hand, on the other hand the fact that the cosmic background radiation is no longer a minimum-phase-system. In this case, the phase-information has to be co-considered, which we have not done as well. According to [26] p. 341 each non-minimum-phase-system allows to be splitted in a minimum-phase- and a non-minimum-phase-share. For latter one, one gets with help of the evaluation-function $\ln\coth|(\ln\omega/\omega_X)/2|$ a corrected transfer-function, with which lower frequencies are higher, higher frequencies are lower evaluated. We don't want to pursue this here further however, since the results are enough for an estimation.

The Q-factor of 0.5 corresponds exactly to the circumstances at the point of time $t_1/4$ as well as $r_1/2$, just at our coupling-length. We want to notice this at first. With the second maximum, we have to do it with a larger Q-factor. That means, should the emission of the cosmic background-radiation occur „continuously“ according to the quantum-mechanical understanding, we would have to do it with a very narrow spectral-line at the present point of time, which overlaps in the area of the maximum of the cosmic background-radiation. Unfortunately, many other spectral-lines are in this area at 178 GHz, caused by organic radicals like e.g. CN^-, CH_3^-, so that a proof is difficult. Now we want to specify an approximation for the present point of time by application of (220). The emitted power follows the time-function $\sin^2 x$ with the effective-value of P_v approximately then, this can be derived on several manner:

$$P_v = -\dot{W}_0 = \frac{\hat{\hbar}_1}{4\pi t^2} = 2\hbar_1 H^2 = 2\hbar Q_0 H^2 = 2\hbar\omega_0 H \qquad (381)$$

That corresponds to a present-day value of $9.6437\cdot10^{-9}$W. At the above-mentioned frequency, it would correspond to an emission-rate of $7.53\cdot10^{13}$ photons as well as to the „creation“ of 64 hydrogen-atoms per second by one single MLE. But the cosmic background-radiation amounts only to 500 photons per cm^3 approximately. This is apparently a contradiction. Before we try to solve this contradiction, we want to deal with the hitherto known qualities of the cosmic background-radiation.

4.6.4.2.3. Qualities of the cosmic background-radiation

If you ask somebody, what the cosmic background-radiation actual is, so most have already heard about it. Investigating further then, you they say that the radiation-temperature, whatever that may be, is about 2.7K or at 3K or somewhere between and somehow, that this radiation has something to do with the big bang. The following calculations are based on a value of the HUBBLE-parameter of 75.9 $kms^{-1}Mpc^{-1}$. The actual temperature of 2.725±0,002K (Wikipedia) measured by the COBE-satellite rather suggests a value of H_0=72 $kms^{-1}Mpc^{-1}$ (see also section 7.5.3. and [46] here in the annex). That are altogether very vague data. As technician I'm especially interested in details like e.g the frequency die and first of all the field strength. Hardly I cannot syntonize my receiver to a frequency of 3K. But that doesn't matter. With these few specifications namely, you can already calculate everything yourself. Now let's do this.

The cosmic background-radiation disposes of three further essential qualities: Firstly it's *isotropic,* secondly it's not *polarized* and thirdly it's *black*, as has been determined with detailed examinations clearly. The third quality is especially important. The cosmic background-radiation seems to behave such as would it be emitted by an ideal black body. On the basis of this quality, the PLANCK's radiation-rules can be applied. However, with thermal radiation, it's not about a discrete spectral-line but with a steady spectral-function.

The intensity of the radiation-field is a function of the frequency being clearly described by PLANCK's radiation-rule:

$$d\mathbf{S_k} = \frac{1}{4\pi^2}\frac{\hbar\omega^3}{c^2}\frac{1}{e^{\frac{\hbar\omega}{kT}}-1}\,\mathbf{e_s}\,d\omega \qquad \text{PLANCK's radiation-rule} \qquad (382)$$

T is the temperature here and $\mathbf{e_s}$ the unit-vector. For the case of very low temperatures ($\hbar\omega \gg kT$) changes (382) into the WIEN radiation-rule (approximation). But it's no mistake to calculate always with (382). We want even to do this. Only to the information:

$$d\mathbf{S_k} \approx \frac{1}{4\pi^2}\frac{\hbar\omega^3}{c^2}e^{-\frac{\hbar\omega}{kT}}\,\mathbf{e_s}\,d\omega \qquad \text{WIEN radiation-rule} \qquad (383)$$

The course of intensity for a temperature of 2.866324K (H_0= 75.9), this value will be specified later, is depicted in figure 67 (curve 6). We can see, there is a definite maximum. This on the other hand, can be determined with the help of WIEN's displacement law:

$$\hbar\omega_{max} = \tilde{x}\,kT = 2.8214393721\,kT \qquad \text{WIEN's displacement law} \qquad (384)$$

Furthermore interests the integral of intensity over the whole frequency range [Wm^{-2}], the POYNTING-vector. That's the STEFAN-BOLTZMANN radiation law:

$$\overline{\mathbf{S}}_\mathbf{k} = \int W_\omega d\omega = \sigma T^4\mathbf{e_s} = \frac{\pi^2 k^4 T^4}{60\,c^2\hbar^3}\,\mathbf{e_s} \qquad \text{STEFAN-BOLTZMANN radiation law} \qquad (385)$$

with $\sigma = 5.669\cdot 10^{-8}Wm^{-2}K^{-4}$. Furthermore, in figure 67 I superimposed the frequency response of an oscillating circuit with the Q-factor of 0.5 (curve 1). Because of the logarithmic presentation a multiplication of the frequency response with the maximum value resp. an attenuation (damping) corresponds to a displacement in y-direction only, so that we can already make a comparison without knowing the value itself. Thus, curve 1 corresponds to the emission spectrum at the moment of in-coupling into the metric transport lattice. I choosed the maximum value such, that both curves come to cover.

We can see, it's possible to achieve a full coverage of both curves in the lower domain. But there is a descent at the higher frequencies of the CMBR-spectrum, which does not correspond to the behaviour of such an oscillating circuit. Maybe, that could be the result of the upper cut-off-frequency of the metrics. To the verification we need the exact frequency the CMBR has been emitted with, in order to determine the value z of redshift. This frequency must be somewhere in the range of ω_1. The upper cut-off-frequency really would come into effect in this case (see also [46]). On the one hand that follows from the length T of the first maximum, on the other hand we have to do it with two frequencies, which are changing temporarily according to different functions. There is once the metric wave field with $\omega_0 \sim t^{-1/2} \sim Q_0^{-1}$, and the CMBR with $\omega_k \sim t^{-3/4} \sim Q_0^{-3/2}$ on the other hand. These functions must have intersected each other at some point in the past having the same value ω.

Let's simply consider the problem as puzzle. The bandwidth of the LAPLACE transform of the first maximum suggests a Q-factor of 0.5. This would correspond to the conditions at the point of time $t_1/4$ with $Q_{0.5}$= ½, $\omega_U = \omega_{0.5}$ as well as $r_1/2$, just our coupling-length. The frequency to this point of time amounts to:

$$\omega_{0.5} = \frac{1}{t_1} = \frac{2\kappa_0}{\varepsilon_0} = \frac{\omega_1}{Q_{0.5}} = 2\omega_1 = 2{,}7982\cdot 10^{104}s^{-1} \qquad (386)$$

This doesn't correspond to the value, that results from the impulse-length of the first maximum, but it is in the magnitude then again. Now the conditions at this time are shaped by a very large uncertainty and a part of the emitted frequencies are, because of the large bandwidth, anyway above, others below (386), so that it is well possible that the in-coupling of the cosmic background-radiation takes place right at this point of time with exactly this centre frequency.

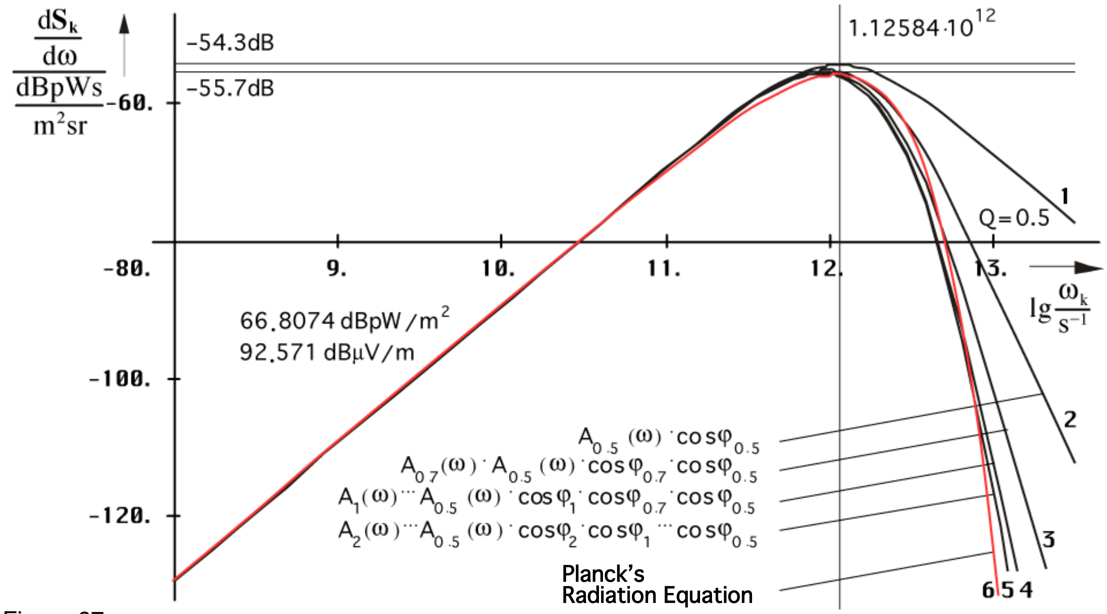


Figure 67
Intensity of the cosmic microwave
background radiation with approximation

The following contemplations for the in-coupling apply to the CMBR particularly. Maybe it seems to be a little bit complicated, but it's just a model, which should reflect reality as well as possible, not the other way around. Now — up to the moment $t_1/4$ of input coupling, the already emitted energy exists as a free wave. The conditions at this point of time are analyzed in detail in section 4.6.5.2. »The aperiodic borderline case«. Now there's going to be the construction of the metric lattice and the signal is coupled in. with the input coupling, a compression of the wavelength occurs i.e. an increase in frequency about the factor $\sqrt{2}$ due to a rotation of the coordinate system about 45°, die we have done in section 4.3.4.3.3. (the metric wave moves in r-direction, the overlaid signals in x-direction).

Furthermore, the metric wave, as well as the energy to be coupled in, exist side by side up to the moment $t_1/4$, both with $\omega_0 \sim \omega_U \sim t^{-1/2} \sim Q_0^{-1}$. But with the in-coupling $\omega_U \rightarrow \omega_s$ the temporal dependence changes into $\omega_s \sim t^{-3/4} \sim Q_0^{-3/2}$. This results in a transformation corresponding to a multiplication by a factor ⅔, comparable with the transition from one medium to another with different refraction indices.

But there is yet another, additional effect: In section 4.6.1. we found, that a cube with the edge length r_0 contains four MLE´s altogether. Hence, the energy must be divided among these four MLE´s. With it, the in-coupling frequency decreases additionally with the effect, that ω_s is smaller than $\omega_1/2$ now. The first two effects are depicted in figure 68a. The split we have to take into account elsewhere.

Altogether, to the frequency at the moment of in-coupling the following factor is applied $\omega_s = \frac{1}{4}\sqrt{2}\,\omega_U = 2\,\frac{1}{4}\sqrt{2}\,\omega_1 = \sqrt{2}/3\,\omega_1 \approx 0.4714\,\omega_1 = 6.59542\cdot 10^{103} s^{-1}$. With respect to the energy $\hbar_U\omega_U = 4\hbar_1\omega_1$ only a share of 94.28% incorporated, since $\hbar$ is neither rotated, divided, nor transformed, it is a property of the metric wave field itself. The split has no effect onto the energy balance. The 94.28% relate to a coefficient of absorption of $\varepsilon_\nu = 0.9428 = \sqrt{2}$. Therefore we are dealing with a *gray body* [47]. The *black body* is only a model, which doesn't exist in nature. The reflected share yields a further decrease of ω_s and with it even of ω_k. So we also have to multiply with ε_ν.

Now to the transfer itself. According to (278) is the frequency of time-like vectors proportional to $\omega \sim t^{-3/4}$. That equals $\omega \sim Q^{-3/2}$ for the Q-factor. We do the following ansatz:

$$\omega_s = \frac{2\cdot 1}{3\cdot 4}\sqrt{2}\,\varepsilon_\nu\omega_{0.5}\left(\frac{Q_{0.5}}{Q_{0.5}}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_\nu\omega_U\left(\frac{1/2}{1/2}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_\nu\omega_U = \frac{1}{3}\sqrt{2}\,\varepsilon_\nu\omega_1 \tag{387}$$

$$\omega_k = \frac{2\cdot 1}{3\cdot 4}\sqrt{2}\,\varepsilon_\nu \omega_U \left(\frac{½}{Q_0}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_\nu \omega_U (2Q_0)^{-\frac{3}{2}} = \frac{1}{3}\sqrt{2}\,\varepsilon_\nu \omega_1 (2Q_0)^{-\frac{3}{2}} \tag{388}$$

$$z = \frac{\lambda_k - \lambda_s}{\lambda_s} = \frac{\omega_s}{\omega_k} - 1 \approx \frac{\omega_s}{\omega_k} = (2Q_0)^{\frac{3}{2}} = 2\sqrt{2}Q_0^{\frac{3}{2}} \qquad z_{ab} = \begin{bmatrix} \dfrac{\omega_1}{\omega_k} & \dfrac{\hbar_1\omega_1}{\hbar\,\omega_k} \\ \dfrac{\omega_U}{\omega_k} & \dfrac{\hbar_U\omega_U}{\hbar\,\omega_k} \end{bmatrix} = \frac{1}{\varepsilon_\nu}\begin{bmatrix} 6Q_0^{\frac{3}{2}} & 6Q_0^{\frac{5}{2}} \\ 12Q_0^{\frac{3}{2}} & 12Q_0^{\frac{5}{2}} \end{bmatrix}^{*} \tag{389}$$

$$\frac{\omega_U}{\omega_s} = 3\sqrt{2} = \text{const}$$

*) Correctly $m(Q_0^{3/2} - 1)$ resp. $m(Q_0^{3/2} - 1)Q_0$

The factor $2\sqrt{2}$ has nearly the same size as the factor 2.8214 from WIEN's displacement law. We can see, that it's better to relate to ω_1 or ω_U. The components z_{1b} are describing the *frequency related*, the z_{2b} however the *energy related redshift*. For ω_k we obtain a value of $1.0614521\cdot 10^{12}\text{s}^{-1}$. Curve 1 in figure 67 corresponds to the signal ω_s redshifted by $(2Q_0)^{3/2}$ with the frequency response of a 1st order filter with in-coupling. Except for the decline in the upper-frequent range it is identical with ω_k. Curve 6 shows the course of a thermal emitter with the temperature of 2.86632K. That's exactly the temperature of a gray emitter with the frequency ω_k.

Now we want to assume that the decrease with higher frequencies is actually caused by the existence of a cut-off frequency. Then the intensity of the cosmic background-radiation should trace exactly the PLANCK's radiation-rule. The fundamentals of the solution already have been compiled in section 4.3.4.4.5. However, the exact proof is somewhat more complicated. First it's necessary to determine the time-function of the frequency (302), incipiently with $t_1/4$ up to the event-horizon 2T. Then we must employ it in the expression of amplitude response (150). I would like to postpone the exact calculation to a later date [46], especially since a very good approximation can be achieved by an approximative solution.

We have already realized that even a single MLE owns a fixed cut-off frequency (147). During propagation, only the active-part $A(\omega)\cdot\cos\varphi_\gamma$ with $\varphi_\gamma = B(\omega)$ is been transferred (real part). Thus we exactly get the value $\omega_g = 2\omega_1$, it applies $\Omega = \omega/(2\omega_1)$. With more exact contemplation we can see, the cut-off frequency may become effective in the first moments of propagation only. Let's have a look at the moment of in-coupling now: The signal ω_s (curve 1) is multiplied with the frequency response $A(\omega)\cdot\cos\varphi_\gamma$ after in-coupling. As a result, we obtain curve 2, which already comes very close to the PLANCK-curve. Now the signal is transferred to another MLE, at which point the frequency has decreased to a value of $\omega_s/\sqrt{2}$ within this period. We now re-apply the frequency response to the signal obtaining curve 3 (We considered the frequency to be constant at the presentation scaling up the upper cut-off-frequency accordingly instead). Curve 3 comes even closer to the targeted result.

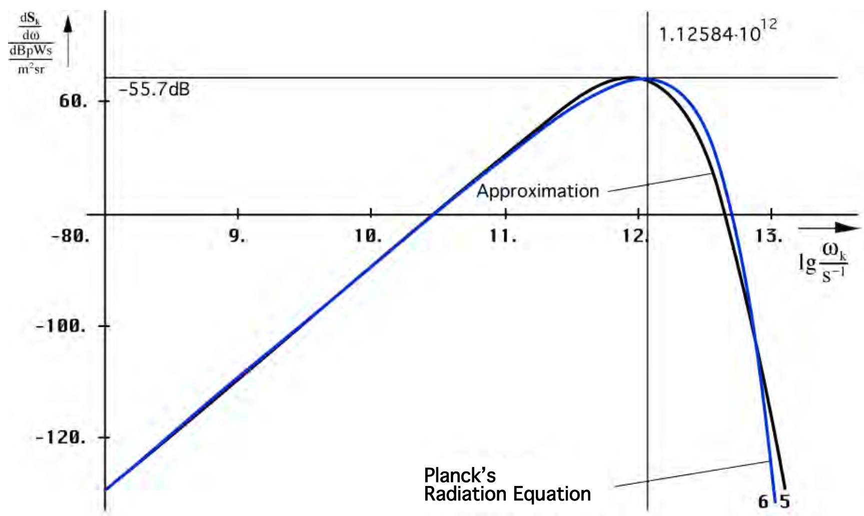


Figure 68
PLANCK's radiation equation and approximation

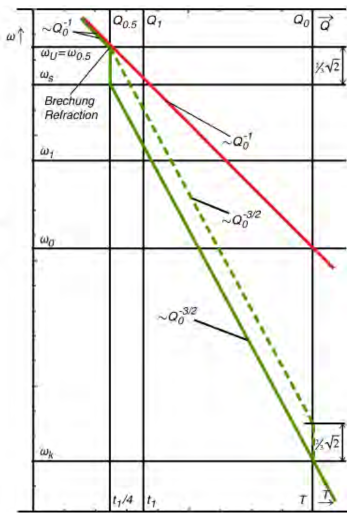


Figure 68a
In-coupling process

We repeat the entire process twice again obtaining graph 4 ($\omega_s/1$) and finally graph 5 ($\omega_s/2$), which figures a very good approximation of PLANCK's graph. For reasons of clearness I have figured graph 5 and the comparison-graph (black emitter) separately once again (figure 68).

It could be so just thoroughly that PLANCK's radiation-rules are really the result of the existence of an upper cut-off frequency of the vacuum. In this connection is to be paid attention to the fact, that that, which is applied to time-like vectors emitted directly after the big bang, must apply to time-like vectors, emitted at a later point of time (e.g. today) too. With time-like vectors, it is impossible to determine exactly, when and where they have been emitted. Since no vector can be marked with respect to a second one, each thermal emission must run according to the same legalities (PLANCK's radiation-rule) then. It remains only to determine, which way the cosmic background-radiation has covered up to the present point of time. By insertion of (389) in (309) we obtain for the distance r:

$$r = \frac{\tilde{R}}{2}\left((z+1)^{\frac{4}{3}} - 1\right) \approx \frac{\tilde{R}}{2} z^{\frac{4}{3}} = 2\tilde{R}Q_0^2 \tag{390}$$

$$r = r_1 Q_0^2 = R = 2cT \qquad \text{with } \tilde{R} = \frac{r_1}{2} \tag{391}$$

The cosmic background-radiation has covered the distance of the local world-radius precisely, just coming from the edge of our local universe. Temporally seen, it's coming from the time immediately after big bang. With it, we have defined the distance to the event-horizon precisely. This one is equal to R as well as 2T. Just, there are exactly two singularities/horizons within our local universe (and even r_0 and r_1) In the distance R/2=cT there is the particle-horizon. This is identical to the inner SCHWARZSCHILD-radius. In the distance R=2cT there is the event-horizon. This is identical to the outer SCHWARZSCHILD-radius.

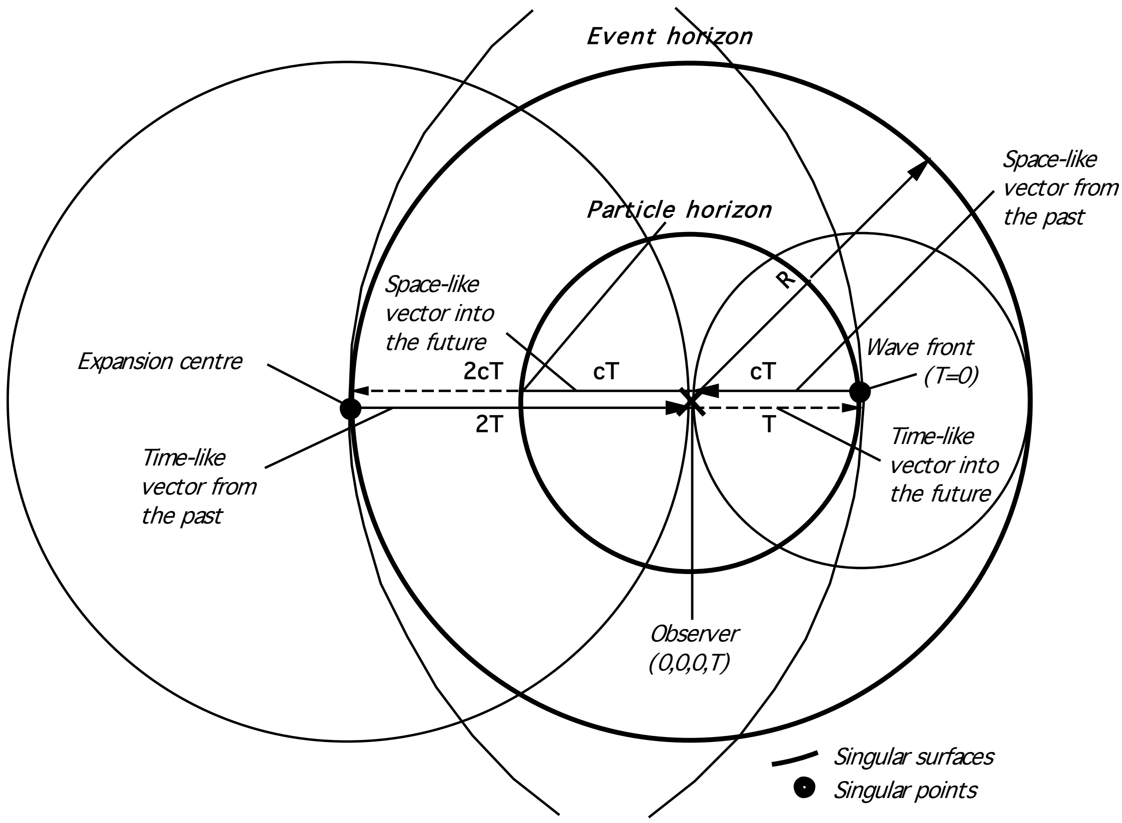


Figure 69
World-model with the course of space- and time-like vectors

Time-like vectors proceed on world-lines, that come from the particle-horizon. After transit through the point of zero they run into the direction of event-horizon asymptotically. By the way this agrees well with the energy W_0 of the discrete MLE, that gains a maximum in the particle-horizon (maximal emission). Therefore the particle-horizon figures a singular point for time-like vectors, whereas the event-horizon forms a singular surface.

Space-like vectors however proceed contrary to the direction of time-like vectors on world-lines coming out of the event-horizon (expansion-centre) directed to the particle-horizon after transit through the point of zero. The event-horizon forms a singular point, the particle-horizon a singular surface for space-like vectors (figure 69). The metric wave-field itself is a space-like vector, as the name already says. Also the explanation of the opposite signs of phases- and group velocity is here. Now the summary once again:

> *VI. Each time-like vector behaves as if it would come out of the particle-horizon being directed to event-horizon. That also applies to the cases of incomplete or interrupted vectors.*
>
> *Each space-like vector behaves as if it would come out of the event-horizon being directed to particle-horizon. That also applies to the cases of incomplete or interrupted vectors..*

These conclusions would also explain the most recent obtained results of the examination of coherent photons (entanglement, tunnel through with „warp speed“). The photons move on the same time-like world-line being coupled via the vacuum, not via the metrics. The cut-off frequency of the vacuum would be even an explanation for the question: Why does our universe mainly contains „normal“ matter instead of antimatter or both? Antimatter as autonomous solution of the field-equations has an inherent-frequency, that is above the frequency of the metric lattice, while the frequency of „normal“ matter is below. With it, the formation of antimatter has an inferior probability then, as a result of the existence of the cut-off frequency (symmetry-breaking), which leads to the contemporaneous circumstances of today.

According to our model, emission should take place with exact the frequency of the cosmic background-radiation, even later. But the frequency of the MLE´s only traces the function $\omega_n = \omega_1/Q_n \sim Q^{-1}$. In case of an emission with the frequency of ω_n (now ω_0) then again, the cut-off frequency would not become noticeable and the spectrum should rather look like graph 1. Furthermore, the bandwidth would become extremely narrow then. Now it would be possible that each thermal emission, coming directly out of the vacuum, is taking place with the frequency ω_s, just without influence of the metric lattice. On coupling into the metric lattice, just an immediate red-shift with frequency-response-adjustment (emission-red-shift) occurs to the adaptation on already existing vectors.

Examples would be on the one hand direct particle-reactions (strong interaction) but also thermal emissions being generated on thrusting processes of particles (heat-radiation) on the other hand. To it, it would need the energy (mass) of the particles to be essentially larger than the hitherto assumed $\hbar\omega_\varepsilon/c^2$ Let's assume the above-mentioned model, which assigns an inherent-frequency below ω_0, just $\omega_0 - \omega_\varepsilon$, to the normal particles, but an inherent-frequency above $(\omega_0 + \omega_\varepsilon)$ to the antiparticles, we would even have the higher energy then.

On interaction-processes with or via the metrics there only the difference-frequency has an effect then (and only $\hbar$, see further below), due to this red-shift, so that the shape of new particles needs only the amount of energy $\hbar\omega_\varepsilon$. The left-over is added by the metrics. In the opposite case (annihilation), even only this amount of energy is being released then. The frequency-response-graph at $2\omega_1$ would be the one non-linear graph, which is necessary to the form of sum- and difference-frequency, then. Since sum- and difference-frequency occur always together, according to $\cos\alpha \cos\beta = [\cos(\alpha-\beta) + \cos(\alpha+\beta)]/2$ there's even always going to be pair-creation.

By what such an immediate red-shift can be caused? Let's assume the metrics to be still connected via the length $r_l/2$ with the vacuum even nowadays, so that are about the same conditions, as with the determination of the temporal dependence of wavelength in section 4.3.4.4.1. (277) and (278). There, we have done a transformation from a singular, purely temporal, to a space-temporal coordinate-system, with which we obtained the expression $\lambda \sim Q_0^{3/2}$ This however exactly corresponds to the red-shift of the cosmic background-radiation of the first moments of expansion. On this occasion, the empty space corresponds to our temporal, the metrics to the space-temporal coordinate-system (without metrics no space). During the coupling into the metrics, the same transformation, as in section 4.3.4.4.1., still takes place just even now. The immediate red-shift of time-like vectors also can be considered as the introduction of an additional fourth dimension, the time. If we observe a process out of the metrics, always all four dimensions need to be transformed.

With it, yields $\omega \sim Q^{-3/2}$ also for the frequency arrived in space (CMBR-frequency). Because during this transformation all frequency-relations remain, the same conditions (bandwidth like with Q=0.5) for each point of time result. With it, our model is confirmed and we casually explained the active principle of the WIEN displacement law and the PLANCK's radiation-rule on the basis of this model. To the better overview, the particular frequencies are figured in table 3 once again:

Emission frequency (H_0=75.9)	ω_U	$2.79820 \cdot 10^{104} s^{-1}$	f_e	$4.45347 \cdot 10^{103}$Hz
Imission frequency (H_0=75.9)	ω_S	$6.59541 \cdot 10^{103} s^{-1}$	f_S	$1.04969 \cdot 10^{103}$Hz
CMBR-frequency (H_0=75.9)	ω_k	$1.12584 \cdot 10^{12} s^{-1}$	f_k	179.18259 GHz
CMBR-frequency (H_0=72.0)	ω_k	$1.09639 \cdot 10^{12} s^{-1}$	f_k	174.49511 GHz
CMBR-frequency (COBE)	ω_k	$1.00675 \cdot 10^{12} s^{-1}$	f_k	160.23±0.1GHz

Table 3
Frequencies of the cosmic
microwave background radiation

4.6.4.2.4. Emission-rate, energy

We have determined the frequency-relations of the cosmic background-radiation. With it, we have noticed that the red-shift z gains a value of $(2Q_0)^{3/2}$ after input coupling. In ciphers, it are $5.858 \cdot 10^{91}$. Calculated from the output-frequency $2\omega_1$ on, the red-shift even amounts to $12Q_0^{3/2}$. With it, the power arrived in space (CMBR-power) P_k no longer equals the power dissipation of the MLE and we have to change (381) accordingly:

$$P_k \overset{?}{=} \frac{\hat{\hbar}_i}{48\pi Q_0^{\frac{3}{2}} t^2} = \frac{1}{6}\hbar_1 H^2 Q_0^{-\frac{3}{2}} = \frac{1}{6}\frac{\hbar H^2}{\sqrt{Q_0}} \qquad P_T = 0.5503\, P_k \qquad (392)$$

The real power P_T results from the surface-ratio of the PLANCK graph (6) and the output-graph (1). I determined it by numerical integration. Then the CMBR-power (new emission) corresponds to a present-day value of P_T=2,1307·10^{-101}W. With the above mentioned frequencies ω_k and ω_T the emission-rate n calculates as follows then:

$$n_k \overset{?}{=} \frac{H^2}{\omega_0} \qquad n_T \overset{?}{=} 0.5503\frac{H^2}{\omega_0} = 1.795 \cdot 10^{-79} s^{-1} \qquad (393)$$

That corresponds to approximately $1.43 \cdot 10^{-91}$ hydrogen-atoms per second caused by a single MLE. This value is more believable than the preceding one in any case. As more exact examinations emerge, also this value is still too high however. Inside a sphere with a radius of 1m namely, in conformity with (342), approximately $2 \cdot 10^{104}$ line-elements are positioned.

So, the emission of approximately $3.6 \cdot 10^{25}$ photons as well as $2.86 \cdot 10^{13}$ hydrogen-atoms per second would still occur there even nowadays (without consideration of the fermion-/boson-ratio). This is apparently wrong. Expression (395) is just not yet complete. Hitherto, we regarded the frequency-caused red-shift only. However, there is an additional energetic red-shift as well, caused by the decrease of the value of PLANCK's quantity of action.

The emission with a frequency of $2\omega_1$ within the vacuum on the niveau $r_1/2$ is not the only peculiarity. Simultaneously, the value $2\hbar_1$ of PLANCK's quantity of action at the point of time $t_1/4$, is applied instead of the „normal“ $\hbar$. It gets lost again during transformation however. So the additional red-shift resulting from it does not have an effect onto frequency but only to the emission-rate. The energetic overall red-shift just amounts to $12 \cdot Q_0^{5/2}$. Expression (391) reads correctly:

$$P_k = \frac{\hat{\hbar}_i}{48\pi Q_0^{\frac{5}{2}} t^2} = \frac{1}{6}\hbar_1 H^2 Q_0^{-\frac{5}{2}} = \frac{1}{6}\hbar H^2 Q_0^{-\frac{3}{2}} \qquad (394)$$

$$n_k = \frac{H^2}{\omega_1} \qquad n_T = 0.5503\,\frac{H^2}{\omega_1} = 2.38 \cdot 10^{-140} s^{-1} \qquad (395)$$

With it, we get the final values for the present emission. Now this has a value of $P_T = 2.825 \cdot 10^{-162}$W only. The emission-rate is about $2.38 \cdot 10^{-140}$ photons per second caused by one single MLE. That is one single photon per year within a ball with a radius of 1.884 million km (1.26AU). For the shape of hydrogen-atoms, the frequency is too low anyway. These values agree with the observations the best as well as are the most believable ones. The difference between the values of (392) and (394) equals the introduction of the fourth dimension, the time, again.

In section 4.6.4.2.5. we will determine, that the metrics beside emission according to (394), also takes in energy (dielectric losses), whereby the magnitude is essentially greater than the emission. That means, the emission of cosmic background-radiation to the present point of time is equal to zero.

That with the emission-red-shift energy quasi „gets lost“ is no contradiction. Even with the normal cosmologic red-shift, energy goes „lost“. Really, the energy doesn't go lost indeed, it only does not become effective, because the energy of time-like vectors is depending from the valid frame of reference after all. Summarizing, we can write once again:

1. *The emission doesn't take place with a frequency of ω_0, but always with $2\omega_1$*
2. *The emission-value of PLANCK's quantity of action is $2\hbar_1$*
3. *The metrics is connected with space via the length $r_1/2$ even nowadays*
4. *With the emission, the full power dissipation becomes effective*
5. *The output-signal is superposed with the frequency characteristic (382) and a red-shift, so that only a fraction of the energy is transferred by the metrics*
6. *Cause of the red-shift is a coordinate-transformation*

The conditions, that have on hand with the emission of the cosmic background-radiation ($2\omega_1$, $2\hbar_1$, $r_1/2$, $Q=1/2$), applies not only in this case but with all processes taking place without participation of the metrics like e.g. mutually impacts of particles and also the strong interaction. If there's going to be emission of photons in this connection, so these are red-shifted in the same way, as the cosmic background-radiation (Macroscopically, we are observing the red-shifted values only).

4.6.4.2.5. Field-strength of the cosmic microwave background-radiation

Having clarified the energy- and power-relations at a discrete MLE, also the electromagnetic field-strength is of interest. Let's look at the field-strength of the cosmic background-radiation first. We want to assume the present conditions to be the result of the 1st maximum with the energy $W_e=2.8967\cdot 10^{131}$J, which have been coupled in by one discrete MLE at the point of time $t_1/4$ into the metric lattice established just now. The coupling-length is $r_1/2$.

Although an apportionment onto four MLE´s occurs with input coupling, at which point the frequency decreases about the factor 4, with simultaneous multiplication with the factor $\frac{2}{3}\sqrt{2}$, that adds up to 6 versus $\hbar_1$, the energy-density remains constant, since the other three MLE´s also generate photons, which are coupled into the other ones. Only a multiplication of photons occurs with constant energy-density. This results directly from the energy-conservation-rule. Let's look at the single MLE first. The *approximation* of W_e results in:

$$W_e \approx \frac{8}{\pi}\hbar_1\omega_1 = \frac{2}{\pi}(2\hbar_1)(2\omega_1) = \frac{2}{\pi}\hbar_{0.5}\omega_{0.5} \tag{396}$$

The fraction results from the qualities of the Bessel function. The energy is smaller than the energy of the MLE to that moment. Then, the energy-density amounts to:

$$w_0 = \frac{8}{\pi}\left(\frac{2}{r_1}\right)^3\hbar_1\omega_1 = 2{,}309\cdot 10^{419}\frac{\text{Ws}}{\text{m}^3} \tag{397}$$

In order to take up a comparison with the field-strength of the cosmic background radiation (spherical coordinates), we have to convert this amount accordingly. The ratio in volume between a cube with the edge length r_0 and a ball with the same diameter amounts to $\pi/6$. Thus, the cube contains 4, the ball $\frac{2}{3}\pi$ MLE´s on average. This result can be obtained even from (342). We just have to multiply (397) with π in order to get the actual energy-density. We get the electromagnetic field-strength by multiplication with c then:

$$w_e = \frac{2}{3}\frac{64\hbar_1\omega_1}{r_1^3} = \frac{4}{3}\frac{\hbar_{0.5}\omega_{0.5}}{r_{0.5}^3} = 4.83\cdot 10^{419}\frac{\text{Ws}}{\text{m}^3} \tag{398}$$

$$|\mathbf{S_e}| = \frac{128\hbar_1\omega_1 c}{3r_1^3} = \frac{128\hbar_1\mu_0\kappa_0^4}{3\varepsilon_0^3} = 1.45\cdot 10^{428}\frac{\text{W}}{\text{m}^2} \tag{399}$$

this value corresponds to a level of 4401.61 dBpWm^{-2}. Now, we want to calculate the current level. First, a geometrical attenuation $A_g\sim r^{-2}$ occurs. Because of $r\sim Q_0$ applies $A_g\sim Q_0^{-2}$. Furthermore, an attenuation appears due to redshift as well as an energetic attenuation by decrease of $\hbar$. Redshift and energetic attenuation amount to $A_\omega\sim Q_0^{-5/2}$ in total. Since this attenuation appears both in x- as well as in y-direction (with propagation in z-direction), it'll be altogether $A_\omega\sim Q_0^{-5}$. With it, the total attenuation is $A\sim Q_0^{-7}$. Now, let's assume the red-shift of the field-strength to be equal to the red-shift of the wavelength ($144Q_0^5$). This is not applied to the geometrical part however. Here, the redshift has only a value of ($4Q_0^2$). The current electromagnetic field-strength, just the POYNTING-vector, would have the following value then:

$$|\mathbf{S_k}| = \frac{2}{27}\frac{\hbar_1\omega_1 c}{r_1^3 Q_0^7} = \frac{2}{27}\frac{\hbar_1\mu_0\kappa_0^4}{\varepsilon_0^3 Q_0^7} = 0.1809\frac{\text{W}}{\text{m}^2} \tag{400}$$

This value corresponds to a level of 112.547 dBpWm^{-2}. Now we still have to subtract the attenuation by dielectric losses, as described in section 4.3.4.4. It amounts to 8.686 dB/R=1 Np/R for the electric field-strength and is an additional geometric attenuation.

On the basis of the definition of the decibel, the same amount is applied to voltage and power. Since we have to do it with two directions (x and y), we calculate with the square of the value, obtaining a value of 2·8.686 dB/R according to the logarithmic rules. Finally, we get a target-value of 95.20 dBpWm^{-2}, that is 1.981 mWm^{-2} resp. 0.864 Vm^{-1}. Actually, the field-strength amounts to 66.8074 dBpWm^{-2} only. The difference of 30 dB can be attributed to the fact, that a part of the cosmic background-radiation has been converted to matter in the course of expansion, a more inferior part even into heat, mechanical or electromagnetic energy with a different wavelength during interactions with the very same matter.

Now we want to examine, whether we succeed with the derivative of an estimation of the present boson-/fermion-ratio from this difference. Even a calculation of the average matter-density should be possible.

Value	Poynting vector	dB	Energy density	Symb.	Definition	Number/m^3
Start	$4.835 \cdot 10^{419}$ Wm^{-2}	4401.61	$1.450 \cdot 10^{428}$ Jm^{-3}	w_e	Emission	—
Target now	$1.981 \cdot 10^{-3}$ Wm^{-2}	95.20	$1.1056 \cdot 10^{-11}$ Jm^{-3}	w_k	Total	—
Actual now	$4.797 \cdot 10^{-6}$ Wm^{-2}	66.81	$1.5990 \cdot 10^{-14}$ Jm^{-3}	w_γ	Bosons	$1.350 \cdot 10^8$
Difference	—	—	$1.6567 \cdot 10^{-11}$ Jm^{-3}	w_M	Fermions	0.2220
Density	—	—	$1.845 \cdot 10^{-31}$ gcm^{-3}	n_γ/n_M	Ratio	$6.080 \cdot 10^8$

Table 4
Field-strength and energy-density
of the cosmic background-radiation

With the calculation of the fermion number I assumed hydrogen to be the most prevalent element in the cosmos. The table has been calculated as follows:

$$w = \frac{|\mathbf{S}|}{c} \qquad n_\gamma = \frac{w_\gamma}{\hbar\omega_T} \qquad n_M = 2\frac{w_k - w_\gamma}{m_a c^2} \tag{401}$$

m_a is the atomic mass-unit. The value of $6.080 \cdot 10^8$ obtained for the boson-/fermion-ratio is very close to that one, determined with other methods. E.g. in [4] a value of $6.486 \cdot 10^8$ is declared, which is only 1.06 times larger. Now, to the determination of the boson-quantity, we have consulted even only the photons of the cosmic background-radiation. In reality of course, there are also photons, which have nothing to do with it, stemming from interaction-processes or which have been originated by annihilation of matter and antimatter. A considerable part of the cosmic radiation-spectrum e.g. is stemming from super-nova-outbursts. Therefore, we have to correct the boson-number slightly upward, the fermion-number downward, approaching the value of [4] more and more. The results obtained are another sign for it that we are close to the reality with our model.

Finally, we already want to specify an estimation of the average-matter-density within our „closer“ surroundings, i.e. approximately 0.01R. By the assumption that all matter and radiation within the universe (with exception of virtual particles) has been generated by the cosmic background radiation exclusively, the calculation results in the following value (including mass of radiation):

$$\rho_G \approx \frac{w_k}{c^2} = 1.230 \cdot 10^{-28}\,\text{kg} \cdot \text{m}^{-3} \qquad \left(1.230 \cdot 10^{-31}\,\text{kg} \cdot \text{dm}^{-3}\right) \tag{402}$$

In [4] a value of $\rho_G \approx 10^{-30}$kg·dm^{-3} is specified, which agrees very well with our value by the way. In our model, the matter-density doesn't have that influence on the property, whether the universe is closed or open, as with other models, since also the density is a function of time and space in it. The temporal and spatial dependencies are depicted in figure 70 to 72. The density is defined as follows:

$$\rho_G = \frac{1}{6e^4}\frac{\hbar_1 \kappa_0^4 Z_0^4}{cQ_0^7} = 0.0030526065\frac{\hbar\omega_0^2}{c^3R^2} \qquad (403)$$

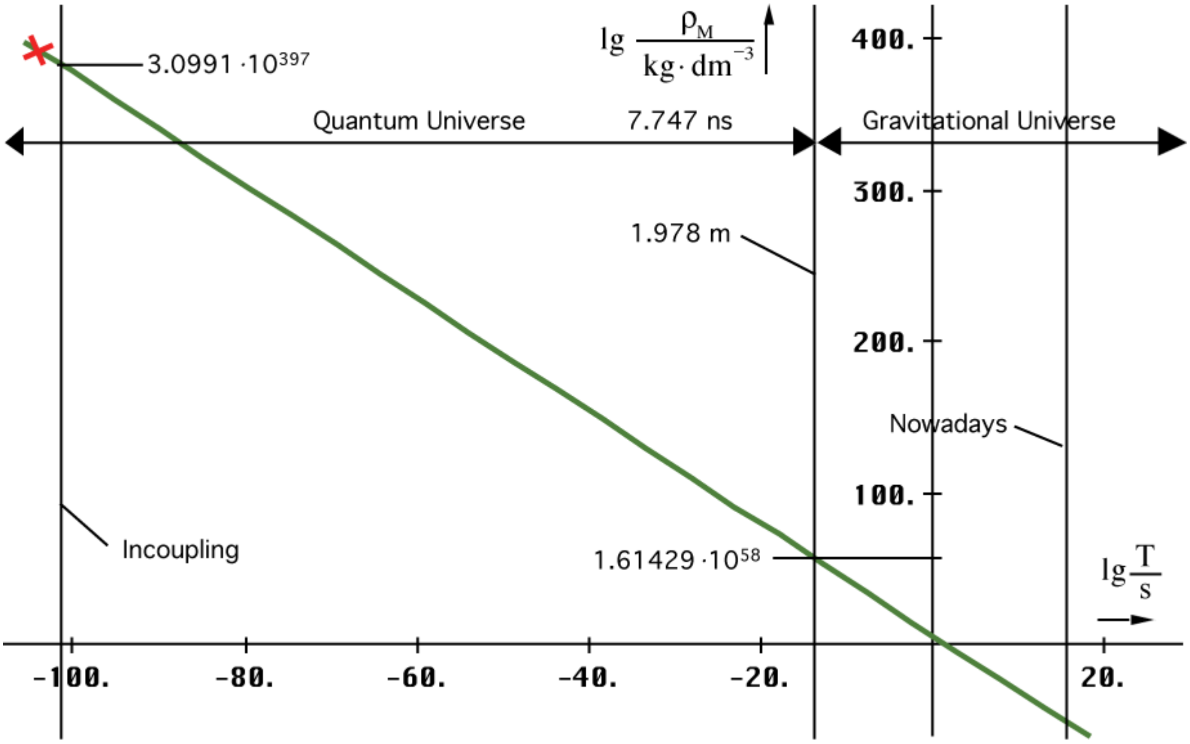


Figure 70
Temporal dependence of average matter-density
considered from the point of time of the input coupling on

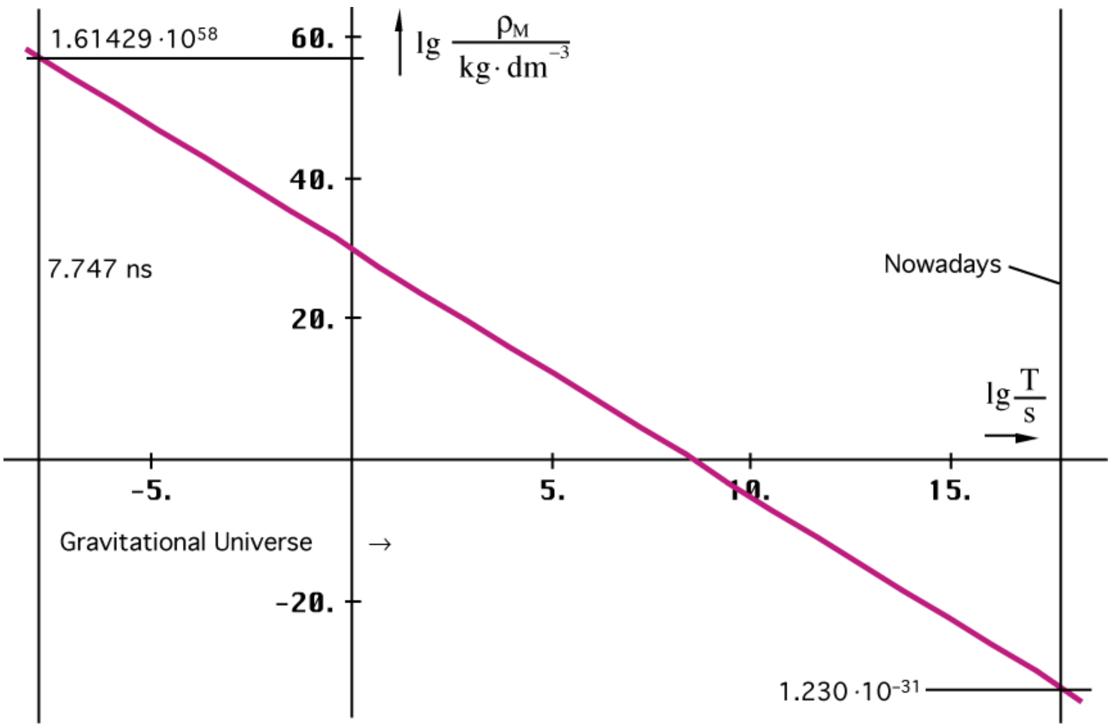


Figure 71
Temporal dependence of average matter-density
considered from the beginning of the gravitational-universe on

The factor e^{-4} arises from the dielectric attenuation, e is the EULER constant here. Now we just have to substitute for Q_0 as before:

$$Q_0 = \tilde{Q}_0 \left(\sqrt{1 + \frac{t}{\tilde{T}}} - \left(\frac{2r}{\tilde{R}} \right)^{\frac{2}{3}} \right) \tag{404}$$

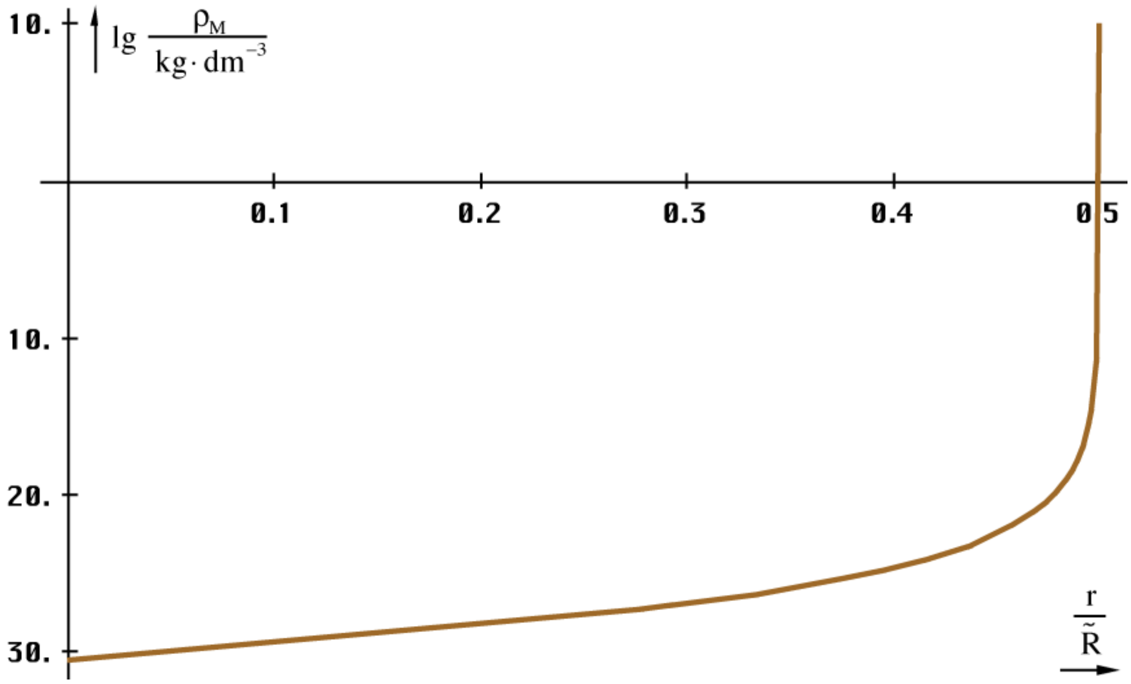


Figure 72
Spatial dependence of the average matter-density at the point of time T (nowadays)

To the moment of in- coupling, there is also a maximum matter-density, which achieves a value of approximately $3.0991 \cdot 10^{397}$ kg dm^{-3}, once again inclusive radiation. Before this point of time, there is no metrics, i.e. no space and therefore even no density. With densities above $1.61429 \cdot 10^{58}$ kg dm^{-3} quantum effects become effective with a magnitude of the entire cosmos resp. the entire area with this density. This is closed outwardly then.

Furthermore it is of great interest, if there is a constant boson-/fermion-ratio over the entire period. We cannot yet make any statement about it to the present point of time however. Probably, it remained unchanged at least during last time, leading to the statement that also the mass should be subject to a certain red-shift

Two contradictions result from it however. Firstly, the shape of the fermions ought have taken place immediately after the input coupling. Because of the high temperature ruling at this point of time, these would not be able to exist according to the classic understanding however, i.e. they would immediately be reconverted into radiation. We will examine an approach to the solution of this problem in the next section. Because PLANCK's quantity of action is time-dependent, namely the fine-structure-constant, by which the action-profile of interaction of matter and radiation is determined, is changing too. At the point of time of the input coupling, it would be so small, that actually no interaction would take place, i.e. the photons would behave just like neutrinos nowadays.

The second contradiction exists with our initial hypothesis that particles as spherical-symmetrical solutions of the field-equations don't change. With constant boson-/fermion-ratio namely also the mass of the fermions would be subject to the same red-shift as the cosmic background-radiation. Considering the relationship $\hbar\omega = mc^2$ where ω corresponds to the DE-BROGLIE-frequency, it's plausible. Even according to the special and universal relativity-principle, the mass is not constant at all but depends on the space-time-coordinates and the gravitational-potential at the place of observer.

Here, one should refer to the model of the previous section once again, in which the particles *without metrics* are being always in the state as in the moment $t_1/4$. In this case, antiparticles have a mass and inherent-frequency greater than, „normal“ particles lower than the cut-off frequency of the vacuum. From it, also the symmetry-breaking results, leading to a universe, consisting of „normal“ matter mainly. In this state, all particles remain, unless an interaction occurs. The new particles possibly originated with it, are also formed with such qualities, as they prevail at the point of time $t_1/4$ ($2\hbar_1$, $2\omega_1$, $r_0/2$, $\alpha_1/2$ etc.). The essential point is now, that the observer himself is a captive of the metrics and therefore only the „shadows“ of the real conditions, just the red-shifted relative mass like e.g. m_p can be observed (PLATO's cave parable). This and not the absolute mass is a function of space and time then.

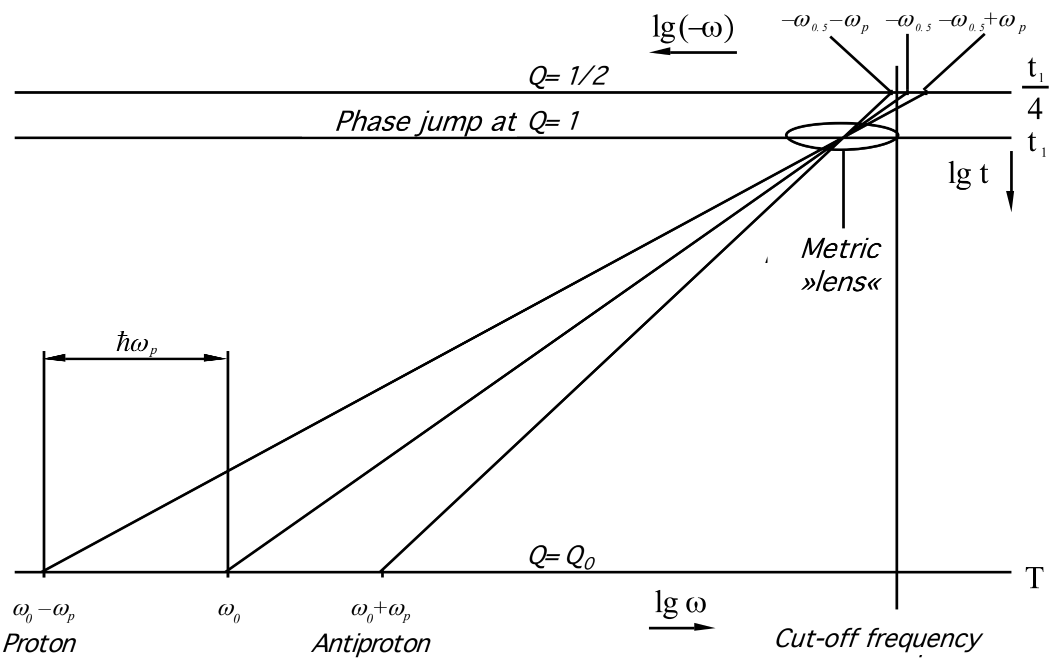


Figure 73
Mass-red-shift at the example of the proton

To it, however it's necessary, that the frequency of the metric wave-field shows the same red-shift, as the frequency of the cosmic background-radiation (for $\hbar$ it's guaranteed anyway), so that the frequency-ratii remain constant too. To the frequency $\omega_0 \sim Q_0^{-1}$ is applied. Additionally, another difference exists with the propagation-velocity, that amounts a value of $Q_0^{-1/2}$ in the approximation. That'll be altogether $Q_0^{-3/2}$, as with overlaid waves. The principle of such a red-shift is figured in figure 73.

Here the metrics acts as a lens, we are looking through at the real conditions. The resolution amounts to $\hbar/2$ exactly. The magnification- or better reduction-factor is changing with time but it's also a function of space and of the gravitational-potential. With a Q-factor of $Q_0=1$ at the point of time t_1 a phase-jump appears, the phase rate of the metric wave-field has a zero-transit (figure 23). Therefore, the frequency is defined negatively before this moment and positively after it.

But how there shall going to be such a lens-effect e.g. with a proton? The particle as such is embedded into the metrics, is even permeated by the metrics. If now a red-shift e.g. of the mass should occur, the metrics around ought to show certain properties, that lead to a red-shift. Namely, if we would work with the normal metrics of empty space, there wouldn't be such redshift anyway. By the way, the red-shift ought to achieve this value, for which the light requires a distance from the „edge of the world" up to us, very quickly, within a very small distance to the particle.

In [29] I found a very good model for it. There NANSTIEL describes a similar model, in which the universe is composed of elements with the dimensions of PLANCK's fundamental length (smallest increment). These elements he describes as bare singularities. Therefore his model doesn't essentially differ from my model, though the PLANCK's smallest increments are seen as particles only as well as particle-like. Either there aren't bare singularities in my model, since they own an event-horizon in the distance r_0 . In reality, PLANCK's fundamental length, which is identical to the MINKOVSKIan line-element (MLE), owns both wave- and particle-properties. In his model NANSTIEL describes an object, be called graviton, which reflects very well the active-principle of the above-mentioned on-site-red-shift. It is, provided with one or two modifications (It's not my opinion that this graviton is a matter of quantum of the gravitational field here), figured in figure 74. Rather the MINKOVSKIan line-element itself is the quantum of the gravitational-field with the additional feature that it forms also the space. This is actually plausible.

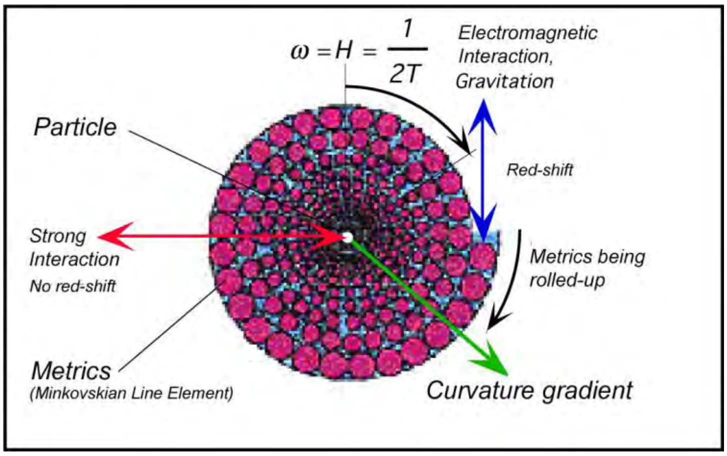


Figure 74
Structure of the metrics in the vicinity of a particle by analogy with NANSTIEL

In accordance with NANSTIEL, free fundamental lengths have the endeavor to roll up around itself as well as around particles. Let's assume more final case, so this could really be the cause for an on-site-red-shift. The particle is in the basic condition ($Q_0=1/2$). With the electromagnetic and gravitative interaction, the action must take the detour across the rolled-up metrics, with which above-mentioned red-shift occurs then. In truth, the action goes the direct way along the curvature-gradient of course. At each new plane there's going to be an adjustment of the frequency-ratio, so that total-red-shift really achieves the above-mentioned high value, just much more quickly. The curvature ascends with decreasing distance to the particle, but it does not become infinite anyway.

During the strong interaction, action uses the direct way without aid of the metrics. However, the particles must be located so densely together then, that there is going to be a total displacement of the metrics. The fundamental physical constants are having the value as in basic condition ($Q_0=1/2$) in this case.

4.6.4.2.6. Temperature of the cosmic background-radiation

While the temperature of the metric wave field is equal to zero, that's not the case for the CMBR. Since it's nearly about black radiation ($\varepsilon_v=0{,}9428= \sqrt{2}$), we are able to calculate the *black temperature* indeed, but we want to keep working with the *gray temperature*. By rearranging of (384) and inserting the energy related redshift $z_{22}= 12\,\varepsilon_v\,Q_0^{5/2}$ from (389) we obtain for $\omega_U=2\omega_1$:

$$T_k = \frac{\hbar\omega_k}{\tilde{x}\mathrm{k}} = \frac{\varepsilon_\nu}{\tilde{x}}\frac{\hbar_1\omega_1}{6\mathrm{k}}Q^{-\frac{5}{2}} = 0.055693\frac{\hbar_1\omega_1}{\mathrm{k}}Q^{-\frac{5}{2}} \qquad \tilde{x} = \begin{cases} 2.821439372 & \text{Exactly} \\ 2\sqrt{2} & \text{Approx.} \end{cases} \tag{405a}$$

$$T_k = \frac{\hbar\omega_k}{\tilde{x}\mathrm{k}} \approx \frac{1}{3}\frac{\hbar_1\omega_1}{6\mathrm{k}}Q^{-\frac{5}{2}} = \frac{\hbar_1\omega_1}{18\mathrm{k}}Q^{-\frac{5}{2}} \qquad \varepsilon_\nu = \frac{2}{3}\sqrt{2} \tag{405b}$$

That’s the temperature of the CMBR in consideration of the frequency response (see figure 75). Because the value $\tilde{x}$ is extremely near to the magic $2\sqrt{2}$, that’s only 0.25% above $\tilde{x}$, we want to keep working with the approximation (405b) for the CMBR, the more so as we get an extremely simple expression thereby. As later calculations will show, we will get even closer to the COBE-measurement, than with (405a). Btw. expression (405b) would correspond to an exact solution, if we would have turned about 44.8586° only, instead of 45° during in-coupling — also possible. That would be just another quantum-caused inaccuracy, this time for the universe as a whole.

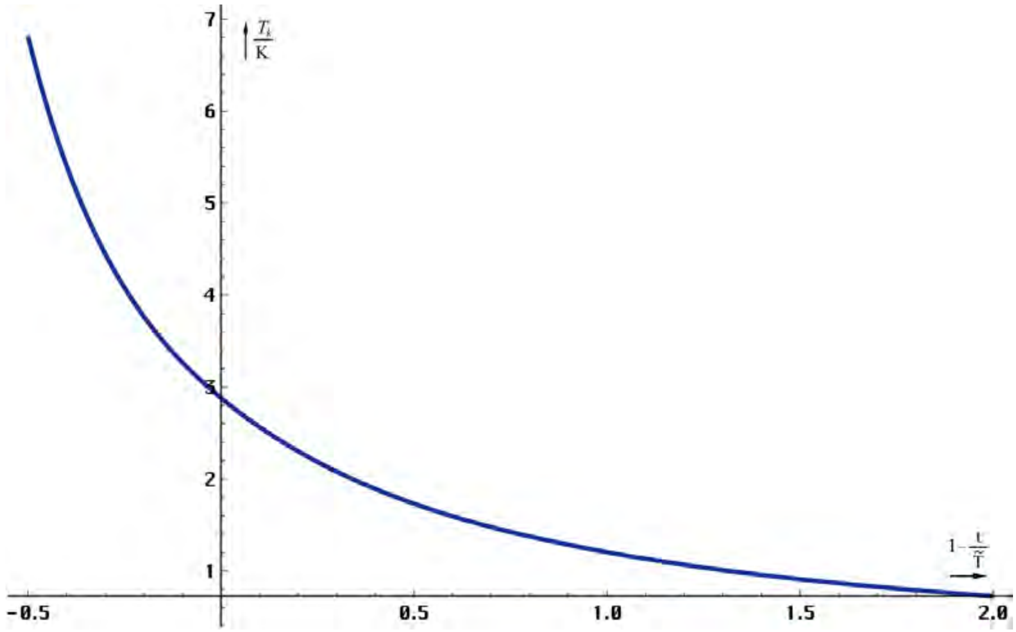


Figure 75
Temporal dependence of the radiation-temperature of the cosmic background-radiation (linearly)

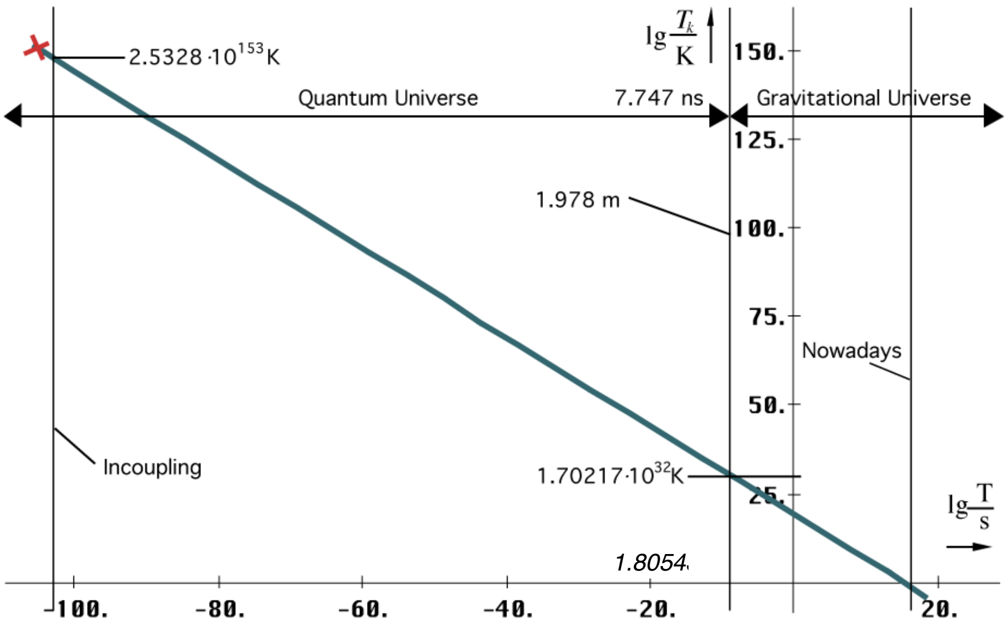


Figure 76
Temporal dependence of the radiation-temperature of the cosmic back-ground-radiation considered from the point of time of input coupling on

The temporal course is depicted in figure 76 to 77. Similarities exist to the energy-density[1]. We will renounce the presentation of the spatial dependence, since it shows similarly too.

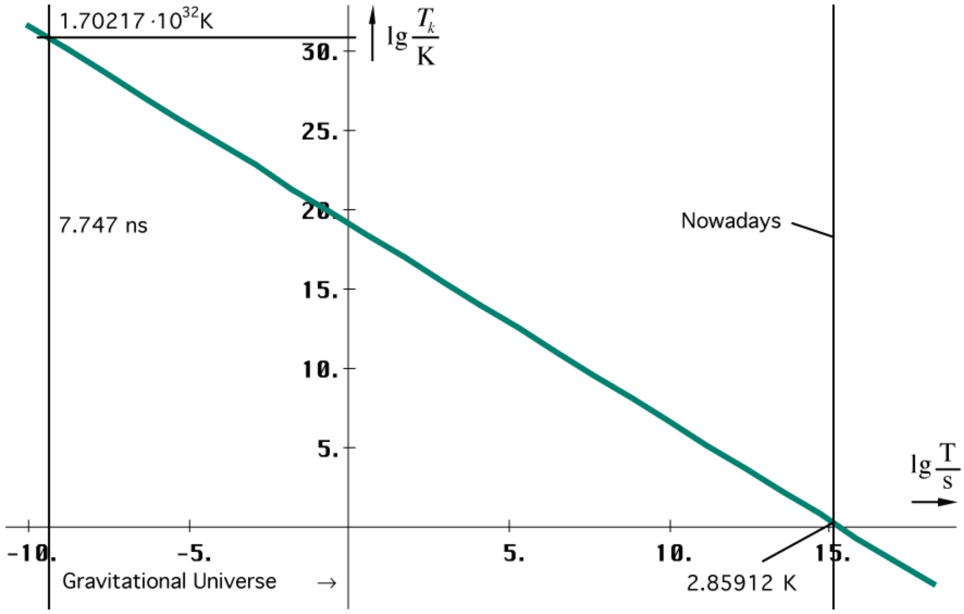


Figure 77
Temporal dependence of radiation-temperature of the cosmic background-radiation considered from the beginning of the gravitational-universe on

4.6.4.2.7. Field-strength of the metric wave-field

Next we want to consider the field-strength of the metric wave-field. In difference to the cosmic background-radiation, the relations are not quite so simply because of the complex propagation-impedance and the propagation-velocity different from c. So, the expression $c=\omega_0 r_0$ applies only for the approximation equations. Here applies $\underline{c}=\omega_0\underline{r}_0$ and $\underline{r}_0=r_1 Z_0^2/\underline{Z}_F^2$ with $r_1=1/\kappa_0 Z_0$. Normally, the POYNTING-vector is defined as $\mathbf{S}=\mathbf{E}\times\mathbf{H}$. With a complex approach however according to [26] applies:

$$\mathbf{S} = \frac{1}{2}\mathrm{Re}\left[\underline{\mathbf{E}}\times\underline{\mathbf{H}}^*\right] \tag{406}$$

Re is the real-part, $\underline{\mathbf{H}}^*$ the conjugate complex time-function. The direction of the POYNTING-vector is always that of the propagation direction. $\underline{\mathbf{E}}$ and $\underline{\mathbf{H}}$ we had defined as:

$$\underline{\mathbf{E}} = \hat{\mathbf{E}}_{\mathbf{i}}\, H_0^{(1)}(2\omega_0 t) \qquad \underline{\mathbf{H}}^* = \hat{\mathbf{H}}_{\mathbf{i}} H_0^{(2)}(2\omega_0 t) \tag{407}$$

But this definition is only applied to a purely temporal coordinate-system (there is no expansion), as e.g. we can find it at the expansion-centre (coupling-length). With it, expression (237) as approximation equation becomes physically pointless. Now, we want to have a look at the relations from the point of view on which we stay, from the metrics, however.

[1] It's based on a value of the HUBBLE-parameter of 75,9 $\mathrm{kms^{-1}Mpc^{-1}}$. The latest temperature measured by the COBE-satellite of 2.725±0.002K (Wikipedia) concludes $H_0 = 72\ \mathrm{kms^{-1}Mpc^{-1}}$. See also section 7.5.3.

First, we replace $\ddot{\mathbf{S}}_i$ with $2\pi\mathbf{S}_1$, for better calculation. Then we have to correct (407) as follows:

$$\underline{\mathbf{E}} = \sqrt{2\pi S_1 \underline{Z}_F}\left(J_0(2\omega_0 t) + jY_0(2\omega_0 t)\right)\mathbf{e_E} \tag{408}$$

$$\underline{\mathbf{H}}^* = \sqrt{\frac{2\pi S_1}{\underline{Z}_F}}\left(J_0(2\omega_0 t) - jY_0(2\omega_0 t)\right)\mathbf{e_H} \tag{409}$$

Now, there is another difference in the propagation-velocity in reference to the normal case however. We have to multiply the expressions with the fraction c/|$\underline{c}$|. Following substitutions apply ($M_0(x)$ is the module of the Hankel-function and identical to the amplitude of the associated Bessel function):

$$Q_0 = 2\omega_0 t \qquad \rho_0\omega_0 t = \frac{c}{|\underline{c}|} = \frac{Z_0}{|\underline{Z}_F|} \sim \frac{1}{2}Q_0^{\frac{1}{2}} \qquad M_0(2\omega_0 t) \sim Q_0^{-\frac{3}{2}} \tag{410}$$

$$\underline{\mathbf{E}} = j\rho_0\omega_0 t\sqrt{2\pi S_1 \underline{Z}_F}\left(J_0(2\omega_0 t) + jY_0(2\omega_0 t)\right)\mathbf{e_E}\, e^{-j\frac{1}{2}\arctan\theta} \tag{411}$$

$$\underline{\mathbf{H}}^* = j\rho_0\omega_0 t\sqrt{\frac{2\pi S_1}{\underline{Z}_F}}\left(J_0(2\omega_0 t) - jY_0(2\omega_0 t)\right)\mathbf{e_H}\, e^{+j\frac{1}{2}\arctan\theta} \tag{412}$$

The definition of ρ_0 can be found in (209). Now, there is to pay attention to another anomaly however. The electric and the magnetic field-strength is defined per meter. With a red-shift caused by the anomalous propagation-velocity, even the „meter-rate" is changed (stretched), so that the total-red-shift will be determined by the square of the product of (411) and (412) overall (without S_1). Under application of (406) we finally get for the amount S_0:

$$S_0 \overset{?}{=} \frac{\pi^2}{4} S_1(2\omega_0 t)^4\left(J_0^2(2\omega_0 t) + Y_0^2(2\omega_0 t)\right)^2\rho_0^4 = 4\pi^2 S_1\rho_0^4\omega_0^4 t^4 M_0^4(2\omega_0 t) \tag{413}$$

$$S_0 \overset{?}{=} S_1(2\omega_0 t - \beta r)^{-4} \qquad \text{Approximation} \tag{414}$$

The approximative solution has been found by trying. Because of $r_0 \sim Q_0$ the POYNTING-vector is also proportional to r_0^{-4}. with it. This is the double geometrical attenuation because of the transformation of the propagation-velocity (ever twice per dimension), just as expected. By the way, no imaginary-part appears in this case (blind-power), so that we can omit the Re[x] in (406). Now we want to determine the absolute value of $\mathbf{S_1}$ using the following approach:

$$\underline{\mathbf{E}} = \frac{q_0\mathbf{e_E}}{\varepsilon_0 r_0^2} = \frac{q_0\mathbf{e_E}}{C_0 r_0} = \frac{1}{c}\frac{i_0}{C_0}\mathbf{e_E} \tag{415}$$

$$\underline{\mathbf{H}} = \frac{\varphi_0\mathbf{e_H}}{\mu_0 r_0^2} = \frac{\varphi_0\mathbf{e_H}}{L_0 r_0} = \frac{1}{c}\frac{u_0}{L_0}\mathbf{e_H} \tag{416}$$

e is the unit-vector, q_0, φ_0, u_0 and i_0 are time-functions. Finally, we get:

$$\mathbf{S_0} = \frac{1}{2}\left(\underline{\mathbf{E}} \times \underline{\mathbf{H}}^*\right) = \frac{\hbar\omega_0^2}{r_0^2}\mathbf{e_r} = \frac{P_0}{r_0^2}\mathbf{e_r} \sim Q_0^{-5} \text{ !!!} \tag{417}$$

Expression (417) only contains effective-values. The factor 1/2 has been integrated into the definition of S_0 with it. But there is an aberration in reference to (413) and (414). The value S_0 of (417) is proportional to Q_0^{-5} (as with overlaid photons) in contrast to Q_0^{-4} in (414). The reason for the difference is the temporal dependence of the PLANCK'S quantity of action. In the approximation applies $\hbar \sim Q_0^{-1}$. In section 4.6.4.1.1. we had already tried to find an exact time-function for it. We however do not use any function figured there but rather another. The problem was indeed, that PLANCK'S quantity of action is a median value, which was not yet defined in the first moments after big bang. Even, $\hbar$ is a special quality of the metric wave-field. If the metrics doesn't exist or does not yet have been established completely, even there is no PLANCK'S quantity of action as well as it would have a smaller value than depicted in section 4.6.4.1.1. Therefore we will use the following exact time-function:

$$\hbar = 1.253314\ \hbar_1\ \rho_0\omega_0 t\ M_0(2\omega_0 t) \approx \hbar_1 Q_0^{-1} \tag{418}$$

The value $\hbar_1$ and the factor 1/2, turning out by expansion of $2\omega_0 t$ are however already contained in S_1, so that the correct versions of (413) and (414) read as follows:

$$S_0 = \frac{\pi^2}{4} 1.253314\ S_1 (2\omega_0 t)^5 \rho_0^5\ M_0^5(2\omega_0 t) \tag{419}$$

$$S_0 = S_1(2\omega_0 t - \beta r)^{-5} \qquad \text{Approximation} \tag{420}$$

With it, the initial value S_1, being applied as well for the exact function as for the approximation, results to:

$$S_1 = \frac{\hbar_1 \omega_1^2}{r_1^2} = \frac{\hbar_1 \mu_0 \kappa_0^4}{\varepsilon_0^3} = 3.3907 \cdot 10^{426}\,\mathrm{Wm}^{-2} \tag{421}$$

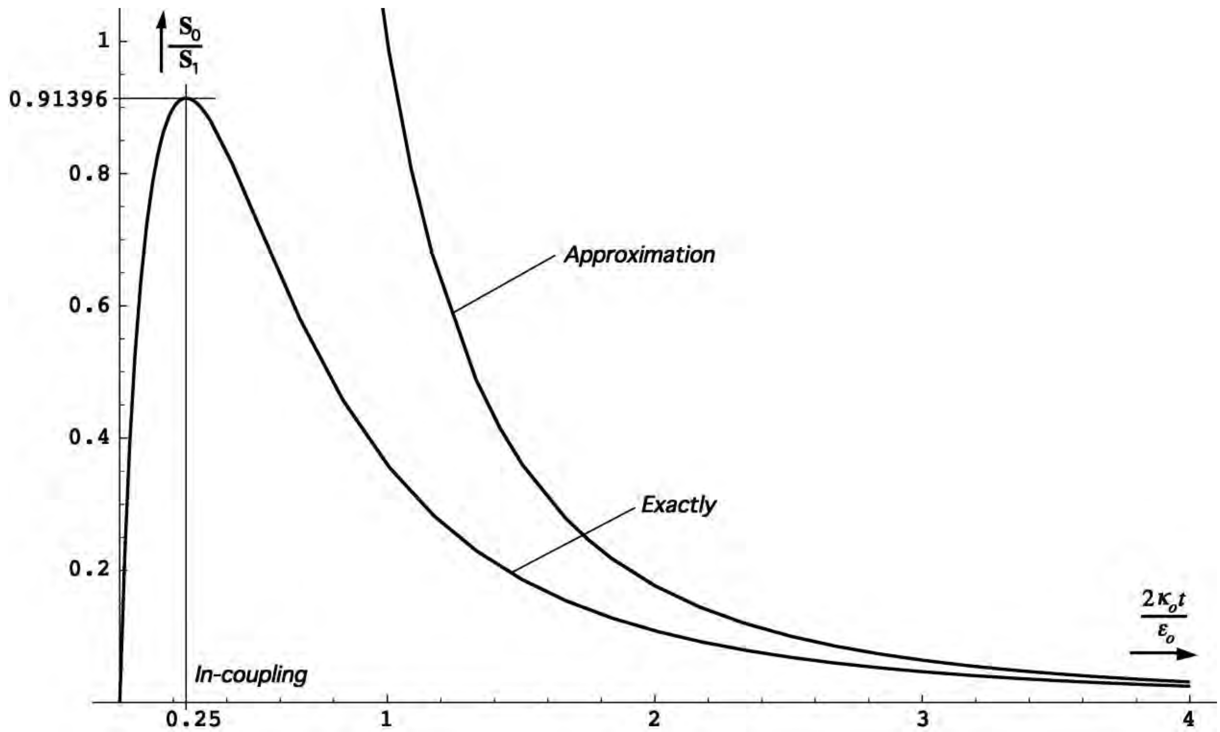


Figure 78
Temporal dependence of the electromagnetic field-strength
of the metric wave-field exactly and approximation

The approximation-value of S_0 to the point of time of input coupling ($S_{0.5}$) is exactly 35 times larger than according to the exact formula. With it, the field-strength of the cosmic background-radiation to this point of time would be approximately as large as that of the metric wave-field. This one and the field-strength of the cosmic background-radiation here can be traced back to the same function (figure 63). The function corresponding with figure 63 is the impulse-response of the empty space to a DIRAC-impulse as origin of the universe then. Cause of the DIRAC-impulse on the other hand is one single powerful quantum-fluctuation.

Perhaps even this is the reason why the shape of fermionic matter occurs at all. The metric wave-field can take in only a specific amount of energy, so that the left-over condenses inevitably in form of fermionic matter. Let's assume, that e.g. only the half of energy can be coupled in as radiation, the solid matter forms from the rest. Then, the ratio of both would not be identical to the present-day one however. Because of the strong red-shift there's quickly going to be, that the metrics is in the situation to take in more radiation-energy however.

Because of the low effective cross-section (to the point of time of input coupling it is equal to 1), with the initially ruling high temperatures, but only a fraction can be re-converted to radiation, so that quickly adjusts the prevalent ratio of nowadays. The course of the electromagnetic field-strength of the metric wave-field (exact and approximation) in the first moments after big bang is shown in figure 78. One realizes that there is still no metrics to the point of time of big bang. It first forms just after it.

As next we want to determine the energy-density of the metric wave-field. Since the POYNTING-vector and the vector of propagation-velocity have the same direction, we can calculate with the absolute values. In this case, an essential difference exists to classic contemplations however. We are used that the POYNTING-vector and the energy-density with technical problems are joined together solidly (the proportionality-factor is 1/c). But with the metric wave-field it is not the case. Here we have to divide by $|\underline{c}|$.

Even here, we can use w_1 for both, approximation and exact solution simultaneously again. Additionally to the division by $|\underline{c}|$ (to the definition of w_1 we set $|\underline{c}_1|=c$) we must take up the transformation for the meter-rate, namely for the third spatial dimension. That does altogether $\sqrt{2\pi}\,\omega_0 t \rho_0 M_0(2\omega_0 t)$. It applies $1.253314\sqrt{2\pi}=\pi$:

$$w_0 = \frac{\pi^3}{8} w_1 (2\omega_0 t)^6 \rho_0^6 M_0^6(2\omega_0 t) \qquad \text{with} \qquad w_1 = \frac{S_1}{c} \tag{422}$$

$$w_0 = w_1 (2\omega_0 t - \beta r)^{-6} \qquad \text{Approximation} \tag{423}$$

The course of the energy-density precisely and the approximation is shown in figure 79. The approximation equation has been determined by trial once again. We would obtain the same expression even from the energy of a discrete MLE ($\sim Q_0^{-2}$) under consideration of the geometrical dilution ($\sim Q_0^{-3}$) and the shift of $\hbar$ ($\sim Q_0^{-1}$).

There is a significant difference to the approximation in the time just after big bang. The energy-density of the metric wave-field initiates with zero. Then it ascends quickly, gaining coincidence with the approximative solution, coming from infinite, descending together with it then. The maximum has been achieved to the point of time of input coupling. In comparison with the power dissipation (figure 63) one can recognize, that the energy from the time immediately after big bang has been used for the construction of the metrics. Once completed, the excess has been emitted into the metrics i.e. coupled in. Here, it deals with red-shifted values again, just like we observe them from inside the metrics.

Now we can finally state a solution for the problem (374), the energy-conservation-rule of the MAXWELL equations. Here there's not much point in it, to calculate with approximation equation. For that purpose, let's look at the derivative of the energy-density first. Admittedly, even an analytic solution exists for it, however it's so complicated, that the time needed to calculate it would be essentially greater than the one of numerical methods. For the sake of simplicity we will calculate with the difference-quotient therefore ($\Delta t=0.0001 t_1$). It applies:

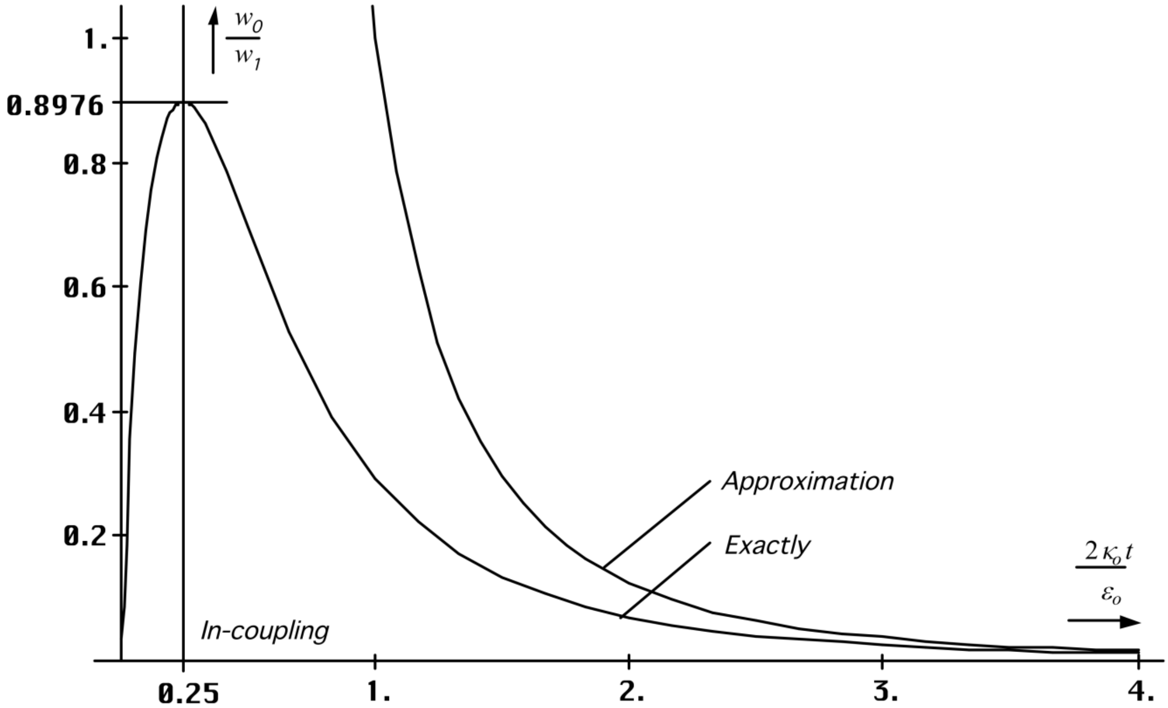


Figure79
Temporal dependence of the energy-density of the metric wave-field exactly and approximation

$$\dot{w}_0 \;=\; 8\pi^3 \dot{w}_1 \frac{d}{dt}\rho_0^6\omega_0^6 t^6 M_0^6(2\omega_0 t) \qquad \text{with} \quad \dot{w}_0 \;=\; 3\frac{S_1}{r_1} \tag{424}$$

$$\dot{w}_0 \;=\; \dot{w}_1 (2\omega_0 t - \beta r)^{-8} \qquad \text{Approximation} \tag{425}$$

The value ofwe obtained by differentiation of the approximative solution (423) after time and subsequent checkup. The factor 3 stems from the exponent of the time of the energy-density (it's proportional t^{-3}). Now to the expression **i**$\underline{\mathbf{E}}$. For $|\underline{Z}_F| \approx Z_0$ and $\mathbf{i} = \kappa_0 \underline{\mathbf{E}}$ applies:

$$\mathbf{i}\underline{\mathbf{E}} \;=\; \kappa_0 \underline{\mathbf{E}}^2 \;=\; \kappa_0 E^2 \;=\; 4\pi^2 \kappa_0 Z_0 S_1 \rho_0^4 \omega_0^4 t^4 M_0^4(2\omega_0 t) \tag{426}$$

$$\mathbf{i}\underline{\mathbf{E}} \;=\; \frac{4}{3}\pi^2 \dot{w}_1 \rho_0^4 \omega_0^4 t^4 M_0^4(2\omega_0 t) \tag{427}$$

$$\mathbf{i}\underline{\mathbf{E}} \;=\; \frac{\dot{w}_1}{3}(2\omega_0 t - \beta r)^{-4} \qquad \text{Approximation} \tag{428}$$

Here we insert consciously the square of (411) without additional correction for $\hbar$ as well as q_0^2. Since the MAXWELL equations shall be LORENTZ-invariant indeed, the correction in (426) on both sides should cancel itself. With the following contemplations, we would get a sort of reference-frame-independent result then (There is only a shift of the point of view of the observer on the time-axis). However, I am not quite sure in this point, specifically with this application. But now we want to insert the values in (374) obtaining finally:

$$\operatorname{div}\mathbf{S_0} = \; -\kappa_0 E^2 - \dot{w}_0 \tag{429}$$

$$\operatorname{div}\mathbf{S_0} = -4\pi^2 \dot{w}_1 \left(\frac{1}{3}\rho_0^4\omega_0^4 t^4 M_0^4(2\omega_0 t) + 2\pi \frac{d}{dt}\rho_0^6\omega_0^6 t^6 M_0^6(2\omega_0 t) \right) \tag{430}$$

According to definition, a positive value of the energy-flow-density-vector $\operatorname{div}\mathbf{S_0}$ corresponds to an emission of electromagnetic energy. The expression $\dot{w}_0$ (figure 80) gives information about the energy-balance of the metrics overall. One sees, first energy is taken in, which is required to the construction of the metric wave-field. Later the total-energy-density decreases again and tends against +0.

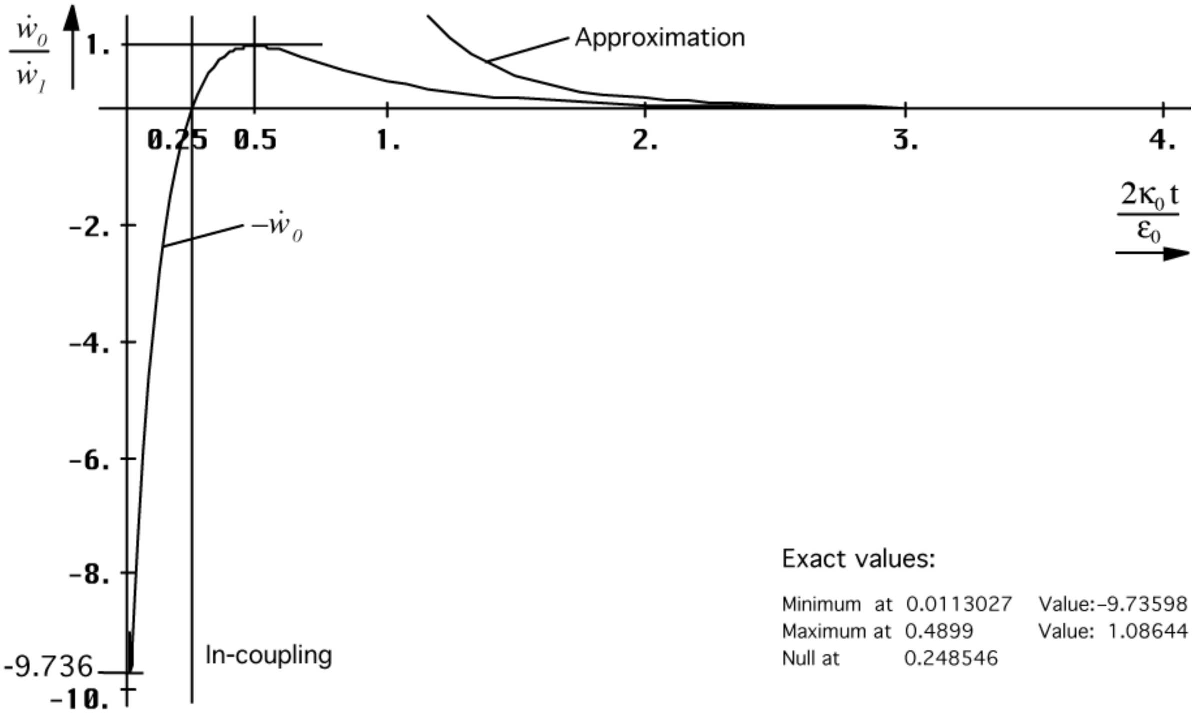


Figure 80
First temporal derivative of the
energy-density of the metric wave-field

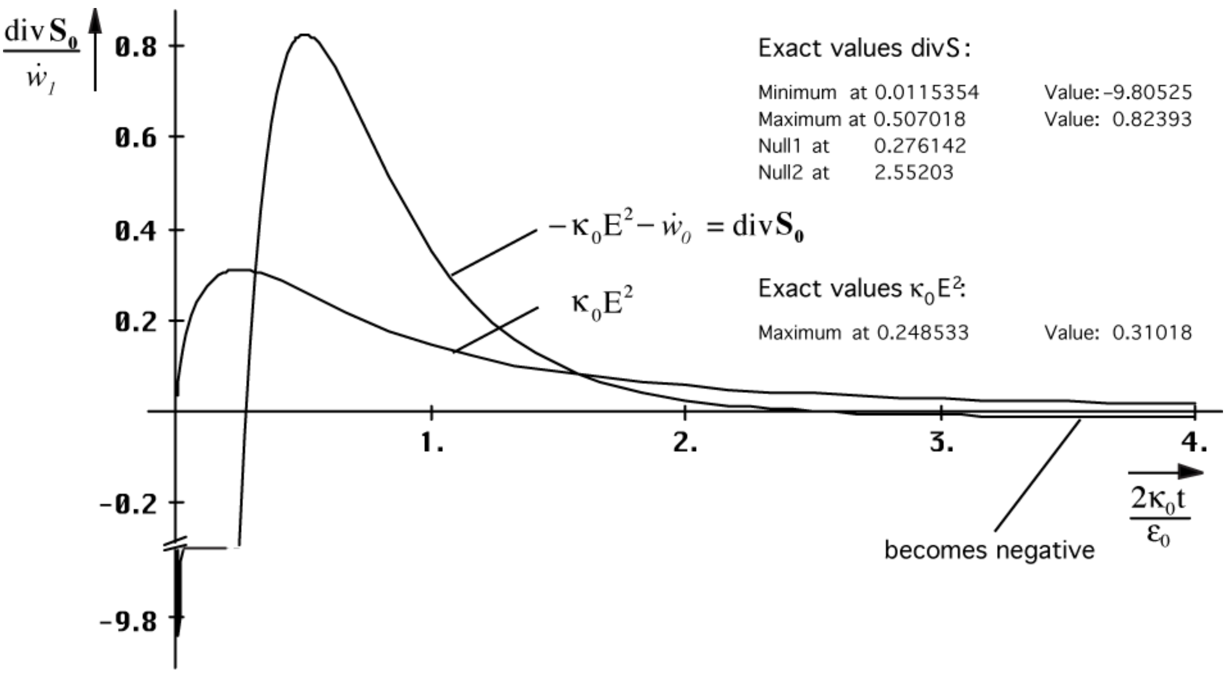


Figure 81
Temporal course of the energy-flow-density-
vector and ohmic losses of the metric wave-field

Especially interesting is the energy-flow-density-vector $\mathrm{div}\,\mathbf{S_0}$. Even this part is negative initially. This corresponds to an influx. Then, energy is emitted again. This is the cosmic background-radiation. But this step in evolution is very short, as already determined in the previous chapter. With a Q-factor of 1.5975, the energy-flow-density-vector has a further zero-transit. Energy is taken in again, even if the amount tends asymptotically against zero. These are nothing other than the dielectric losses during wave-propagation of overlaid photons. Just no energy gets lost.

With large-scale values of t, the expression $\dot{w}_0$ (becomes small with respect to the other ones, so that we can neglect it. Then applies:

$$\operatorname{div}\mathbf{S_0} + \kappa_0 E^2 = 0 \qquad \text{for } t \gg 0 \tag{431}$$

$$\operatorname{div}\mathbf{S_0} = -\frac{\dot{w}_1}{3}(2\omega_0 t - \beta r)^{-4} \qquad \text{Approximation} \tag{432}$$

Now we want to examine, whether the share $\kappa_0 E^2$ for the metrics really corresponds to the in-taken energy of the cosmic background-radiation. An essential criterion for it is, that as well the share of the metrics $\kappa_0 E^2$ as the one of dielectric losses of the cosmic background-radiation $\kappa_{0R} E_K^2$ have the same temporal course. It applies:

$$\kappa_{0R} = 2\kappa_0 Q_0^{-2} \sim Q_0^{-2} \qquad \mathbf{E_K} \sim r_0^{-1} \sim Q_0^{-1} \tag{433}$$

$$\kappa_{0R} E_K^2 \sim Q_0^{-4} \qquad \text{CMBR} \tag{434}$$

$$\kappa_0 E^2 \sim Q_0^{-4} \qquad \text{Metrics} \tag{435}$$

The electric field-strength-vector of the cosmic background-radiation $\mathbf{E_K}$ is subject to the geometrical dilution only, caused by the expansion of space. Here is the „meter-rate“ stretched once again. An adaptation of velocity is not necessary, since the background-radiation always propagates with speed of light and our observations take place with speed of light too. Since only the red-shifted conductivity of the vacuum κ_{0R} (see 4.3.4.4.2.) becomes effective for overlaid waves, the same temporal dependence arises for large t indeed.

In normal case (positive energy-flow-density-vector), the share $\kappa_0 E^2$ corresponds to ohmic losses, that lead to an additional diminution of the energy-density. A positive share $\operatorname{div}\mathbf{S_0}$ especially describes the energy-(away-)transportation through the electromagnetic field. If the energy-flow-density-vector becomes negative (energy-influx) however, so this energy either can be added to the electromagnetic field or be changed into other energy-forms. Because of $\dot{w}_0 \to 0$, only the second case is possible. Since the appearance of such a share means a conversion into other energy-forms in general (in a conductive medium always a part is changed into other energy-forms) arises the question from it, into which?

Once let's be able to tell the energy-relations by the look of us more exactly, so these are situated approximately in the area of the difference between debit- and true-field-strength of the cosmic background-radiation. That means that the energy $\kappa_0 E^2$ would be fully transformed into „solid“ matter, while the share $\operatorname{div}\mathbf{S_0}$ would be joined with the cosmic background-radiation in principle.

The particle-formation already begins with the beginning of the expansion then. The metrics is fully developed to the point of time $t_1/4$ approximately and starts to emit radiation-energy (cosmic background-radiation) thereupon. However, it would also be possible that the metrics builds itself with the overlaid background-radiation in one piece quasi together.

Approximately from the point of time $2.552t_1$ on the metrics commences to re-absorb a part of the energy of the cosmic background-radiation again (dielectric losses). This is changed completely into matter then. Here, we just have answered the question, whether still cosmic background-radiation is emitted to the present point of time. The answer is no.

However, there are areas in the universe (particle-horizon) in those an emission takes place even „nowadays".

If we completely assign the share $\kappa_0 E^2$ to the shape of matter on the one hand, the share div$\mathbf{S_0}$ to the emission/annihilation of electromagnetic radiation on the other hand, so it should be possible to determine the temporal course of the Boson-/Fermion-ratio. With the same red-shift for radiation (bosons) and particles (fermions) the following expression would arise for it:

$$\frac{n_\gamma}{n_M} = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{\int \dot{w}_0 dt}{\kappa_0 \int E^2 dt} - 1\right) = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{-w_0 + 0{,}897659 w_1}{\kappa_0 \int E^2 dt} - 1\right) \tag{436}$$

The integration-constant has been determined with help of the function FindRoot under the condition that the integral is equal to zero in the maximum of w_0, the integral $\kappa_0 E^2$ by numerical integration (NIntegrate). The associated temporal course is shown in figure 82.

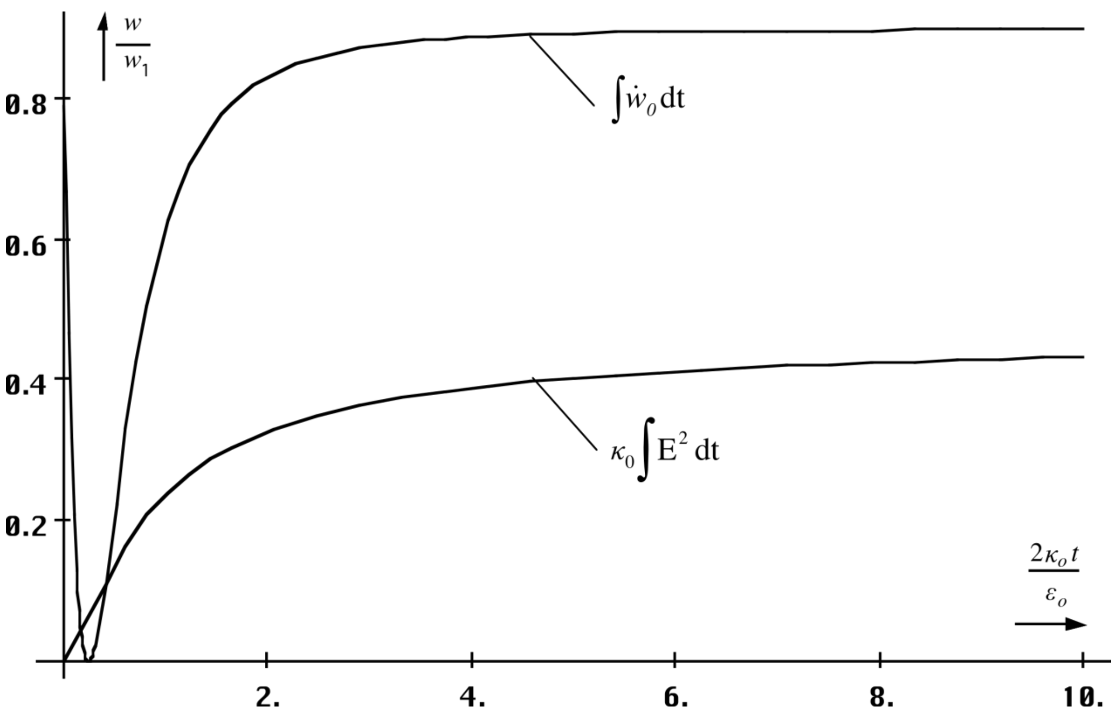


Figure 82
Integrals of energy-density and dielectric losses of the metric wave-field

The calculation of (436) results in a course of the boson-/fermion-ratio, as it is pictured in figure 83. One recognizes, it turns out a value $6.080 \cdot 10^8$ being much greater than determined in section 4.6.4.2.5. But with increasing age it decreases again approaching a value of $2.3864 \cdot 10^{12}$ to the present point of time asymptotically.

The reason is that the fermion-number created by the process $\kappa_0 E^2$ of the metric wave-field is not equal to the total fermion-number. The creation process of fermions taking place immediately after big bang does not form particles, as they occur today most frequently (electron, proton, neutron) but highly excited states of super-heavy subatomic particles, as we still not know them at all. However, these particles are having the characteristic to decay into a multiplicity of smaller and lighter subatomic particles with change of the outer relations. As a result the fermion-number increases continuously or discontinuously and the graph in figure 83 descends much more intensive.

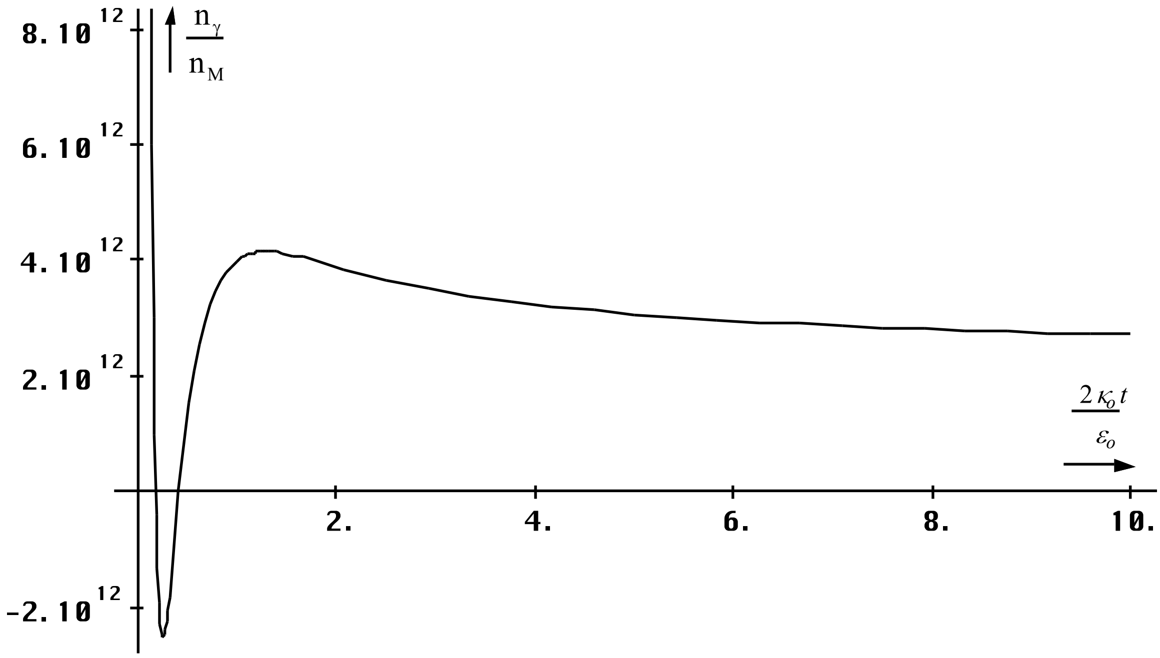


Figure 83
Part of the boson-/fermion-ratio, determined by the metric wave-field as a function of time without consideration of the fermion-multiplication

We cannot make any more exact statements about the magnitude of the multiplication. We consider it by an additional factor η, which we merge into expression (436) as follows:

$$\frac{n_\gamma}{n_M} = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{\int_0^T \dot{w}_0 dt}{\eta\,\kappa_0 \int_0^T E^2 dt} - 1\right) = 6.080\cdot 10^8 \qquad (437)$$

$$\frac{n_\gamma}{n_M} = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{0.897659}{2.5939\cdot 0.34598} - 1\right) = 4.9362769\cdot 10^{-4}\,\frac{m_a c^2}{\hbar\omega_T} \qquad (438)$$

It turns out a value of η=2.5939. With high probability, the fermionic matter formed by the metrics doesn't amount the total fermionic matter however. Namely, there is another second process, with which fermions can be formed too. The existence of such a process is substantiated by the following contradictions:

1. *The aberrant boson-/fermion-ratio.*

2. *The metric wave-field is established over a time period of $t_1/4$. Energy is taken in during this time continuously. To go out from a singular agitation in form of a* Dirac*-impulse, the energy of this impulse should have to be buffered somewhere for this time period at least.*

3. *The function according to figure 83 has a negative domain, which equals to an annihilation of bosons. However, these already must have been existed previously, because where is nothing, even nothing can be destroyed.*

4. *The prior existence implies a prior formation, to assume an empty universe to the point of time T=0 by exclusion of a „creation“ of fermionic matter.*

This process have to see temporally be before the formation of the metrics and to start with the point of time T=0. It would be also reason for the additionally generated fermionic matter then. However, now the question arises about which process it could be. The simplest case for such a process would be the solution of the MAXWELL equations for a loss-affected medium without expansion according to 4.3.4.2, just the classic solution. On the basis of the high value of the specific conductivity κ_0 of the vacuum this solution would have degenerated so strongly that the response to a DIRAC-impulse would be one single impulse, which would fit into our temporal screen very well. We want to call this impulse primordial impulse. The qualities of such a primordial impulse we will examine in the next section.

4.6.5. The primordial impulse

4.6.5.1. The DIRAC-impulse

We assume an unique agitation by a DIRAC-impulse δ(t). This impulse is actually no function but a distribution with the following qualities:

$$\delta(t) = \begin{cases} \infty & \text{für } t = 0 \\ 0 & \text{für } t \neq 0 \end{cases} \qquad \delta(t) = \frac{d}{dt}\sigma(t) \tag{439}$$

σ(t) is the jump-function with the amplitude 1. Another essential quality results from the second expression:

$$\int_{-0}^{\infty}\delta(t)dt = \int_{-0}^{\infty}\delta(t)e^{-pt}dt = \mathscr{L}\ \delta(t) = 1 \tag{440}$$

The integral as well as the surface below the DIRAC-impulse is equal to 1. On the basis of (439) even the LAPLACE transform is equal to 1, which corresponds to a continuous spectrum, which shows the same amplitude, namely 1, over the entire frequency domain $0 \leq \omega \leq \infty$. The bandwidth is infinite with it.

We just assume this impulse as base of our reflections. It comes closest to the imaginations of a big bang too. Since it is about a degenerated case, we want to try to find a solution of the MAXWELL-equations for it. First, we have to quantize the space for this purpose. We assume our model 4.2.1. expression (70) however without expansion:

$$C_U\ddot{\varphi}_U + \left(\dot{C}_U + \frac{1}{R_U}\right)\dot{\varphi}_U + \frac{1}{L_U}\varphi_U = 0 \qquad \text{with } \dot{C}_U = 0 \tag{441}$$

$$\ddot{\varphi}_U + \frac{1}{R_U C_U}\dot{\varphi}_U + \frac{1}{L_U C_U}\varphi_U = 0 \tag{442}$$

Since we not yet know the quantization-factor, the coupling-length, we want first to assume it as r_l/n. Then, the „components" are defined as follows:

$$L_U = \frac{\mu_0 r_l}{n} = \frac{1}{n}\frac{\mu_0}{\kappa_0 Z_0} = \frac{1}{n}\frac{1}{\kappa_0 c} \tag{443}$$

$$C_U = \frac{\varepsilon_0 r_l}{n} = \frac{1}{n}\frac{\varepsilon_0}{\kappa_0 Z_0} = \frac{1}{n}\frac{\varepsilon_0^2 c}{\kappa_0} \tag{444}$$

$$R_U = \frac{\kappa_0 r_1 Z_0^2}{n} = \frac{1}{n} Z_0 \tag{445}$$

This leads to the following characteristic differential equation:

$$\ddot{\varphi}_U + n\frac{n\kappa_0}{\varepsilon_0}\dot{\varphi}_U + \left(\frac{n\kappa_0}{\varepsilon_0}\right)^2 \varphi_U = 0 \qquad \text{with} \quad \omega_U = \frac{n\kappa_0}{\varepsilon_0} \tag{446}$$

$$\ddot{\varphi}_U + n\,\omega_U\dot{\varphi}_U + \omega_U^2\varphi_U = 0 \tag{447}$$

$$ar^2e^{rx} + bre^{rx} + ce^{rx} = 0 \qquad a = 1 \quad b = n\omega_U \quad c = \omega_U^2 \tag{448}$$

$$r^2 + br + c = 0 \qquad \text{Characteristic equation} \tag{449}$$

$$r_{1,2} = -\frac{b}{2} \pm \sqrt{\frac{b^2}{4} - c} = -\frac{n}{2}\omega_U\left(1 \pm \sqrt{\frac{n^2}{4} - 1}\right) \tag{450}$$

The solution of the differential equation is dependent on (450) and with it on n. For $n<2$ we obtain the standard solution according to 4.3.4.2. and for $n=2$ the aperiodic borderline case. That means for values $n\geq 2$, a wave-propagation is no longer possible because the solution of expression (450) has no imaginary-part respectively there is no phase rate β defined. Of course, even no phase velocity exists.

4.6.5.2. The aperiodic borderline case

Since we have already examined the case 4.3.4.2. in detail, we now want to consider the aperiodic borderline case ($n=2$) more exactly. Generally applies then:

$$\omega_U = \frac{2\kappa_0}{\varepsilon_0} = 2\omega_1 \qquad \omega_U t = \frac{2\kappa_0 t}{\varepsilon_0} = (2\omega_0 t)^2 \qquad r_U = \frac{r_1}{2} \tag{451}$$

Interestingly enough, the same coupling-length $r_1/2$ arises here as with the metric wave-field. Also the frequency ω_U is the same like the output-frequency of the metrics and of the cosmic background-radiation. Obviously all interactions can be lead back on one and the same conditions, as they have been with the coupling-length $r_1/2$. With it, one can assume with high probability, that the primordial impulse has the same coupling-length too. Because of the special conditions as they rule in cosmology, an exact proof is nearly impossible however. Rather we are always dependent on certain assumptions and can only check, whether the results agree with the observations or not.

The middle expression of (451) is advantageous in so far as it allows an exact temporal comparison of primordial impulse with the metric wave-field and with the cosmic background-radiation. Quite broadly seen the condition $r_1/2$ ($Q=0.5$) seems to represent a sort of basic condition of the „empty space without metrics“. Since the concept „empty space without metrics“ has appeared already frequently being somewhat hard to handle, we want to call it *subspace* in the future. It is to be supposed that also the subspace disposes of something like a structure.

Now let's go on to the solution of our differential equation. With the initial conditions $\varphi(0)=\varphi_\uparrow$ we get the following solution for the aperiodic borderline case:

$$\varphi_U = (1+\omega_U t)\, e^{-\omega_U t}\ \varphi_\uparrow \tag{452}$$

$$\mathbf{H} = \frac{4\varphi}{\mu_0 r_1^2}\mathbf{e_r} = \frac{4\kappa_0^2\varphi}{\varepsilon_0}\mathbf{e_r} = 2\kappa_0\varphi\omega_U\mathbf{e_r} \tag{453}$$

$$\underline{\mathbf{H}}_U = (1+\omega_U t)\, e^{-\omega_U t}\ \mathbf{H}_\uparrow \qquad \underline{\mathbf{E}}_U = (1+\omega_U t)\, e^{-\omega_U t}\ \mathbf{E}_\uparrow \tag{454}$$

$$\underline{\mathbf{S}}_U = (1+\omega_U t)^2\ e^{-2\omega_U t}\ \mathbf{S}_\uparrow \tag{455}$$

For the transition $\varphi \rightarrow \underline{\mathbf{H}}$ we must insert the coupling-length here again (453). The problem now is that we don't know the value of $\varphi_\uparrow$ Therefore, we can first make general contemplations only. Possibly the values can be derived from the boson-/fermion-ratio. However, with the aperiodic borderline case, it is also about a borderline case for the classic MAXWELL model. This is less valid for the field-strength itself as especially for the energy-density.

With a periodic function, the spectrum consists only of one single frequency with defined propagation-velocity. Therefore the value and the shift of the energy-density, as well as the energy-flow-density-vector can be described by this model very well. In the present case however the „signal“ consists of one discrete impulse of defined length with a continuous spectrum, whereby the different shares propagate with different velocities. Therefore, there is no definite energy-density, rather an energy-density-distribution, which is highly dependent on frequency, distance and time. This is not applied to solution 4.3.4.3.1. which is nearly periodic. The temporal course of solution (455) is shown in figure 84. It corresponds to the requests put in the previous section (energy-storage up to the formation of the metrics).

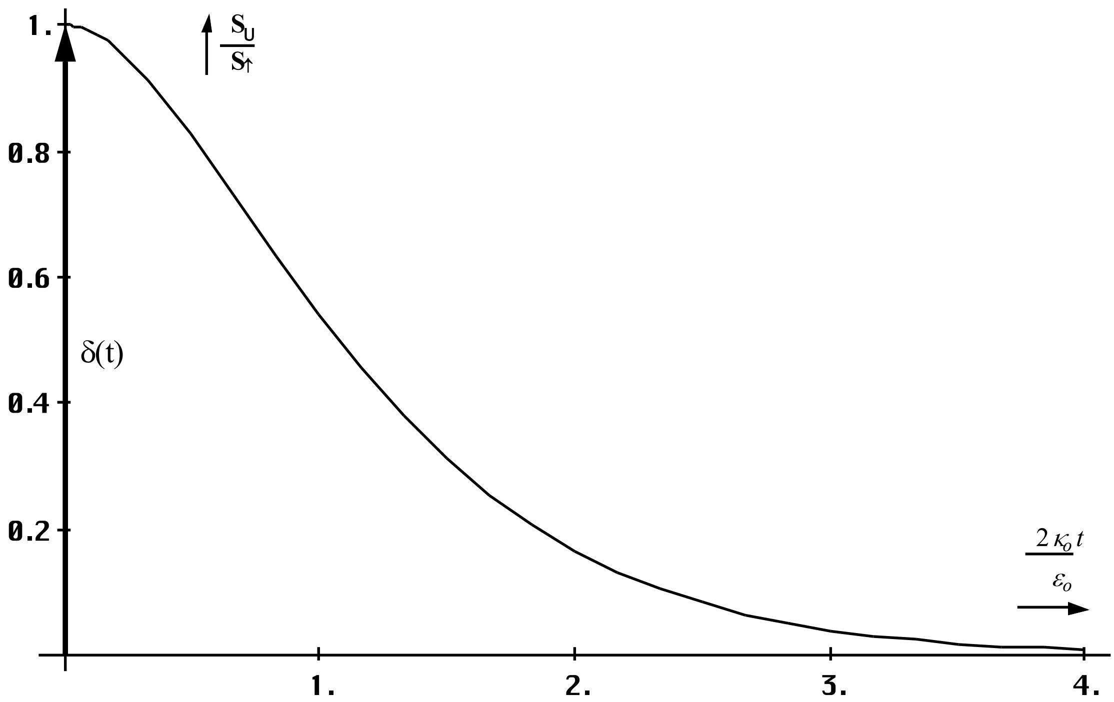


Figure 84
Temporal course of the POYNTING-vector
of the primordial impulse at the point r=0

4.6.5.3. Spectral-function

Since it's about a discrete impulse, which is defined from the point of time $t=0$ first, a continuous spectral-function arises. We obtain it by solving (447) with help of the LAPLACE-transformation once again. The initial conditions $f_0^{(0)}=\varphi_\uparrow$ and $f_0^{(1)}=0$ we gather from the preceding section.

$$\ddot{\varphi}_U + n\,\omega_U\dot{\varphi}_U + \omega_U^2\varphi_U = 0 \quad \rightarrow \quad p^2\varphi_U - p\varphi_\uparrow + 2p\varphi_U - 2\varphi_\uparrow + \omega_U^2\varphi_U = 0 \qquad (456)$$

$$\varphi_U\left(p^2 + 2p\omega_U + \omega_U^2\right) = \varphi_\uparrow\,(p+2) \qquad (457)$$

$$\varphi_U = \varphi_\uparrow \frac{p+2\omega_U}{\left(p+\omega_U\right)^2} = \varphi_\uparrow\left(\frac{1}{p+\omega_U} + \frac{\omega_U}{\left(p+\omega_U\right)^2}\right) \qquad (458)$$

The retransformation leads to expression (452) again then. We are interested in the spectral-function however. As a result of the substitution $p \rightarrow j\omega$ we get the frequency response of the medium (actually the amplitude-density), which is simultaneously our searched spectral-function in this case (DIRAC-impulse = multiplication with 1). Neglecting the factor $1/\omega_U$ (amplitude-density) and scaling to the factor 1 at $\omega=0$ we finally get ($\Omega_U=\omega/\omega_U$):

$$X_n(j\omega) = \frac{1}{2}\,\frac{1}{1+j\Omega_U}\left(1+\frac{1}{1+j\Omega_U}\right) \qquad \text{Complex spectral-function} \qquad (459)$$

$$A_n(\omega) = \frac{1}{2}\,\frac{1}{\sqrt{1+\Omega_U^2}}\left(1+\frac{1}{\sqrt{1+\Omega_U^2}}\right) \qquad \text{Amplitude response scaled} \qquad (460)$$

The real-part of (459), the amplitude response of the magnetic flux and even the electric and magnetic field-strength, is painted in figure 85 and 86.

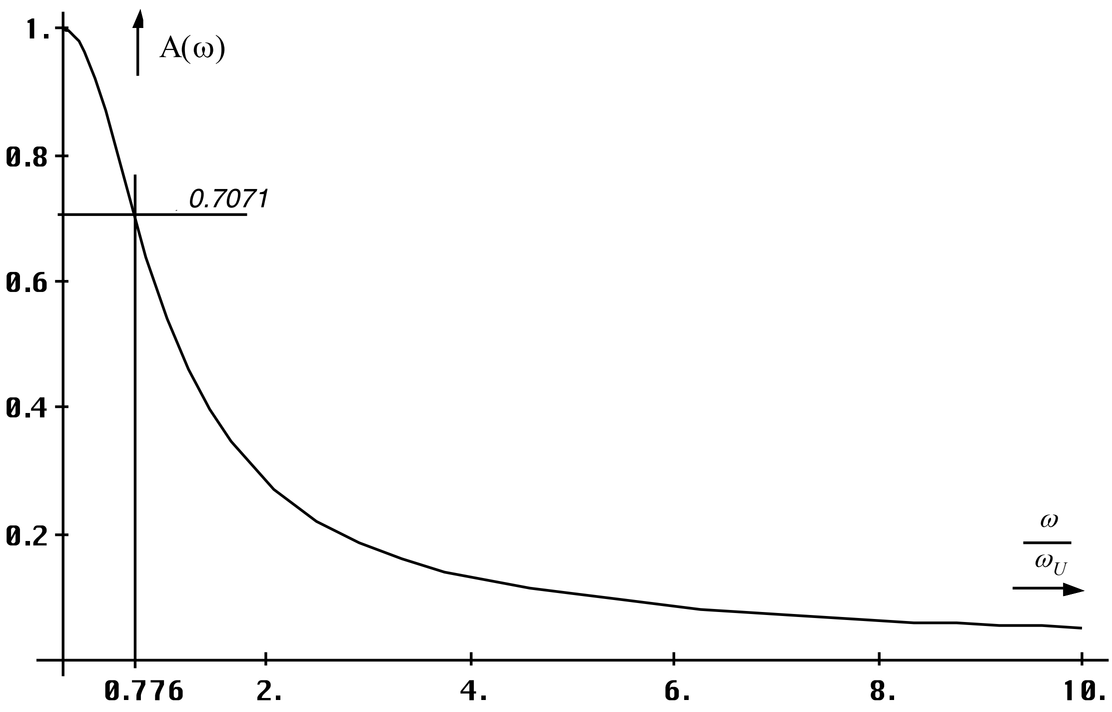


Figure 85
Scaled spectral-function of the electric as well as of the magnetic field-strength of the primordial impulse (linear scale)

For the POYNTING-vector, we must square (459) and (460). The 3dB-cut-off frequency is situated at 0.776ω_U as well as 1.552ω_1. This agrees with the cut-off frequency for photons, overlaid to the metrics, very well (figure 20) which stands as further argument for it, that the coupling-length is also $r_1/2$ at the primordial impulse.

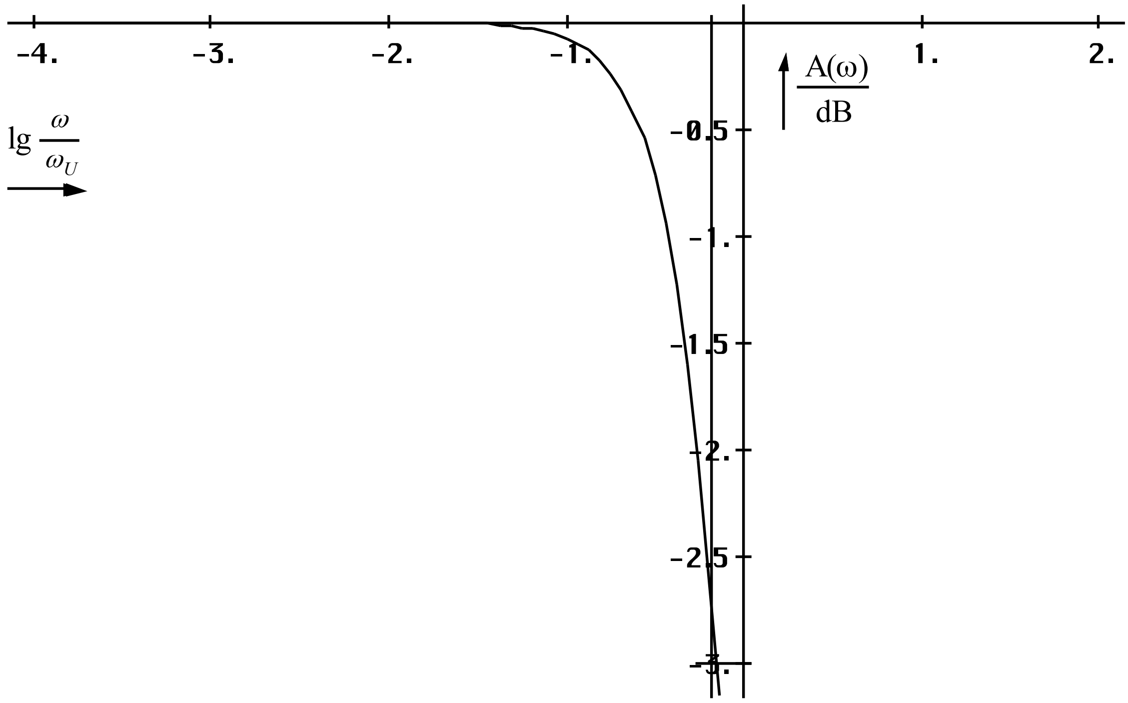


Figure 86
Scaled spectral-function of the electric as well as of the magnetic field-strength of the primordial impulse (logarithmic scale)

4.6.5.4. Energy-density

We obtain the energy-density by division of the POYNTING-vector by the propagation-velocity. But it must be determined primarily for that purpose. Since it's about a single impulse with defined length, there is no uniform propagation-velocity, because the individual spectral shares propagate with different velocity. Frequencies below ω_U behave according to the standard-model 4.3.4.2. (classic solution for a loss-affected medium). In this connection, the propagation-velocity is depending on the frequency (178). The higher frequency, all the higher velocity. It doesn't exceed the value of c however.

For frequencies above ω_U there is no propagation at all, albeit their energy stays within the area of the metric wave-field for a certain time. The higher frequency, all the shorter the half period, just all the more inferior the average temporal amplitude-density. Also applies on the other hand, the larger frequency, all the larger energy. Therefore, we want to see, whether there is a median value, that it suffices, to regard in order to determine the total-energy-density. We don't actually want to know more at the moment. We first look at the energetic spectrum to it. That is the weighted amplitude-density. We get it by multiplication of (458) with the frequency. The course is shown in figure 87.

It shows, that the low frequencies have practically no share at the energy-content of the impulse. Considered about the entire frequency domain a median value can be found, which has the quantity 1.

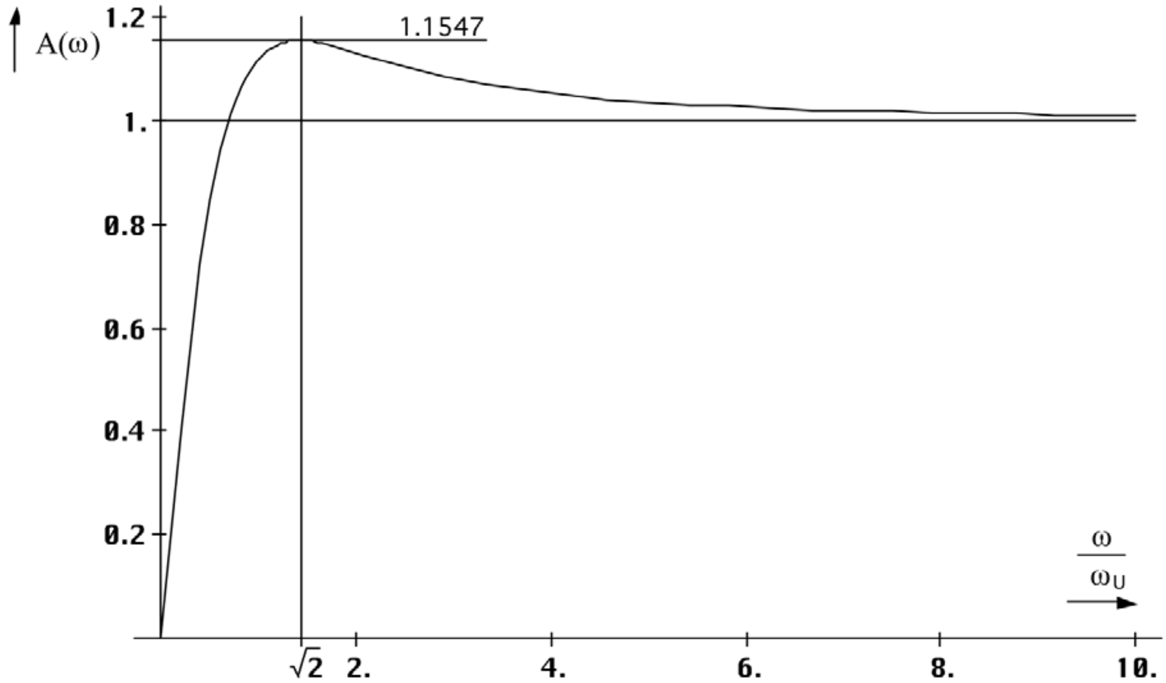


Figure 87
Energetic spectrum of the electric as well as of the magnetic field-strength of the primordial impulse

With the POYNTING-vector, the maximum is situated at 4/3 by the way. The average temporal amplitude-density on the other hand is identical to the scaled amplitude response (figure 85). If we form the quadratic median value of both, so we get the course painted in figure 88.

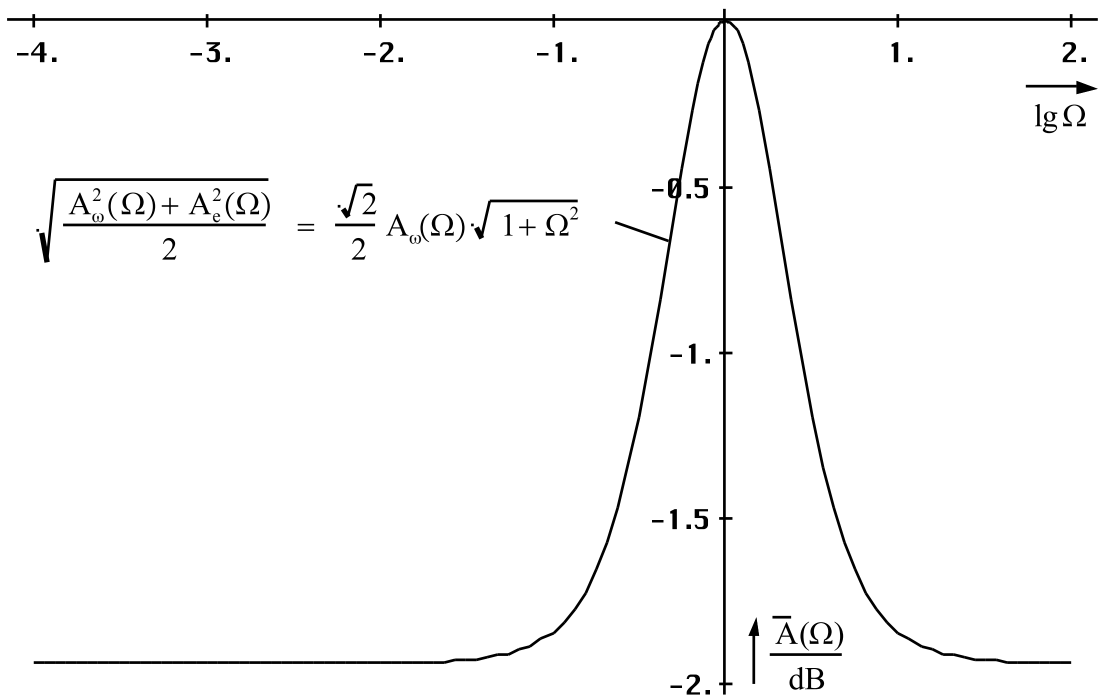


Figure 88
Quadratic median value of energetic and average temporal amplitude-density (E- and H-field) of the primordial impulse

The quadratic median value of energetic and average temporal amplitude-density is situated at ω_U as well as $2\omega_1$ (aperiodic borderline case). So it is suitable the best to the determination of the average energy-density of the primordial impulse. Now we want to determine the propagation-velocity for this case and want to look at another solution of the MAXWELL equations to it.

4.6.5.4.1. Solution of the MAXWELL equations for the aperiodic borderline case

At first, we proceed like in section 4.3.4.2. but with a different approach for the magnetic and electric field-strength:

$$\text{curl}\,\underline{\mathbf{H}} = \left(\kappa_0 + \varepsilon_0 \frac{\partial}{\partial t}\right) \underline{\mathbf{E}} \qquad \text{curl}\,\underline{\mathbf{E}} = -\mu_0 \frac{\partial \underline{\mathbf{H}}}{\partial t} \tag{461}$$

$$\underline{\mathbf{H}} = \left(1+\omega_U t\right) e^{-\omega_U t}\, \mathbf{H} \qquad \underline{\mathbf{E}} = \left(1+\omega_U t\right) e^{-\omega_U t}\, \mathbf{E} \tag{462}$$

For the first derivative of the magnetic field-strength applies (always analogously for **E**):

$$\frac{\partial \underline{\mathbf{H}}}{\partial t} = -\omega_U^2 t\, e^{-\omega_U t}\, \mathbf{H} = -\omega_U \frac{\omega_U t}{1+\omega_U t}\, \underline{\mathbf{H}} \tag{463}$$

We also require the second derivatives once again:

$$\frac{\partial^2 \underline{\mathbf{H}}}{\partial t^2} = -\omega_U^2 \left(1-\omega_U t\right) e^{-\omega_U t}\, \mathbf{H} = -\omega_U^2 \frac{1-\omega_U t}{1+\omega_U t}\, \underline{\mathbf{H}} \tag{464}$$

Now, we can insert into (461) with $\varepsilon_0\omega_U=2\kappa_0$:

$$\text{curl}\,\underline{\mathbf{H}} = \left(\kappa_0 - \varepsilon_0\omega_U \frac{\omega_U t}{1+\omega_U t}\right) \underline{\mathbf{E}} = \frac{\kappa_0\left(1+\omega_U t\right) - 2\kappa_0\omega_U t}{1+\omega_U t}\, \underline{\mathbf{E}} \tag{465}$$

$$\text{curl}\,\underline{\mathbf{H}} = \kappa_0 \frac{1-\omega_U t}{1+\omega_U t}\, \underline{\mathbf{E}} \qquad \text{curl}\,\underline{\mathbf{E}} = \mu_0\omega_U \frac{\omega_U t}{1+\omega_U t}\, \underline{\mathbf{H}} \tag{466}$$

$$\text{curl}\,\text{curl}\,\underline{\mathbf{H}} = \text{curl}\left(\kappa_0 \frac{1-\omega_U t}{1+\omega_U t}\right) \underline{\mathbf{E}} = \kappa_0 \frac{1-\omega_U t}{1+\omega_U t}\, \text{curl}\,\underline{\mathbf{E}} = -\Delta \underline{\mathbf{H}} \tag{467}$$

$$-\Delta \underline{\mathbf{H}} = \mu_0\kappa_0\omega_U^2 t \frac{1-\omega_U t}{\left(1+\omega_U t\right)^2}\, \underline{\mathbf{H}} = -\mu_0\varepsilon_0 \frac{\kappa_0}{\varepsilon_0} \frac{t}{1+\omega_U t} \frac{\partial^2 \underline{\mathbf{H}}}{\partial t^2} \tag{468}$$

On propagation in x-direction only re-applies:

$$\frac{\partial^2 \underline{\mathbf{H}}}{\partial x^2} = \frac{1}{2c^2} \frac{\omega_U t}{1+\omega_U t} \frac{\partial^2 \underline{\mathbf{H}}}{\partial t^2} \qquad \frac{\partial^2 \underline{\mathbf{E}}}{\partial x^2} = \frac{1}{2c^2} \frac{\omega_U t}{1+\omega_U t} \frac{\partial^2 \underline{\mathbf{E}}}{\partial t^2} \tag{469}$$

$$\frac{dx}{dt} = \sqrt{2}\, c \sqrt{1+\frac{1}{\omega_U t}} \qquad \frac{dr}{dt} = c \sqrt{1+\frac{1}{\omega_U t}} \tag{470}$$

The factor $\sqrt{2}$ is inapplicable on mapping to the metrics, which propagates in an angle of 45° to it. There is just even a solution for this special-case. With the interpretation however, we must be very carefully. Since the solution is all-real, a propagation-velocity is not defined. It is rather about an expansion-velocity, as we had also already found it at the discrete MINKOVSKIan line-element (57):

$$\dot{r}_U = c\sqrt{1+\frac{1}{\omega_U t}} = c\sqrt{1+\frac{1}{\omega_0^2 t^2}} \qquad \dot{r}_0 = \frac{1}{\sqrt{2\mu_0\kappa_0 t}} = \frac{c}{2\omega_0 t} \tag{471}$$

$$r_U = ct\left(\sqrt{1+\frac{1}{2\omega_0^2 t^2}} + \frac{1}{2\omega_0^2 t^2}\,\text{arcoth}\sqrt{1+\frac{1}{2\omega_0^2 t^2}}\right) \qquad r_0 = 2\omega_0 t\, r_1 \tag{472}$$

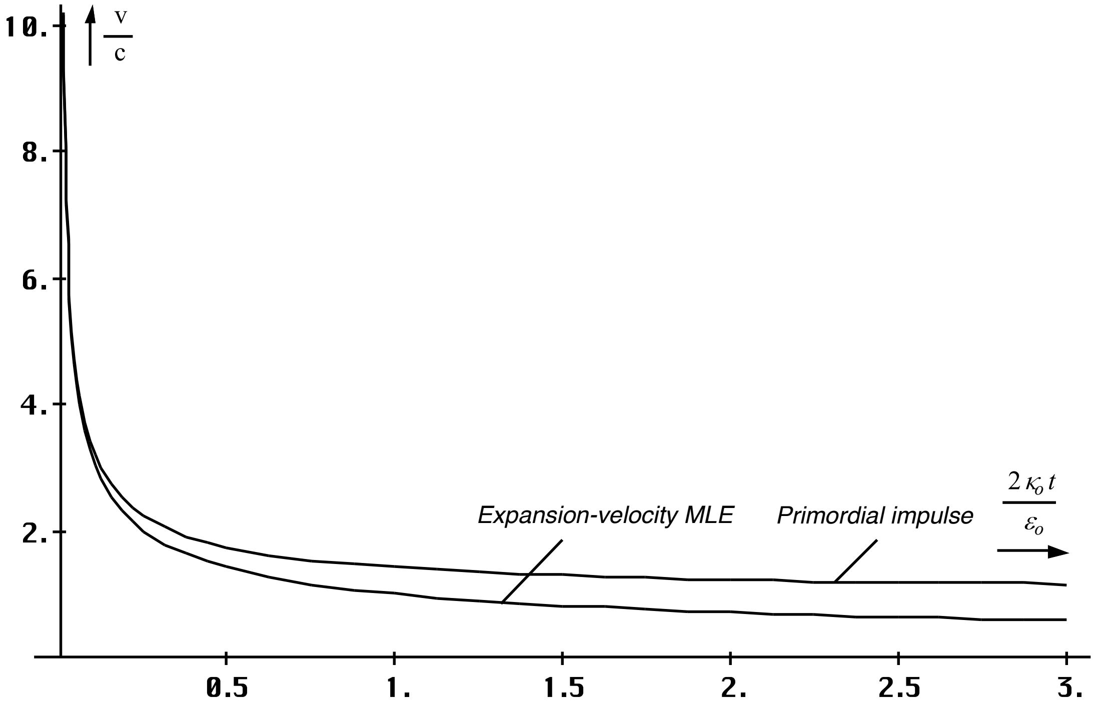


Figure 89
Expansion-velocity of primordial impulse and of the MINKOVSKIan line-element No. 1

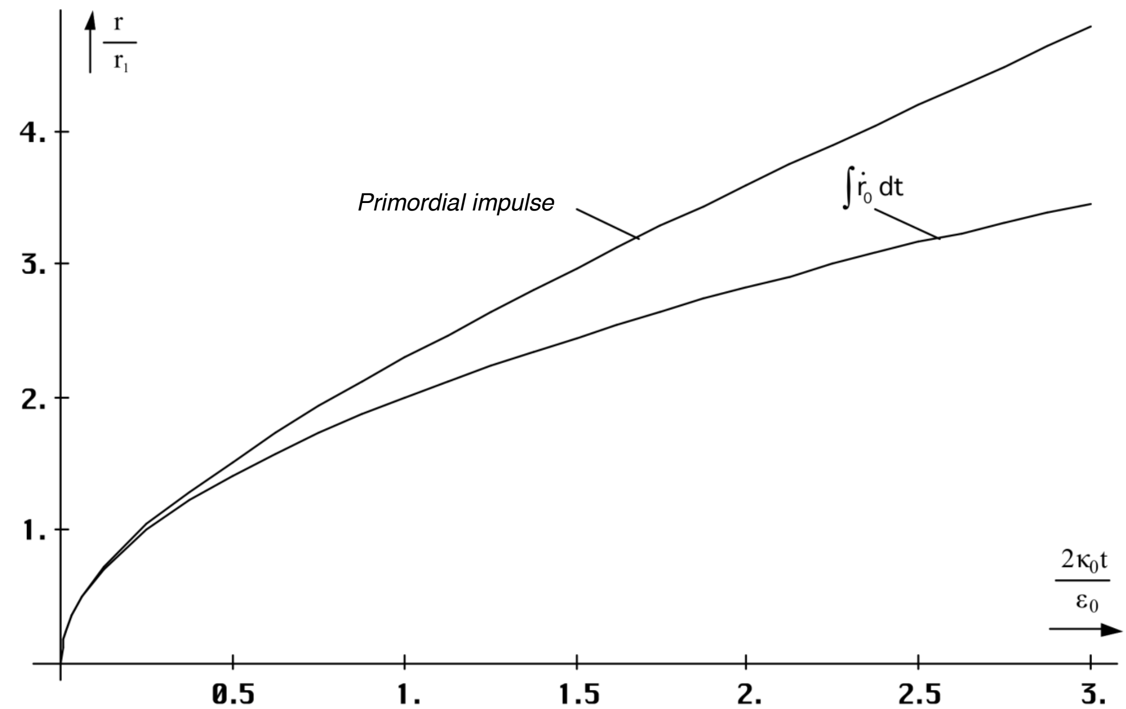


Figure 90
Expansion of primordial impulse and the MINKOVSKIan line-element No. 1 as a function of time

Also, the temporal validity of the solution is strongly restricted. Let's compare the two expressions stated in (471), so the course should have to be almost identical at $\omega_U \ll 1$ We can well recognize this in figure 89. It is applied to the expansion of the primordial impulse as well as to the radius of the MINKOVSKIan line-element No. 1 (figure 90) too. That is the first line-element, in which the entire energy of the universe has been concentrated at the beginning.

Up to the point of time t_1 the expansion of the primordial impulse is approximately identical to that of the line-element No. 1. Then the primordial impulse exceeds the limits of the first line-element. Still a noticeable overlap survives however. Meanwhile, new adjoining line-elements, which now can also gather energy from the primordial impulse, have already been formed by wave-propagation. At the latest from this point of time on, expression (471) becomes invalid, since we are concerned with the superimposition of two subsystems, which are coupled together.

However, we can assume that the primordial impulse doesn't cross the outer limit of the universe. Even a balance of different local energy-density-values occurs over the metrics. Then, the same propagation-velocity for the primordial impulse like for the metric wave-field would apply (210).

4.6.5.4.2. Determination of the average energy-density of the primordial impulse

The average energy-density is calculated by division of the expression for the POYNTING-vector (455) by the value of the *propagation*-velocity (210):

$$w_U = w_\uparrow \rho_0 \omega_0 t\,(1 + 4\omega_0^2 t^2)^2 e^{-8\omega_0^2 t^2} \qquad \text{with } w_\uparrow = \frac{S_\uparrow}{c} \tag{473}$$

The course is shown in figure 91. It shows, that the lifetime of the impulse amounts to $3t_1$ exactly. After it, the entire energy has been transformed into other forms. The second zero-transit of the function $\operatorname{div}\mathbf{S_0}$ is at $2.55t_1$. With it, the model fulfills the demands with respect to the buffering of the energy of the DIRAC-impulse. However, it must be pointed out once again, that it is only about an approximation. The real relations are essentially more complicated.

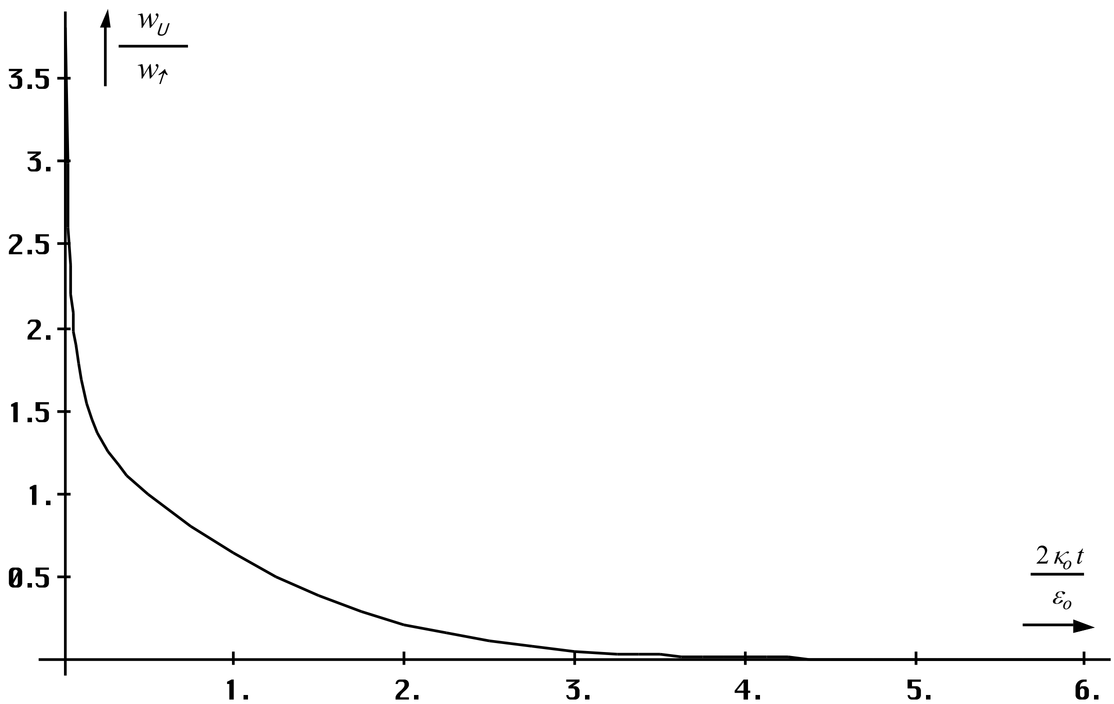


Figure 91
Average energy density of the primordial impulse

Now, we can reapply the energy-conservation-rule of the MAXWELL equations in order to determine the magnitude of $w_\uparrow$. But now we are concerned with an „oversupply" of energy at which point the outflow div$\mathbf{S}_U$ doesn't emerge in the accustomed manner but from the absorption capacity of the metric wave-field –div$\mathbf{S}_0$. The surplus energy is also converted into fermionic matter then, making it even more difficult to make a moderately reliable statement about the boson-/fermion-ratio for the time period immediately after big bang. It applies:

$$\dot{w}_f = \mathrm{div}\mathbf{S_0} - \dot{w}_U \qquad \text{Power density fermion generation} \quad \dot{w}_f \mathrel{\hat{=}} \kappa_0 \mathrm{E}^2 \qquad (474)$$

With help of (474) at least the lower limit of $w_\uparrow$ can be determined. It results from the assumption that the value of (474) must not become negative. At the metric wave-field, there is a negative domain, in which energy has got from the primordial impulse. With the primordial impulse itself that won't work any longer, because we otherwise should have to „borrow" energy from the nothingness. The course of (474) for several values of $w_\uparrow$ is shown in figure 92. The first derivative of w_U has been determined with the help of the difference-quotient once again.

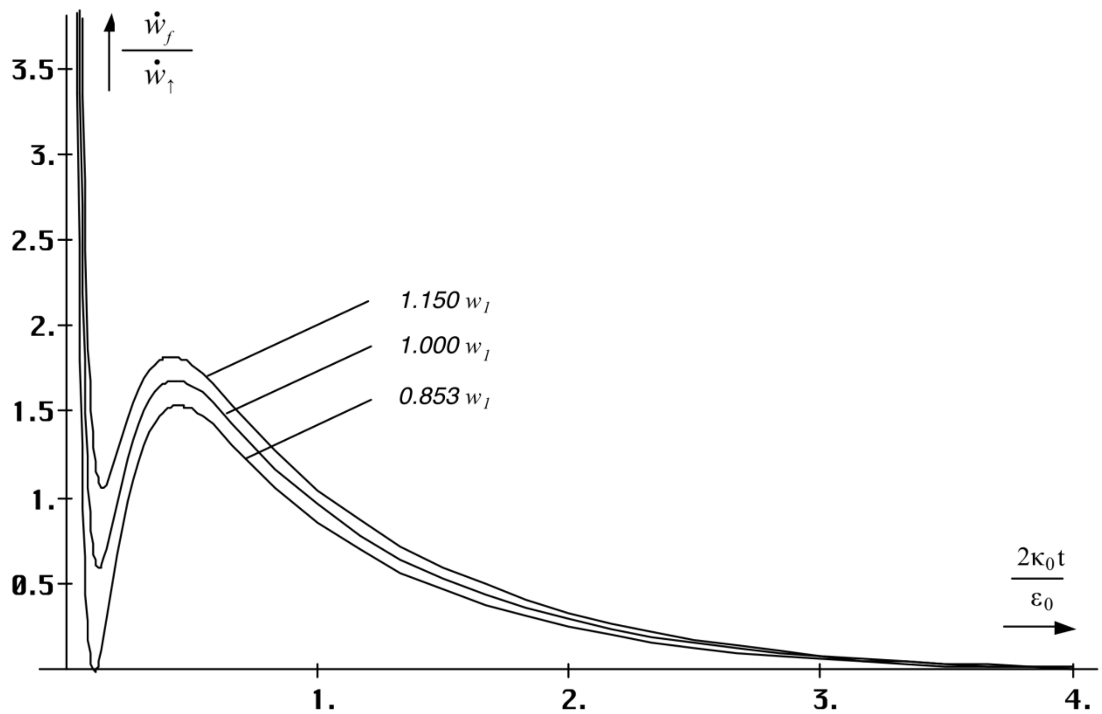


Figure 92
Power-density of the fermion-generation at the primordial impulse

As lower limit for $w_\uparrow$ a value of 0.8533 w_1 arises here. The upper limit can be derived from the boson-/fermion-ratio (438) assuming the fermion-multiplication-factor to be equal to one. Attempting to determine $w_\uparrow$ exactly, we observe that this is impossible, since the integration-constant of $\int \dot{w}_u \mathrm{d}t$ can't be determined.

The reason is that our average energy-density in figure 91 tends to infinity at the point t=0 Our model just fails in this point. However, it's anyway only about a rough approximation. Hence, the most probable assumption is $w_\uparrow = w_1$. As substantiation may apply, that, if energy is converted into other forms, the total-energy-density does not change anyway. The second substantiation is: The metric wave-field does not yet exist at the beginning. However it propagates with approximately the same velocity like the primordial impulse. Here, also the phenomenon of the infinite velocity to the beginning becomes clear: A not (yet) existing field may propagate with infinite velocity perfectly well, at least mathematically.

Unfortunately, further statements can't be made. Also, a determination of the total-energy of the universe is impossible.

5. Light speed

In section 4.3.4.4. we achieved good results with the calculation of the cosmologic red-shift in that we assumed the photons propagating rectangular to the expansion-graph of the metrics (figure 34). The frequency results from the product of the local growth of wavelength (growth of world-radius), caused by the expansion of the MINKOVSKIan line-element, and the local propagation-velocity of the metrics c_M. In the approximation applies:

$$\omega = \tilde{\omega}\frac{\tilde{Q}_0}{Q_0}\frac{c_M}{c} = \tilde{\omega}\frac{\tilde{Q}_0}{Q_0}\sin\delta = \tilde{\omega}\frac{\tilde{Q}_0\tilde{Q}_0^{\frac{1}{2}}}{Q_0 Q_0^{\frac{1}{2}}} = \tilde{\omega}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} = \tilde{\omega}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{3}{4}} \qquad (475)$$

with $\tilde{Q}_0 = 1$ and $\tilde{\omega} = \omega_1$ for the cosmic background-radiation. Otherwise, even other values can be written here. But this is right in the approximation only and corresponds to the case that the angle of intersection α between time-like and metric vector in the triangle always amounts to $\pi/2$. However, in the time just after big bang and with it also with strong gravitational-fields and/or very high velocities it's no longer about a right angle indeed. Then, a completely other behaviour arises with the addition of speeds.

First, we want to examine the relations more exactly, as they prevailed to this point of time as well as near the singularity. Before however, our model of the photon, just as we know it today, needs to be expanded a little bit. Until now, we assumed the photon to own the spin ± 1 ($\pm\hbar$) and the frequency $\pm\omega$, which leads to the result, that the photon is identical to its antiparticle ($-\hbar$)($-\omega$). A negative frequency just does not cause any difficulties here. Now we have seen further, that the metrics for photons behaves like a conduction and the conducting-theory calculates not only with negative but also with complex frequencies.

The question is now, why it should not be so even in the theory of the photon? So, recently a lot of models have been worked out, being based on the assumption that the rest mass of the photon and even of the neutrinos could be different from zero. But exactly this, according to the rules of the theoretical electrotechnics, corresponds to the introduction of complex frequencies (comp. section 5.3.2.). According to this model, the rest mass of a photon arises to $m_0 = \hbar H/c^2 = 2.886\cdot 10^{-69}$ kg. This agrees with the statements in literature very well.

Purely mathematically seen, there is also a so-called longitudinal as well as a purely time-like photon (don't confuse with the time-like photon described here, with which the concept time-like refers to the propagation direction opposite to that of the space-like photon) in the solution of the wave-equation of the photon. These two conditions are also called ghost-conditions and are eliminated by means of laborious mathematical methods. That may be applied to the purely time-like photon. What's about the longitudinal photons however? Is there anything similar in nature?

Really, there are the neutrinos, which show the same qualities like photons in general. But they are propagating in form of a „corkscrew-graph“. Let's assume simply, that these longitudinal photons are the very same neutrinos. Then, they would be photons which occur twisted about the angle $\pi/2$ in reference to the propagation direction of the photons, i.e. they would propagate around the angle $\pi/2$ to the propagation direction of the photons (part c_v). How that could look is demonstrated in figure 93 and 98. The neutrinos would have an imaginary frequency and a real spin with it. That would lead to an imaginary energy too (blind-power). The neutrinos could perform practically no work then and the intersection angle with the metrics would become virtually zero, the effective cross-section extremely

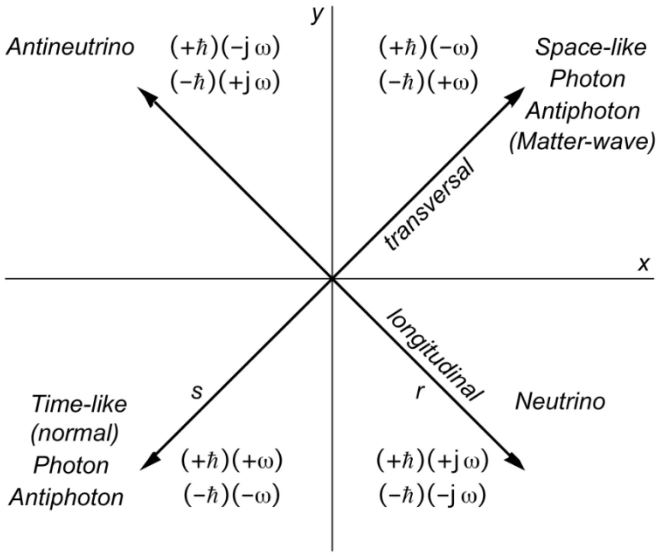


Figure 93
Extended photon model

small. Exactly that are the qualities of the neutrinos however. The propagation-velocity c_v in propagation direction of the photons would become extremely small too (c_M), which would lead to the above-mentioned corkscrew-graph, because even in this case the geometrical sum is equal to c.

It shows, even here the corresponding neutrino has an antiparticle, which is identical to itself (antineutrino and anti-antineutrino). Now however, there are actually three different types of neutrinos (ν_e, ν_μ and ν_τ). But what's the difference between these three kinds of neutrinos? The answer is: it's energy, frequency and/or character phasing. Neutrinos are only formed by kernel-processes (β-decay, weak interaction). Therefore, because of quantum-effects, the variance of energy is limited to the very same three quantities.

The hypothesis, that all three kinds of neutrinos are actually only different states of one single particle, is substantiated by the recently executed neutrino-detection-experiments. So, it has been determined that the detected neutrinos, ordered by its direction of arrival, are not uniformly distributed. The number of neutrinos, which have traversed the earth's core before detection, is more inferior, than that, coming from other directions. Thereby has turned out that these does not have been „vanished" by e.g. (weak) interactions with any baryons but, that they have been converted into other kinds of neutrinos which cannot be detected with the experimental arrangement (neutrino-oscillation).

How can this happen? The neutrinos already differ in a second quality from the photons, the spin. While the photons have an integer spin, they are bosons, the neutrinos have a half-integer spin, they are just fermions. As long as the neutrinos move in the vacuum, this quality is insignificant. In the earth's core, they move through matter however. Even if the effective cross-section for collisions with individual baryons is no much larger, as in the vacuum, so an essentially greater probability arises after all that the neutrinos hit an electron shell, especially since the earth's core is compressed very strongly and with it also the electron shells.

And in the electron shell, the fermion-qualities are suddenly no longer insignificant. If now two neutrinos move through an electron shell in common, they cannot occupy the same energy-state simultaneously. One of the two neutrinos must subordinate and shift to a different energy-condition, i.e. it's converted into a different kind of neutrino. Therefore, the three kinds of neutrinos are actually different resonances of one and the same particle. This would be possible with e.g. a double or triple rotation-velocity with the same wavelength.

Whenever a particle-physicist reads these lines, he will probably have a good chuckle, because we want to lump even neutrinos and photons together. We must first discuss the problem with the spin for this purpose. I personally do not see any problem in assuming the spin to be a function of the phase-angle of the propagation-function of the particle anyway. Even if the neutrinos should have a rest mass different from zero (this would be equal to the one of the photon then and actually be caused by the metrics), also the neutrinos would have a complex frequency and with it even a real spin, i.e. the spin could take on fractured values too. This would be a particle with properties between photon and neutrino then.

Now such particles have not been observed until now, since they are not usually formed with natural processes, but they would be quite possible. According to this model, they could have existed just after big bang and should have to be observed near black holes even today. That would be nor more implausible than some non-local model. One example would be photons with circular polarization with a very high rotation-frequency around the propagation-axis.

However, this model implies also the existence of a so-called space-like photon, that is a photon with negative propagation-velocity. That means it propagates „opposite to the propagation direction“, just quasi stands still on it's position forming a standing wave. There is also something similar in nature, namely the so-called DEBROGLIE-matter-waves, which are associated with the particles. With the exception of the standing-wave-properties these are subject to the same inherent laws like „normal“ photons. That is applied also to the red-shift.

If you should now be of the opinion, the neutrino is definitely a different particle as the photon, i.e. both cannot be unified in a common model by no means, please take notice of the following: With this model, we have introduced only one single new particle, the space-like photon, which is besides similar to or identical to the DEBROGLIE-matter-waves.

But now, to assign a rest mass as well to the photon as to the neutrinos, considering both as different particles, we would wear not only one but 7 or even 15 new particles (15, if we would insist on three different for each individual kind of neutrino ν_e, ν_μ und ν_τ). Because then, there would be also neutrino-like photons/anti-photons and photon-like neutrinos/antineutrinos all at once, and these in time- and space-like implementations. I cannot simply believe that.

Therefore it’s just the statement from photons and neutrinos. But if the just named case should become true, please replace the terms neutrino/antineutrino by neutrino-like as well as antineutrino-like photon independently. However, the said, analogously should have to be applied also to the neutrinos then, how much there may even be. At first, just let's have a look at the quite normal photon.

5.1. Photons

Near the singularity, the relations are just like shown in figure 94. In this connection I must clarify a contradiction, which otherwise could be charged against me as error. Until now, I have always called photons as time-like vectors, although they generally are identified as zero-vectors (velocity c). If I speak of a time-like vector, I always mean the part $\underline{c}_\gamma$. The part $\underline{c}_M$ is a space-like vector and c the zero-vector, which we measure.

Now however let's go on to our problem. Particularly we are interested in γ, the angle of intersection with the derivative $\underline{c}_M$ along the metric expansion-graph and also the amount of $|\underline{c}_\gamma|=c_\gamma$. Since it's not about a rectangular triangle, the sine-rule applies:

$$c^2 = c_M^2 + c_\gamma^2 - 2c_M c_\gamma \cos\alpha \tag{476}$$

$$c_\gamma^2 - c_\gamma\left(2c_M\cos\alpha\right) + c_M^2 - c^2 = 0 \tag{477}$$

$$c_\gamma = c_M\cos\alpha \pm \sqrt{c_M^2\cos^2\alpha + c^2 - c_M^2} \tag{478}$$

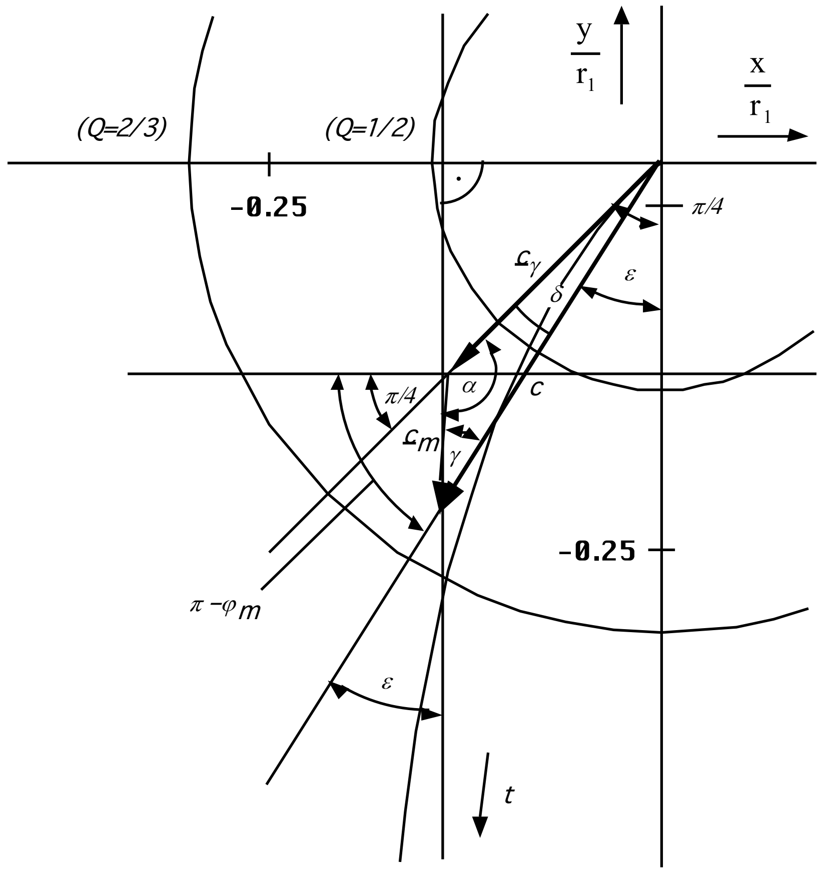


Figure 94
Vectorial speed-addition with photons near the singularity

$$\frac{c_\gamma}{c} = \frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\left(1-\cos^2\alpha\right)} \tag{479}$$

The positive sign is applied to „normal photons“ γ (arises from the approximative solution). The negative sign applies to space-like photons γ*, which behave differently near the singularity.

$$c_\gamma = c\left(\frac{c_M}{c}\cos\alpha + \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right) \qquad \text{Time-like photons} \tag{480}$$

$$c_{\bar\gamma} = c\left(\frac{c_M}{c}\cos\alpha - \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right) \qquad \text{Space-like photons} \tag{481}$$

For the angle α_γ applies in both cases (see (209)):

$$\alpha_\gamma = \frac{\pi}{4} - \arg\underline{c} = \frac{\pi}{2} - \frac{1}{2}\operatorname{arccot}\underline{\theta} = \frac{3}{4}\pi + \frac{1}{2}\arg\left(\left(1-A^2+B^2\right)+j2AB\right) \tag{482}$$

The course of the individual speed-components for the two kinds of photon as well as for the neutrino and antineutrino is shown in figure 95. It shows that individual components also can have a larger velocity than c. But just always c becomes effective. The low graph figures the course of the expansion-velocity of the metrics. The behaviour of the diverse particles and antiparticles differs all the more, the closer we come to the point Q=1 (symmetry-breaking), to decrease again thereafter.

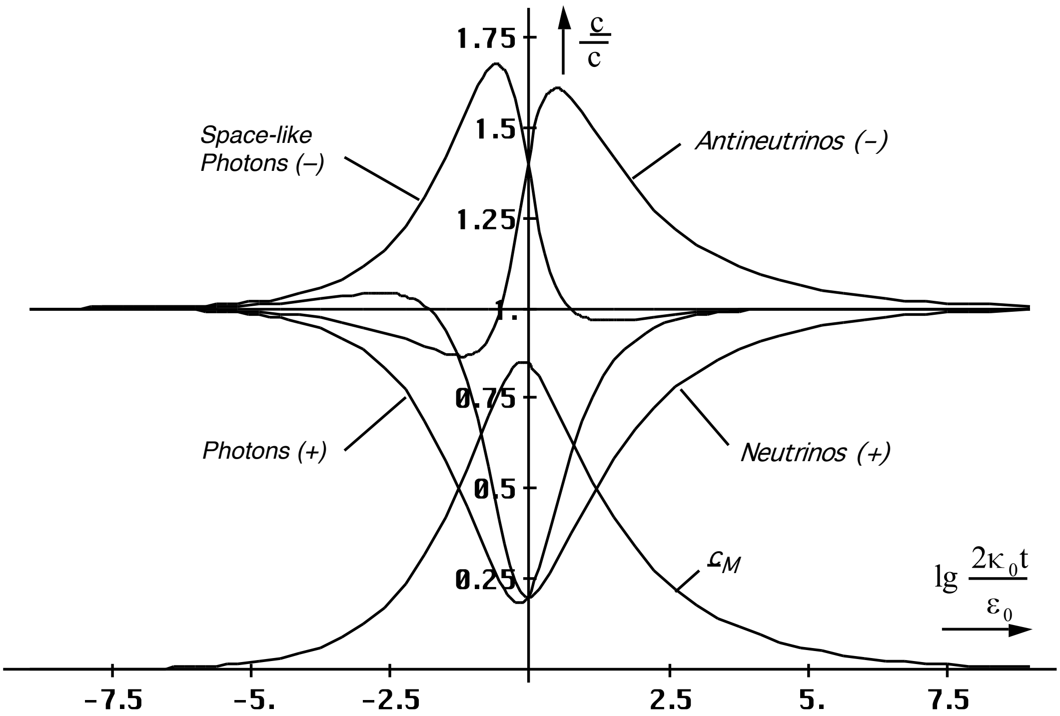


Figure 95
Course of the individual speed-components (absolute value)
for photons and neutrinos near the singularity

The intersection angle γ with the metrics of the (normal) photons we get by application of the sine-rule ($\alpha = \alpha_\gamma$):

$$\frac{c_M}{c} = \frac{\sin\delta}{\sin\alpha} \qquad \sin\delta = \frac{c_M}{c}\sin\alpha = \frac{\sin\alpha}{\rho_0\omega_0 t} \tag{483}$$

$$\delta = \arcsin\left(\frac{\sin\alpha}{\rho_0\omega_0 t}\right) \qquad \gamma = \pi - \alpha - \delta \tag{484}$$

$$\gamma = \arg\underline{c} - \arcsin\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4} - \arg\underline{c}\right)\right) + \frac{3}{4}\pi \qquad \text{Time-like photons} \tag{485}$$

$$\gamma = \frac{1}{2}\arctan\theta + \arccos\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) + \frac{\pi}{4} \tag{486}$$

Figure 97 shows the course. But figured is the value $\sin\gamma$, which carries an essentially major weight as the angle itself. In order to avoid miscalculations, the function $\arg\underline{c}$ always has been determined directly from (206).

As for the rest, to the calculation of arctan q we should better work with (211), since one would get a partially wrong result because of the ambiguity of the arctan-function else. For the absolute phase-angle φ of the resultant c applies:

$$\varphi = -\arccos\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) - \frac{\pi}{4} \qquad \text{Time-like photons} \tag{487}$$

We will dispense with the presentation of φ here. Another approach is applied to the space-like photons:

In the prolongation of $\underline{c}_\gamma$ namely another second triangle can be constructed alongside $\underline{c}_M$ with the angles α* (complementary-angle to α), γ* (angle of intersection with the metrics beside γ) and δ* (opposite to $\underline{c}_M$). This corresponds to the second solution of (479) and applies also for antineutrinos.

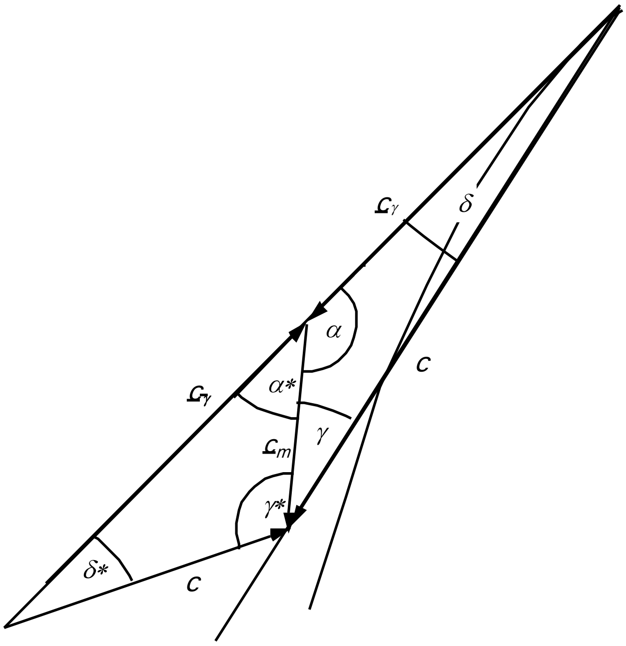


Figure 96
Complementary triangle and angle as second solution of the quadratic equations with reversed speed-vector $\underline{c}_\gamma$

For the complementary angles applies:

$$\alpha^* = \pi - \alpha \qquad \sin\alpha^* = \sin(\pi - \alpha) = \sin\alpha \tag{488}$$

$$\frac{c_M}{c} = \frac{\sin\delta^*}{\sin\alpha} \qquad \sin\delta^* = \frac{c_M}{c}\sin\alpha = \frac{\sin\alpha}{\rho_0\omega_0 t} \tag{489}$$

$$\delta^* = \arcsin\left(\frac{\sin\alpha}{\rho_0\omega_0 t}\right) \qquad \gamma^* = \pi - \alpha^* - \delta^* = \alpha - \delta^* \tag{490}$$

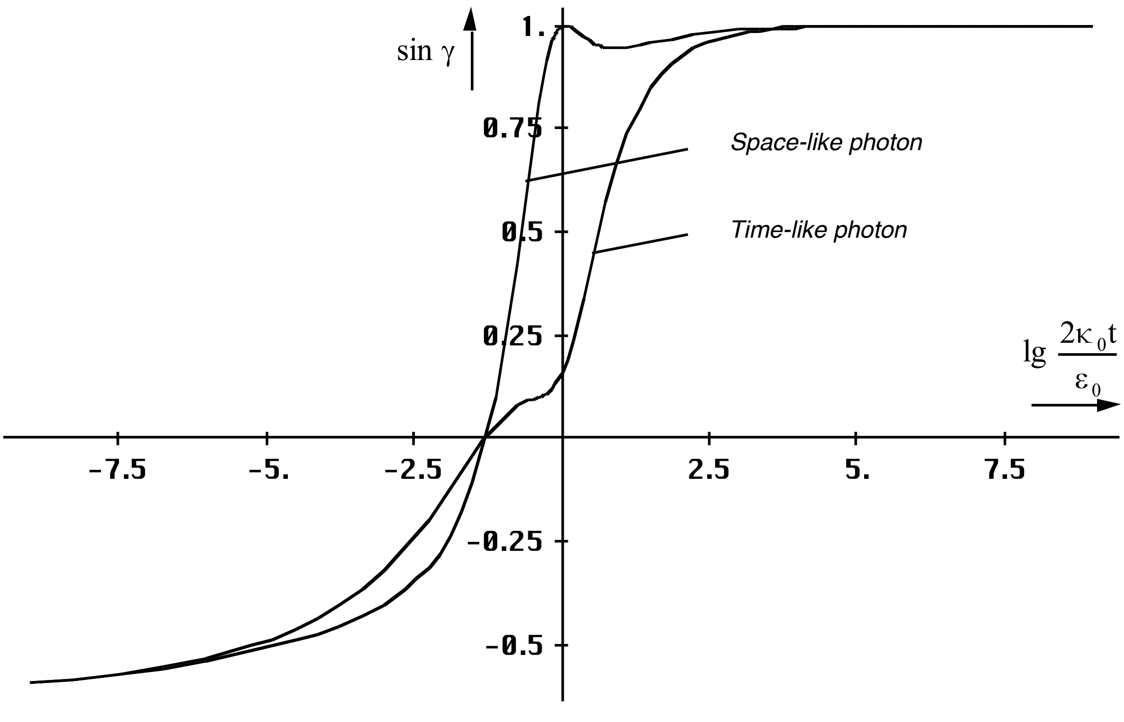


Figure 97
Course of the function sinγ of the angle of intersection with the metrics for time-like (normal) and space-like photons near the singularity

$$\gamma^* = -\arg \underline{c} - \arcsin\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4} - \arg \underline{c}\right)\right) + \frac{\pi}{4} \qquad \text{Space-like photons} \qquad (491)$$

$$\gamma^* = -\frac{1}{2}\arctan\theta - \arcsin\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) + \frac{\pi}{4} \qquad (492)$$

The course of $\sin\gamma^*$ is also shown in figure 97. For the absolute phase-angle φ^* of the resultant c applies:

$$\varphi^* = \arcsin\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) - \frac{\pi}{4} \qquad \text{Space-like photons} \qquad (493)$$

5.2. Neutrinos

We now look at the model according to figure 98. Once again, it interests the angle of intersection γ with the derivative $\underline{c}_M$ along the metric expansion-graph and even the amount of $|\underline{c}_\nu| = c_\nu$.

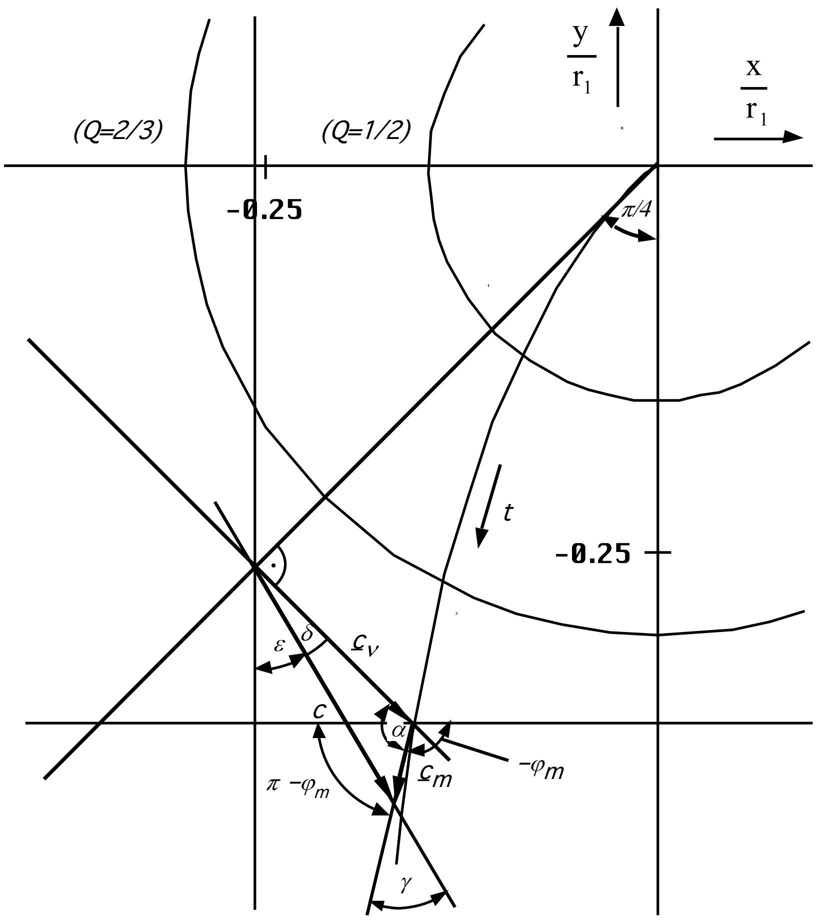


Figure 98
Vectorial speed-addition with neutrinos near the singularity

Since it is not about a rectangular triangle, the sine-rule applies again with the solution:

$$c_\nu = c\left(\frac{c_M}{c}\cos\alpha + \sqrt{1 - \frac{c_M^2}{c^2}\sin^2\alpha}\right) \qquad \text{Neutrinos} \qquad (494)$$

$$c_{\bar{\nu}} \;=\; c\left(\frac{c_M}{c}\cos\alpha-\sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right) \qquad \text{Antineutrinos} \qquad (495)$$

For the angle α_ν applies in both cases (see (209)):

$$\alpha_\nu = \;\frac{5}{4}\pi+\arg\underline{c} \;=\; -\frac{3}{4}\pi+\arg\underline{c} \;=\; -\left(\frac{\pi}{2}+\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right) \;=\; -\left(\frac{\pi}{2}+\alpha_\gamma\right) \qquad (496)$$

The angle α_ν just figures a sort of complement-angle of α_γ i.e. we can dispense with the value α_ν With α, we just always mean α_γ. Important relationships can be obtained from the reduction-formula for arbitrary angles: $\sin\alpha_\nu=-\cos\alpha_\gamma$, $\cos\alpha_\nu=-\sin\alpha_\gamma$, $\cos\alpha_\nu=-\sin\alpha_\gamma$, and $\tan\alpha_\nu=\cot\alpha_\gamma$. The course of the functions (495) and (496) is painted in the figure 95 (amounts) in turn. The intersection angle γ of the neutrinos with the metrics we obtain also directly by application of the sine-rule ($\alpha=\alpha_\gamma$):

$$\frac{c_M}{c}=\frac{\sin\delta}{\sin\alpha_\nu}=-\frac{\sin\delta}{\cos\alpha} \qquad \sin\delta = -\frac{c_M}{c}\cos\alpha \;=\; -\frac{\cos\alpha}{\rho_0\omega_0 t} \qquad (497)$$

$$\delta \;=\; -\arcsin\left(\frac{\cos\alpha}{\rho_0\omega_0 t}\right) \qquad \gamma \;=\; \pi-\alpha-\delta \;=\; -\frac{\pi}{4}-\arg\underline{c}-\delta \qquad (498)$$

$$\gamma \;=\; -\arg\underline{c}+\arcsin\left(\frac{1}{\rho_0\omega_0 t}\cos\left(\frac{\pi}{4}-\arg\underline{c}\right)\right)-\frac{\pi}{4} \qquad \text{Neutrinos} \qquad (499)$$

$$\varphi^* \;=\; \arcsin\left(\frac{1}{\rho_0\omega_0 t}\sin\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)-\frac{\pi}{4} \qquad \text{Space-like photons} \qquad (500)$$

We can see the course of $\sin\gamma$ in figure 99. It is also well to be seen that the interaction-cross-section of the neutrinos increases with ascending energy, which corresponds to the present knowledge-level. For the absolute phase-angle φ of the neutrinos applies:

$$\varphi \;=\; -\arcsin\left(\frac{1}{\rho_0\omega_0 t}\cos\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)+\frac{\pi}{4} \qquad \text{Neutrinos} \qquad (501)$$

Yet another approach is applied to antineutrinos in turn. The angles in the triangle are defined as follows: α^* (complementary angle to α), δ^* (intersection angle with the metrics beside δ) and γ^* (opposite to $\underline{c}_M$). It applies:

$$\alpha_\nu^* \;=\; \pi-\alpha_\nu \qquad \begin{aligned}\sin\alpha_\nu^* &= \sin(\pi-\alpha_\nu) \;=\; \sin\alpha_\nu\\ \cos\alpha_\nu^* &= \cos(\pi-\alpha_\nu) \;=-\cos\alpha_\nu\end{aligned} \qquad (502)$$

$$\frac{c_M}{c}=\frac{\sin\delta^*}{\sin\alpha_\nu}=-\frac{\sin\delta^*}{\cos\alpha} \qquad \sin\delta^* = -\frac{c_M}{c}\cos\alpha \;=\; -\frac{\cos\alpha}{\rho_0\omega_0 t} \qquad (503)$$

$$\delta^* \;=\; -\arcsin\left(\frac{\cos\alpha}{\rho_0\omega_0 t}\right) \qquad \gamma^* \;=\; \pi-\alpha_\nu^*-\delta^* \;=\; \alpha_\nu-\delta^* \qquad (504)$$

$$\gamma^* \;=\; \arg\underline{c}-\arccos\left(\frac{1}{\rho_0\omega_0 t}\cos\left(\frac{\pi}{4}-\arg\underline{c}\right)\right)-\frac{\pi}{4} \qquad \text{Antineutrinos} \qquad (505)$$

$$\gamma^* \;=\; \frac{1}{2}\arctan\theta - \arccos\left(\frac{1}{\rho_0\omega_0 t}\cos\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)-\frac{\pi}{4} \qquad (506)$$

Figure 99 shows the course of $\sin\gamma^*$. For the absolute phase-angle φ^* of the resultant c we finally get:

$$\varphi^* \;=\; \arccos\left(\frac{1}{\rho_0\omega_0 t}\cos\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)+\frac{\pi}{4} \qquad \text{Antineutrinos} \qquad (507)$$

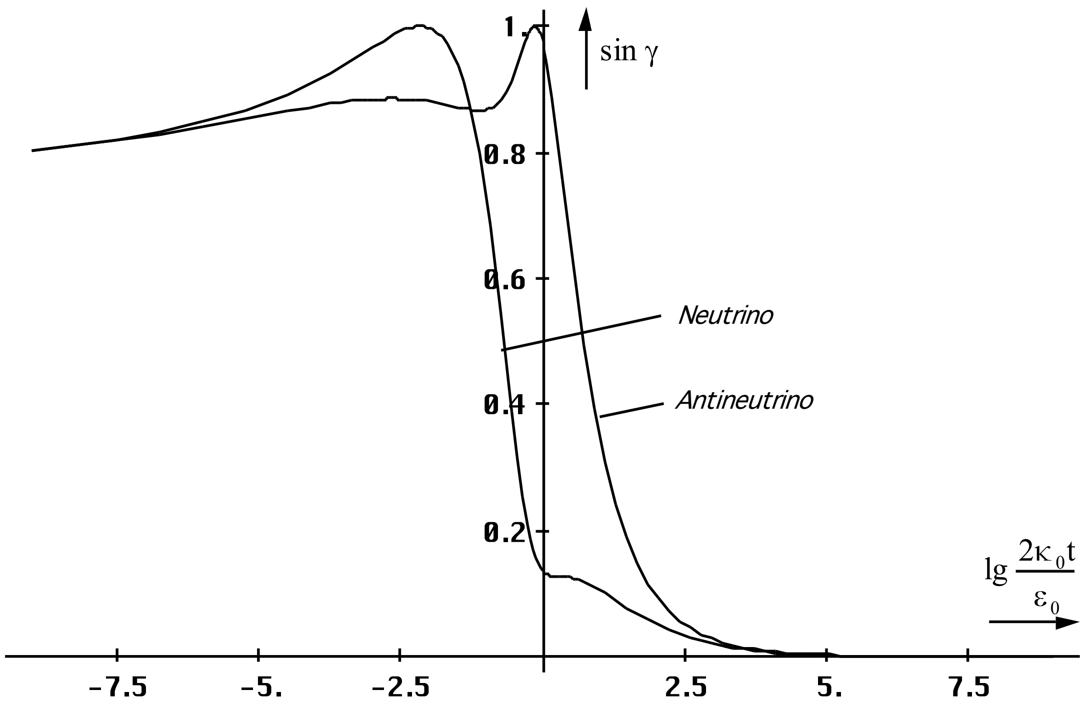


Figure 99
Course of the function $\sin\gamma$ of the angle of intersection with the metrics for neutrinos and antineutrinos near the singularity

With it, we have proven that, at least according to this model, photons in the time just after big bang and also in very strong gravitational-fields and with very high relative velocities behave like neutrinos and vice-versa. To the conclusion once again a summary of the essential expressions:

$$\gamma_\gamma \;=\; \arg \underline{c} + \arccos\left(\frac{\sin\alpha}{\rho_0\omega_0 t}\right)+\frac{\pi}{4} \qquad \gamma_{\bar\gamma} \;=\; -\arg \underline{c} - \arcsin\left(\frac{\sin\alpha}{\rho_0\omega_0 t}\right)+\frac{\pi}{4}$$

$$\gamma_\nu \;=\; -\arg \underline{c} + \arcsin\left(\frac{\cos\alpha}{\rho_0\omega_0 t}\right)-\frac{\pi}{4} \qquad \gamma_{\bar\nu} \;=\; \arg \underline{c} - \arccos\left(\frac{\cos\alpha}{\rho_0\omega_0 t}\right)-\frac{\pi}{4} \qquad (508)$$

Intersection angle γ with the metrics for the several kinds of photon

5.3. Red-shift of photons and neutrinos

5.3.1. Fundamentals

Since all photons (and neutrinos) are really or/and virtually connected with the temporal singularity, there are two types of photons at the observer. The photons with a frequency above the frequency of the cosmic background-radiation, are the first type. I would like to call them contemporary photons, since their origin is within our universe. The so-called orphan photons are the second type with a frequency below the frequency of the cosmic background-radiation. Orphan, because their origin is outside our universe, i.e. in order to be red-shifted to their present frequency the age 2T is not enough, the origin not yet exists. Nevertheless they are likewise already connected with the temporal singularity, because the time stands still there. Past, present and future form an unit.

We want to try to find an exact expression for the red-shift of photons and neutrinos which is independent from their frequency. As already noticed in the preceded section and in section 4.3.4.4.3. the relations are being determined as well by the side-relations as by the angles in the metric triangle. Therefore, based on (297) we consider an arbitrary frequency $\omega_\square=2\pi c/\lambda$ at the temporal singularity, i.e. before the transformation. Since it is about a temporal singularity in this case, each frequency there has the value $2\omega_1$ and $\omega_S=\omega_1\sqrt{2}/3$ after splitting into 6 MLEs. This equals the frequency of the cosmic background-radiation at the input coupling by the way. The effective frequency at the observer „arises" only by the application of the frame of reference. Ignoring the frame of reference, we obtain the desired universal relationship. Let's employ $2\omega_1$ for the initial-value $\tilde{\omega}$ and 1/2 (γ) as well as 2/3 ($\bar{\gamma}$) for the associated Q-factor $\tilde{Q}$, we obtain with the help of (623) and (671c):

$$\omega \;=\; \tilde{\omega}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_\gamma^4-1}{\beta_\gamma^4-1}} \;\approx\; \frac{\sqrt{2}}{3}\omega_1\frac{1}{Q^2}\frac{1.19663}{\sqrt{\beta_\gamma^4-1}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{\beta_\gamma^4-1}} \qquad \text{for } Q\gg 1 \qquad (509)$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(\sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right)^{-4}-1\right)^{-\frac{1}{2}} \;=\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(1-\sin^2\delta\right)^{-2}-1\right)^{-\frac{1}{2}} \qquad (510)$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{\cos^4\delta}-1\right)^{-\frac{1}{2}} \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(\frac{1}{1-\frac{1}{2}\delta^2}\right)^4-1\right)^{-\frac{1}{2}} \qquad \text{for } \delta\ll 1 \qquad (511)$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{1-2\delta^2+\frac{3}{2}\delta^4-\frac{1}{2}\delta^6+\frac{1}{16}\delta^8}-1\right)^{-\frac{1}{2}} \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\sqrt{\frac{1}{2\delta^2}-1} \qquad (512)$$

This result apparently corresponds to expression (274) with $\delta^2=y=Q_0^{-1}$. We employ again:

$$\omega \;\approx\; H/2\,\sqrt{\omega_0 t-1} \;=\; H/\sqrt{2}\,\sqrt{2\omega_0 t} \qquad \omega\sim Q_0^{-\frac{3}{2}} \qquad (275)$$

This also exactly agrees with expression (275), as not otherwise was to be expected. That means, there is only one approximation for time- and space-like photons, but two different exact expressions. With the space-like photons, there is a problem by the way. The solution of the phase-function Ξ at the reference point 2/3 namely is plain imaginary, so that there is no real reference of the space-like photons to this point, which leads, amongst other things, to the result that these have particular qualities. So, the rest-velocity is equal to zero and the photons can be shifted at will which equals the qualities of the DEBROGLIE-matter-waves. However, problems result from it with the application of (299) during the conversion to the reference point.

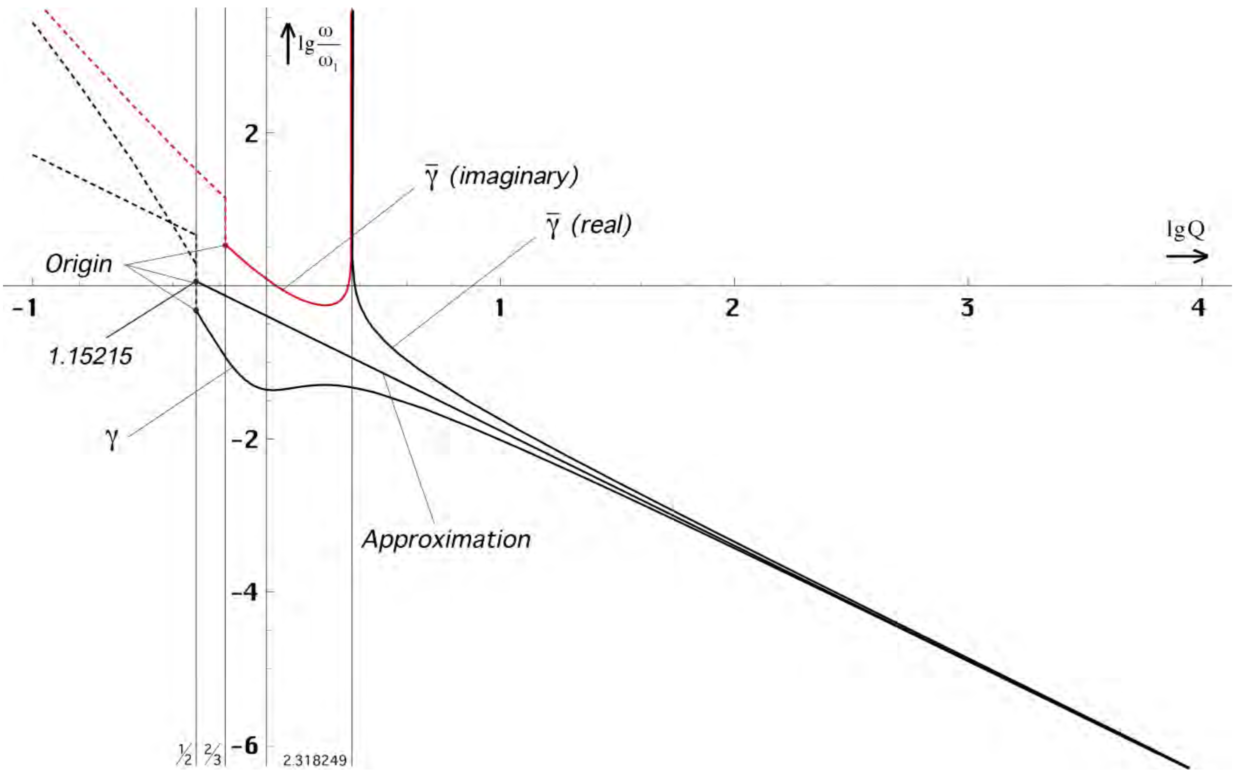


Figure 100
Red-shift of photons exactly and approximation

Only to determine the red-shift of a matter-wave with a start-point greater than Q=2.318249 (phase-jump), (299) can be applied, as it is. With the reference to the point 2/3 the expression must be modified indeed, namely in the following manner:

$$\omega \;=\; j\omega_{\bar{1}}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\gamma}}^{4}-1}{\beta_{\bar{\gamma}}^{4}-1}} \;\approx\; 3.27369\omega_1\frac{1}{Q^2}\sqrt{\frac{1-\tilde{\beta}_{\bar{\gamma}}^{4}}{\beta_{\bar{\gamma}}^{4}-1}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{\beta_{\bar{\gamma}}^{4}-1}} \qquad \text{for } Q \gg 1 \qquad (513)$$

This corresponds to an imaginary frequency at the reference point 2/3, of which we want only take notice for the moment. The values emerge from the necessary convergence of both functions for $Q\rightarrow\infty$. For the approximation function applies exactly:

$$\omega \;\approx\; \tilde{\omega}\left(\frac{\tilde{Q}}{Q}\right)^{\frac{3}{2}} \qquad \text{for Q and } \tilde{Q} \gg 1 \qquad\qquad \omega \;\approx\; 0.4073456\omega_1 Q^{-\frac{3}{2}} \qquad \text{for } Q \gg 1 \qquad (514)$$

The course of the three functions is painted in figure 100. It shows, the approximation is sufficiently exact downward till $Q=10^3$. Only in very strong gravitational-fields the exact expressions are required. In the cosmologic scale suffices the approximation equation.

With it, we have found the solution for both types of photons. What we do not know yet, is the solution for neutrinos and antineutrinos. This is also the reason why we have derived the approximation so detailed. Other rules are now applied to neutrinos. With help from (299) and (622) for a reference point of 1/2 we obtain:

$$\omega \;=\; \tilde{\omega}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\nu}^{4}-1}{\beta_{\nu}^{4}-1}} \;\approx\; 1.4437\omega_1\frac{1}{Q^2}\frac{0.39073}{\sqrt{\beta_{\nu}^{4}-1}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{\beta_{\nu}^{4}-1}} \qquad \text{for } Q \gg 1 \qquad (515)$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(-\frac{c_M}{c}\sin\alpha+\sqrt{1-\frac{c_M^2}{c^2}\cos^2\alpha}\right)^{-4}-1\right)^{-\frac{1}{2}} \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(-\frac{c_M}{c}+1\right)^{-4}-1\right)^{-\frac{1}{2}} \qquad (516)$$

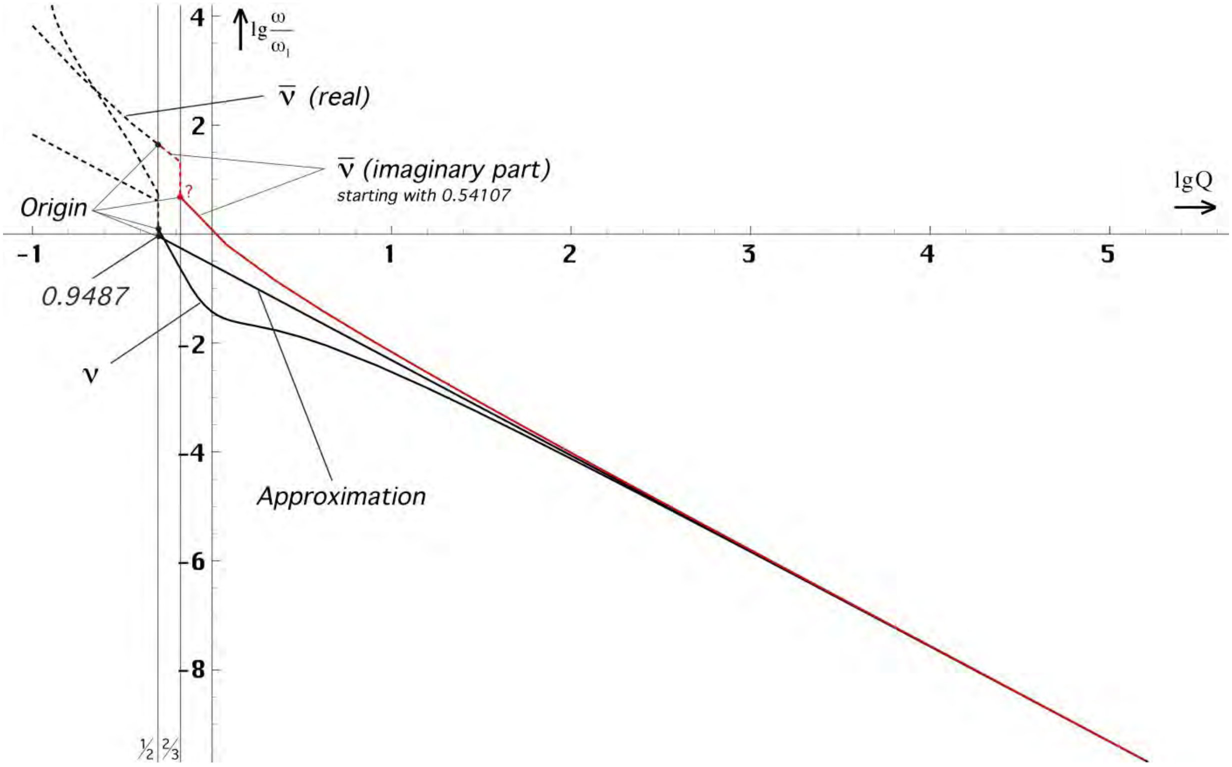


Figure 101
Red-shift of neutrinos exactly and approximation

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(-\frac{2}{Q^{\frac{1}{2}}}+1\right)^{-4}-1\right)^{-\frac{1}{2}} \;=\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{\left(1-2Q^{-\frac{1}{2}}\right)^4}-1\right)^{-\frac{1}{2}} \qquad \text{for } \frac{c_M}{c}\approx 2Q^{-\frac{1}{2}} \tag{517}$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{1-8Q^{-\frac{1}{2}}+24\cancel{Q}^{-\frac{2}{2}}-32\cancel{Q}^{-\frac{3}{2}}+16\cancel{Q}^{-\frac{4}{2}}}-1\right)^{-\frac{1}{2}} \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\sqrt{\frac{1}{8}Q^{\frac{1}{2}}} \tag{518}$$

$$\omega \;\approx\; \frac{\omega_1}{8}\sqrt{2}\;Q^{-\frac{8}{4}}Q^{\frac{1}{4}} \;=\; \frac{1}{8}\sqrt{2}H\;Q^{\frac{1}{4}} \qquad \omega\sim Q_0^{-\frac{7}{4}} \tag{519}$$

$$\omega \;\approx\; \tilde{\omega}\left(\frac{\tilde{Q}}{Q}\right)^{\frac{7}{4}} \quad \text{for Q and } \tilde{Q}\gg 1 \qquad \omega \;\approx\; 0.282048\,\omega_1 Q^{-\frac{7}{4}} \quad \text{for } Q\gg 1 \tag{520}$$

For antineutrinos we obtain the same result. Obviously, the neutrinos with $Q^{7/4}$ are more red-shifted than the photons with only $Q^{6/4}$. Therefore they converge even more slowly with the approximation function, as it shows in figure 101. And with the antineutrinos, there is a similar problem like with the space-like photons. While with latter ones the numerator of the radicand of (299) has been negative at the reference point 2/3, that means an imaginary root-expression, it's exactly vice-versa with the antineutrinos. Here just a real solution arises for the reference point 1/2. Starting with Q=0.54107 however all solutions become imaginary. Even here it becomes noticeable only if we want to determine the red-shift in reference to the reference point 1/2. The problem can be solved then again with an imaginary frequency, but negative imaginary this time:

$$\omega \;=\; -j\omega_{\bar{1}}\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\nu}}^4-1}{\beta_{\bar{\nu}}^4-1}} \;\approx\; 18.2787\,\omega_1\frac{1}{Q^2}\frac{0.03086}{\sqrt{1-\beta_{\bar{\nu}}^4}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\,\omega_1}{\sqrt{1-\beta_{\bar{\nu}}^4}} \tag{521}$$

For references above Q=0.54107 however there is no effect, since then as well the numerator as the denominator becomes negative, the root-expression real again. Expression (299) can be used unchanged with it.

Now however, we only assumed the reference point of the antineutrinos to be at 1/2. It has been substantiated by the particular qualities of the space-like photons, which would refer exclusively to 2/3 then. Because of symmetry-reasons one should rather assume the reference point of „normal“ particles to be at 1/2, the one of antiparticles at 2/3 however.

Then, the problem of the antineutrinos would be solved, expression (299) applies always and unchanged. By the way, the basic frequency of antiparticles for Q<1 is always greater than the metrics' frequency w0 (summary frequency) and with it above the cut-off frequency of the subspace. The other way round the basic frequency of „normal“ particles is always below it (difference-frequency). With it, antiparticles first can exist at a later point of time. This is the symmetry-breaking just after big bang, which is the reason why our universe almost only consists of „normal“ matter.

On the basis of (513) and (521) it shows that the basic frequency $\omega_{\bar{1}}$, even if it's imaginary, is still far above the cut-off frequency ω_1 of the subspace, which also seems to indicate a reference point of 2/3 for the antineutrinos. Then, the particular qualities of the space-like photons would emerge from it that they have an imaginary basic-frequency exclusively, a polus of 1^{st} order and with it no real connection to its reference point. Therefore, I favour the version 2/3 for antineutrinos. This has no practical effects on the further contemplations however.

The reference of the photons and neutrinos to its origin (temporal singularity) would agree with the so-called pilot-ray in some non-local theories. The reference is timeless, the action instantaneous. It even already has been verified by experiments. Separating an entangled photon-pair, preserving both photons one by one as a standing wave, the matching photons would „feel“ each other even on a large distance. A super photonic communication would be possible with it – theoretically. The connection takes place via the temporal singularity. But the real problem is to get the one photon intact e.g. to Alpha Centauri.

5.3.2. Propagation-function for photons and neutrinos

After we have done a trip into the future of communication, now however let's go on in the context. In the course of the antecedent section the term imaginary frequency has appeared already twice and the question is, what does this mean specifically for the wave-propagation of photons and neutrinos? In the electrotechnics, one works with imaginary and complex frequencies for a long time having even no problems with it.

However, let's look at our propagation-function (305), so it shows that it describes only one special-case, namely the one of a flat, linearly polarized wave, which propagates in r-direction. The electric and magnetic field-strength varies in x-direction. With it, expression (306) would be applicable for linearly polarized photons, however not for neutrinos, because they are polarized circularly.

In order to depict all these additional parameters, we must extend (305). Additionally to the solution x(r) we require another solution in the third dimension y(r). Then, according to [26], the propagation-function consists of altogether 4 equations (the second solution can be derived by analogy with (265)). It applies:

$$\underline{\mathbf{E}}_{x0} = \hat{\mathbf{E}}_x e^{j\underline{\omega} t} \qquad \underline{\mathbf{E}}_{y0} = \hat{\mathbf{E}}_y e^{j\underline{\omega} t} \qquad \frac{j\underline{\omega}\mu_0}{\underline{\gamma}} = \underline{Z}_F \approx Z_0 \qquad \text{Input values}$$

$$\underline{\mathbf{E}}_x = \underline{\mathbf{E}}_{x0}\, e^{-\underline{\gamma} r} \qquad \underline{\mathbf{H}}_y = \frac{\underline{\gamma}}{j\underline{\omega}\mu_0}\underline{\mathbf{E}}_x \qquad \underline{\mathbf{E}}_y = \underline{\mathbf{E}}_{y0}\, e^{-\underline{\gamma} r} \qquad \underline{\mathbf{H}}_x = -\frac{\underline{\gamma}}{j\underline{\omega}\mu_0}\underline{\mathbf{E}}_y \tag{522}$$

This is the universal propagation-function for an elliptically polarized flat wave in the vacuum. Here, the point r=0 is located at the signal-source. With the reference to the observer, we have to insert the value of $-\underline{\gamma}$ instead of $+\underline{\gamma}$ and to take up the corrections according to section 4.3.4.4.6. With circular polarization applies $\mathbf{E}_{x0}=\mathbf{E}_{y0}$, with linear polarization $\mathbf{E}_{y0}=0$. Thereat, the magnetic field is always perpendicular to the electric one.

In the approximation, the most naturally originated photons are polarized purely linearly, the neutrinos on the other hand behave circularly, they are polarized longitudinally however. Since the respective field-strength-maximum with circularly polarized waves migrates according to a periodic function between x and y, there is even another additional frequency, the rotation-frequency ω_{HF}. This depends on the angle $\delta = \omega_{HF} T_\omega$. The expression T_ω is the period of the time-function. But how do we now get the rotation of the polarization direction into our propagation-function? This is achieved by the introduction of complex frequencies. We first define four complex frequencies, for each particle one, to it:

$$\underline{\omega} = +\tilde{\omega}\left(\cos\delta \pm j\sin\delta\right) \quad \text{Time-like photons} \quad (523)$$

$$\underline{\omega} = -\tilde{\omega}\left(\cos\delta \pm j\sin\delta\right) \quad \text{Space-like photons} \quad (524)$$

$$\underline{\omega} = +\tilde{\omega}\left(\sin\delta \pm j\cos\delta\right) \quad \text{Neutrinos} \quad (525)$$

$$\underline{\omega} = -\tilde{\omega}\left(\sin\delta \pm j\cos\delta\right) \quad \text{Antineutrinos} \quad (526)$$

$\tilde{\omega}$ is the amount of $\underline{\omega}$. The upper sign applies to the x-coordinate, the lower sign to the y-coordinate. The relations cannot be derived directly from (479), (494) as well as (495), since these are based on a universal triangle, the complex exponential-function however on a rectangular triangle. Instead of the real and imaginary part of the frequency $\underline{\omega}$ therefore the projections on x and y are used as it is shown in figure 104.

For the lineup of an absolutely correct propagation-function, the complex e-function namely is not well-suited, one requires the Hankel-function to it. Because in reality, there are not any sine-functions in the nature. These would be defined up to the point of time $t=-\infty$ and such a point does not exist for known reasons. With it, for small values of Q a minor residual error remains. But since the wavelength is correctly calculated by the factor $\Xi(r)$, this does not express itself in a wrong character phasing but in a drift of the wave off the straight line R. But if we define the propagation-function along the arc of r, this deviation plays no more role. Then, the curvature of r is determined by outer influences and is not a component of the propagation-function.

The wavelength, that we measure, is always the real-part. With the photon, this equals the actual wavelength, with the neutrino the rise of the „screw thread“. The imaginary-part at the photon on the other hand corresponds to a rotation of the direction of polarization (there are just actually circularly or elliptically polarized photons only), at the neutrino, it is joined with the „screw thread-diameter“.

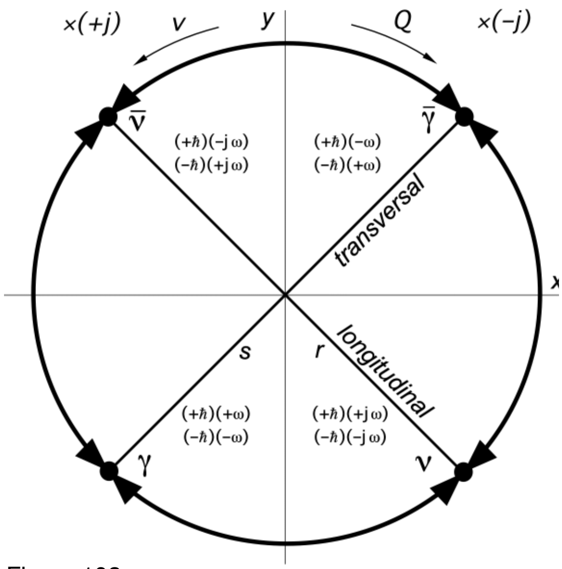


Figure 102
Photon-circle, variance of the properties of the kinds of photon on change of Q and v

So, the multiplication of the time-function with ±j means the transformation of a particle into a second one, i.e., the properties of the photons and neutrinos change with the occurrence of imaginary frequencies. This is always the case with a very small Q-factor or a very large velocity v, i.e. at very strong gravitational-fields, just after the big bang or when the velocity is close to c ($c-10^{-50}ms^{-1}$).

Figure 102 shows the situation of the individual particles in the phase space and the variance with changes of Q and V. In principle doesn't change the particles themselves but the metrics. It's therefore only about an observational phenomenon, even if the varied properties are physically real.

The transition takes place nor gradually but abruptly and that the steeper, the major the value Q in the frame of reference of the observer. That's why this effect cannot be detected e.g.

with accelerator-experiments, neither today, nor in far future, since the energies needed are outside the availability of mankind. As later examinations will show, the particles, even with strongest curvature, doesn't exceed essentially the coordinate-axes x and y. Therefore, a photon remains a photon, a neutrino a neutrino etc. That means, the reference point of the antineutrino is with 2/3.

With technically generated circularly polarized photons the rotation-frequency ω_{HF} can take on arbitrary, even negative values (right-hand screw) which depend on the discretion and the possibilities of the technician. This happens e.g., in that we use a circularly polarized transmitting-antenna or a polarization-filter in front of a light-source rotating with a certain velocity.

According to [26] a circularly polarized wave can be depicted as the superimposition of two by x and y linearly polarized waves with the same amplitude which are phase-shifted by 90° against each other. This however is the special case, when ω_{HF} and ω are of the same size. Then, the direction of polarization of the wave rotates around 2π exactly one time when it has covered the distance λ. With a rotation-frequency aberrant there from, naturally the phase-shift is smaller (photons) or even greater (neutrinos). Now, with (522) we have already found such an equation-system, however without phase-shift. If we add these, it has only effects to the time-function. The actual transfer-function $e^{-\underline{\gamma} r}$ remains untouched, i.e. it doesn't matter to the metrics, which type of signal is transferred. Although, different functions $\Xi(r)$ are applied.

Considering only purely linearly polarized photons or purely longitudinally polarized neutrinos, the rotation-frequency ω_{HF} is defined by the angle δ_N. Decisive is the phase-angle, the argument of the complex frequency $\underline{\omega}$. It applies:

$$\delta_\gamma = \arctan\frac{+\sin\delta}{+\cos\delta} = +\arctan\tan\delta = +\delta \qquad \text{Time-like photons} \tag{527}$$

$$\delta_{\bar\gamma} = \arctan\frac{-\sin\delta}{-\cos\delta} = -\arctan\tan\delta = -\delta \qquad \text{Space-like photons} \tag{528}$$

$$\delta_\nu = \arctan\frac{+\cos\delta}{+\sin\delta} = +\arctan\cot\delta = +\left(\frac{\pi}{2}-\delta\right) \qquad \text{Neutrinos} \tag{529}$$

$$\delta_{\bar\nu} = \arctan\frac{-\cos\delta}{-\sin\delta} = -\arctan\cot\delta = -\left(\frac{\pi}{2}-\delta\right) \qquad \text{Antineutrinos} \tag{530}$$

The term $\pm j\pi/2$ with the neutrinos corresponds to a rotation of the coordinate-system by ±90°. The transfer-function (522) namely is in the form, we used it until now, not suitable for neutrinos, since the neutrinos are propagating in the right angle to the photons (see figure 94 and 98). Rather, the universal propagation-function $e^{j\underline{\omega}t-\underline{\gamma}r}$ describes only the wave-propagation along the real coordinate of the phase space. Herewith, the part $j\underline{\omega}t$ represents the time-like, the part $\underline{\gamma}r$ the space-like vector, both standing perpendicularly one against the other. In order to describe a wave-propagation along the imaginary coordinate, above-mentioned rotation is necessary. This happens, in that we multiply the whole time-function with ±j. And this multiplication exactly turns out the expression $\pm j\pi/2$ in the exponent. We just take up a transition from the real to the imaginary coordinate. With it, we obtain for the universal transfer-function:

$$\begin{aligned} &\underline{\mathbf{E}}_{x0} = \hat{\mathbf{E}}_x e^{j(\underline{\omega}t+\delta_N)} \qquad \underline{\mathbf{E}}_{y0} = \hat{\mathbf{E}}_y e^{j(\underline{\omega}t-\delta_N)} \qquad \text{Time-function} \\ &\underline{\mathbf{E}}_x = \underline{\mathbf{E}}_{x0}\, e^{-\underline{\gamma}r} \qquad \underline{\mathbf{H}}_y = \frac{1}{\underline{Z}_F}\underline{\mathbf{E}}_x \qquad \underline{\mathbf{E}}_y = \underline{\mathbf{E}}_{y0}\, e^{-\underline{\gamma}r} \qquad \underline{\mathbf{H}}_x = -\frac{1}{\underline{Z}_F}\underline{\mathbf{E}}_y \end{aligned} \tag{531}$$

Thereat a positive value δ_N corresponds to a left-hand screw, a negative to a right-hand screw on propagation in r-direction. With technical photons, the unnatural rotation-share

$\delta_K=\omega_{HF}T_\omega$ adds up to the natural δ_N. As already mentioned more above, δ_N does not exceed the value $\pi/4$, neither with strongest curvature. Thus, the individual kinds of photon cannot be converted in one another. They only show similar properties then. The angle δ, different from zero, is also responsible for the occurrence of a rotation of the polarization direction of linearly polarized photons in the cosmologic time frame. This effect is however very bad to demonstrate, since it's extremely weak. After we have worked out the universal propagation-function, as next we want to look at the „normal", i.e. time-like photons more exactly.

5.3.2.1. Time-like photons

At first, we want to figure the expression for the propagation rate $\underline{\gamma}$ once again. It doesn't differ from the already known expression (306):

$$\underline{\gamma}_\gamma = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_\gamma(r) \right) \Phi(\omega) \qquad \text{Phase rate} \qquad (532)$$

The phase rate is independent from the respective coordinate. Interestingly enough, the angle δ doesn't appear at all. Only the amount $\tilde{\omega}$ of the complex frequency $\underline{\omega}$ is used. However, always only the real-part of the wavelength can be observed. The rest is hidden in the third dimension y.

Since the attenuation α with its share $1/R=H/c$ is a function of the distance r, it is because of $r=ct$ a function of time too. And this dependence must express itself also in the relation $j\underline{\omega}t$ at the signal-source. It arises from the introduction of an additional cosmologic component, the imaginary frequency jH. With disregard of the cut-off frequency, it plays no role at the source, we obtain:

$$j\underline{\omega}_\gamma t = j\left(j\tilde{H} + \tilde{\omega}\Xi_\gamma(t)\right)t = \left(-\tilde{H} + j\tilde{\omega}\Xi_\gamma(t)\right)t \qquad \text{Time-function} \qquad (533)$$

The part –H corresponds to the time-dependent expansion and attenuation at the observer at the point r=0. Of course, like each point in the universe, this is even subject to a temporal red-shift and attenuation. Therefore, there is also a share $\operatorname{div}\mathbf{S}$ at the point r=0, which is now a function of time however. Going back in time (–t), so there is also a larger amplitude, i.e. to an earlier point of time natural emissions took place with higher energy. The origin of the time-like photons is at Q=1/2.

But we have only characterized the wave-properties of the photon with it, however it disposes of particle-properties too. In this point I affiliate the current doctrine, with one exception—namely, with the help of (528), a photon rest mass different from zero can be defined, as it is postulated by several modern, local and non-local theories. The value agrees very well with the there made projections[1]:

$$\tilde{m}_0 = \frac{\hbar\tilde{H}}{c^2} = 2.73727 . 10^{-69}\,\text{kg} \qquad \text{Rest mass photons} \qquad (534)$$

5.3.2.2. Space-like photons

As next we look at the propagation rate $\underline{\gamma}$ for space-like photons. Next in turn we start from (306). Since space-like photons however propagate opposite to the propagation direction (velocity –c), we must take this into account accordingly:

$$\underline{\gamma}_{\bar{\gamma}} = \left(\left(\frac{\tilde{H}}{-c} + \frac{\tilde{\omega}_0}{-c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{-c} \Xi_{\bar{\gamma}}(r) \right) \Phi(\omega) \qquad (535)$$

[1] By the way, in the time just after big bang and in strong gravitational fields, the photons dispose of a non-considerable rest mass.

$$\underline{\gamma}_{\bar{\gamma}} = \left(\left(-\frac{\tilde{H}}{c} - \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) - j\frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(r) \right) \Phi(\omega) \quad \text{Phase rate} \quad (536)$$

Since space-like photons are moving opposite to time-like ones, they have a negative phase rate exclusively. Especially interesting is this in connection with the expression $j\underline{\omega}t$. We want to determine this as next. Because finally standing waves come out, the expression $\Psi(\omega)$ for the cut-off frequency at the source this time cannot be disregarded:

$$j\underline{\omega}_{\bar{\gamma}} t = j\left(\left(j\tilde{H} + j\tilde{\omega}_0 \Psi(\omega) \right) + \tilde{\omega} \Xi_{\bar{\gamma}}(t) \right) t \quad (537)$$

$$j\underline{\omega}_{\bar{\gamma}} t = \left(\left(-\tilde{H} - \tilde{\omega}_0 \Psi(\omega) \right) + j\tilde{\omega} \Xi_{\bar{\gamma}}(t) \right) t \quad \text{Time-function} \quad (538)$$

For the difference $j\underline{\omega}t - \underline{\gamma}r$ with $r=(-c+v)t$, v=const we obtain by expansion:

(539)

$$j\underline{\omega}_{\bar{\gamma}} t - \underline{\gamma}_{\bar{\gamma}} r = \left(\left(-\frac{\tilde{H}}{c} - \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j\frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(r) \right) ct - \left(\left(-\frac{\tilde{H}}{c} - \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) - j\frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(r) \right) \frac{\cancel{\Phi(\omega)}}{\cancel{\Phi(\omega)}} (-c+v)\, t$$

$$j\underline{\omega}_{\bar{\gamma}} t - \underline{\gamma}_{\bar{\gamma}} r = -2\left(\tilde{H} + \tilde{\omega}_0 \Psi(\omega) \right) t + \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j\frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(t) \right) vt \quad (540)$$

v is the velocity, with which the wave is moved by external inducement, (translational motion). The positive term of H/c describes the energy-increase during acceleration, i.e. the relativistic mass-increase as a function of the velocity as well as the mass-increase by approach to the temporal singularity. The linear addition of the velocities is correct, since both velocities are referred to the same system. Now let's substitute v=0, so we receive a plain real result, the propagation rate has the value zero. With it it's about a standing wave:

$$j\underline{\omega}_{\bar{\gamma}} t - \underline{\gamma}_{\bar{\gamma}} r = -\left(2\tilde{H}t + 2\tilde{\omega}_0 t\ \Psi(\omega) \right) = -\left(\frac{t}{\tilde{T}} + \tilde{Q}_0 \Psi(\omega) \right) \approx -\frac{t}{\tilde{T}} \qquad \underline{\gamma}_{\bar{\gamma}} = 0, \quad v = 0 \quad (541)$$

The approximation is valid for $\omega \ll \omega_0$. Since the angle δ is untouched, a possible rotation of the polarization direction (spin?) survives. The occurrence of a twofold attenuation-factor 2/R=1/(R/2) let's still presume, that it's about a space-like vector in this case.

With it the question arises afterwards for the actual character of the space-like photons. Until now we had assumed, that the fermions somehow consist of them. But it does not seem to be the case. So the space-like photons are bosons with integer spin, while the fermions have a half-integer spin. It is however hard to imagine that particles with half-integer spin should consist of such with integer spin, rather the other way round.

Let's further do a comparison with the time-like photons, these mediate the mutual electromagnetic interaction of the fermions *via* the metrics, the space-like photons could be responsible for the same interaction of the fermions *with* the metrics. For that purpose however they must move into the same direction as the fermions (space-like vector) and with the same velocity (arbitrary). Since the metrics is omnipresent, they even don't need to cover large distances (limited lifetime). With it, the space-like photons mediate the metrical properties of the particles (mass, length etc).

As well, as the time-like photons the space-like photons naturally dispose of particle-properties too. These however rather resemble those of the DEBROGLIE-matter-waves than those of the time-like photons. It is yet about bosons. The origin of the space-like photons is at Q=2/3. The rest mass equals to that of the time-like photons.

5.3.2.3. Neutrinos

Now, it is absolutely necessary to write down the relationship also for neutrinos and antineutrinos. We expect a behaviour similar to the one of the time-like photons, since neutrinos also propagate with light speed. Let's begin with the neutrinos for one thing. We start with expression (306) once again looking at the relationship for $\underline{\gamma}$r at first. This time however we have to take into account, that the wave doesn't propagate with c but with jc, i.e. in the right angle to the photons, and to consider it in the denominator of $\underline{\gamma}$ accordingly. Then, the function is neither defined along the arc r, but along jr, so that the factor j cancels out in turn. But if we define r as the actual propagation direction of the neutrinos, we can assume an unchanged expression for $\underline{\gamma}$:

$$\underline{\gamma}_{\nu} jr = \left(\left(\frac{\tilde{H}}{jc} + \frac{\tilde{\omega}_0}{jc} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{jc} \Xi_{\nu}(r) \right) \Phi(\omega) jr \tag{542}$$

$$\underline{\gamma}_{\nu} jr = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\nu}(r) \right) \Phi(\omega) r \tag{543}$$

$$\underline{\gamma}_{\nu} = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\nu}(r) \right) \Phi(\omega) \qquad \text{Phase rate} \tag{544}$$

With exception of Ξ, the phase rate doesn't differ from that one of the photons. This was not otherwise to be expected by the way, is it about the same medium after all. The neutrinos are also subject to the red-shift and cut-off frequency.

Since the angle δ_{ν} is positive because of (529), neutrinos are rotating in a mathematical positive manner (counterclockwise/left-hand screw) with propagation in r-direction. This property is also called (negative) helicity and is the substrate of the weak charge. At the neutrino, it has the value –1. With inversion in all dimensions the helicity survives. So the neutrino is its own antiparticle. By the way, this applies even to both kinds of photon. As next, we want to determine the time-function j$\underline{\omega}$t:

$$j\underline{\omega}_{\nu} t = j \left(j\tilde{H} + \tilde{\omega} \Xi_{\nu}(t) \right) t = \left(-\tilde{H} + j\tilde{\omega} \Xi_{\nu}(t) \right) t \qquad \text{Time-function} \tag{545}$$

It shows, a real attenuation appears at the signal-source. Neutrinos in the same way are subject to the parametric attenuation, like the photons. These are only the wave-properties then again. The particle-properties are characterized by the fact that the neutrinos are fermions with half-integer spin. This seems to be associated with the location of the propagation direction in the complex phase space therefore. For jπ(2n)/2 an integer spin emerges, for jπ(2n+1)2 a half-integer spin. The sign is defined by the phase-angle jπ/2. The origin of the neutrinos is at Q=1/2. The rest mass equals to that of the photons too.

5.3.2.4. Antineutrinos

As we know, even antineutrinos propagate with speed of light, in contrast to the neutrinos however along the negative imaginary axis with the velocity –jc. It applies:

$$\underline{\gamma}_{\bar{\nu}} (-j) r = \left(\left(\frac{\tilde{H}}{-jc} + \frac{\tilde{\omega}_0}{-jc} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{-jc} \Xi_{\bar{\nu}}(r) \right) \Phi(\omega) (-j) r \tag{546}$$

$$\underline{\gamma}_{\bar{\nu}} (-j) r = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\bar{\nu}}(r) \right) \Phi(\omega) r \tag{547}$$

$$\underline{\gamma}_{\bar{\nu}} = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c}\Psi(\omega)\right) + j\frac{\tilde{\omega}}{c}\Xi_{\bar{\nu}}(r)\right)\Phi(\omega) \qquad \text{Phase rate} \qquad (548)$$

Since the antineutrinos are antiparticles, they actually should have also a negative phase rate. According to (545) it is really the case, only it's negative imaginary, because of $1/j = -j$. But we can also work with the same phase rate, as with the photons, if we define the propagation-function along the arc r, that coincides with the real propagation direction, once again. The antineutrinos are subject to the red-shift and cut-off frequency once again.

The only difference from the neutrinos is the negative sign of $\delta_{\bar{\nu}}$, see (530). Thus, antineutrinos rotate mathematically seen negatively (clockwise/right-hand screw) with propagation in r-direction. They have a positive helicity and the weak charge +1. With inversion the helicity survives too. So also the antineutrino is its own antiparticle, not the neutrino. This condition is called parity violation. As next, we want to determine the time-function $j\underline{\omega}t$:

$$j\underline{\omega}_{\bar{\nu}}t = j\left(j\tilde{H} + \tilde{\omega}\Xi_{\bar{\nu}}(t)\right)t = \left(-\tilde{H} + j\tilde{\omega}\Xi_{\bar{\nu}}(t)\right)t \qquad \text{Time-function} \qquad (549)$$

A real attenuation appears at the signal-source in turn, antineutrinos are subject to the parametric attenuation like the photons and neutrinos. The particle-properties are following: Antineutrinos are fermions with half-integer spin. The phase-angle is $-j\pi/2$. Since it is about antiparticles, the origin is at Q=2/3. The rest mass also equals that of the photons.

With it, we have worked out a maximally efficient, contradiction-free, extended photon-model, which is able to explain also the behaviour of the neutrinos and antineutrinos, that is valid even under cosmologic points of view.

As one can well recognize at (538), neutrinos and antineutrinos dispose of essentially more degrees of freedom than the photon. Thereat, the spin is defined by the propagation direction, the weak charge by the helicity, just δ_N. We could allocate two particle properties with it.

In section 5. I already formulated the hypothesis that with the three hitherto identified kinds of neutrino (ν_e, ν_μ, ν_τ) it's actually only about resonances of one and the same particle, at which point the neutrino-oscillation prevents a violation of the PAULI-principle, if several neutrinos of identical „construction“ are crossing an electron shell simultaneously.

In what however turns out the difference between these three kinds of neutrino, more it shouldn't be indeed, in the propagation-function? We only can make guesses about it, which would be there:

1. *It's about different particles indeed.*

2. *It's about the same particle with different frequency/energy. Neutrinos are only generated or resorbed with certain reactions within a definite energy band. Thereat, the value depends on the type of reaction.*

This is the simplest answer, but it wouldn't explain the neutrino-oscillation anyway.

3. *It's about different resonances of one and the same particle. With violation of the PAULI-principle, a particle adapts its energy to an already free energy level. But for neutrinos, it's only of interest during the stay within an electron shell.*

This would be a practicable option. It would explain the neutrino-oscillation. But it remains the open question, in what extent this manifests in the propagation-function. A fixed additive phase-angle to the angle δ_N would be practicable (additional phase-shift). Here, an angle of e.g. $2/3\pi$ would be possible in order to guarantee the number of three. Another option would be a multiple of 2π. Then, more than 3 kinds of neutrino would be possible however. Perhaps, 3 kinds of neutrino are sufficient however? Another option would be the occurrence of a positive or negative twofold frequency in the y-component of the wave-function. The neutrino-wave consists of two components x and y indeed. If one of it has the twofold frequency, a periodic solution occurs too. The corkscrew becomes a rotating 8 as with the LISSAJOUS-figures. Thereat, there are parallels to the atom, what lets appear this explanation quite possible. The s-orbital is also circular in the top view, the p-orbital looks like an 8 and there are altogether four of them. But one of them is dropped, since it lies in propagation direction, that makes three altogether. And here still the last option:

4. *The difference between the three kinds of neutrino cannot be figured in the propagation-function.*

However, I would like to leave open the final answer to this question turning over to the following section as next.

6. The special relativity-principle

Originally, this topic should be treated first to a later point of time. In the next section however, special new, SRT related information is used, so that I decided to anticipate the chapter velocity and relativity.

6.1. Velocity and relativity

Having hitherto looked at the temporal and spatial dependence of different quantities, it's time to examine also the dependence from the velocity. Still interesting are the relationships to the newly introduced quantities Q-factor (phase-angle), ω_0 and κ_0. As starting point, we assume the statements of the SRT, just as they have been formulated by EINSTEIN. Therefore, by velocity, we understand the relative velocity of one observer to another (frame of reference).

6.1.1. Fundamentals

We first of all assume an imagined Cartesian coordinate-system. In its zero is the observer. This coincides with the centre of the universe (each point, at which an observer is, is always the centre of the universe for him). With it, the relative-velocity of the observer is equal to zero, not only in reference to the coordinate-system but also in reference to the metrics, but not in reference to the empty space (c_M). Furthermore, we observe a body from this point, moving with the relative-velocity v in reference to the coordinate-origin. We measure the *length* x´ in ratio to the *rest-length* x, that we determined, before we have accelerated the body to the velocity v. According to the just yet classic statement of the SRT applies to the observed length (doesn't apply to wavelengths!):

$$x' = x\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}} \tag{550}$$

We don't want to question this relationship in principle, is it proven by a lot of spectacular experiments after all. Although, these proof don't apply to the entire range $0 \leq v \leq c$. The largest hitherto reached velocity, with which measurements have been taken up, is about approximately 0.997c for the time being (I can be wrong here) and was achieved in a particle-accelerator. At this velocity, no dissents with respect to the statements of the SRT, especially expression (550) have been found. Nevertheless, it's well possible that there is a velocity v<c from which on the statements of the classic SRT apply only restrictedly or no more at all. If we should come to a statement, aberrant from the SRT, in the course of the further contemplations, so this must be of line with the statements of the classic mechanics for very small velocities, and with the statements of the SRT and the yet gained observation-results in the range above it up to 0.997c.

LANCZOS assumes in [1], that the relativistic effects first result from the existence of the metric lattice, with which the fermionic particles even figure autonomous spherical symmetrical solutions of the field-equations which exist independently from the metric lattice. But we observe them only via an indirection by means of bosons (photons) which propagate across the metric lattice, which behave like a lens with the resolution $\hbar/2$ (uncertainty).

If our particle now is moving in reference to the metrics and with it in reference to the observer, there's going to be the occurrence of a definite difference-frequency ω, which depends on the velocity, the particle moves through our „crystal“. The particle even owns wave properties simultaneously indeed. The frequency depends on the number of MINKOVSKIan line-elements the particle „grazes“ during its motion within a certain time period and with it also on the local MLE-density (age, gravitational-potential).

After I have read the lecture of Professor LANCZOS, I got on the occasion of another physics-lecture (this is already behind a while now and herewith I would like to thank the lecturer Mister Dr. Propp warmly once again) an essential suggestion to this model. Subject of this lecture was the mechanical oscillator.

With the mechanical oscillator it's about an externally agitated system with the differential equation [5]:

$$\ddot{x} + 2k\dot{x} + \omega_0^2 x = \frac{F_0}{m}\cos\omega t \tag{551}$$

x is the deflection, ω_0 the resonance-frequency, ω the frequency of the exciting oscillation, F_0 the force and m the mass of the oscillator. By the way, the quotient F_0/m also equals to the gravitational-field-strength. The coefficient k is a measure of the attenuation. This is microscopic in general. Interestingly enough, a similarity exists with (76). A comparison leads to the essential statement $k \mathrel{\hat{=}} H$. For the amplitude A applies then:

$$A = \frac{F_0}{m}\left((\omega_0^2 - \omega^2)^2 + 4k^2\omega^2\right)^{-\frac{1}{2}} \tag{552}$$

With k→ 0 we obtain the following expression:

$$A = \frac{F_0}{m}(\omega_0^2 - \omega^2)^{-1} = \frac{F_0\omega_0^2}{m}\left(1 - \frac{\omega^2}{\omega_0^2}\right)^{-1} = A_0\left(1 - \frac{\omega^2}{\omega_0^2}\right)^{-1} \tag{553}$$

To compare the result with (550), so are both expressions identical with exception of the exponents, i.e. there is a similarity between the behaviour of the mechanical oscillator and the relativistic mass-increase. Particularly interesting is the fact that the amplitude during an agitation with a frequency of zero is equal to 1—in contrast to the electric oscillatory circuit—here it is the amplitude equal to zero, since the signal is short-circuited by the inductivity. An exception forms the model according to figure 10 with input coupling over the capacitor. With approach to the resonance-frequency, an amplitude-increase appears. The amplitude tends against infinity with vanishing attenuation—in turn exactly as with the relativistic mass-increase. Then however, the behaviour above ω_0 deviates: A phase-jump about $-\pi$ appears while the solution (550) becomes imaginary. This is not further remarkable, in the one case, it's about a deflection (energy), in the second case about a length, which cannot be compared without further ado.

6.1.2. Velocity and length

6.1.2.1. Relations between length, velocity and Q-factor

Therefore I have wondered, whether a particle with acceleration not also could behave like a mechanical oscillator, with which is the mass proportional to the amplitude of the externally agitated inherent oscillation (DEBROGLIE-matter-wave). The same should be applied analogously even to quantities like length and time then. If ω_0 is the frequency of the MLE at the place of the observer, the velocity-dependent frequency ω at the place of the particle arises to $\omega = v/r_0$. Now, we only have to insert into (553) obtaining the classic expression of the SRT for wavelengths, however in the square ($\omega_0 r_0 = c$):

$$A = A_0\left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} = A_0\left(1-\frac{v^2}{\omega_0^2 r_0^2}\right)^{-1} = A_0\left(1-\frac{v^2}{c^2}\right)^{-1} \qquad (554)$$

6.1.2.1.1. Approximative solutions

The relativistic dilatation-factor β apparently results from the reciprocal of the root of the bracketed expression of (554). Furthermore, we require an expression, in which the velocity is joined with the Q-factor. But this is not so simple, as it appears for one thing. Therefore, we want to try next to determine one or even more approximative solutions for it. For that purpose, we don't simply want to assume expression (552) and (553), taken from [5], but examine, how to acquire it in general. At first, we start from (551) comparing with equation (76). Then, expression (551) corresponds to the inhomogeneous differential equation of (76), if we set $x=\varphi_0$. It applies:

$$\ddot{\varphi}_0 + 2H\dot{\varphi}_0 + \omega_0^2\varphi_0 = \dot{u}_a \cos\omega t \qquad (555)$$

To the finding of the first approximative solution, first of all we want to ignore the HUBBLE-parameter completely, since it's extremely small ($H=0$). Furthermore $u_a = d\varphi/dt = -\omega_0\varphi$ applies as well as $d^2\varphi/dt^2 = \omega_0^2\varphi$. The angular frequency ω_0 just works like a differential-operator. Sought is the amplitude response $A(\omega)$. According to [5] we obtain it by solving the inhomogeneous differential equation (556). For the solution, we use the LAPLACE-transformation:

$$\ddot{\varphi}_0 + \omega_0^2\varphi_0 = \omega_0^2\varphi_a \cos\omega t \qquad (556)$$

$$\mathcal{L}\ \ddot{\varphi}_0 = p^2\varphi_0 - pf_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = 0 \qquad (557)$$

$$\mathcal{L}\ \ddot{\varphi}_0 = p^2\varphi_0 \qquad \mathcal{L}\ \cos\omega t = \frac{p}{p^2+\omega^2} \qquad (558)$$

After substitution in (556) we get the following characteristic equation:

$$p^2\varphi_0 + \omega_0^2\varphi_0 = \varphi_a\omega_0^2\frac{p}{p^2+\omega^2} \qquad \varphi_0\left(p^2+\omega_0^2\right) = \varphi_a\omega_0^2\frac{p}{p^2+\omega^2} \qquad (559)$$

$$\varphi_0(p) = \varphi_a\omega_0^2\frac{p}{\left(p^2+\omega_0^2\right)\left(p^2+\omega^2\right)} \qquad \varphi_0(t) = \mathcal{L}^{-1}\ \varphi_0(p) \qquad (560)$$

$$\varphi_0(t) = \varphi_a\omega_0^2\frac{\cos\omega t - \cos\omega_0 t}{\omega_0^2-\omega^2} = 2\varphi_a \sin\frac{\omega_0+\omega}{2}\sin\frac{\omega_0-\omega}{2}\left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \qquad (561)$$

The function (561) looks like a 100% amplitude-modulated signal, at which point the envelope traces the frequency ω both in the positive as in the negative range. Thereat, there's going to be constrictions in which the amplitude is equal to zero. With it, the energy is not equally distributed along the way. Rather, the transportation takes place in „packages“, the photons (particles). Since the value of the sum, but even that of the difference of two cosine-functions is always in the range $-2 \leq y \leq 2$ and the value φ_a doesn't play any role (for $\omega=0$ we get a value of 1), applies generally for the amplitude and the relativistic dilatation-factor β:

$$\hat{\varphi}_0 = \varphi_a \left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} = \varphi_a \left(1-\frac{v^2}{c^2}\right)^{-1} \qquad \beta = \left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}} \tag{562}$$

Another exception exists in the resonance-case $\omega=\omega_0$. Here, the function actually is not defined ($0/0^2$). The value tends against infinity however. With it, expression (562) equals to the classic EINSTEIN solution. According to our model, this can be true only in a loss-free medium however. An expression for the Q-factor in dependence from the velocity cannot yet be declared here, since the function doesn't contain the Q-factor.

We have found a result, based on the solution of the inhomogeneous differential equation (556). We however want to examine, whether there is a second possibility to acquire the same result. The reason is, that considerable mathematical difficulties will appear during the search for an exact solution, if we try to solve the inhomogeneous differential equation.

We have already applied the second solution-method in section 4.3.2. It is based on the solution of the homogeneous differential equation with help of the LAPLACE-transformation with subsequent transition $p \rightarrow j\omega$, at which point a retransformation $\mathscr{L}^{-1}$ is not necessary. We just start from (543). The approach:

$$\ddot{\varphi}_0 + \omega_0^2 \varphi_0 = 0 \qquad \rightarrow \qquad p^2 \varphi_0 + \omega_0^2 \varphi_0 = 0 \tag{563}$$

(563) first of all leads only to the trivial result $\varphi_0=0$. We just have to modify the initial-conditions, namely in the following manner:

$$\mathscr{L}\ \ddot{\varphi}_0 = p^2\varphi_0 - p f_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = \omega_0^2 \varphi_a \tag{564}$$

$$\mathscr{L}\ \ddot{\varphi}_0 = p^2\varphi_0 - \omega_0^2 \varphi_a \tag{565}$$

$$p^2 \varphi_0 + \omega_0^2 \varphi_0 = \omega_0^2 \varphi_a \qquad \varphi_0 = \varphi_a \frac{\omega_0^2}{p^2+\omega_0^2} \tag{566}$$

$$G(p) = \frac{\omega_0^2}{p^2+\omega_0^2} \qquad G(j\omega) = \frac{\omega_0^2}{\omega_0^2-\omega^2} = \left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \tag{567}$$

$$A(\omega) = \left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \qquad B(\omega) = \begin{cases} 0 & -\omega_0 < \omega < \omega_0 \\ \pi & \omega < -\omega_0, \omega > \omega_0 \end{cases} \tag{568}$$

$$\beta(v) = \left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}} \qquad \phi(v) = \begin{cases} 0 & -c < v < c \\ \frac{\pi}{2} & v < -c, v > c \end{cases} \tag{569}$$

Both solutions are just identical and we can declare also an expression for the phase-angle ϕ. The finally applied procedure has the advantage of a simpler calculation. A function $Q=f(v)$ we still cannot yet declare however. We have to co include the HUBBLE-parameter into the contemplation for that purpose. To the certainty, we apply both solution-procedures once again. For the second approximation, we consider H as a constant, since the value practically doesn't change to the present point of time (adiabatic principle). Then however, the factor 2 before $\dot{\varphi}_0$ is allotted. If we assume H as constant, namely the expansion-share $\dot{r}_0/r_0$ becomes equal to zero, i.e. the factor is equal to 1 (see (72)). It applies:

$$\ddot{\varphi}_0 + H\dot{\varphi}_0 + \omega_0^2\varphi_0 = \omega_0^2\varphi_a \cos\omega t \tag{570}$$

$$\mathscr{L}\ \dot{\varphi}_0 = p\varphi_0 - f_0^{(0)} \qquad f_0^{(0)} = 0 \tag{571}$$

$$\mathscr{L}\ \dot{\varphi}_0 = p\varphi_0 \tag{572}$$

$$\mathscr{L}\ \ddot{\varphi}_0 = p^2\varphi_0 - pf_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = 0 \tag{573}$$

$$\mathscr{L}\ \ddot{\varphi}_0 = p^2\varphi_0 \qquad \mathscr{L}\ \cos\omega t = \frac{p}{p^2+\omega^2} \tag{574}$$

After substitution in (570) we get the following characteristic equation:

$$\varphi_0 p^2 + H\varphi_0 p + \omega_0^2\varphi_0 = \varphi_a\omega_0^2 \frac{p}{p^2+\omega^2} \tag{575}$$

$$\varphi_0\left(p^2 + Hp + \omega_0^2\right) = \varphi_a\omega_0^2 \frac{p}{p^2+\omega^2} \tag{576}$$

$$\varphi_0 = \varphi_a\omega_0^2 \frac{p}{\left(p^2 + Hp + \omega_0^2\right)\left(p^2+\omega^2\right)} \tag{577}$$

Here, our endeavours already finish, because this expression is not contained in the correspondence-table and even the BRONSTEIN doesn't help. One gets a solution after the decomposition into partial fractions. However, we don't want follow up this turning to the second procedure immediately:

$$\ddot{\varphi}_0 + H\dot{\varphi}_0 + \omega_0^2\varphi_0 = 0 \tag{578}$$

$$\mathscr{L}\ \dot{\varphi}_0 = p\varphi_0 - f_0^{(0)} \qquad f_0^{(0)} = 0 \tag{579}$$

$$\mathscr{L}\ \dot{\varphi}_0 = p\varphi_0 \tag{580}$$

$$\mathscr{L}\ \ddot{\varphi}_0 = p^2\varphi_0 - pf_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = \omega_0^2\varphi_a \tag{581}$$

$$\mathscr{L}\ \ddot{\varphi}_0 = p^2\varphi_0 - \omega_0^2\varphi_a \tag{582}$$

We substitute again in (570) obtaining finally:

$$\varphi_0 p^2 + H\varphi_0 p + \omega_0^2\varphi_0 = \varphi_a\omega_0^2 \qquad \varphi_0\left(p^2 + Hp + \omega_0^2\right) = \varphi_a\omega_0^2 \tag{583}$$

$$G(p) = \frac{\omega_0^2}{p^2 + Hp + \omega_0^2} \qquad G(j\omega) = \frac{\omega_0^2}{\left(\omega_0^2 - \omega^2\right) + jH\omega} \tag{584}$$

$$G(j\omega) = \omega_0^2 \frac{(\omega_0^2 - \omega^2) - jH\omega}{(\omega_0^2 - \omega^2)^2 + H^2\omega^2} \tag{585}$$

$$A(\omega) = \omega_0^2 \frac{\sqrt{(\omega_0^2 - \omega^2)^2 + H^2\omega^2}}{(\omega_0^2 - \omega^2)^2 + H^2\omega^2} = \omega_0^2\left((\omega_0^2 - \omega^2)^2 + H^2\omega^2\right)^{-\frac{1}{2}} \tag{586}$$

With the exception of the factor 4 this exactly equals to expression (552) stated in [5]. We have calculated just right. But expression (586) can be transformed even more ($HQ_0=\omega_0$):

$$A(\omega) = \frac{\omega_0^2}{\sqrt{(H\omega)^2 + (\omega_0^2 - \omega^2)^2}} = \frac{\frac{\omega_0^2}{H\omega}}{\sqrt{1 + \left(\frac{\omega_0^2 - \omega^2}{H\omega}\right)^2}} \tag{587}$$

$$A(\omega) = \frac{\tilde{Q}_0 \frac{\omega_0^2}{\omega_0\omega}}{\sqrt{1 + \tilde{Q}_0^2\left(\frac{\omega_0^2 - \omega^2}{\omega_0\omega}\right)^2}} = \frac{\tilde{Q}_0 \frac{\omega_0}{\omega}}{\sqrt{1 + \tilde{Q}_0^2\left(\frac{\omega}{\omega_0} - \frac{\omega_0}{\omega}\right)^2}} \tag{588}$$

$$A(\omega) = \frac{c}{v}\frac{\tilde{Q}_0}{\sqrt{1 + \tilde{Q}_0^2 V^2}} = \frac{\tilde{Q}_0}{\sqrt{\frac{v^2}{c^2} + \tilde{Q}_0^2\left(1 - \frac{v^2}{c^2}\right)^2}} \quad \text{with } V = \frac{v}{c} - \frac{c}{v} \tag{589}$$

Thereat (capital letter) V is the detuning (380), as we know it from the electrotechnics. After substitution of ω by v, we receive for the dilatation-factor β:

$$\beta(v) = \frac{\sqrt{\tilde{Q}_0}}{\sqrt[4]{\frac{v^2}{c^2} + \tilde{Q}_0^2\left(1 - \frac{v^2}{c^2}\right)^2}} \approx \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \quad \text{for } Q_0 \gg 1 \tag{590}$$

The approximation (590) is identical to the EINSTEIN expression and with our first approximation. We can specify also a phase-angle. Based on (585) applies:

$$B(\omega) = -\arctan\frac{\omega H}{(\omega_0^2 - \omega^2)} = \arctan\frac{1}{Q_0}\frac{\omega\omega_0}{(\omega^2 - \omega_0^2)} = \arctan\frac{1}{Q_0 V} \tag{591}$$

$$B(\omega) = -\pi + \operatorname{arccot}(Q_0 V) = -\frac{\pi}{2} - \arctan(Q_0 V) \tag{592}$$

$$\phi(v) = \frac{B(\omega)}{2} = -\frac{\pi}{4} - \frac{1}{2}\arctan(Q_0 V) \overset{?}{=} \alpha - \frac{\pi}{2} \tag{593}$$

The last expression is very interesting. It could give us a relation between Q-factor, velocity and the angle α anyway. Unfortunately this doesn't work, since both functions have a different value-range. So, ϕ covers the range $-\pi/4\ldots-3/4\pi$, but the function $\alpha-\pi/2$ the range $-\pi/4\ldots-\pi$.

If we want to determine the Q-factor, we must make another approach. The substitution $\omega = v/r_0$ applies to the moved body. Really, we still have gotten an expression for the relativistic dilatation-factor β. What however we look for now, is a relation for the Q-factor.

If we say Q-factor, we mean the Q-factor of the metrics at the position of the moved body and for this applies $\omega = \omega_0 + v/r_0$. Thereby we take advantage of the fact, that the resonance-super elevation always exactly equals the value of the Q-factor. In expression (589) the super elevation in the case $v = 0$ has the value 1 and the value Q_0 for $v = c$, exactly vice-versa as with the metrics. Here, the Q-factor amounts to Q_0 for $v = 0$ and 1 for $v = c$. So, we have good reasons to assume that the Q-factor traces a sort of mirrored function (589). We obtain this by inserting the expression $\omega = \omega_0 - v/r_0$ in (584) to:

$$Q_0 = \tilde{Q}_0 \frac{\dfrac{1}{1-\dfrac{v}{c}}}{\sqrt{1+\tilde{Q}_0^2\left(\dfrac{1}{1-\dfrac{v}{c}}-\left(1-\dfrac{v}{c}\right)\right)^2}} \qquad \text{Mirrored function} \qquad (594)$$

Unfortunately, this function doesn't fulfill the set standards, since it's not symmetrical concerning the y-axis. So, the value $Q_0(-c)$ amounts to 1/3, the value $Q_0(+c)$ to 1. The reverse relation exists at the displaced function (595) with $\omega = \omega_0 + v/r_0$:

$$Q_0 = \tilde{Q}_0 \frac{\dfrac{1}{1+\dfrac{v}{c}}}{\sqrt{1+\tilde{Q}_0^2\left(\dfrac{1}{1+\dfrac{v}{c}}-\left(1+\dfrac{v}{c}\right)\right)^2}} \qquad \text{Displaced function} \qquad (595)$$

So, this is not suitable too. Now, we however know that both, the sum- as well as the difference-frequency, appear simultaneously with the multiplication of two frequencies. This approach leads to the correct solution then:

$$Q_0 = \tilde{Q}_0 \frac{\dfrac{1}{1+\dfrac{v}{c}}}{\sqrt{1+\tilde{Q}_0^2\left(\dfrac{1}{1+\dfrac{v}{c}}-\left(1-\dfrac{v}{c}\right)\right)^2}} = \frac{\tilde{Q}_0}{\sqrt{\left(1+\dfrac{v}{c}\right)^2+\tilde{Q}_0^2\dfrac{v^2}{c^2}}} \qquad (596)$$

with the approximative solution:

$$Q_0 \approx \frac{1}{1-\left(1-\dfrac{v^2}{c^2}\right)} = \frac{c^2}{v^2} \qquad \text{for } Q_0 \gg 1 \qquad (597)$$

For v=0 expression (597) has an infinite solution, which not quite corresponds to the observations. Let's however insert the propagation-velocity of the metrics c_M as basic-velocity, then applies $v=c_M+v_M$, so we receive for $v_M=0$ precisely the local Q-factor:

$$Q_0 \approx \frac{c^2}{c_M^2} \approx \sqrt{Q_0^2} \qquad \text{because of (224)} \qquad (598)$$

We must just add the space-like vector of the metrics to the velocity here. Thus, it's about an approximative solution with definition of the velocity in reference to the empty space (absolute velocity). This corresponds to an imagined Cartesian coordinate-system, which normally does not carry weight in the relativistic physics, with exception on the definition of the metrics itself. In contrast, the velocity in (596) is defined in reference to the metrics (frame of reference). In this case, we must *not* add the metric vector $\mathbf{c_M}$, since it already has been considered during the definition of the frame of reference (Q_0) Following basic rule applies: Always if the function contains the Q-factor, r_0 or ω_0, $\mathbf{c_M}$ must not be added. The reason follows later.

As well with the function of the Q-factor by the velocity (596) as with the expression for β (590) it's about approximative solutions, since the angular relations does not have been taken into account here. An important question is also that for the physical content of (596). The expression describes the Q-factor, which an observer would measure at a body moved in reference to its local frame of reference. This depends on the velocity v.

For an exact solution however (596) does not carry weight. The course of both functions is presented in figure 103, at which point $\mathbf{c_M}$ has been added in (590) on a trial basis. To the comparison, also the classic EINSTEIN solution is to be seen including the imaginary branch and the course of Q_0 With small Q-factors there's going to be an asymmetry of the function (596) around the point zero. One clearly realizes, that the maximum has been displaced into the negative range. It coincides with the minimum of the dilatation-factor, however not quite exactly. This is not a slight blemish but the transition to the universal relativity-theory. In a strong gravitational-field, the dilatation-factor with committed Q-factor Q_0 and v=0 is automatically smaller than one. This is the effect of the non-vanishing basic curvature in the strong gravitational-field, i.e. a length with zero-velocity already appears smaller than in reality. Usefully, the minimum of the relativistic dilatation-factor should coincide with the maximum of Q. With the addition of $\mathbf{c_M}$ this is guaranteed for larger Q-factors only. This was even to be expected, as it contravenes against the basic rule stated above, since the expression contains Q_0.

Thus, we want to determine the value of displacement needed to obtain a coincidence of minimum and maximum. The function to be displaced is (590). This results from the fact that we have committed the value of Q_0 for v=0. Therefore of course, we cannot suddenly calculate a Q-factor different from the committed value for v=0. A displaced function (590) also fulfills the differential equation (578).

We primarily calculate the first derivative of (589) and (596) in that we equate them to zero. In order to simplify the calculation, we however don't calculate the derivative of the function itself but that of its square. *For a wonder*, one time, we set c=1 here. This should not turn into the habit however:

$$\beta^{2\prime} = \tilde{Q}_0^2 \frac{4\tilde{Q}_0^2 v\left(1-v^2\right)-2v}{\left(v^2+\tilde{Q}_0^2\left(1-v^2\right)^2\right)^2} = 0 \qquad 2\tilde{Q}_0^2 v\left(1-v^2\right)-v = 0 \qquad (599)$$

$$v^3 - v\left(1-\frac{1}{2\tilde{Q}_0^2}\right) = 0 \qquad v_1 = 0 \text{ Minimum} \qquad v_{2,3} = \pm\sqrt{1-\frac{1}{2\tilde{Q}_0^2}} \text{ Maximum} \qquad (600)$$

$$Q_0^{2\,\prime} = -\tilde{Q}_0^2 \frac{2\tilde{Q}_0^2 v^2 + 2(1+v)}{\left(\tilde{Q}_0^2 v^2 + (1+v)^2\right)^2} = 0 \qquad \tilde{Q}_0^2 v + (1+v) = 0 \qquad (601)$$

$$v\left(1+\tilde{Q}_0^2\right) + 1 = 0 \qquad v = -\frac{1}{1+\tilde{Q}_0^2} \quad \text{Maximum} \qquad (602)$$

With it, following substitution applies for (590) with $c \neq 1$:

$$\frac{v}{c} = \frac{v_M}{c} + \frac{1}{1+\tilde{Q}_0^2} \qquad (603)$$

For the extreme values applies under consideration of (603) with $v_M = 0$ resp. $v = v_{max}$:

$$Q(0) = \tilde{Q}_0 \qquad Q_{max} = \sqrt{1+\tilde{Q}_0^2} \qquad (604)$$

$$\beta(0) = \frac{\sqrt{\tilde{Q}_0}}{\sqrt[4]{\frac{1}{(1+\tilde{Q}_0^2)^2} + \tilde{Q}_0^2\left(1 - \frac{1}{(1+\tilde{Q}_0^2)^2}\right)^2}} \qquad \beta_{max} = \sqrt{\tilde{Q}_0} \qquad (605)$$

With (590) it's nevertheless still about an approximation. Simultaneously, we have revealed even the secret of negative velocities. The SRT knows only positive velocities in the actual sense. This is also of line with our model in so far as an observer is always in the centre of the universe.

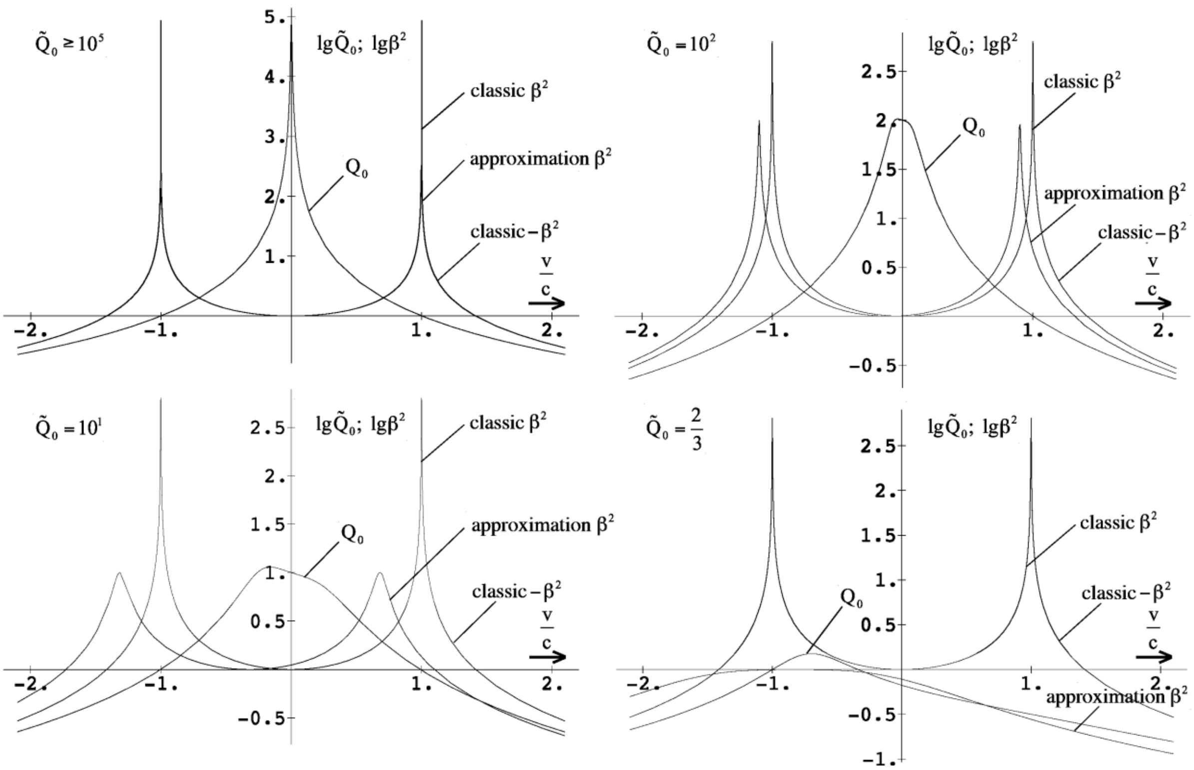


Figure 103
Relativistic dilatation-factor β and
Q-factor as a function of the velocity

Regardless into which direction, the observer or object always moves toward the particle-horizon cT (with positive velocity). Therefore, the classic EINSTEIN expressions result the same even if negative velocities are used. If however, each velocity always is defined as the sum of the metric and the speed-vector, just altogether in reference to the empty space, in strong gravitational-fields (small Q-factors) there is a point, at which this symmetry is broken, since the metric vector no longer can be disregarded. Obviously, it's neither irrespective of whether you move toward or away from a black hole.

Now, with (404) and (596), we have found two relations, which are independent from each other, describing the dependence of the Q-factor from space and time on the one hand and the dependence from the velocity on the other hand. The task consists in that we bring together both relations. Let's start with expression (404). It reads as follows:

$$Q_0 = \tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) \qquad (606)$$

At all, there are three output variables included (Q_0, T and R) which are coupled tight together. If we want to bring this expression (596) together, it is useful to reduce the quantity to one. Therefore, we want to substitute T and R, so that in the end only Q_0 and true constants appear in the equation. For that purpose let's have a look at the Q-factor once again. This is of central importance in this model, since it affects nearly all rulers in the universe. In table 5 are shown (not completely) the most important relations between the quantities of the empty space (left column, all are proper constants), the microcosm (middle column, variables) and the macrocosm (right column, variables).

r_1	— [× Q_0] →	r_0	— [× Q_0] →	R	Elementary length/World radius
t_1	— [× Q_0] →	t_0	— [× Q_0] →	T	Smallest time unit/Age
ω_1	— [: Q_0] →	ω_0	— [: Q_0] →	H	Frequency MLE/HUBBLE-parameter
$2\kappa_0$	— [: Q_0] —————		→ [: Q_0] →	κ_{0R}	Specif. conductivity vacuum/Metrics
???	— [: Q_0] →	$\hbar_1$	— [: Q_0] →	$\hbar$	PLANCK's quantity of action

Table 5
Relations between the fundamental values
of space and of the micro- and macrocosm

Our model owns the essential quality of the logarithmic periodicity with it. Then, under application of the relation stated in the table, we can transform expression (606) as follows:

$$Q_0 = \tilde{Q}_0\left(\left(1+\frac{1}{\tilde{Q}_0^2}\frac{t}{t_1}\right)^{\frac{1}{2}} - \left(\frac{2}{\tilde{Q}_0^2}\frac{r}{r_1}\right)^{\frac{2}{3}}\right) \quad \text{with} \quad t_1 = \frac{1}{2}\frac{\varepsilon_0}{\kappa_0} \quad \text{and} \quad r_1 = \frac{1}{\kappa_0 Z_0} \qquad (607)$$

Now, we can merge this expression with (596). For it there are two options in principle. The first one describes the case, where the velocity is defined in reference to the coordinate-origin. Thereat is to be paid attention to the fact, that the basic Q-factor in (607) depends on the result of (596) and vice-versa. There is just a reciprocal dependence:

$$Q_0 = \frac{\tilde{Q}_0}{\sqrt{\left(1+\frac{v}{c}\right)^2 + \tilde{Q}_0^2 \frac{v^2}{c^2}}} \left(\left(1 + \frac{1}{Q_0^2}\frac{t}{t_1}\right)^{\frac{1}{2}} - \left(\frac{1}{Q_0^2}\frac{2}{r_1}\int \mathbf{v}dt\right)^{\frac{2}{3}} \right) \tag{608}$$

A solution is possible, if v is small in reference to c and t is small in reference to T and r is small in reference to R. Then, we can assume both values (T and R) as constants obtaining an analytic solution. Otherwise, a solution is got using numerical procedures by solving the equation:

$$\frac{\tilde{Q}_0}{\sqrt{\left(1+\frac{v}{c}\right)^2 + \tilde{Q}_0^2 \frac{v^2}{c^2}}} \left(\left(1 + \frac{1}{Q_0^2}\frac{t}{t_1}\right)^{\frac{1}{2}} - \left(\frac{1}{Q_0^2}\frac{2}{r_1}\int \mathbf{v}dt\right)^{\frac{2}{3}} \right) - Q_0 = 0 \tag{609}$$

This way however the frame of reference gets lost, so that the solution is physically useless. The observed body moves out off the range of our frame of reference. Then we are concerned with a second, independent frame of reference and have to take up a LORENTZ-transformation for the velocity. In the second case, here is the velocity referred to a point in the distance r from the coordinate-origin, it doesn't look better. Now, we must take up a LORENTZ-transformation for the distance r. However, the associated relation should not be further presented.

This problem appears by the way even in the classic EINSTEIN theory. So, a frame of reference always applies locally only. How large the local area is, depends on the initial conditions.

Now, we want to continue our examinations with the reserve that the results exactly apply only for the moment dt and in the area dr.

6.1.2.1.2. Exact solution

To obtain an exact relation both, for the dilatation-factor as well as for the Q-factor, we first of all try to solve equation (76), at which point we don't regard H as constant this time. Also with other output-conditions we obtain the same result as in section 4.3.2.

Neither with the variation of the integration-constants nor with other methods however it's possible to get a result, which agrees even only approximately with the observations. On the contrary, the results are standing in a glaring contrast to it. The question is, why? Another question is, why are the approximative solutions so approximate to the verity?

The answer is in the physical content of the used equations. The solution of (76) results in a time-function. But we look for a function in dependence from the velocity dr/dt just the first derivative of the way by the time. In (78) except for t is only contained the frequency ω_1. This is a genuine constant admitting only the introduction of an absolute velocity with it (in reference to the empty space), if such a one should exist. Indeed, there is an absolute velocity but only just one, namely the speed of light.

If we just want to determine the function in dependence of another velocity, we first have to define a coordinate-system (frame of reference) and that's exactly our problem. At first, we define a location. A definite longitudinal ruler (r_0) applies at this and also an associated temporal ruler (T). Furthermore, also the associated value ω_0 applies. All these values are tight coupled over the parameter Q_0 (space-temporal coordinate-system). With the definition of the zero, all scales and values are just explicitly defined.

Also in the inverse case, with the definition of Q_0, the frame of reference is explicitly determined. By the way also a fixed value of H belongs to it, i.e. with the definition of a frame of reference one accepts H as constant automatically ($\dot{r}_0/r_0=0$). That is the reason that we could achieve so good results with the solution of (578). To the value Q_0 still belongs a fixed value c_M and the angle θ is fixed explicitly too. Furthermore follows that also the angle α has a fixed value (482).

But we have to consider the limited spatial and temporal range of each frame of reference, mathematically seen actually only for an infinitesimal segment dr and for an infinitesimal time period dt. For a higher Q-factor, the solutions are passable also for larger sections and time periods. For small Q-factors however (high curvature) the relations really apply for dr and dt only. If we want to determine the exact function, we have to integrate over dr and dt. Then however, the result depends on the way covered and the course.

We have proven with it, that we are unable to get a physically useful relation by the solution of (76) and (78). The exact solution rather arises by the application of the fundamentals gained in section 5.1. and 5.2. under consideration of the angular relations. Thereat, we obtain the value of a by substitution of the basic-Q-factor in (482). While the angle α just has a fixed value, the angles γ and δ are dependent on the velocity v. In this connection, the speed-vector **v** points into the same direction as the metric vector $\mathbf{c_M}$. With it, for the angle δ applies for all kinds of photons:

$$\delta = \arcsin\left(\left(\frac{1}{\rho_0\omega_0 t}+\frac{v}{c}\right)\sin\alpha\right) \tag{610}$$

This once again, has effects on frequency and wavelength of photons and neutrinos, which are tightly joined with the angle δ. The angle γ is differently defined for photons and neutrinos just as for their antiparticles:

$\gamma_\gamma = \arg\underline{c} + \arccos\left(\left(\frac{1}{\rho_0\omega_0 t}+\frac{v}{c}\right)\sin\alpha\right)+\frac{\pi}{4}$	Time-like photons	(611)
$\gamma_{\bar\gamma} = -\arg\underline{c} - \arcsin\left(\left(\frac{1}{\rho_0\omega_0 t}+\frac{v}{c}\right)\sin\alpha\right)+\frac{\pi}{4}$	Space-like photons	(612)
$\gamma_\nu = -\arg\underline{c} + \arcsin\left(\left(\frac{1}{\rho_0\omega_0 t}+\frac{v}{c}\right)\cos\alpha\right)-\frac{\pi}{4}$	Neutrinos	(613)
$\gamma_{\bar\nu} = \arg\underline{c} - \arccos\left(\left(\frac{1}{\rho_0\omega_0 t}+\frac{v}{c}\right)\cos\alpha\right)-\frac{\pi}{4}$	Antineutrinos	(614)

6.1.2.2. Relativistic length contraction

In the preceding paragraph, I already implied, that the hitherto obtained solutions are approximative solutions, which are based on the assumption, that the angle α between the photon and the metrics always amounts to $\pi/2$ exactly. If this is not the case, with it also changes the hitherto as unchallengeable considered EINSTEIN expression for the relativistic length contraction. To my apology, I would like to declare here, that the modification results from the basic assumption of this model, namely that the relativistic effects should result from the existence of the metric lattice only macroscopically. In a manner of speaking, we have taken up a „digitalization“ (better quantization) of the space and this leads inevitably to an offset on higher frequencies (velocities). With it, the „guilt“ is at Prof. LANCZOS, which had the idea to this model. To the determination of the exact solution, we first of all assume expression (516), which is correct under acceptance of the validity of the Pythagoras theorem. We reduce this as follows:

$$\beta^{-1} = \sqrt{1-\frac{v^2}{c^2}} \qquad \beta^{-2}c^2 = c^2 - v^2 \tag{615}$$

$$c^2 = \beta^{-2}c^2 + v^2 \tag{616}$$

Wanted now is a new value β with application of the cosine-rule instead of the PYTHAGORAS. Expression (616) must be expanded then as follows:

$$c^2 = \beta^{-2}c^2 + v^2 - 2\beta^{-1}cv\cos\alpha \tag{617}$$

$$\beta^{-2}c^2 - 2\beta^{-1}cv\cos\alpha + (v^2 - c^2) = 0 \tag{618}$$

$$\beta^{-2} - 2\beta^{-1}\frac{v}{c}\cos\alpha - \left(1-\frac{v^2}{c^2}\right) = 0 \tag{619}$$

$$\beta_{1,2}^{-1} = \frac{v}{c}\cos\alpha \pm \sqrt{1-\frac{v^2}{c^2}+\frac{v^2}{c^2}\cos^2\alpha} = \frac{v}{c}\cos\alpha \pm \sqrt{1-\frac{v^2}{c^2}\left(1-\cos^2\alpha\right)} \tag{620}$$

We find a congruity with (479). With it, the positive sign is applied to time-like photons (γ) and neutrinos (ν), the negative to space-like photons ($\bar{\gamma}$) and antineutrinos ($\bar{\nu}$). Expression (620) finally dissolves into the final, corrected version of the EINSTEIN expression for the dilatation-factor β, which now applies also for velocities near c and in very strong gravitational-fields ($\alpha=\alpha_{\gamma,\nu}$):

$$\beta^{-1} = \frac{v}{c}\cos\alpha \pm \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha} \tag{621}$$

Exact expression of the relativistic dilatation-factor

The discovered expression now no longer alone depends on the relative velocity but also from the angle α, which has been established with the definition of the frame of reference. The velocity v is equal to the sum of metric and speed-vector. It applies $\underline{\mathbf{v}}=\underline{\mathbf{v}}_\mathbf{M}+\underline{\mathbf{c}}_\mathbf{M}$ and $v=v_M+c_M$. With the approach:

$$\frac{v_\gamma}{\sin\gamma_\gamma} = \frac{c}{\sin\alpha_\gamma} \qquad \alpha_\nu = \alpha_\gamma - \frac{\pi}{2} \qquad \sin\alpha_\nu = -\cos\alpha_\gamma \tag{622}$$

we get following expressions for the dilatation-factor β ($\alpha=\alpha_\gamma$):

$$\beta_\gamma^{-1} = \frac{v_\gamma}{c} = \frac{\sin\gamma_\gamma}{\sin\alpha} \quad \text{Time-like photons} \qquad \beta_{\bar{\gamma}}^{-1} = \frac{v_{\bar{\gamma}}}{c} = \frac{\sin\gamma_{\bar{\gamma}}}{\sin\alpha} \quad \text{Space-like photons} \tag{623}$$

$$\beta_\nu^{-1} = \frac{v_\nu}{c} = \frac{\sin\gamma_\nu}{-\cos\alpha} \quad \text{Neutrinos} \qquad \beta_{\bar{\nu}}^{-1} = \frac{v_{\bar{\nu}}}{c} = \frac{\sin\gamma_{\bar{\nu}}}{\cos\alpha} \quad \text{Antineutrinos} \tag{624}$$

With it, we have derived the refraction-rule for all types of photons and neutrinos at the same time. That shows, that we are on the right way. The angles can be determined with the help from (482) resp. (611-614). The test results in an exact match with (621) in the case $v=v_M+c_M$. The expressions (623) and (624) correspond to the product of the temporal and geometrical part of the total red-shift (511), as it easily can be verified. The spatial part with the velocity-induced red-shift does not become effective, since it's caused by the motion of the photons through the space (wavelength-gradient). So we can present expression (621) also in the following form:

$$\beta^{-1}_{\gamma,\bar{\gamma}} \;=\; \frac{v}{c}\cos\alpha \;\pm\cos\delta \;\approx\; \pm\cos\delta \qquad (625)$$

$$\beta^{-1}_{\nu,\bar{\nu}} \;=\; \frac{v}{c}\sin\alpha \;\pm\cos\delta \;\approx\; \frac{v}{c}\pm 1 \qquad (626)$$

In this connection, we must be quite careful. The part $v/c\cos\alpha$ namely does not equals the value $\sin\delta$ at all, as one may think with fleeting glimpse. Rather it's about the projection of the speed-vector **v** on the vector $\mathbf{c}_\gamma$, as one can recognize in figure 104 very well:

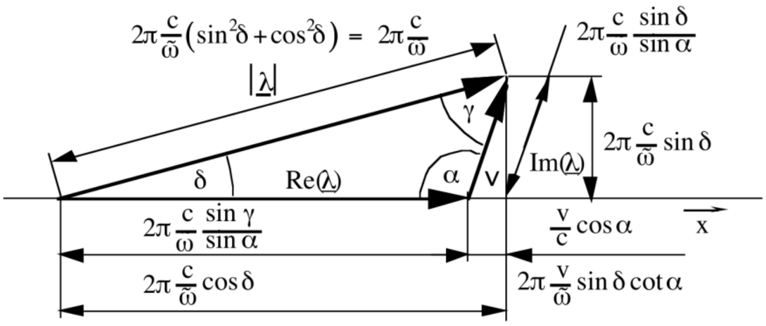


Figure 104
Effect of the relativistic dilatation-factor β

According to the direction of propagation it adds to or subtracts from $\mathbf{c}_\gamma$. Under usual conditions (very high Q-factor) however, the value is extremely small and can be disregarded. Then, only the value $\cos\delta$ d for the photons resp. $\sin\delta$ for the neutrinos remains, which agrees with the phase rate β of the propagation-functions in section 5.3.2.

In order to get an exact solution here, we must expand the corresponding β-values with the expressions $v/c\cos\alpha$ resp. $v/c\sin\alpha$. The course of the function β for time- and space-like photons for a Q-factor $Q_0 > 10^5$ is presented in figure 105.

Here, a contradiction arises with the space-like photons (and fermions) which is based on the observation, that the reciprocal of β is used for them in contrast to the time-like photons and neutrinos, whereas in section 5.3.2. except for a different sign, we got the same expression for the phase rate β for both kinds of photon. How this contradiction can be solved now? In section 5.3. we just had introduced the complex frequency of a time-like photon. Generally, it consists of a real- and imaginary-part:

$$\underline{\omega} \;=\; \omega\left(\cos\delta + j\sin\delta\right) \qquad (627)$$

The tangentially red-shifted frequency however doesn't arise to $\underline{\omega}\beta_\gamma$, as suspected first of all. The reason is, that the relation $c=\lambda\nu$ is not really correct, if we insert the measured values (real-part) for λ and ν. Really, in the theoretical electrotechnics the relation $\lambda=2\pi/\beta$ (β=phase rate) applies. That means, that with the shape of the wavelength becomes effective actually only the imaginary-part of the phase rate, just as it's being observed (real-part). This corresponds to the case that the total-wavelength (amount) is distorted by a certain angle in reference to the propagation direction, exactly as in our model.

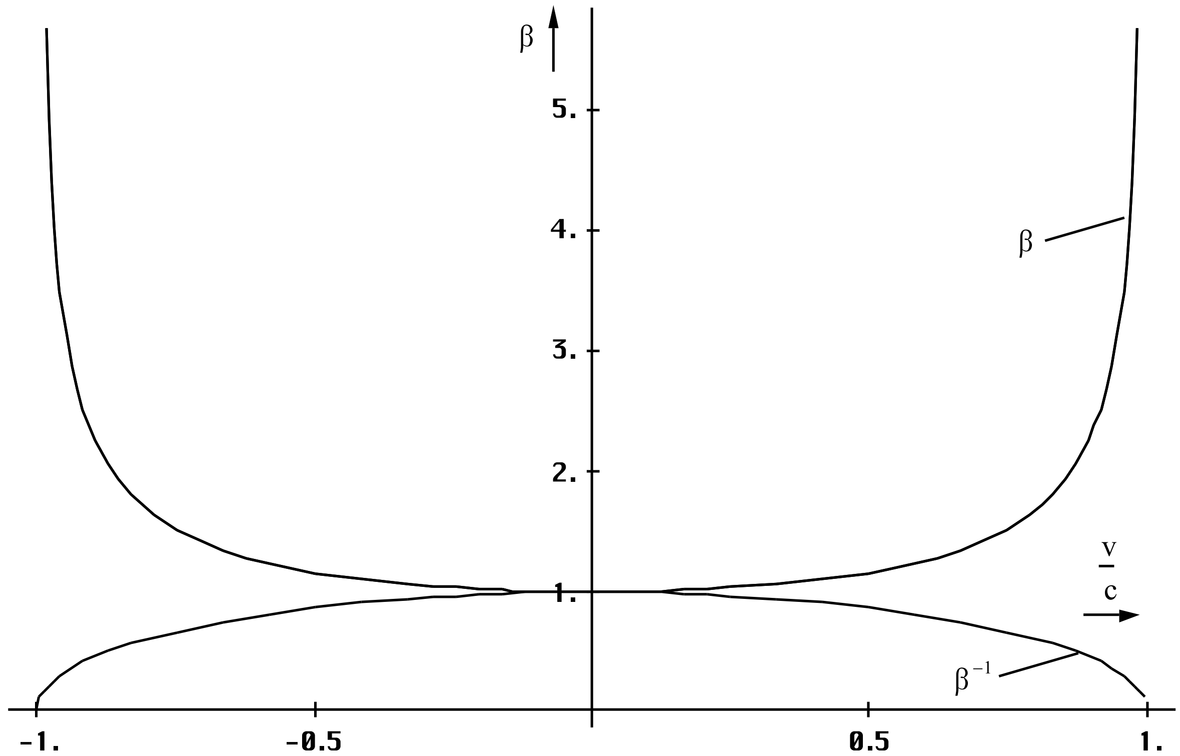


Figure 105
Relativistic dilatation-factor β_γ for time- and space-like photons in comparison with the classic EINSTEIN solution (Q_0>10^5)

Of course, even a complex wavelength of $\underline{\lambda}$ can be defined, the measured wavelength corresponds to the real-part of $\underline{\lambda}$ then, and the first relation is right: $\underline{c}=\underline{\lambda}\cdot\underline{\nu}$ (see figure 104). Then applies:

$$\underline{\lambda} \;=\; 2\pi\frac{c}{\omega}\left(\cos\delta - j\sin\delta\right) \qquad (628)$$

And exactly the space-like photons were the only ones with a negative phase rate, i.e. they move opposite to all other kinds of photon on a space-like vector. The cause that the reciprocal of β becomes effective is the particular characteristic of the exponential-function ($e^{-\gamma r} = 1/e^{\gamma r}$) in connection with the Pythagoras of the trigonometric functions ($\cos^2 x+\sin^2 x=1$). Where is now however the point, at which the relativistic dilatation-factor β applies? This problem had not yet been noticed in the SRT, but it should be known actually.

Expression (628), with regard to the contents, agrees with the relation $\underline{\lambda}=2\pi/\underline{\gamma}$. Obviously, β influences the *amount* of the wavelength-vector $|\underline{\lambda}|=2\pi/|\underline{\gamma}|$ working simultaneously on α and β with it. Since we observe only the real-part of $\underline{\lambda}$, that is the part $2\pi c/\omega \sin\gamma/\sin\alpha$ resp. $2\pi/\omega\,(c\cos\delta - v\sin\delta\cot\alpha)$, presented in figure 104, applies altogether: $\lambda'=\lambda\sin\gamma/\sin\alpha$ (space-like) as well as $\lambda'=\lambda\sin\alpha/\sin\gamma$ (time-like). Both solutions are identical to the expressions $\lambda'=2\pi/\beta(v)$ (space-like) resp. $\lambda'=2\pi\beta(v)$ (time-like). We get the function $\beta(v)$ (phase rate) by substitution of the part of the metric vector c_M by $v=v_M+c_M$ in all expressions including $\Xi(v,r)$ and β That corresponds to the application of the velocity-dependent expressions (610-614) for δ and γ. Since the function $\Xi(v,r)$ already turns out the real-part of ω, we must make a projection for the amount α. We choose the exact space-like vector and not the projection. Expression (532) and the corresponding expressions for neutrinos and antineutrinos would read then as follows:

$$\underline{\gamma}_\gamma \;=\left(\left(\frac{\tilde{H}}{c}+\frac{\tilde{\omega}_0}{c}\Psi(\omega)+\frac{\tilde{\omega}}{c}\frac{\sin\delta\cos\delta}{\sin\gamma}\;\Xi_\gamma(v,r)\right)+j\frac{\tilde{\omega}}{c}\;\Xi_\gamma(v,r)\right)\Phi(\omega) \qquad (629)$$

Both c_M as well as sinα a are stipulated with the definition of the frame of reference. Here, the part ω/c·sinδcosδ/sinγ·Ξγ(v,r) doesn't describe an additional attenuation but a deviating of the wave from the original propagation direction r into the direction of the space-like vector v. It shows, our simple model reaches it's borderline. Therefore we did not defined the propagation-function in section 5.3.2. in {x,y,r,t}, but along the arc r having substituted the real-part for ω. The attenuation rate is equal to zero then and the propagation-function independent from the direction of propagation. For the exact calculation under consideration of the propagation direction, there are essentially more comfortable methods. The most important is the notation in tensorial form (comp. Section 7.2.5. ff).

Since the angle α is extremely close to π/2 in the normal case, it shows no difference to the classic EINSTEIN solution, both graphs cover each other completely. How would this classic solution look for neutrinos however? This shows figure 106:

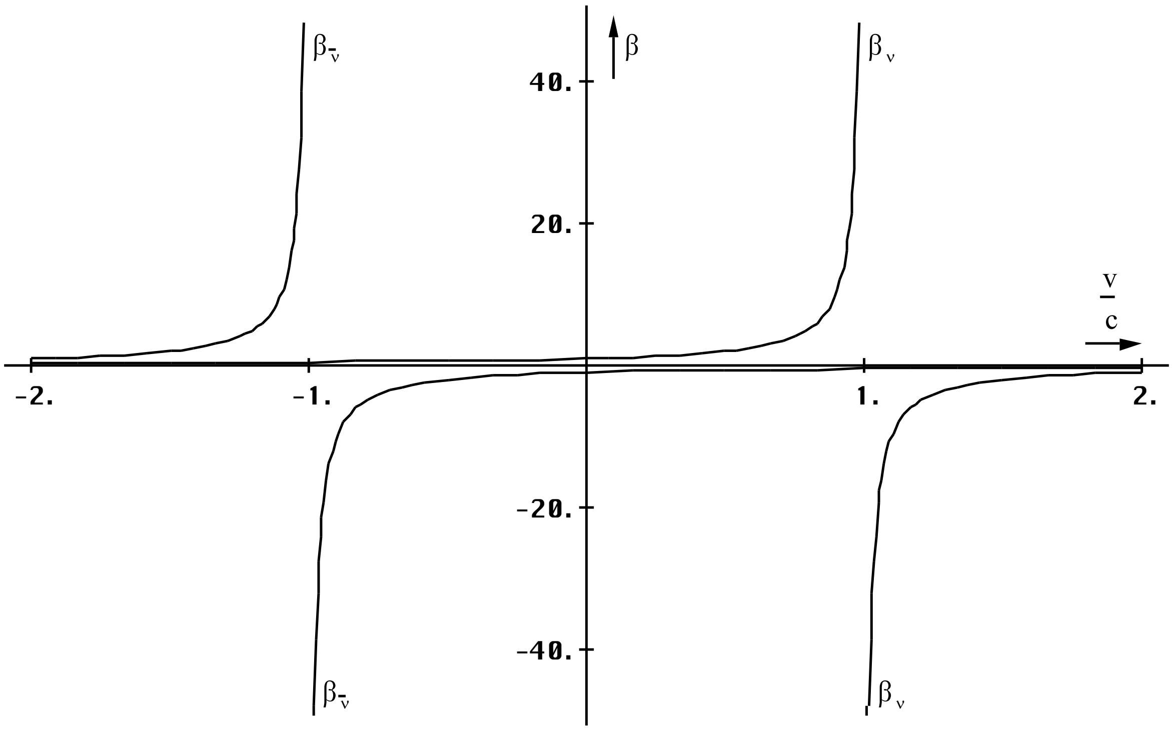


Figure 106
Relativistic dilatation-factor β_α for neutrinos and antineutrinos in comparison with the hypothetical classic solution (Q_0>10^5)

Here, β_ν traces the function v/c+1 resp. v/c–1. With it, also real solutions exist for velocities greater than ±c. But there are differences to the EINSTEIN solution with smaller initial-Q-factors, since the value cosα is different from (near to) zero and sinα≠1. The course of β for the four different kinds of photon and for several smaller Q-factors is presented in figure 107-110. With the time-like photons, we observe the same displacement as already with the approximative solution, however caused by the part c_M at this point. Thereby there's going to be a displacement of the polus in the negative range out of the definition range (real solution), so that the maximum for –v is smaller than infinity. Beyond, the solution becomes complex.

At least, it's just theoretically possible, to jump over the „edge“. On the other hand there is a negative branch behind the polus in the positive range. With extremely small initial-Q-factors there's going to be a rotation around the angle π/2. The photons behave similarly like neutrinos then.

The course of β for space-like photons appears as a (not quite exact) inversion of the conditions with the time-like photons. Even here there is the same displacement into the negative range caused by c_M. The maximum super elevation, different from infinity, is now located at positive velocities. The minor the initial-Q-factor, all the minor the maximum super elevation.

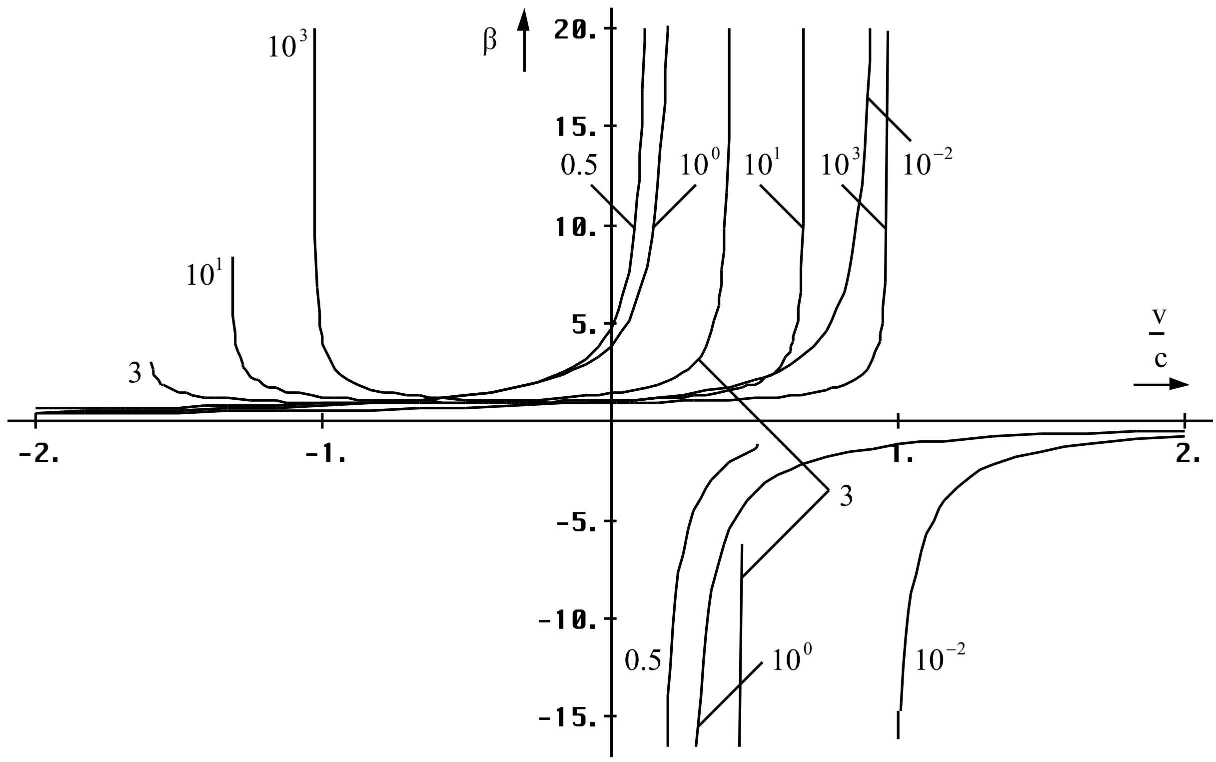


Figure 107
Relativistic dilatation-factor $\beta_\alpha(v)$ for time-like photons for small Q-factors

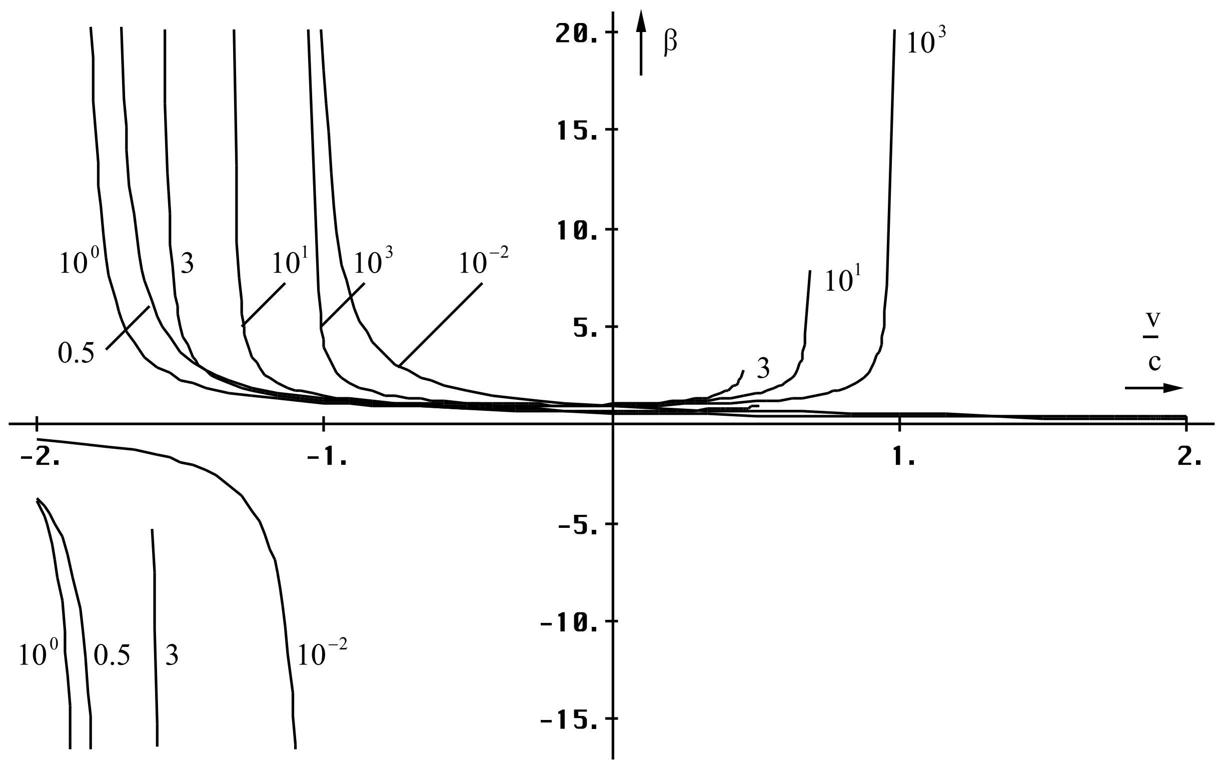


Figure 108
Relativistic dilatation-factor $\beta_\alpha(v)$ for space-like photons

Analogical are the relations for neutrinos and antineutrinos. However, there is no maximal super elevation but only one polus and a sort of minimum. That is the boundary of the real definition range (branch point of 1st order). On very small Q-factors neutrinos behave like photons. Then there is also a maximal super elevation, which coincides with the branch point, (the maximum at the photons is a branching too). We get the location of the polus using $v=c_M+v_M$ by solving the equation:

$$\mp\frac{v}{c}\cos\alpha+\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha} \;=\; 0 \qquad \text{to} \quad v=\pm\left(c-c_M\right) \tag{630}$$

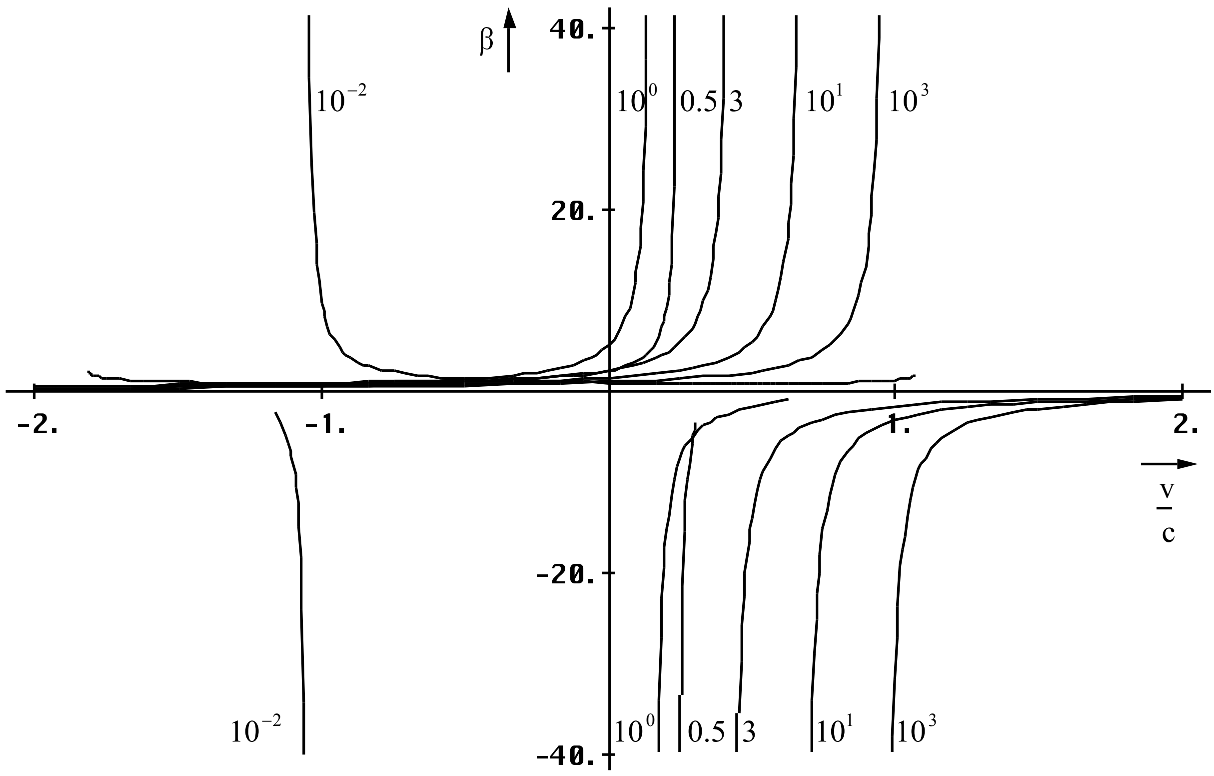


Figure 109
Relativistic dilatation-factor $\beta_\alpha(v)$ for neutrinos

By the way, expression (630) applies even to neutrinos. The maximum super elevation (branching) we find always on the side with opposite sign. The values calculate as follows:

$$\frac{\left(c_M+v_M\right)^2}{c^2}\sin^2\alpha \;=\; 1 \qquad\qquad v=\mp\frac{c}{\sin\alpha}-c_M \tag{631}$$

$$\hat{\beta}_\gamma \;=\; \cot\alpha\mp\frac{c_M}{c}\cos\alpha \quad \text{Photons (Maximum)} \qquad \breve{\beta}_\nu \;=\; \tan\alpha\mp\frac{c_M}{c}\sin\alpha \quad \text{Neutrinos (Branching)} \tag{632}$$

$$\hat{\beta}_\gamma \approx \cot\alpha \;\approx\; \frac{4}{3}\tilde{Q}_0 \qquad\qquad \breve{\beta}_\nu \approx \tan\alpha \;\approx\; \frac{3}{4}\tilde{Q}_0^{-1} \tag{633}$$

Herewith, the upper sign is applied to the time-like, the lower one to the space-like photon. To the comparison, the course of the exact (632) and of the approximative solution (633) for photons is presented in figure 111. It shows, the approximation is good for values down until $Q_0=1$. This would be the relations directly at the SCHWARZSCHILD-radius.

So we have to relativize the good news, that it is possible, to jump over the „edge“ in turn. Indeed the polus in the classic EINSTEIN solution are the reason why it's impossible for a material body to achieve a velocity greater than c. There is, at least theoretically, a chance in this model that this body may overcome the wall with a positive velocity. However, the thereto necessary velocity at the current Q-factor of approximately 10^{60} is so close to c that such a question becomes physically pointless. If we really should be successful in building a spaceship, able to achieve a velocity greater than c, the temporal dilatation up to the achievement of this point would be so large, that, even if it should last only one second for the passengers, on the earth would have passed a time period greater than the present age.

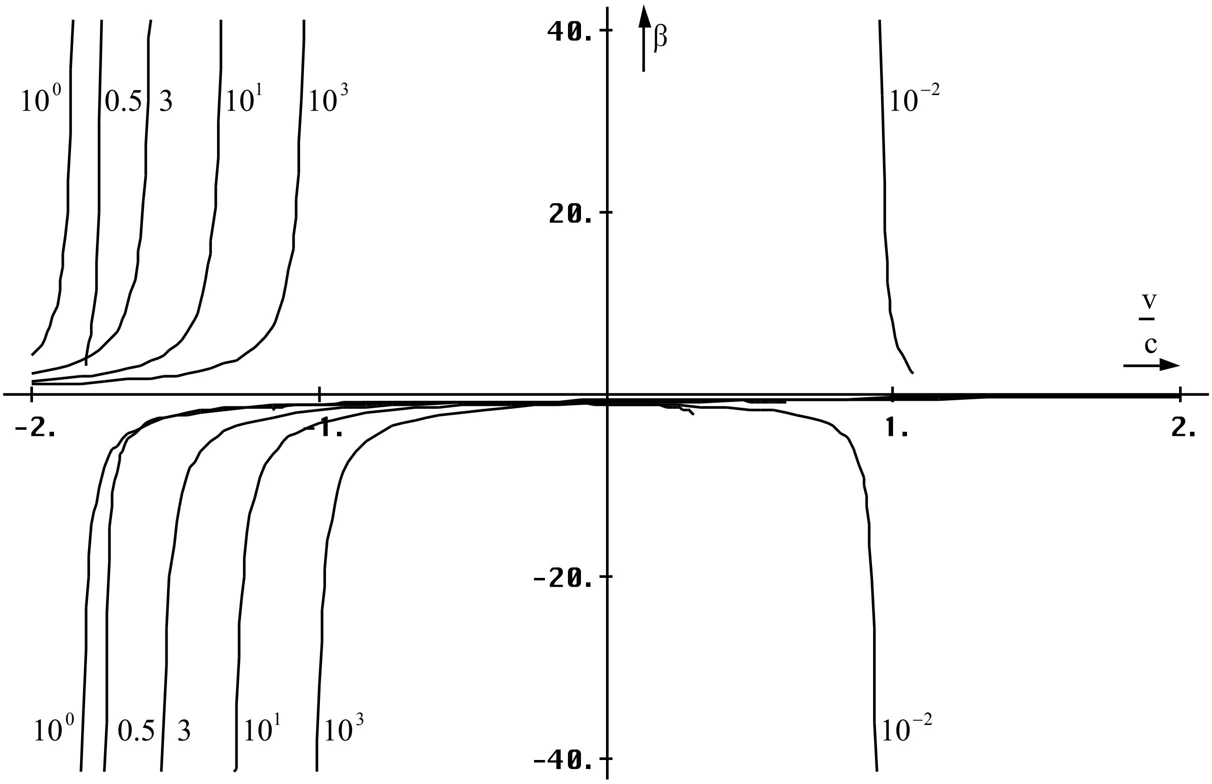


Figure 110
Relativistic dilatation-factor $\beta_\alpha(v)$ for antineutrinos

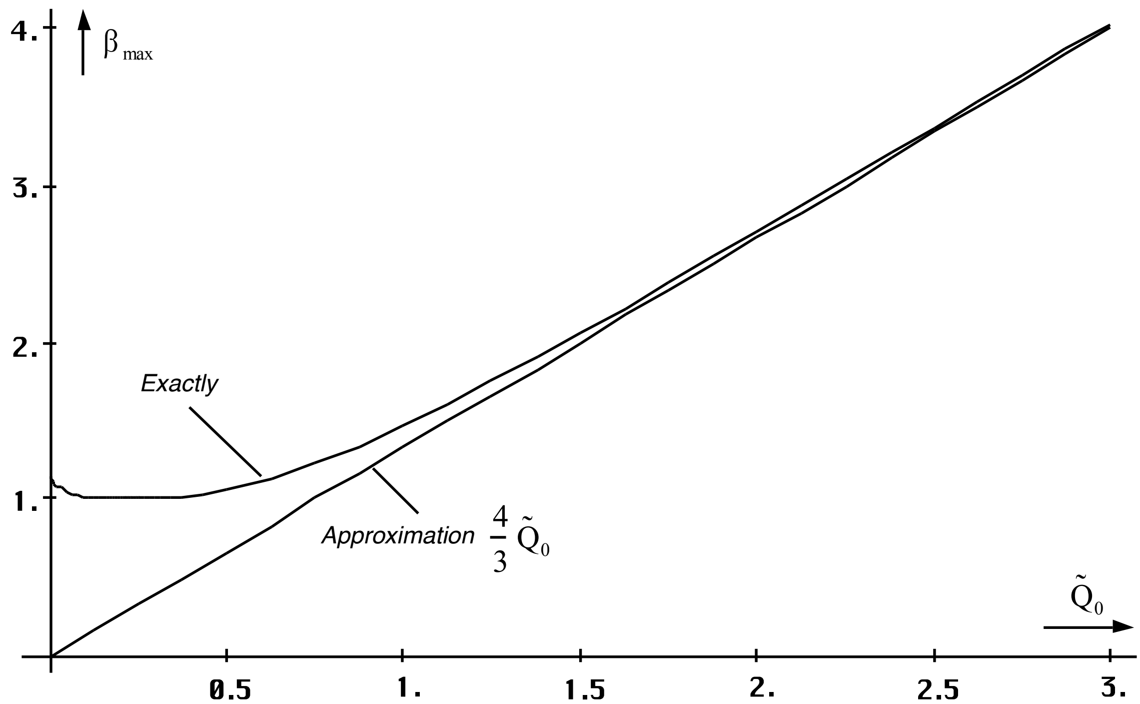


Figure 111
Exact course and approximation for the maximum super elevation β at the time- and space-like photon

At a possible return, one would not find the earth. Even, there would be problems with the propulsion, specifically when braking. A photon-drive would turn into a neutrino-drive, which shows no action. They just should have to take along an additional antineutrino-drive in order to achieve a retardation.

What does a negative or complex solution mean for β then again? If a negative solution appears, the wave executes a phase-jump and the frequency becomes negative. In the conducting-theory, this is synonymous with a negative phase velocity. The wave propagates into the opposite direction then, a time-like photon turns into a space-like one, a neutrino turns into an antineutrino and vice-versa. But the frame of reference remains still intact, we can receive an action from the moved signal-source. In contrast, a complex solution means the breakdown of the frame of reference, i.e. a LORENTZ-transformation is no longer possible. That however also means that there is no more causal correlation between source and observer.

At the end, it should still be pointed out that the tangential part of the time-like photon (rotation of the direction of polarization) is subject to the doppler shift too — a fact, which easily should can be demonstrated by experiments. A circularly polarized wave turns into an elliptically polarized one. With it, the relations are essentially more complicated than usually presented in literature. Popularly, an „ideal“, purely horizontally or vertically polarized wave is assumed without attenuation, which doesn't exist. The proof is the existence of the cosmologic red-shift, which doesn't have stated this way.

Therefore, I would not like to deepen the contemplations more in this direction, but rather encourage a discussion in that I imply only popularly, what the physical content of a complex solution could mean. We get a complex solution, if the root-expression becomes negative or if the argument of arcsin as well as arccos becomes greater than one. Then, e.g. a complex solution for $\beta = \operatorname{cosec}\gamma = a + jb$ with $b > a$ turns out and it applies:

$$\frac{\lambda}{\sin\gamma} = \tilde{\lambda}\left(a + jb\right) \qquad (634)$$

While both parts of λ are only stretched with a real solution, an additional rotation of the wavelength-vector around the angle arctan(b/a) occurs with a complex solution. Since this however contains an however small imaginary part, so there is still a certain real part after multiplication with j, which also should can be detected, unless the energy vanishes in the noise. Then, the energy $\hbar\underline{\omega}$ splits into a real and into an imaginary part, at which point only the real-part is able to perform work.

The imaginary part is the equivalent to the blind power (ask your electrician). Since $b > a$ applies the photon now behaves like a neutrino, which is just hardly detectable as you know. But there is a chance of detection with the help of the weak interaction. With it, the causality-principle is violated.

Now, what's the accordance like between our exact and the approximative solution found in the previous section? I have checked that. The course of the approximation agrees with the exact solution downward until about $Q_0 = 10^5$ However, the approximation has two instead of one maximum and the value is too small. If we use the sum $c_M + v$ instead of v, there is another good accordance downward until $Q_0 = 10^3$.

Furthermore, we are interested in the relation to the classic EINSTEIN solution. For that purpose first let's have a look at the square of the classic dilatation-factor β:

$$\beta^2 = \left(1 - \frac{v^2}{c^2}\right)^{-1} \qquad (635)$$

To assume idealized conditions, this expression can be combined in the following manner:

$$\beta^2 = -\left(+\sqrt{1-\frac{v^2}{c^2}}\right)^{-1}\left(-\sqrt{1-\frac{v^2}{c^2}}\right)^{-1} = -\beta_\gamma\beta_{\bar\gamma} \qquad \alpha = \frac{\pi}{2} \tag{636}$$

$$\beta^2 = -\left(\frac{v}{c}+1\right)^{-1}\left(\frac{v}{c}-1\right)^{-1} = -\beta_\nu\beta_{\bar\nu} \qquad \alpha = 0 \tag{637}$$

According to the rigid EINSTEIN expression, there is actually no difference between time-like and space-like photons, adsum it's only the sign. And which rule applies to the neutrinos, just can be suspected only. We are glad, if we are able to detect some of them at all. We however can assume, that (622) applies. After all, we have succeeded in finding a new inherent law:

$$\beta^2 = -\beta_x\beta_{\bar x} = \left(1-\frac{v^2}{c^2}\right)^{-1} \qquad x = \gamma, \nu \tag{638}$$

The classic value β represents the geometric mean of the dilatation-factor of particles and antiparticles with it. We check further:

$$\beta^2 = -\left(\frac{v}{c}\cos\alpha+\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}\right)^{-1}\left(\frac{v}{c}\cos\alpha-\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}\right)^{-1} \tag{639}$$

$$\beta^2 = -\left(\frac{v^2}{c^2}\left(\sin^2\alpha+\cos^2\alpha\right)-1\right)^{-1} = \left(1-\frac{v^2}{c^2}\right)^{-1} \tag{640}$$

Expression (638) which we have gotten with the help of the approximation, applies exactly with it. Still remains to examine, whether it is possible to find a simplification of the calculation of $\sin\gamma$, which makes it possible to reduce the number of values to be calculated, e.g. to replace one or several values with another, as we have done it successfully with the angle α. An exact examination of (614) immediately leads to the result:

$$\sin\gamma_{\bar\gamma}(v) = -\sin\gamma_\gamma(-2c_M - v) \quad \text{and} \quad \sin\gamma_{\bar\nu}(v) = -\sin\gamma_\nu(-2c_M - v) \tag{641}$$

The angle α just cancels out. It has been successful with it to reduce the number of values to be calculated more and more. Furthermore we have proven, that antiparticles move opposite to particles. Finally, we want to specify the relations for the relativistic length-contraction referred to the real-part of the (wave-)length once again:

$$x' = x\sin\gamma_{\bar\gamma}\operatorname{cosec}\alpha \qquad \text{Space-like photons + fermions} \tag{642}$$

Herewith we have accepted on the quiet, that even a macroscopic body can be observed warped in reference to the metrics, of course not in total, but as the sum of the particles of which it consists. And these particles are described by, although special, wave-functions. What else should the relativistic length contraction occur then? Solution (640) and the following are applied to $\beta \in R$, at which point R represents the multitude of the real numbers. For „usual" wavelengths other relations apply. Without consideration of the doppler shift applies:

$$\lambda' = \lambda\operatorname{cosec}\gamma_\gamma\sin\alpha \qquad \text{Time-like photons (photons)} \tag{643}$$

$$\lambda' = -\lambda\operatorname{cosec}\gamma_\nu\cos\alpha \qquad \text{Neutrinos} \tag{644}$$

$$\lambda' = \lambda\operatorname{cosec}\gamma_{\bar\nu}\cos\alpha \qquad \text{Antineutrinos} \tag{645}$$

The expressions (642) until (645) in all represent the temporal part of the relativistic red-shift, the so-called radial doppler shift, which appears, when the signal incidents/is emitted in the right angle to the direction of motion, plus geometrical share (perspective). With axial/-r incidence/emission the share of the axial doppler shift comes into addition, at which we want to have a look in the next section.

6.1.2.3. The relativistic doppler shift

In principle there is the doppler shift only in the cases (643) until (645), since space-like photons don't propagate, they are only moved. Furthermore we have to distinguish the case the source is approaching (–v) and that it's moving away from the observer (+v). Generally, the second case is considered, namely that where the source is moving away. Alternatively, we just have to employ a negative velocity v. We even only want to examine the purely axial doppler shift, since all other cases can be split into a radial and axial vector. According to the classic view applies generally:

$$\lambda' = \lambda \frac{1+\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}} = \lambda \left(\frac{1+\frac{v}{c}}{1-\frac{v}{c}} \right)^{\frac{1}{2}} \tag{646}$$

The bracketed expression is called k-factor by the way. The root-expression represents the radial share. This is always a red-shift. Therefore, the root-expression is even always in the denominator. The signal reaches the observer in a manner of speaking „from the back around the corner".

We want now to derive the exact expressions for photon, neutrino and antineutrino. For one thing, we have to replace the root-expression in (646) by the exact expression (621). This is however not yet the final solution:

$$\lambda' = \lambda \frac{1+\frac{v}{c}}{\frac{v}{c}\cos\alpha_\gamma + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\gamma}} \tag{647}$$

The reason is, that our photon should behave like a neutrino with higher velocities. Furthermore, the expression (647) cannot be correct, since the angle a doesn't appear in the numerator. But since the wavelength-vector is distorted in reference to the metrics about a certain angle, which draws attention to itself at the transversal doppler shift, also the radial share must be concerned, since it's oriented to it in the angle π/2 precisely.

Just an expression is wanted to avoid this dilemma, turning out expression (646) in the case of smaller velocities. To neutrinos, the following approximation is applied in the case of smaller velocities (cosα is always negative):

$$\frac{v}{c}\cos\alpha_\nu + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\nu} \approx -\frac{v}{c} + \sqrt{1-\frac{v^2}{c^2}0} = 1-\frac{v}{c} \qquad \text{Neutrinos} \tag{648}$$

$$\frac{v}{c}\cos\alpha_\nu - \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\nu} \approx -\frac{v}{c} - \sqrt{1-\frac{v^2}{c^2}0} = -\left(1+\frac{v}{c}\right) \qquad \text{Antineutrinos} \tag{649}$$

But the second expression is exactly equal to the expression in the numerator of (649). We now suspect that the numerator exactly equals the left part of (649). Then the measured wavelength is equal to the wavelength in the rest-condition, multiplied with the quotient of the extension-factor of the imaginary-part and the one of the real-part of the wavelength. Our problem would have been solved with it. The expression for time-like photons reads then exactly:

$$\lambda'_{\gamma} = -\lambda_{\gamma} \frac{\frac{v}{c}\cos\alpha_{\nu} - \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_{\nu}}}{\frac{v}{c}\cos\alpha_{\gamma} + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_{\gamma}}} \qquad \text{Photons} \qquad (650)$$

This corresponds to the temporal and perspective share in total. With it, expression (650) is already identical to the exact solution, which can be read also as follows:

$$\lambda' = -\lambda \frac{\beta_{\gamma}}{\beta_{\bar{\nu}}} = -\lambda \frac{\sin\gamma_{\bar{\nu}} \sin\alpha}{\sin\gamma_{\gamma} \cos\alpha} = -\lambda \frac{\sin\gamma_{\bar{\nu}}}{\sin\gamma_{\gamma}} \tan\alpha \qquad \text{Photons} \qquad (651)$$

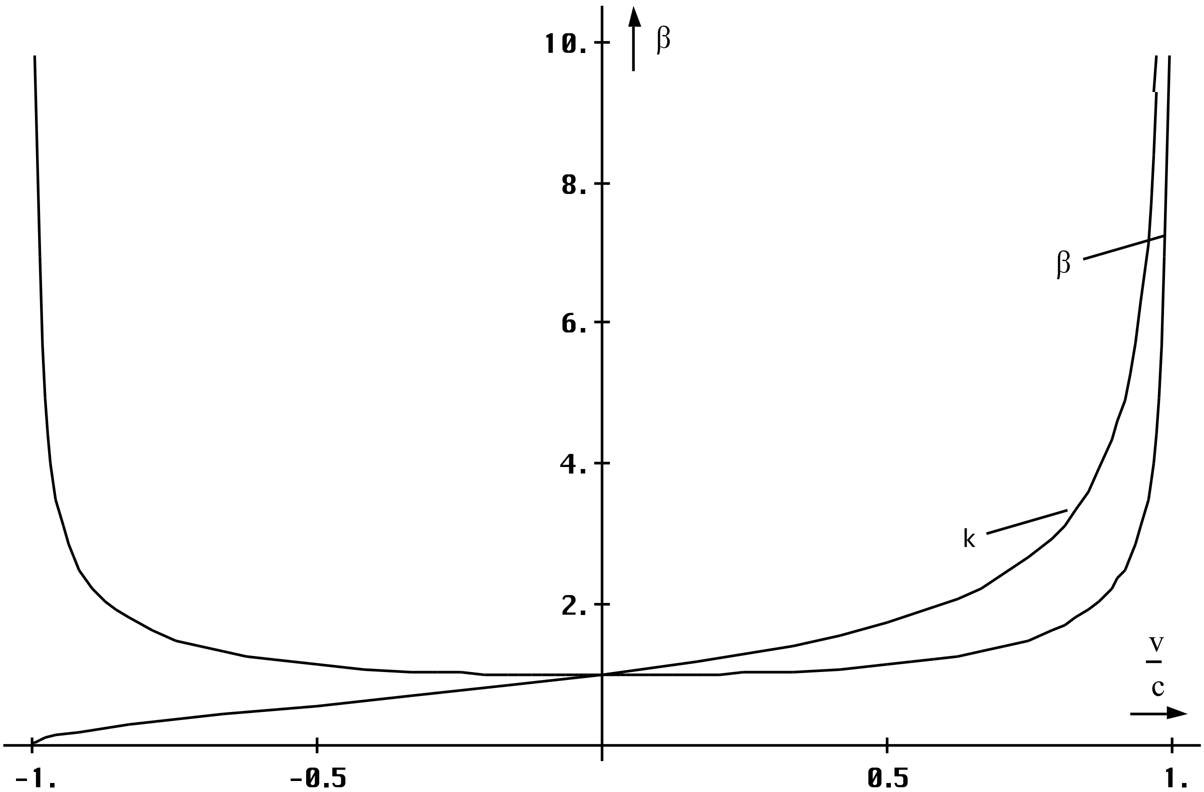


Figure 112
Ratio between k-factor and relativistic
dilatation-factor β classic and model-solution $Q_0>10^5$

In this case, λ is the wavelength of the zero-vector and λ′ the real-part of the complex wavelength-vector, i.e. the value, which is measured. For the neutrino and antineutrino similar relations can be found. Here, we however want to figure only the trigonometrical expressions according to (552):

$$\lambda' = \lambda \frac{\beta_{\nu}}{\beta_{\bar{\gamma}}} = -\lambda \frac{\sin\gamma_{\bar{\gamma}} \cos\alpha}{\sin\gamma_{\nu} \sin\alpha} = -\lambda \frac{\sin\gamma_{\bar{\gamma}}}{\sin\gamma_{\nu}} \cot\alpha \qquad \text{Neutrinos} \qquad (652)$$

$$\lambda' = \lambda \frac{\beta_{\bar{\nu}}}{\beta_{\gamma}} = \lambda \frac{\sin\gamma_{\gamma} \cos\alpha}{\sin\gamma_{\bar{\nu}} \sin\alpha} = \lambda \frac{\sin\gamma_{\gamma}}{\sin\gamma_{\bar{\nu}}} \cot\alpha \qquad \text{Antineutrinos} \qquad (653)$$

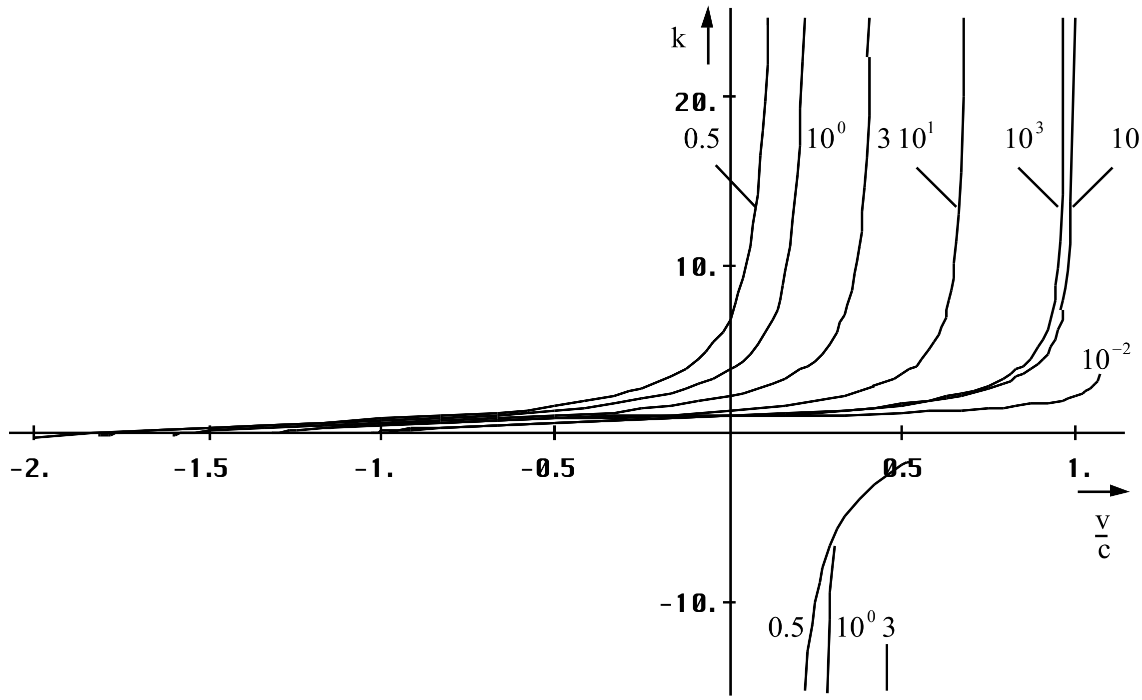


Figure 113
Relativistic doppler shift (wavelength) of the
time-like photons and neutrinos at a Q-factor of $Q<10^5$

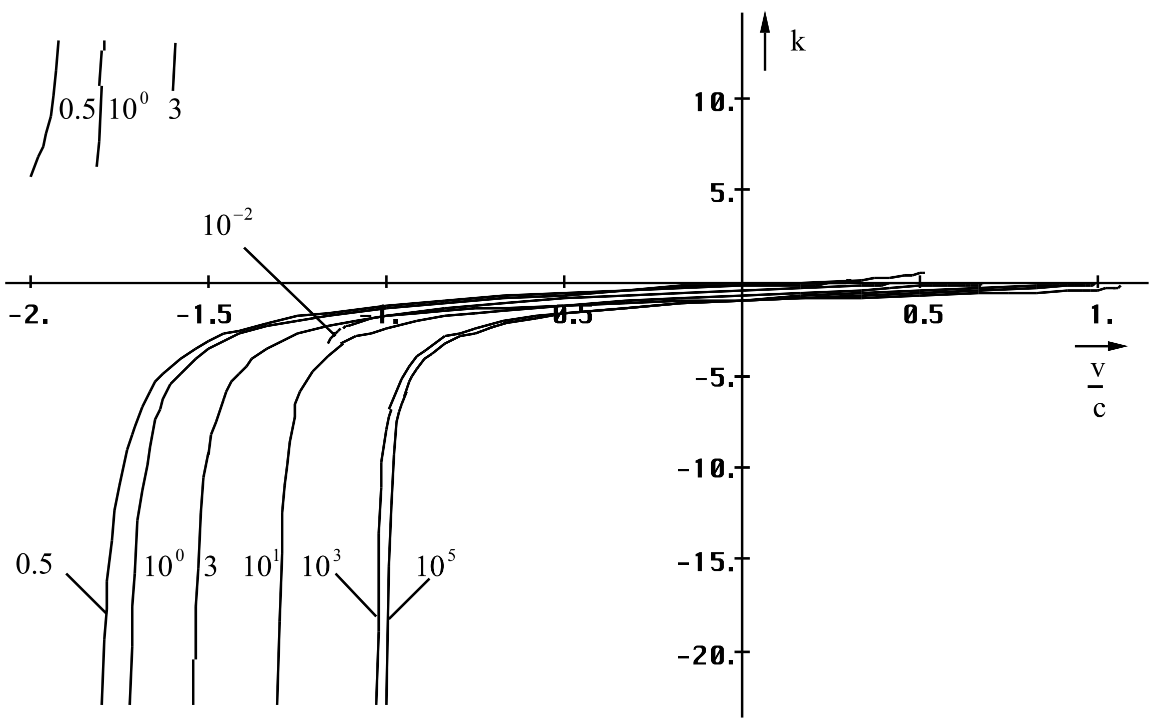


Figure 114
Relativistic doppler shift (wavelength)
of the antineutrinos at a Q-factor of $Q<10^5$

The idealized course for time-like photons and the two kinds of neutrino is presented in figure 112. It shows the graph for $Q_0 > 10^5$, which covers the classic k-factor, in comparison with the classic expression β.

Figure 113 and 114 show the relations for smaller initial-Q-factors. The function-course for time-like photons and neutrinos is identical, the one for antineutrinos mirrored in x and y. With somewhat good will, one also recognizes the asymmetry caused by the share H/c.

There is no expression for space-like photons for the known reasons. In terms of figures, this also exists of course. Then, it's identical to that one of the anti-neutrinos. But it has no physical meaning anyway. With it, we have explicitly characterized the relativistic doppler shift. As next, we want to have a look at the relativistic temporal dilatation.

6.1.3. Velocity and time

The fundamentals to this subject we have already formulated in principle in the preceding section. It applies [30]: If a body (system S´) is moving relatively to another with a definite velocity v, so the time t passes for him more slowly (in reference to the rest-system S). If he now observes a process, which has the duration of t in the rest-system S, so the time period has the duration t´ for him (system S´):

$$t' = t \operatorname{cosec} \gamma_{\gamma} \sin\alpha \qquad \text{Relativistic temporal dilatation} \qquad (654)$$

t´ is essentially longer than T. for him. The occurrence of the expression β_{γ} already shows that the observation takes place by means of photons. That means, that even the temporal vector is observed skewed about a certain angle in reference to the metrics (space-time), exactly as the wavelength. Because it's about a space-temporal coordinate-system, this is no further remarkable.

We can recall the temporal dilatation even like that: The observed photons have a certain wavelength. If we mark the start and the end on the ray of light (e.g. by a short intermission), the moved observer would receive the ray with a larger wavelength because of the red-shift (at this point only the transversal, time-like doppler shift is regarded). Since the wave count and even c are constant, it lasts of course longer, until the observer receives the second pause.

If we would observe the process by means of neutrinos (if possible), we would have to insert β_{ν} here obtaining and measuring a duration different from t´.

6.1.4. Velocity and mass

The dependence of the mass of the relative-velocity is an indisputable fact and is secured by a lot of experiments and applications. According to the classic theory (SRT) following applies [30]: We look at a body with the rest mass m_0 in the coordinate-system S (with the determination of the rest mass we have automatically accepted the coordinate-system). If we now accelerate this body to the velocity v in reference to S, so it now has the mass:

$$m = m_0 \operatorname{cosec} \gamma_{\bar{\gamma}} \sin\alpha \qquad \text{Relativistic mass increase} \qquad (655)$$

I have already put in the value $\beta_{\bar{\gamma}}$ in this place, since the body consists of a specific layout of fermions, which interact with the metrics with the help of space-like photons. Therefore, the inert mass would be the resistance, with which the metrics counters a body during acceleration.

The greater the energy of the space-like photons, all the greater the resistance. With it, the inert mass and even the gravitating mass obey the inherent laws of the space-like photons.

If we accept this, we accept the existence of negative, just even imaginary masses at the same time. Negative masses would attract each other just as positive ones. As far as their character goes, they would have to be assigned to the antimatter. In contrast, two bodies, the first made from „normal“ matter, the second from antimatter would repel each other. Negative masses would have also a negative energy. If we would define the energy m_0c^2 as the difference-energy to the energy of the metric wave-field (like in section 4.6.4.2.5.), this would be quite possible. With the definition of the frame of reference, we commit a fixed value for $\hbar\omega_0$ and with it also for the difference to the energy of the particle, that means the rest mass.

What does it look like with imaginary masses then again? If we accept an imaginary frequency $\underline{\omega}$, we must accept also the existence of imaginary masses and the acceptance of imaginary masses implies the existence of negative masses automatically. An imaginary mass for example, would be the imaginary part of the energy $\hbar\underline{\omega}$ of an electromagnetic wave, at which we look from the side, twisted about a certain angle. Since it's about an energy-form at this point, which is impossible to perform any work, an imaginary mass wouldn't wield any force-action respectively be subject to a force-action. Neutrinos and antineutrinos own a high ratio of imaginary mass $\hbar\mathrm{Im}(\underline{\omega})/c^2$ (the rest mass is zero or better $\hbar H/c^2$). Since there is still an, although microscopic, real-part, neutrinos can even only propagate with light speed. They are just no tachyons.

Now, one should think, expression (655) would already be the correct, exact solution. But this statement is not yet unique. So (655) only corresponds to the product of temporal and geometrical part. With wavelengths and time periods, it is easily to be understood that these only are subject to the temporal and geometrical share of the red-shift, whereas the spatial share is specified by the definition of the coordinate-system. Whether it's the same with the mass, we want to examine as next.

We have already noticed that the fermionic matter owns wave properties, the so-called DEBROGLIE-matter-waves. Of course, these are also subject to the red-shift then, be it the cosmologic red-shift or the one, caused by a relative-velocity. Starting from (348), with a temperature T=0 of the metric radiation-field, we acquire the fundamental expression:

$$W = \hbar\omega = mc^2 \qquad \text{resp.} \qquad m = \frac{\hbar\omega}{c^2} \tag{656}$$

In section 4.6.4.2.3. we had determined that the frequency ω is proportional $Q_0^{-3/2}$ (approximatively). A comparison with (521) immediately leads to the solution:

$$m \overset{?}{\approx} \frac{\hbar\tilde{\omega}}{c^2}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} = m_0\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} \approx m_0\frac{\sin\alpha}{\sin\gamma_{\dot{\gamma}}} = m_0\beta_{\bar{\gamma}} \tag{657}$$

If we insert the exact expression $\beta_{\bar{\gamma}}$ and for v the sum $v=v_M+c_M$ in exchange, the result is not yet identical to the one, found in section 4.6.4.1. The PLANCK's quantity of action namely is also a function of Q_0 according to this model. It applies $\hbar\sim Q_0^{-1}$. With it, we get in total the expression for the energetic red-shift $W\sim Q_0^{-5/2}$, as already found during the examination of the cosmic background-radiation:

$$m \approx \frac{\hbar\tilde{\omega}}{c^2}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}} = m_0\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}} \approx \frac{m_0}{\sqrt[3]{1-\frac{v^2}{c^2}}}\frac{\sin\alpha}{\sin\gamma_{\bar{\gamma}}} = m_0\beta^{\frac{2}{3}}\beta_{\bar{\gamma}} \tag{658}$$

If we just regard the PLANCK's quantity of action as variable, the mass would be proportional $Q_0^{-5/2}$, then, which is easily to accept. The „difference" of Q_0^{-1} however exactly equals the spatial share of the red-shift. The navigation-gradient and the magnitude of $\hbar$ is dependent on the frame of reference. We have proven with it, that only the product of temporal and geometrical share comes into effect for the mass within a frame of reference.

The spatial share is considered with the definition of the frame of reference. Cosmological seen, all natural bodies are located along r in the free fall, so that they don't move in reference to the metrics (v=0), as we will already see, whereby v is the velocity in reference to the metrics. The right-hand bracketed expression in the navigation-gradient is dropped completely then and we get for the mass:

$$m = m_0 \frac{\sin\alpha}{\sin\gamma_{\dot{\gamma}}} \left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{1}{\tilde{R}}\int \mathbf{v}\,dt\right)^{\frac{2}{3}} \right)^{-1} = m_0 \frac{\sin\alpha}{\sin\gamma_{\dot{\gamma}}} \left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}}_{v=0} \tag{659}$$

Here, a thought Cartesian coordinate-system applies outside the metrics and the angle γ is not constant. We have used such a coordinate-system in order to define the qualities of the metrics.

What means however a non constant PLANCK's quantity of action for the physical rules? If we assume $\hbar$ to be no constant, on the basis of the definition of $\hbar$ (37) the charge and the magnetic flux would be no constants too. The same is applied even to the electron charge then.

$$\hbar = q_0\varphi_0 \sim Q_0^{-\frac{2}{2}} \quad \rightarrow \quad q_0 \sim Q_0^{-\frac{1}{2}} \quad \varphi_0 \sim Q_0^{-\frac{1}{2}} \tag{660}$$

Similarly, the relations are with the gravitating mass (gravitative attraction), since the gravitational-constant is dependent from the frame of reference too. See section 6.2.4. for details. The universal action to the physical inherent laws shall be examined on the basis of a simple example, the HEISENBERG's uncertainty principle. As well m, as λ are subject to a red-shift thereat:

$$\Delta(mv)\cdot\Delta\lambda \geq \frac{\hbar}{2} \tag{661}$$

$$\beta\Delta(mv)\cdot\beta^{-1}\Delta\lambda \geq \frac{\hbar}{2} \tag{662}$$

$$\Delta(mv)\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}}\cdot\Delta\lambda\left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{3}{2}} \geq \frac{\hbar}{2} \qquad \text{Classically} \tag{663}$$

$$\Delta(mv)\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}}\cdot\Delta\lambda\left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{3}{2}} \geq \frac{\hbar}{2}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{2}{2}} \qquad \text{Really} \tag{664}$$

With it, the electrons e.g. in a particle-accelerator (see section 6.2.2) are, in terms of quantity, subject to completely different physical rules, as hitherto assumed. The measurable result however agrees with the classic model, i.e. the changes cancel each other, since as well mass, length and PLANCK's quantity of action are depending on the frame of reference. That means an observer sees, even quantitatively, always the same physical rules, independently from the frame of reference. As a consequence, we also have to revise the statements concerning the uncertainty of place and impulse of electrons in the time just after big bang, made in section 4.6.4.1.2. There, we had assumed a constant mass for the electron.

This however ascends about the factor $Q_0^{-5/2}$ the more we draw near the point of time t=0, so that the uncertainty of that time would have had the same value as nowadays. Finally, we can make the following statement:

> *VII. Regarding the PLANCK's quantity of action as variable, one observes the same as by analogy with the classic model, since also values like charge and magnetic flux are no longer constants then and the changes cancel out.*

Well, if we don't exactly want to formulate a gravitational-theory or to explain the cosmologic red-shift, we can lean back comfortably leaving the PLANCK's quantity of action a constant, and we will obtain the regular results nevertheless.

6.1.5. Velocity and other values

In the preceding sections, we have seen that values like length, time and mass depend as well on the velocity as on the frame of reference. Furthermore, we have noticed that other values, like e.g. charge and flux depend on the frame of reference only. This dependence is caused by the spatial share of the red-shift and corresponds to the navigation-gradient at the fermions. But these values also depend on time and the distance to the coordinate-origin and thus indirectly on the velocity (integral) with it. For the charge applies e.g.:

$$q_0 = \tilde{q}_0 \left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \right)^{-\frac{1}{2}} = \tilde{q}_0 \left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2}{\tilde{R}}\int \mathbf{v}dt\right)^{\frac{2}{3}} \right)^{-\frac{1}{2}} \qquad (665)$$

This corresponds to the dependence of Q_0 (660) and applies precisely. If we for example want to transform the charge from one to another frame of reference (LORENTZ-transformation), in contrast to the prevailing opinion $q_0 \sim Q_0^{1/2} \sim \beta^{1/3}$. applies. In this connection, β is the classic relativistic dilatation-factor. However, the charge and flux-increase is balanced by an additional mass-increase of the same magnitude in turn, so that we observe the same, as if q_0 and φ_0 would be invariant in reference to LORENTZ-transformations and it applies $m \sim \beta$.

Thus however, even other values, as e.g. voltage and current depend on the frame of reference. By application of relations like $q=C\cdot U=\varepsilon_0 r\cdot U$ and $\varphi=L\cdot I=\mu_0 r\cdot I$ one gets the following subjections: $U \sim Q_0^{-3/2} \sim \beta$ and $I \sim Q_0^{-3/2} \sim \beta$. In the normal case however, all these values can be considered as constants.

The electron charge forms a special case. For one thing, this depends also on the frame of reference and traces the value of q_0. On very high velocities (near c) and/or small Q-factors there is however another additional dependence on the velocity. Let's have a look at this in the next section.

6.2. Physical quantities of special importance

Hence, we want to continue this work with the examination of physical constants, that has large influence on the construction of our world. One of these is SOMMERFELD's fine-structure-constant.

6.2.1. The fine-structure-constant

The fine-structure-constant a is α characteristic fundamental quantity of DIRAC's theory of the electron. It is a measure for the strength of electromagnetic interaction, i.e. for the coupling of loaded subatomic particles with photons. According to [5] it is defined as follows:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137.038} = \frac{1}{4\pi}\cdot 0.0917 = 0.007297 \qquad (666)$$

e is the electron charge in this case. The fine-structure-constant has been well proven with the description of the decomposition of the atom-spectra (Lamb-Shift) yet. Also, it is used to explain the dissent between spin and magnetic moment, as it appears with the electron. Now we want to see, whether there is not hidden another essential, more fundamental legality behind expression (666).

It is obviously opportune to calculate on the interaction of electrons or protons with photons with the electron charge. In section 4.6.3 however we have noticed that there is another second charge, namely the charge of the ball-capacitor in the MLE q_0, which is with 3.301378 e near that value (350).

With a constant, it has no influence on the physical content in general, to multiply it with another constant. It's about time to try, what happens, if we would substitute the electron charge in (666) with q_0:

$$\alpha_0 = \frac{q_0^2}{4\pi\varepsilon_0\hbar c} = \frac{\hbar}{4\pi\varepsilon_0 c\hbar Z_0} = \frac{1}{4\pi} \qquad q_0 = \sqrt{\frac{\hbar}{Z_0}} \qquad (667)$$

We have uncovered the nature of SOMMERFELD's fine-structure-constant with it. Following clear statement applies:

VIII. The SOMMERFELD fine-structure-constant is the square ratio of electron charge and charge of the MINKOVSKIan line-element multiplied with a geometrical factor.

The geometrical factor corresponds to the full space-angle of 1sr and is equal to the factor applied on the calculation of the surface of a ball. This is not further remarkable, have we to do it here with the mutual interaction of two different solutions of the field-equations after all. The first one is the electron (ball), that second one the photon (wave/cube).

We have uncovered the nature of the fine-structure-constant with it indeed, but it turns out a new question, that we have already asked in the course of this work:

1. *Why does the electron charge just amount to 0.302822 q_0?*

This is however not yet everything. From this question and the assumption, that PLANCK's quantity of action is not a constant, arise a row of more questions:

2. *Is the ratio constant between both? If yes, why?*
3. *If no or don't know:*
   Is it a coincidence that the electron charge is close to q_0 today of all days?
4. *According to which legality does the value of the fine-structure-constant change or does it remain constant?*
5. *Which effects does it have on other areas of the physics (atomic-model)?*

As fundamental, question 3 crystallizes here, that we cannot answer with absolute certainty however. With great probability, we can say that it is no coincidence. That would mean how-ever, that the electron charge is not constant. We don't want to exclude the second case however. See next chapter.

6.2.2. The electron charge

6.2.2.1. Static contemplation

Already DIRAC has formulated a hypothesis, as per which the electron charge is a function of time, (DIRAC's hypothesis). In his model the gravitational »constant« is no constant too. That means, one cannot exclude this possibility and it is worthwhile in any case, to engage further examinations at this point.

If we assume, that it is not a coincidence, that the electron charge is near q_0, so it's also obvious to say that a ratio exists between both, which acts according to a certain inherent law.

The definition of q_0 contains the PLANCK's quantity of action, which is of essential meaning nevertheless for the theory of the bosons (e.g. photons) as for fermions (e.g. electrons)—combined with the wave-propagation-impedance Z_0 of the vacuum. This suggests the conjecture that both charges are actually one and the same, at which point the electron charge, on the basis of particular conditions, only *seems* to be smaller. Therefore we want to examine, whether it is possible to calculate the electron charge from the charge q_0 of the MINKOVSKIan line-element. Let's consider the model according to figure 115 for that purpose.

We have yet noticed that the basic condition of the metrics is located near the expansion centre (0) at a Q-factor of Q=1/2 (1). The expansion-graph in this area is sketched in figure 93. Furthermore we have noticed that there must be something like a basic condition even for the fermionic matter, whereby we can observe both types of matter only red-shifted through the *lens* of the metrics. It turns out the question: What's the Q-factor the basic condition of the fermionic matter is located at?

The most obvious assumption would be that this is at the point Q=1/2 too. Now, we have noticed that this point (1) forms the aperiodic borderline case, in which no periodic wave-function can exist anyway. This is however a necessary condition for the existence of e.g. the electron as matter-wave (DEBROGLIE). Matter-waves are moving, according to our definition, opposite to the propagation direction of the metrics, which has the consequence, that they don't move anyway. They persist quasi on the position forming standing waves. Furthermore arises, that these waves, in contrast to time-like vectors, cannot surmount the (3) point Q=1, in which a phase-jump appears, since they are been reflected there. With it, a matter-wave would be „locked up“ between the points 1 and 3.

We now assume further, that the electron in reality has the charge q_0 too, of which we only „see“ the share e, since the electron is warped about an angle β into the phase space in reference to the observer, who is positioned far on the r-axis.

The (shifted) r-axis is the asymptote of the track-graph of expansion (figure 25) and behaves near the zero like a parable, farther, like a hyperbole. First of all, we are interested in the angle ε, which emerges, from the argument of the integral of the complex propagation-velocity $\underline{c}$ of the metrics (206). It applies:

$$\varepsilon = \arg \int_0^T \underline{c}\,dt = -\arg j2 \int_0^T \frac{1}{2\omega_0 t} \frac{dt}{\sqrt{1-\Theta^2(2\omega_0 t)}} \qquad (668a)$$

At this point the integral of c̲ and not the value itself comes into effect, since not the velocity c̲ of the electron but his location is of interest for the further calculations. With the help of (209) we are able to transform (668a) in the following manner:

$$\varepsilon = -\arg c\int_0^T \frac{1}{\rho_0\omega_0 t}\left(\cos\frac{1}{2}\arg\theta + j\sin\frac{1}{2}\arg\theta\right)dt = \arg 2c\int_0^T \frac{1}{2\omega_0 t\rho_0} e^{-j\frac{1}{2}(\arg\theta+\pi)}dt \qquad (668b)$$

The integral by the time is not particularly well-suited however, since the frequency ω_0 itself is a function of time. Therefore we substitute t by the phase-angle $Q=2\omega_0 t$ obtaining for the angle ε and for the amount of the zero-vector r_N:

$$Q = \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad dQ = \frac{1}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_0}}\, t^{-\frac{1}{2}}dt \qquad dt = \frac{\varepsilon_0}{\kappa_0}Q\,dQ \qquad (669a)$$

$$\varepsilon = \arg 2r_1\int_0^Q \frac{1}{\rho_0} e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ = \arg\int_0^Q \frac{1}{\rho_0} e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ \qquad (669b)$$

$$r_N = \left|2Zr_1\int_0^Q \frac{1}{\rho_0} e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ\right| \qquad Z = \frac{R(Q)}{r_0(Q)} = \frac{H_1 R}{H_0 r_0} = \frac{3}{2}Q^{\frac{1}{2}} \qquad (669c)$$

With $r_1=1/(\kappa_0 Z_0)$. Although, the left expression of (669c) is not yet complete. It only describes the propagation of the wave. It still lacks the expansion-share Z of the constant wave count vector r_K across the entire world-radius R, otherwise applies $Z=2mQ^{1/2}$ see (329). It has the characteristic of a zoom-factor and is to be placed before the integral, since it influences all elements dr simultaneously (see section 4.5.2.). Altogether applies:

$$r_N = \left|3r_1 Q^{\frac{1}{2}}\int_0^Q \frac{1}{\rho_0} e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ\right| \qquad (669d)$$

Now certainly an analytic solution of this integral can be found, if there is enough time. This however would go beyond the scope of this work. Therefore, we determine the integral with the help of the »Mathematica«-function NIntegrate numerically. With it however the function $1/\rho_0$ makes particular difficulties, namely because of the many nulls of the Bessel function. In order to make possible an exact solution nevertheless, we substitute the expression $1/\rho_0$ by an interpolation-function with list (function Interpolate). Then, expression (669b) Ep[Q] and (669d) Rn[Q] can be calculated as follows (without r_1):

```
A=Function[(BesselJ[0,#]*BesselJ[2,#]+BesselY[0,#]*BesselY[2,#])/(BesselJ[0,#]^2+BesselY[0,#]^2)];
B=Function[(BesselY[0,#]*BesselJ[2,#]-BesselJ[0,#]*BesselY[2,#])/(BesselJ[0,#]^2+BesselY[0,#]^2)];
RhoQQ=Function[If[#<30,Sqrt[Sqrt[(1-A[#]^2+B[#]^2)^2+(2*A[#]*B[#])^2]],2/Sqrt[#]]];
ArgThetaQ=Function[Arg[1-A[#]^2+B[#]^2+I*2*A[#]*B[#]]];
rq={{0,0}};
For[x=-8; i=0, x<4, ++i, x+=.01; AppendTo[rq, {10^x, N[1/RhoQQ[10^x]]}]];              (669e)
RhoQ1=Interpolation[rq];
RhoQQ1=Function[If[#<10^4,RhoQ1[#],.5*Sqrt[#]]];
Ep=Function[Arg[NIntegrate[RhoQQ1[x]*Exp[-I/2*(ArgThetaQ[x]+Pi)],{x,0,#}]]];
Rn=Function[Abs[3*Sqrt[#]*NIntegrate[RhoQQ1[x]*Exp[-I/2*(ArgThetaQ[x]+Pi)],{x,0,#}]]];
```

The absolute error is smaller than 10^{-7}. Then the electron charge is the rectangular mapping of the charge q_0 upon the r-axis as presented in figure 115:

$$\sin\gamma = \cos\beta = \sin\left(\frac{\pi}{4}-\varepsilon\right) = \frac{e}{q_0} \qquad e = q_0 \sin\gamma \tag{670}$$

The exact calculation with the help of the function FindRoot results in values of $\varepsilon=-2.04854$ as well as Q=0.656724. for the basic condition of the electron. Since the observer to the point of time $T \gg t_1$ (approximately) is positioned directly on the r-axis, thus the electron charge results from the actual charge of the electron q_0 multiplied with the sine of the difference angle between the phase-angle of the electron in the basic condition and the phase-angle of the observer ($-\pi/4$).

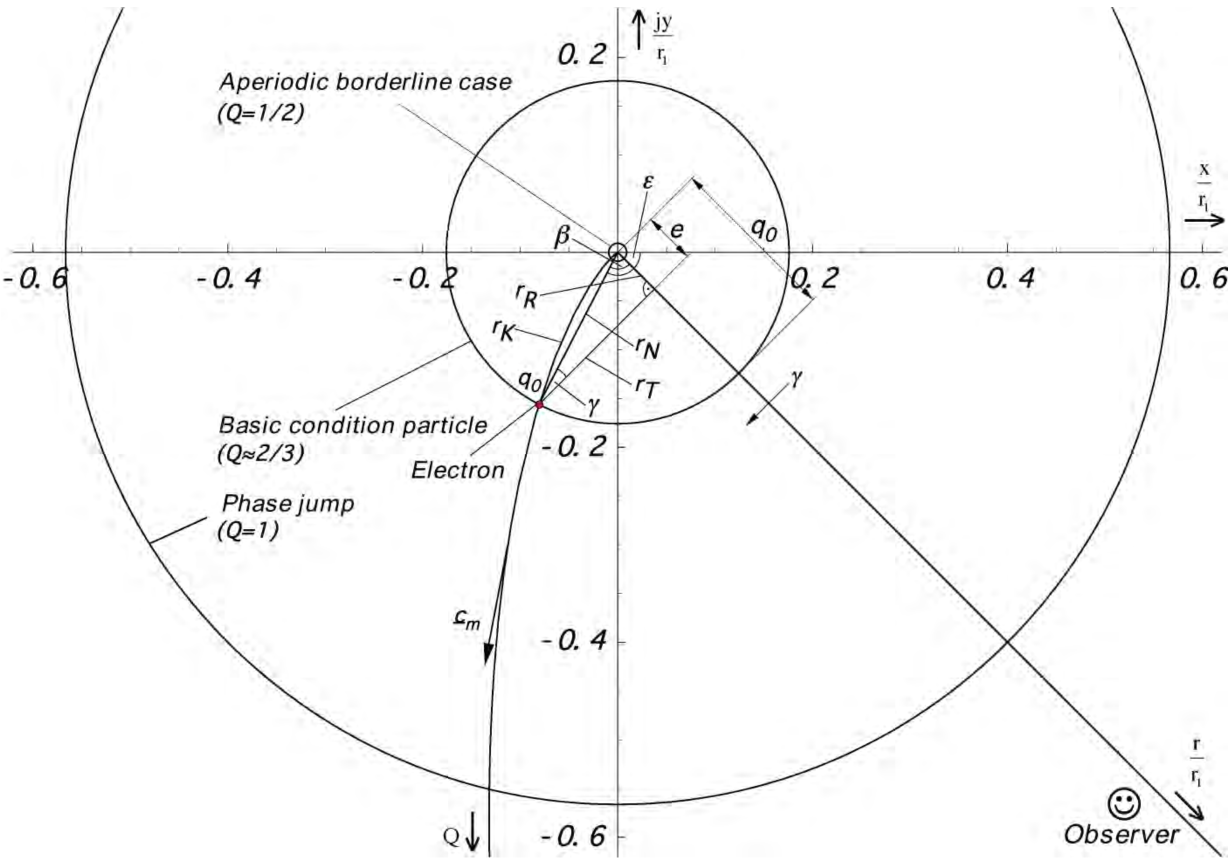


Figure 115
Ratio of electron charge and charge of the MLE in the phase space of the electron

This is constant over a large area ($\sin\gamma \approx 0.302822$). With it, the electron charge traces the charge q_0 of the MLE directly. Only on extremely relativistic conditions, the ratio between q_0 and e varies according to figure 96.

With the fine-structure-constant itself it are just actually about two different „constants" which only coincides to the present point of time. Firstly it's about the ratio of the observed to the actual electron charge, secondly about the angle of intersection between electron and photon. It can be interpreted even like that the charge of the electron itself is a wave-function and it's periodic. Because of the spin (rotation) the measured charge is a function of the angle of incidence α then (figure 115).

On this occasion, the photon always incidents with the angle $-3/4\pi$ This corresponds to the real-part, because only this is able to perform work during an interaction. During the calculation of action, we must multiply with the value $\underline{\sin}\gamma_\gamma$ therefore. The same is applied also to the interaction with neutrinos (inverse b-decay $\bar{\nu}+p\rightarrow n+e^+$). Latter one also today yet figures one of the some many options to the proof of neutrinos. First of all, only the extremely small real-part (in this case), becomes effective during the reaction of the proton with the antineutrino, which leads to the so small effective cross-section. Then, in the subsequent reaction of course the entire neutrino is absorbed, including the „blind energy".

On higher velocities (near c), near the particle-horizon or even in strong gravitational-fields thus the uniform „constant“ splits into two different variables. The weak interaction becomes strong quantitatively seen, since the neutrinos behave like photons then. At the same time there's going to be a symmetry-breaking.

However back to the electron: While the basic condition of the metrics is settled at Q=1/2, we have found a value of Q=0.656724 for the electron, but we expected a value of Q=2/3. Using Q=2/3, we obtain a value for e, which is about 2.54% beyond the really observed one. How this deviation can be interpreted?

As is generally known, the fine-structure-constant is used in the interpretation of interaction-processes between electron and photon, at which point the observer usually is located far away on the constant wave count vector r_K at a point Q» 1. In a large distance, this coincides with the r-axis. Even the electron as a fermion only moves along the constant wave count vector. Since the Q-factor is identical to the phase-angle of the Hankel function, it is defined along r_K, i.e. along the arc. The wave-function of the electron shows a certain curvature with it. The photon itself, the zero vector r_N in contrast, is rectilinear i.e. not curved. Since it's about a photon, which is observed at a point with Q» 1 the angle α is extremely close to $\pi/2$.

The real interaction indeed takes place in the basic condition of the electron at Q=2/3 i.e. the zero vector is being up scaled with all its angles to the phase space of the electron. The result of the interaction on the other hand is being observed downscaled at Q» 1 then. And an adaptation occurs obligatorily during the real interaction (stretching) of the curvilinear wave-function of the electron onto the non curvilinear zero vector. For this reason, it is of interest to determine the arc length of r_K. Even if we weren't able to find any analytical solution for (669d), we can say yet, that the determination of the arc length is not impossible. With the help of (668b) we obtain:

$$r_K = \int_{t_1}^{t_2} \sqrt{\dot{x}^2 + \dot{y}^2}\,dt \; = \; \frac{\varepsilon_0}{\kappa_0}\int_0^Q Q\sqrt{x'^2 + y'^2}\,dQ \qquad (671a)$$

$$r_K = 2r_1\int_0^Q \frac{Q}{Q}\frac{1}{\rho_0}\sqrt{\cos^2\frac{1}{2}\arg\theta + \sin^2\frac{1}{2}\arg\theta}\;dQ \; = \; 2r_1\int_0^Q \frac{dQ}{\rho_0} \qquad (671b)$$

This is however only the share of the wave-propagation in turn. Together with the expansion-share, this is applied to the arc length too, we get:

$$r_K \; = \; 3r_1 Q^{\frac{1}{2}}\int_0^Q \frac{dQ}{\rho_0} \; = \; 3r_1 Q^{\frac{1}{2}}\int_0^Q \frac{dQ}{\sqrt[4]{(1-A^2+B^2)^2 + (2AB)^2}} \; \stackrel{def}{=} \; R(Q) \qquad (671c)$$

Also for the expression (671c) there is certainly an analytic solution, this is however still too complicated, so that we will determine this integral numerically too, at least for small values Q, because to large values, the approximation $2/\rho_0 \approx Q^{1/2}$ is applied and the integral turns analytically solvable with it:

$$r_K \; = \; \frac{3}{2}r_1 Q^{\frac{1}{2}}\int_0^Q \frac{2}{\rho_0}dQ \; \approx \; \frac{3}{2}r_1 Q^{\frac{1}{2}}\int_0^Q Q^{\frac{1}{2}}dQ \; = \; r_1 Q^2 \qquad Q \gg 1 \qquad (671d)$$

This is a known relation, which we have derived with it. It is applied however only to values Q» 1. For the numerical determination of the integral we apply usefully the following expression in »Mathematica«:

```
Rk=Function[If[#<10^4,3*Sqrt[#]*NIntegrate[RhoQQ1[x],{x,0,#}],#^2]];
```
(671e)

Now, we are particularly interested in the ratio between r_K and r_N. The course is presented in figure 116 with and without expansion-share.

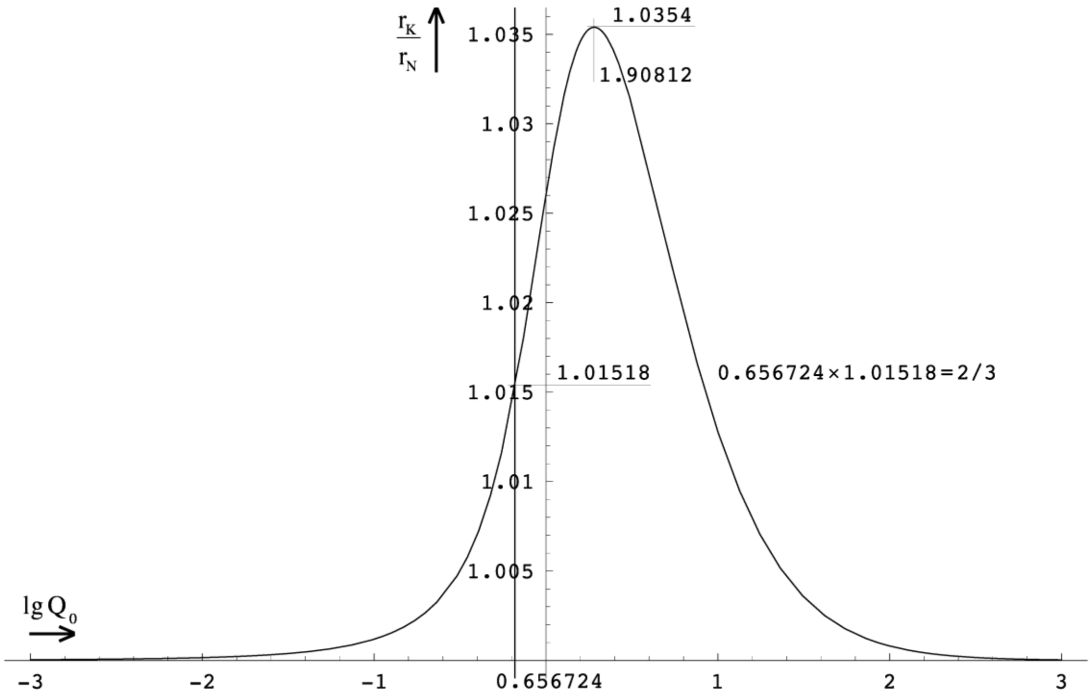


Figure 116
Ratio between the length of the constant wave-count vector r_K and the length of the zero vector r_N as a function of Q_0

The expansion-share cancels out in this case. And it shows following at this point: If we assume the basic condition (r_N) of the electron to be at Q_0=0.656724, so the associated constant wave count vector r_K is exactly about 1.0151826 longer. If we however multiply the phase-angle $Q_0=2\omega_0 t$=0.656724 with 1.0151826, so a value of 0.6666946. turns out. This is a deviation of only $2.794 \cdot 10^{-5}$ to 2/3. The reason could be the computational error during the numerical integration. Having duplicated the precision of the calculation however, we got exactly the same result up to the last position. It could only be about a systematic error then or about others, not considered influences (e.g. hyper-fine-structure) during the determination of the electron charge in the experiment. Or however the value is really not exactly at 2/3 but at 0.6666946. This should not necessarily figure a problem and a deviation of only $2.794 \cdot 10^{-5}$ in the QED is already a full success.

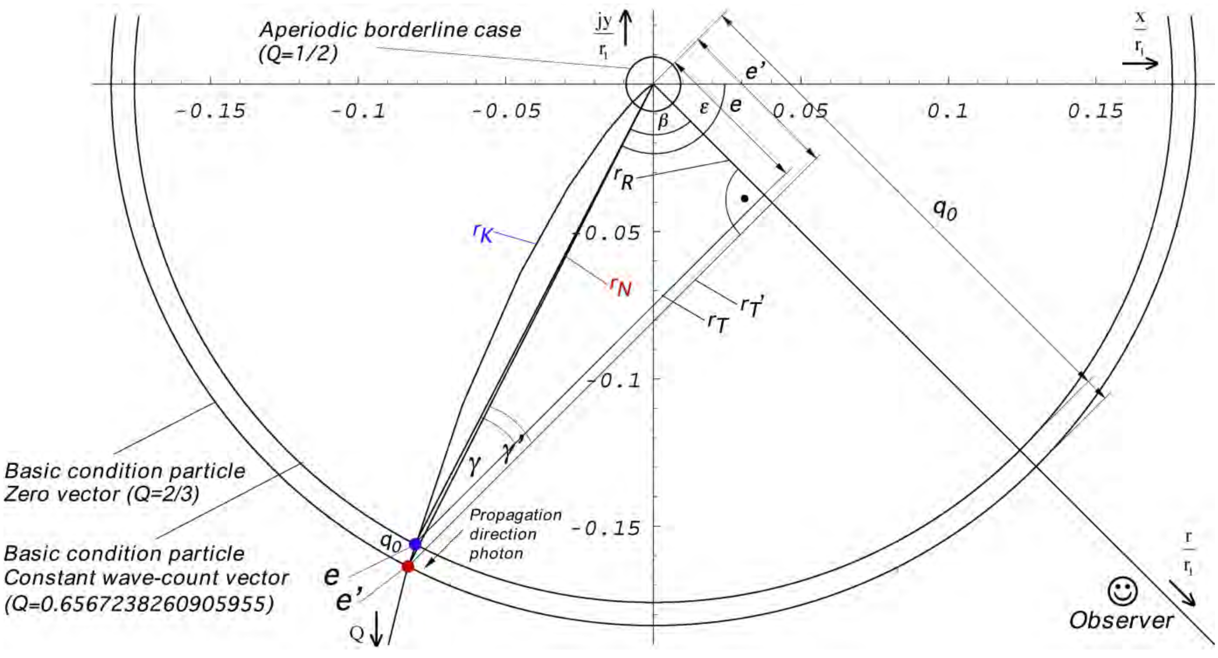


Figure 117
Ratio of electron charge and charge of the MLE
in the phase space of the electron (larger scale)

In figure 117 the exact relations are presented in a larger scale once again. One recognizes the two basic conditions of the electron e (blue) and e´ (red), at which point more final should be equal to the stretched constant wave count vector of e. This is not the case by the way, since the angle ε and with it also β varies negligibly with the stretching. We determine the lengths of r_K as well as r_N for the three values to:

$$r_K(0.656724) = 3r_l\sqrt{0.656724}\int_0^{0.656724}\frac{dQ}{\rho_0} = 0.178510r_l \tag{672a}$$

$$r_N(\tfrac{2}{3}) = \left|3r_l\sqrt{\frac{2}{3}}\int_0^{\frac{2}{3}}\frac{1}{\rho_0}e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ\right| = 0.183660r_l \tag{672b}$$

$$r_N(0.666695) = \left|3r_l\sqrt{0.666695}\int_0^{0.666695}\frac{1}{\rho_0}e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ\right| = 0.183683r_l \tag{672c}$$

It shows, there is no match in length. Even if we deduct the expansion-factor from the result we always get a deviating result (the best fit would be at a phase-angle of 0.660147). That means, the basic condition e is not with Q=2/3 but with an arc-length r_K=2/3r_1. Furthermore, with good probability we can assume the condition e´ to be located at a phase-angle of Q=2/3. This value also often occurs as a factor in the QED by the way. Now, we already want to calculate the corresponding charges:

$$q_0\sin\left(\frac{\pi}{4}-\arg\int_0^{0,656724}\frac{1}{\rho_0}e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ\right) = e \tag{672d}$$

$$q_0\sin\left(\frac{\pi}{4}-\arg\int_0^{\frac{2}{3}}\frac{1}{\rho_0}e^{-j\frac{1}{2}(\arg\theta+\pi)}dQ\right) = 1.0253956e = e' \tag{672e}$$

Thereat, I would call the condition e´ the activated condition of the electron. Just with the fine-structure-constant (coupling-constant for interactions between photons and electrons) always corrections must be taken up, in order to bring the arithmetical result in accord with the measurements. At this point generally the all-over published value (666) is assumed to be the basic condition of α with an energy W=0, which increases all the more, the greater the energy of the interaction. On average, α is being corrected about 10% upward. Now of course, we can assume also an upward corrected electron charge e´ instead of a corrected α and because e occurs in α to the square, the value (672e) would offer itself here, now and then, because $1.0254^2=1.05144$. That's already less than 10% admittedly, but if the charge is corrected, the mass must be corrected too in the same course and it applies $1.05144^2=1.10552$.

It would be possible of course, that there is a variety of different activated conditions of the electron besides e´, which all are situated on the constant wave count vector. We have proven with it that it is possible, to find a relation between the charge e of the electron and the charge q_0 of the MLE. Maybe, these two charge-bearing particles are actually identical, one time as free particle (electron) one time bound in the metrics?

6.2.2.2. Dynamic contemplation

We have determined yet that the electron charge is (could be) equal to the rectangular mapping of the charge q_0 of the MLE onto the metrics-axis of r. What now happens, if the observer moves with a certain velocity or is located in an area of strong curvature or quite simply, what's the spatial and temporal dependence of the electron charge?

If the observer is moving with a relative-velocity different from zero in reference to the coordinate-origin, he is, in terms of physics, moving backwards on the expansion-graph in the direction to the zero. The same is applied in the proximity of a strong gravitational-field or that of the particle-horizon. The temporal dependence is inverse. In the natural time-direction, he moves away from the zero of the expansion-graph.

All this depends on the value of Q_0 (frame of reference), on time, distance, velocity and/or the gravitational-potential. In order to determine this dependence, let's have a look at the model according to figure 115 once again, namely without expansion (plays no role at this point).

Is the observer far away on the r-axis, so the phase-angle $\varepsilon-\beta$ of the metrics, that is the vector from the origin to the point of the observer on the expansion-graph, amounts to (almost) $-\pi/4$ (r-axis). The r-axis forms the asymptote of the expansion-graph. If one now approaches the origin, so the value of the angle becomes greater (the r-axis turns to the left). The charge now arises to $e'=q_0\sin\gamma'$ (not identical to e' and γ' of figure 117). On this occasion the right angle (α) survives, because with the turnover also the propagation direction of the photons changes. In the triangle $e' r_T' q_0$ then the following relation applies:

$$\gamma = \pi-\frac{\pi}{2}-\beta = \frac{\pi}{2}-\left(-\varepsilon_e+\arg\int \underline{c}dt\right) \tag{673}$$

$$\sin\gamma = \sin\left(\frac{\pi}{2}-\left(-\varepsilon_e+\arg\int \underline{c}dt\right)\right) = \cos\left(2.04846+\arg\int \underline{c}dt\right) \tag{674}$$

$$e' = q_0\cos\left(2.04846+\arg\int \underline{c}dt\right) \tag{675}$$

The course of the associated function in dependence of Q_0 is presented in figure 118. It shows, that the ratio of the electron charge and the charge of the MLE is almost constant across a large area. The fine-structure-constant is just really a constant, at least in the nowadays technically accessible domain. If approaching the origin, e.g. with velocities near c, the ratio changes. The maximum is at Q=2/3.

Since for the angle sin g not the function c itself but their integral comes into effect, it's even more difficult, to formulate the function in dependence of the velocity v in this case. Then, a possible approach would be, that instead of the relativistic dilatation-factor also its integral arcsin(v/c) would come into effect. This already an angle turns out and the relation (675) would be then as follows:

$$e' \overset{?}{=} q_0\cos\left(2{,}04846+\arg\int_0^T \underline{c}\,dt+\arcsin\frac{v}{c}\right) \tag{676}$$

$$e' \overset{?}{\approx} q_0\cos\left(1{,}26306+\arcsin\frac{v}{c}\right) \tag{677}$$

But the last both expressions cannot survive anyway, since there are contradictions with the measuring results of accelerator-experiments. A noticeable discrepancy of the electron charge, which does not have been found yet, should appear already with the now reached velocities. Also, expression (676) corresponds to the application of the angle $\gamma_{\bar{\gamma}}$ from the theory of the photon, i.e. it can be figured with the help of the angle $\gamma_{\bar{\gamma}}$ with ($v=c_M+v_M$). However the integral to the time, just the way, becomes effective.

With the help of expression (675) at least it's possible to figure the function cosβ in dependence of the Q-factor. If we now would be able to figure the Q-factor as a function of the velocity, we would have found the function cosβ (v) in turn. In section 6.1.2.1 we found an approximative solution for cosβ (v)). At the same time, with the expression for the relativistic dilatation-factor β we however found a phase-angle ϕ(v) with which we couldn't do anything yet (593).

If we now want to express our angle β with the help of ϕ, we must take up an adjustment of the value-ranges before (phase-adjustment), because both are different. Wanted is the difference ε–β, which runs over a range of 3/4π i.e. (–π/4…–π):

$$\varepsilon-\beta \;=\; \arg\int \underline{c}\;dt \;\approx\; -\frac{5}{8}\pi-\frac{3}{4}\arctan\tilde{Q}_0 V \qquad (678)$$

In this connection, V is the detuning according to (589). Inserted in (675) we finally get:

$$\sin\gamma \;\approx\; \cos\left(0{,}0849646-\frac{3}{4}\arctan\tilde{Q}_0 V\right) \;\approx\; \cos\frac{3}{4}\arctan\tilde{Q}_0 V \qquad (679)$$

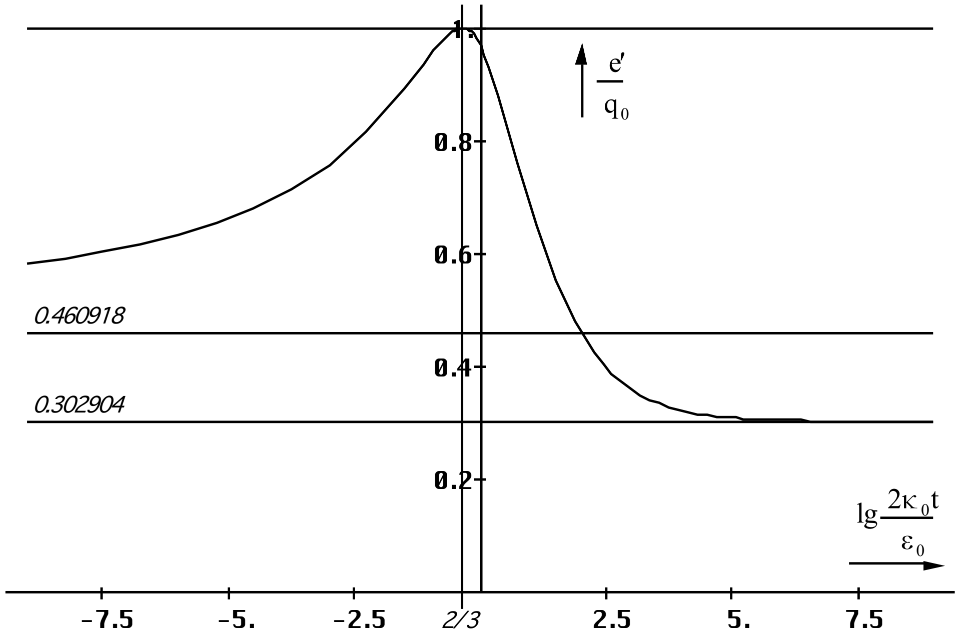


Figure 118
Ratio of electron charge and charge of the MINKOVSKIan line-element as a function of time/Q-factor according to (675)

The small zero-angle of 0.0849646 once again seems to be a curvature-phenomenon of the QED, at which point the value could be quite equal to zero when assuming the exact initial conditions. Wherefrom however the factor of 3/4 exactly has been acquired? The multiplication of a phase-angle with a factor of 3/4 corresponds to the exponent 3/4 in the value. If we look at the expression $\arg\int\underline{c}\,dt$ more exactly, so $\underline{c}$ depends on the time dt. In the approximation applies $\underline{c}\sim Q_0^{-1/2}\sim t^{-1/4}$. Put into the integral we get in turn:

$$\int\underline{c}\,dt \;\approx\; c\int Q_0^{-\frac{1}{2}}dt \;=\; c\sqrt[4]{\frac{\varepsilon_0}{2\kappa_0}}\int t^{-\frac{1}{4}}dt \;=\; \frac{4}{3}c\sqrt[4]{\frac{\varepsilon_0 t^3}{2\kappa_0}} \qquad (680)$$

$$\int\underline{c}\,dt \;\approx\; \frac{2}{3}r_1\left(\frac{2\kappa_0 t}{\varepsilon_0}\right)^{\frac{3}{4}} \;=\; \frac{2}{3}r_1 Q_0^{\frac{3}{2}} \;\hat{=}\; \frac{\tilde{R}}{2}\beta^{-1} \qquad (681)$$

R is the world-radius and β the classic relativistic dilatation-factor. Adsum, we just really obtain an exponent of 3/4 for t and this equals the reciprocal of the relativistic dilatation-factor directly. Thus, expression (679) would not become implausible. But it figures only an approximative solution in the strict sense, since it is based on the (right) solution of the wrong differential equation. We get the exact expression by expansion of (679) with the help of (149) as solution of the exact differential equation and comparison of coefficients ($\Omega = Q_0 V$) to:

$$\sin\gamma \;=\; \cos\left(0.0849646 - \frac{3}{4}\left(\arctan\,\tilde{Q}_0 V \;-\frac{\tilde{Q}_0 V}{1+\tilde{Q}_0^2 V^2}\right)\right) \tag{682}$$

The course of both solutions is presented in the following figures. The characteristics of (682) are following: For large-scale values of Q_0 the fraction can be disregarded and the value $\sin\gamma$ is constant until close to c. After it γ jumps up to $-\pi$ directly. With an initial value of $Q_0 = 10^{60}$ e.g. not until a velocity of $c(1-10^{-30})$ a noticeable variation arises, i.e. just outside the technical possibilities. Differently, it looks like with smaller initial Q-factors. In this case there is a smooth transition.

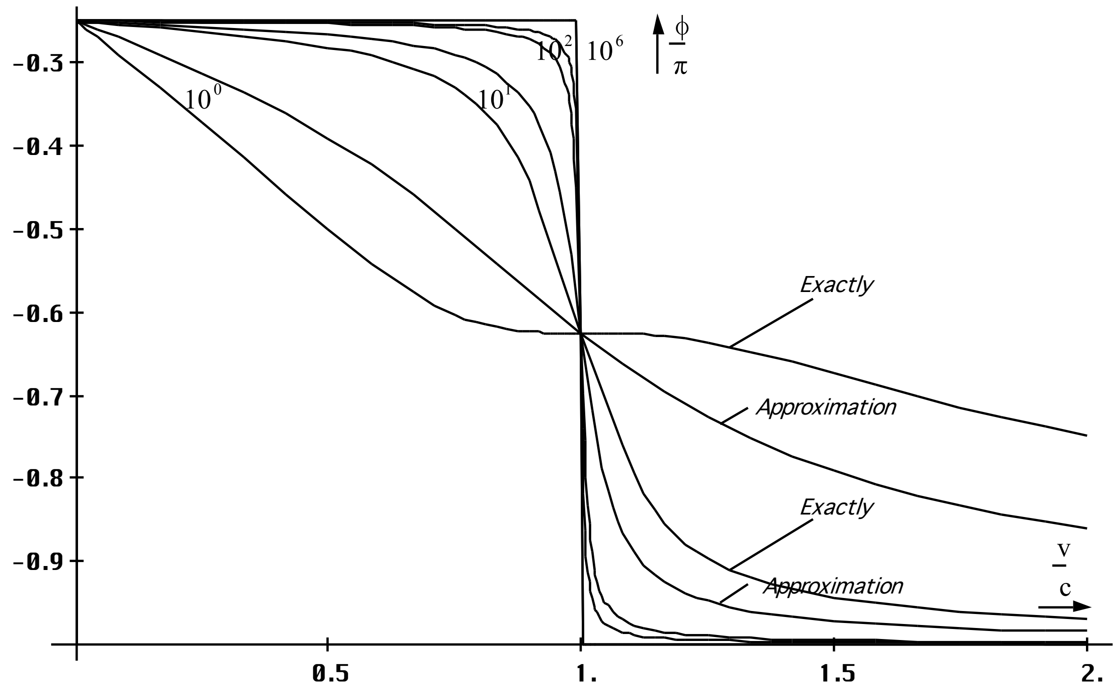


Figure 119
Phase-angle ϕ of the observer
as a function of the velocity $v=v_M$

Here, a value of $v=v_M$ for the velocity has been assumed, just in reference to the metrics. But with smaller initial Q-factors, this case does not correspond to the realities, since the angle ϕ already with v=0 should be different from $-\pi/4$. So we have to add the metric vector c_M even here, in order to take the influence of the non-irrelevant basic-curvature into account, as it e.g. appears near a particle-horizon. This stands in contrast to the original statement, made in section 6.1.2.1, which I withdraw herewith. The metric vector just have to be added to all velocities, even if the corresponding expression is containing Q_0, ω_0 or r_0. The real(?) course of the phase-angle ϕ as well as of the ratio between the electron charge and the charge of the MLE resulting from it, is presented in figure 120 and 121.

For the decisive Q-factors between 10^3 and 10^{60} the fine-structure-constant is just really a constant (the value 10^3 already has been achieved $3.2 \cdot 10^{-99}$s after big bang). Within or behind a particle-horizon, it has a different value however. If we would move the origin of the frame of reference into the proximity of a singularity, we would measure a total different charge-ratio dependent on the velocity, apart from the spatial share, which has an effect on e and q_0 at the same time, and is available in each frame of reference. Additionally of course, e is varying with q_0, which should not be forgotten.

But expression (679) and (682) are applied for positive velocities only. If we are e.g. near (outside) a SCHWARZSCHILD-radius, the velocity is directed toward the centre of the singularity. If we now are moving off this place with a velocity, with which the sum c_M+v_M becomes negative, we would have left the region of influence of the singularity. The new velocity is positive in turn, directed toward the particle-horizon of the universe R/2.

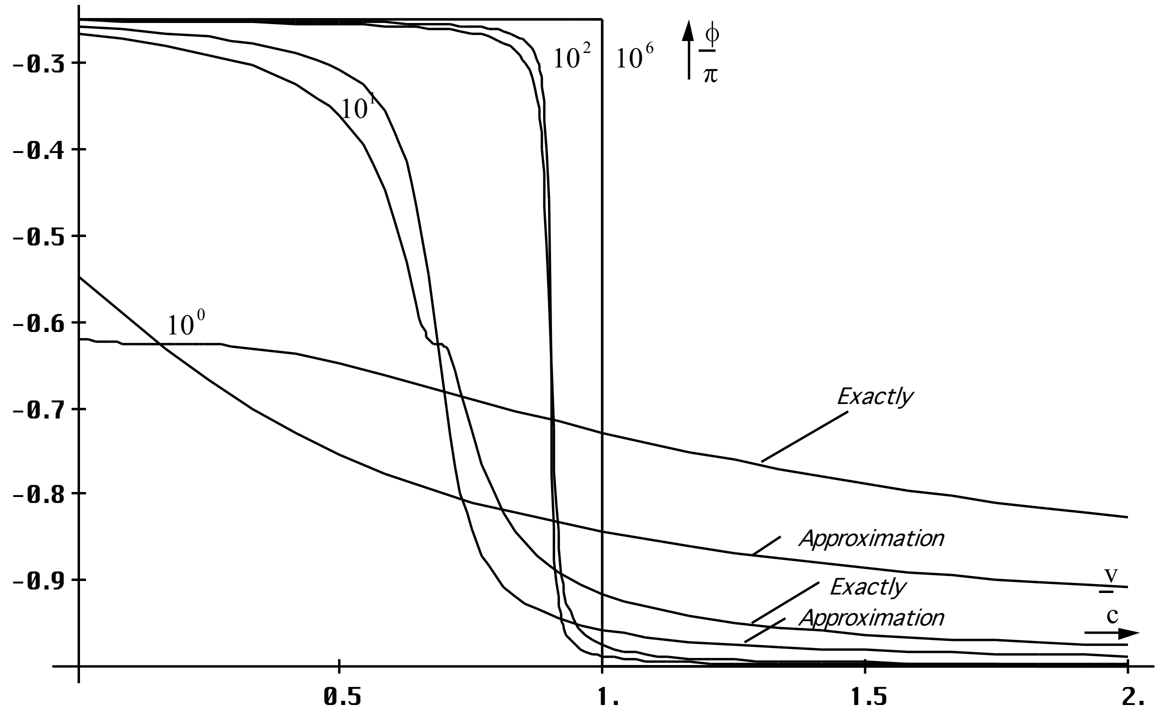


Figure 120
Phase-angle ϕ of the observer
as a function of the velocity $v=v_M+c_M$

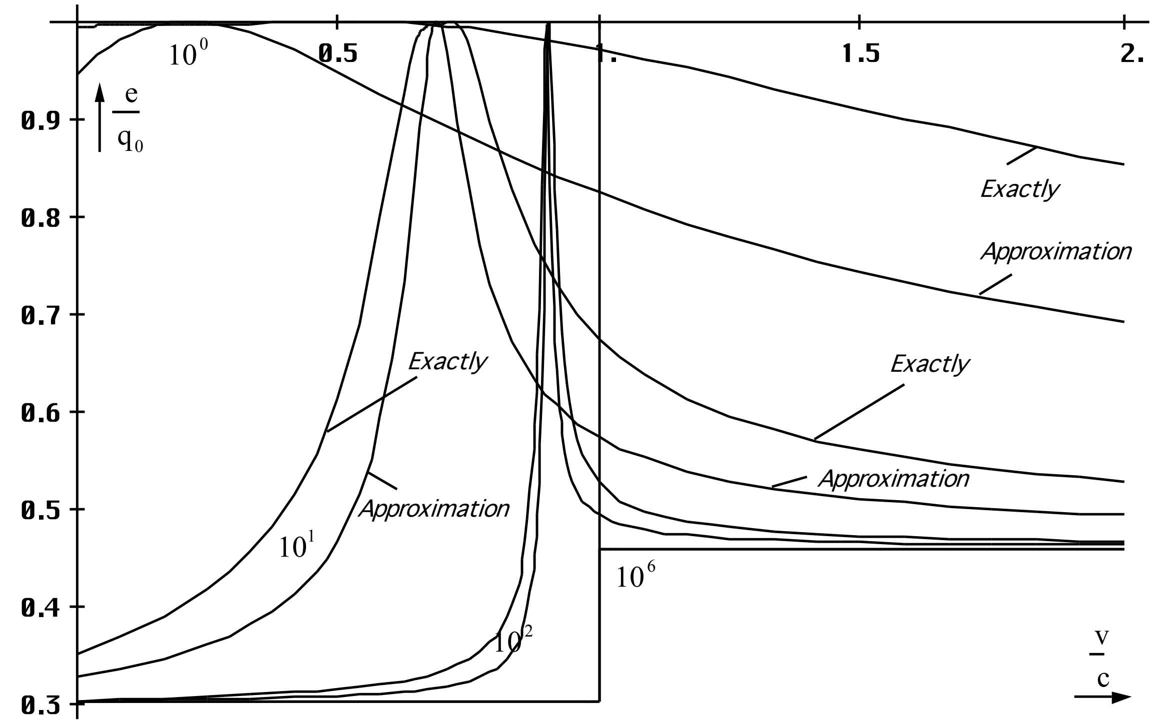


Figure 121
Ratio of electron charge and the charge of the MINKOVSKIAN
line-element as a function of the Q-factor and the velocity $v=v_M+c_M$

To the conclusion still to the topic particle-accelerators. I had promised to examine this point once again concerning the additional share of the mass- and charge-increase more exactly. The question is, do the additional shares cancel out even in the particle-accelerator? First let's recall the different dependences:

$$mc^2 \sim Q_0^{-\frac{5}{2}} \qquad \hbar\omega \sim Q_0^{-\frac{5}{2}} \tag{683}$$

$$\omega \sim Q_0^{-\frac{3}{2}} \qquad \hbar = q_0\varphi_0 \sim Q_0^{-\frac{2}{2}} \quad \rightarrow \quad q_0 \sim Q_0^{-\frac{1}{2}} \qquad \varphi_0 \sim Q_0^{-\frac{1}{2}} \tag{684}$$

The approximation equation suffice for the technically accessible area. At present, as well the electron charge as the PLANCK's quantity of action are assumed to be genuine constants. The same is applied also to the magnetic induction $B = d\varphi/dA$, by which the electron is kept on its track in the accelerator.

Now we are concerned with two different kinds of forces. On the one hand, the electron is subject to the centrifugal force $F_Z = m_e v/r$, on the other hand it generates a LORENTZ-force $\mathbf{F_L} = e(\mathbf{v}\times\mathbf{B})$. Both are opposite to each other. It applies $v \perp r$, just $F_L = e\,vB$. For the cyclotron (B=const) and even for the synchrotron ($B\neq$const) we get the classic expression with it:

$$r = \frac{\beta(\tilde{m}_e v)}{eB} \sim \beta v \tag{685}$$

According to this model as well m_e, e as the induction B are now subject to an additional red-shift. Altogether applies to the electron mass $m_e \sim Q_0^{-5/2} \sim \beta^{5/3}$, to the electron charge $e \sim Q_0^{-1/2} \sim \beta^{1/3}$ and, based on the fact, that the track-radius r and with it also the surface-elements dA of the magnetic field B are not subject to a length contraction (for the observer), to the induction $B \sim \varphi \sim Q_0^{-1/2} \sim \beta^{1/3}$. Inserted in (685) we finally get with

$$r = \frac{\beta^{\frac{5}{3}}(\tilde{m}_e v)}{\beta^{\frac{1}{3}}\tilde{e}\beta^{\frac{1}{3}}\tilde{B}} \sim \beta v \tag{686}$$

the same result as with the classic model, where we have regarded e and B as constants. The additional mass-increase just really cancels out.

6.2.3. The classic electron radius

Meanwhile, we know that there is actually none, the electron is described by a wave-function indeed. But the electron disposes of particle properties too. Now, we have described the MINKOVSKIan line-element as a ball-capacitor which moves in its inherent magnetic field. Additionally, we have assigned a radius of $r_0/(4\pi)$ to it, which shows similarities with the procedure on the definition of the classic electron radius.

In this connection one assumed at that time that also the electron resembles a ball-capacitor with a certain capacity, which should depend on the radius of the electron. Since the charge was well-known, there was only a certain radius, at which energy, charge and capacity could be brought in accord. This is defined as follows:

$$r_e = \frac{e^2}{4\pi\varepsilon_0 \beta m_e c^2} \sim \beta^{-1} \tag{687}$$

Here we have applied the relativistic dilatation-factor β for the mass on the spot. With it, the classic electron radius, according to the classic understanding (interesting doubling), traces the function of the relativistic length contraction, which is not a contradiction. Now we insert the real values for the mass and the charge of the electron obtaining the expression for the „modern" classic electron radius:

$$r_e = \frac{\beta^{\frac{2}{3}} e^2}{4\pi\varepsilon_0 \beta^{\frac{5}{3}} m_e c^2} \sim \beta^{-1} \sim Q_0^{\frac{3}{2}} \qquad (688)$$

The additional mass-share and the charge-increase cancel out even here. Even according to the „modern" opinion the radius is subject to the plain relativistic length contraction with it. So there is an essential difference to the capacitor of the MLE, whose radius is only proportional to Q_0.

6.2.4. The BOHR's hydrogen-radius

Even at the atom, a similar effect can be observed. For that purpose, as a simple example, let's consider the classic BOHR's hydrogen-radius, which of course does not correctly reflect the real conditions, but it can serve as a ruler for the proportions within the atom. According to [5] it is defined as follows (we make use of the approximation once again inserting β for the mass immediately):

$$r = \frac{4\pi\varepsilon_0 \hbar^2}{\beta m_e e^2} \sim \beta^{-1} \qquad (689)$$

Even the BOHR's hydrogen-radius is subject to the plain relativistic length contraction with it, i.e. the atomic scales are observed shortened about the factor β^{-1} exactly like a macroscopic body. What does it look like with the additional shares however?

$$r = \frac{4\pi\varepsilon_0 \beta^{\frac{4}{3}} \hbar^2}{\beta^{\frac{5}{3}} m_e \beta^{\frac{2}{3}} e^2} \sim \beta^{-1} \sim Q_0^{\frac{3}{2}} \qquad (690)$$

The additional shares cancel out even in this place. That means, as well the dimensions of the particles as the „track-radii", i.e. the dimensions of the orbitals, are subject to the plain relativistic length contraction only. Else, the atoms would have had different chemical qualities to a former point of time of the expansion of the universe.

6.2.5. The COMPTON wave-length of the electron/proton/neutron...

By analogy with [5] it is defined as follows (representatively, we consider the electron only):

$$\lambda = \frac{\hbar}{\beta m_e c} \sim \beta^{-1} \qquad (691)$$

Even this expression well agrees with the statements of the SRT in turn. Now, with the additional relativistic shares, we obtain the following expression:

$$\lambda = \frac{\beta^{\frac{2}{3}} \tilde{\hbar}}{\beta^{\frac{5}{3}} \tilde{m}_e c} \sim \beta^{-1} \sim Q_0^{\frac{3}{2}} \quad \rightarrow \quad \lambda = \frac{\tilde{\hbar}}{\tilde{m}_e c} \beta^{-\frac{2}{3}} \frac{\sin\gamma_{\tilde{\gamma}}}{\sin\alpha} \qquad (692)$$

The shares cancel out even here in turn. But the exact expression reads different and is presented on the right-hand side, since it's about a (space-like) wave-function.

6.2.6. The BOHR's magneton/nuclear magneton

The BOHR's magneton is the magnetic dipole-moment of the electron, the nuclear magneton the magnetic dipole-moment of the proton. Both differ only in the mass (m_e respectively m_p) in the denominator. According to the classic opinion applies:

$$\mu_B = \frac{e\hbar}{2\beta m_e} \sim \beta^{-1} \tag{693}$$

Inserting the additional shares we get here:

$$\mu_B = \frac{\beta^{\frac{1}{3}} e \beta^{\frac{2}{3}} \hbar}{2\beta^{\frac{5}{3}} m_e} \sim \beta^{-\frac{2}{3}} \sim Q_0 \tag{694}$$

In this case, we obtain an aberrant result. Since the magnetic moment however always is to be considered in connection with a charge or a magnetic flux, these are proportional $\beta^{-1/3}$, the balance of the additional shares occurs even here. In sum, one can say that the spatial share at the total-red-shift has no quantitative or qualitative influence on the physical rules at the observer. It has only a cosmologic meaning and plays an essential role on the specification of a gravitational-theory.

6.2.7. The gravitational-constant

We have seen, that PLANCK's quantity of action is not a constant but a function of space and time. From the definition of κ_0 (55) arises, that this must be applied even to NEWTON's gravitational-constant. We get after rearrangement:

$$G = \frac{c^3}{\mu_0 \kappa_0 \hbar H} = \frac{2c^3 t}{\mu_0 \kappa_0 \hbar} = \frac{c^2}{\mu_0 \kappa_0 \hbar} R \tag{695}$$

By substitution of (138) we finally get:

$$G = \frac{c^2}{\mu_0 \kappa_0 \hbar_1} Q_0 R \tag{696}$$

At this point, the product Q_0R appears for the first time, which leads, because of the logarithmic periodicity of the universe, to the interesting question, what is in the distance Q_0R at all? Possibly there is a superordinated universe of which our own forms a microscopic part (r_0) only? The cosmic background-radiation, be continued accordingly, would form the metric radiation-field of that superordinated universe then.

6.2.7.1. Temporal dependence

We replace Q_0 and R with the corresponding time-functions (697) and transform onto our local coordinates (698) afterwards:

$$G = \frac{2c^3 t}{\mu_0 \kappa_0 \hbar_1} 2\omega_0 t \tag{697}$$

$$G = \tilde{R}\tilde{Q}_0 \frac{c^2}{\mu_0 \kappa_0 \hbar_1}\left(1+\frac{t}{\tilde{T}}\right)^{\frac{3}{2}} = \frac{2c^3\tilde{T}\tilde{Q}_0}{\mu_0 \kappa_0 \hbar_1}\left(1+\frac{t}{\tilde{T}}\right)^{\frac{3}{2}} \quad (698)$$

The temporal course at the point r=0 is presented in figure 122 and 123. The value of the gravitational-constant at the beginning of the expansion has been zero, as we can well recognize in figure 120. In figure 123 is also filled in the value of the gravitational-constant 1s after big bang.

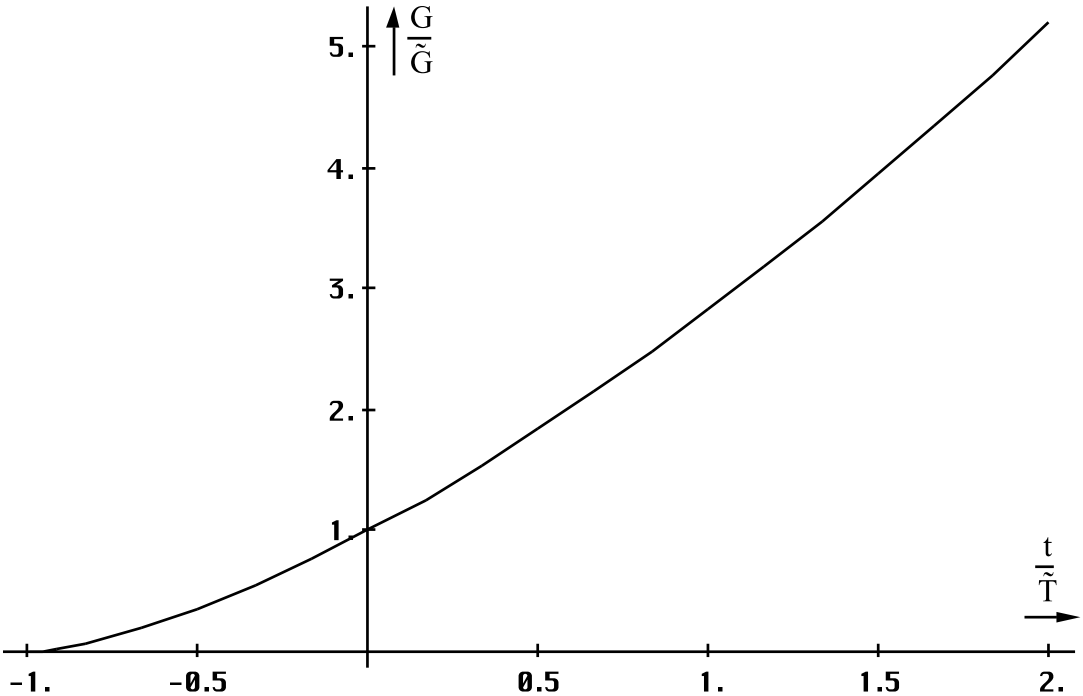


Figure 122
Temporal course the gravitational-constant
at the point r=0 (linear scale)

Therefrom results, that gravity could not have played an essential role to a point of time t<7.747 ns (quantum-universe). Therefore gravity and quantum-effects are excluding each other. Only, this exclusion is not absolute. Rather there is a transition-zone, in which as well gravity as quantum-effects in the scale of the entire universe have been existed. To the point of time t=0 and, qualitatively seen, shortly thereafter there was no gravity anyway.

By the way, that could be the explanation for the fact, that no gravitational-quanta could have been detected until now—there is no quantum-gravity. This circumstances actually should be clear. It does no sense however, to calculate the gravitational-force of a particle, about which one doesn't know at all, at which point it's located at present or where it will be soon. With somewhat good will, one could call the space-like photons gravitational-quanta or even the MINKOVSKIan line-elements themselves. More final particularly for that reason, because their qualities (they are bosons with the spin-quantum-number 2) give the best match with the quanta of the gravitational-field predicted by the SRT. In this connection however is to be paid attention to the fact, that they aren't freely maneuverable but rather are forming the space respectively the space-time itself.

The expansion of the universe, increases also the distance of two masses, which are coupled by gravitational-forces. That increase is compensated by the increase of the value of the gravitational-constant. Whether this compensation is complete, we will examine more exactly at the end of this section.

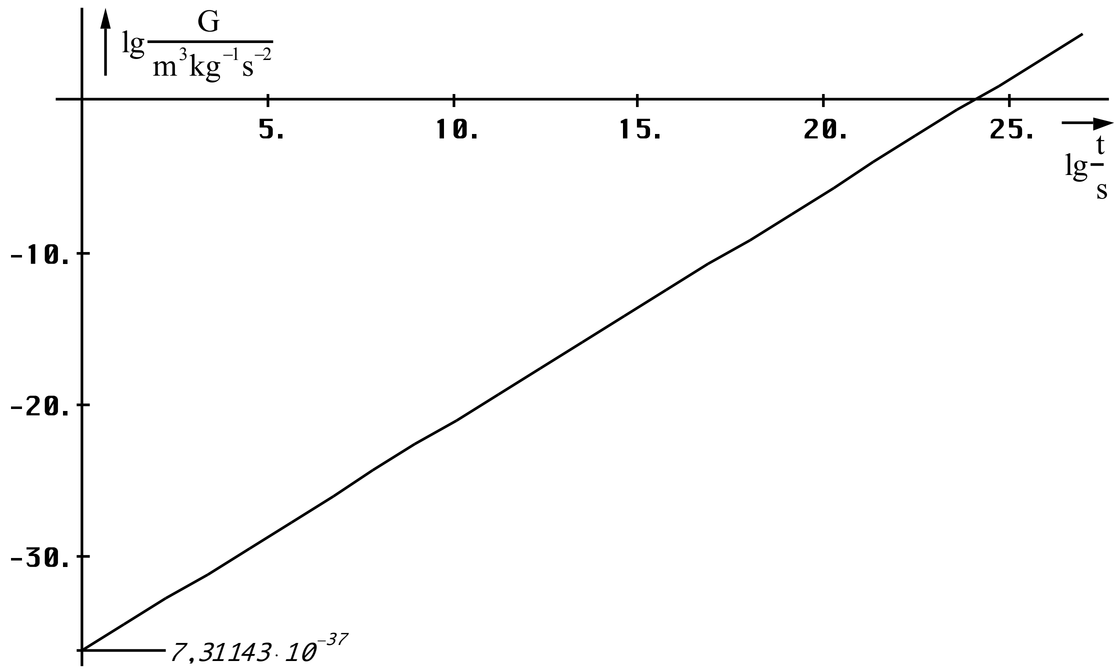


Figure 123
Temporal course of the gravitational- constant
with respect to the local age (logarithmic scale)

6.2.7.2. Spatial dependence

If a temporal dependence exists, so there is also a spatial dependence. We directly get the relation by expansion of (697), the local world-radius depends on the time only.

$$G = \frac{2c^3 t}{\mu_0 \kappa_0 \hbar_1}(2\omega_0 t - \beta r) \tag{699}$$

$$G = \tilde{R}\tilde{Q}_0 \frac{c^2}{\mu_0 \kappa_0 \hbar_1} \underbrace{\left(1+\frac{t}{\tilde{T}}\right)}_{\text{spatial}} \underbrace{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)}_{\text{temporal}} \tag{700}$$

Expression (700) can be split also into a spatial and a temporal share. Here the spatial share goes down with the double exponent. Actually also a rotation belongs to it, particularly on small values of Q_0, which did not has been considered here ($\sin\alpha$?). This however doesn't act on G but on the involved masses, as we will see yet. The functional course is presented in figure 124. The coordinate-origin is the point r=0.

It shows an interesting phenomenon. The value of the gravitational-constant decreases down to zero when approaching the local world-radius R/2. Beyond this point however, it becomes negative, the attraction turns into a repulsion. The attractive effect of the gravity is just restricted to a maximal distance. Objects as well as structures, whose dimensions are greater, cannot exist in consequence. This is probably the reason, why no larger structures could be found above the super clusters in the cosmos. Directly at the particle-horizon, the gravitational-constant is equal to zero. Maybe a space traveler, who overcomes a SCHWARZSCHILD-horizon, doesn't come out respectively come in as a stamp as expected.

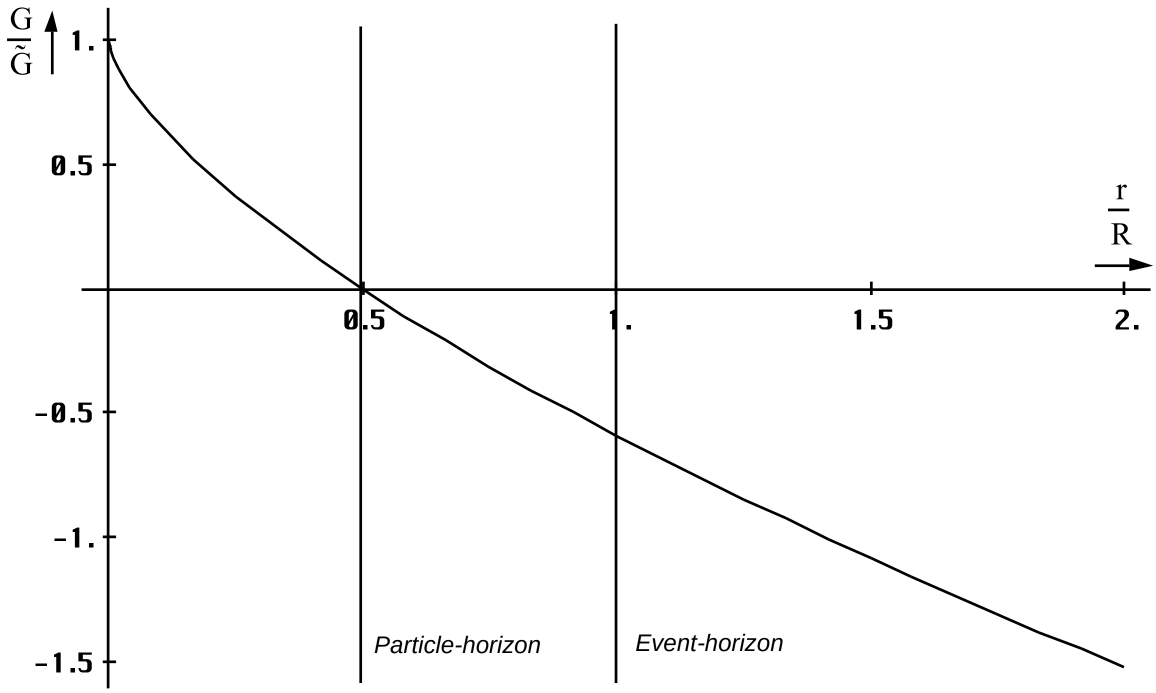


Figure 124
Spatial dependence of the gravitational-constant
to the point of time T (linear scale)

The course behind the event-horizon is hypothetical. One can understand from figure 61 that the energy of the metric wave-field decreases very quickly behind R. Probably there is even nothing, unless other universes, whose external fields are overlaid our inherent one. An action out of this area into the our cannot take place anyway. The not insignificant negative value of the gravitational-constant at this place may be the cause for the expansion of this superordinated universe however.

In figure 125 the course of the gravitational-constant for the case of a constant wave count vector is presented. This corresponds to a body moved with the metrics. For the distance-function (329) has been inserted. Expectedly, the course depends on the initial-distance (R is the present-day value). With it, a body, which is initially behind the particle-horizon (–G), already can be overtaken by this.

With any initial-distance the gravitational-constant increases proportional to $t^{3/2}$ With distances greater than 0.01 R however there's going to be a temporal shift, i.e. the local value is achieved later on. This can be seen very well, if a logarithmic scale is applied to both axes of the function of figure 125 (not presented in this place).

Finally we want to examine, whether the spatial share cancels out even on the gravitational-constant. First of all we want to have a look at the entire case for that purpose, including the spatial share and expression (698) which we will transform into units of Q_0 (approximation):

$$G = G_1 Q_0^3 = G_1 \beta^{-2} \tag{701}$$

With it the gravitational-constant depends on the velocity too, a fact, which actually already emerges from the classic theory (SRT), because the distance between two celestial bodies, with an observer moving with the speed v, is observed shortened about the factor β^{-1}. This would correspond to a temporal increase of the distance $r \sim t^{3/4}$ as with the wavelengths. Only, it is not accepted in general. Rather the gravitational-constant is assumed as constant. Then, according to the classic opinion, the distance r would not increase then again but decrease proportionally to $t^{-3/4}$, which actually cannot be the fact, isn't it?

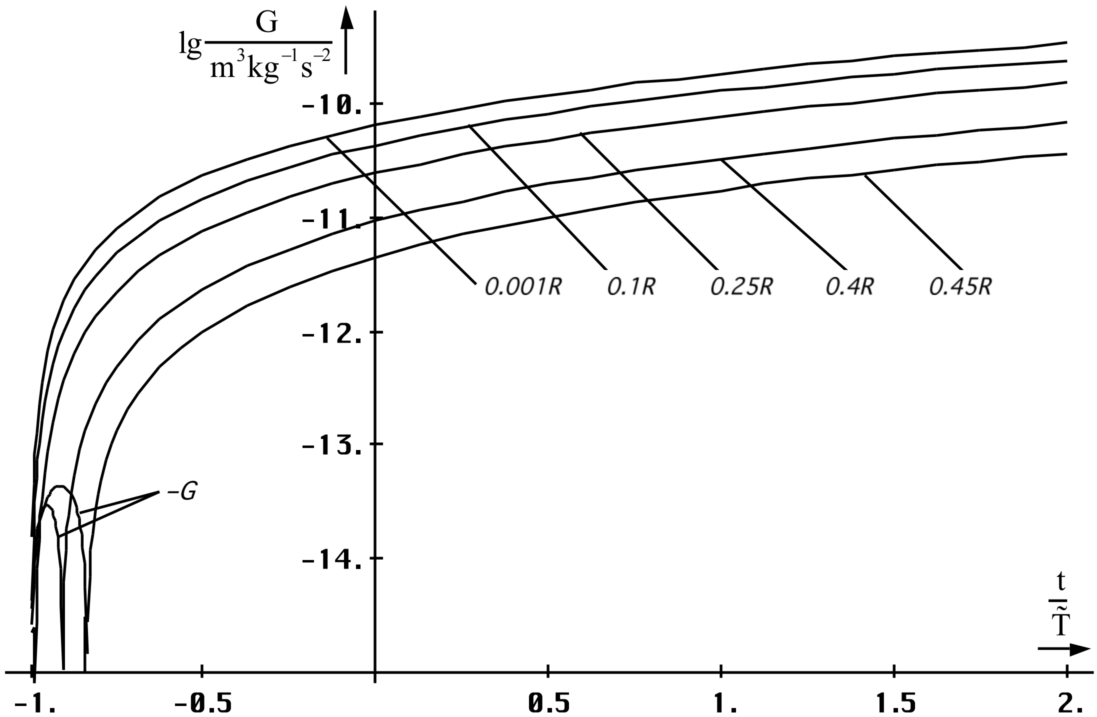


Figure 125
Temporal course of the local gravitational-constant
in the distance r with constant wave count vector

Back to the space-like share: For that purpose, simplifying, we look at two bodies with the masses M and m which are in the distance $r \ll 0{,}01R$ to each other. Another restraint is that $M \gg m$ should apply, furthermore m should describe an orbit around M, just all together conditions, with which the classic NEWTON's relation can be applied.

We place the coordinate-origin into the centre of M which only works, if $M \gg m$ applies. Otherwise, both masses would rotate around a common centre of gravity outside both bodies. The kinetic energy of m amounts to $0.5 \cdot mv^2$ and is subject to the same energetic red-shift as all other energy-forms with it. The velocity v is constant, since as well dx as dt show the same red-shift which cancels out with it. Thus the velocity within a frame of reference is absolute. It only must be transformed with an observation from another frame of reference off, a fact, which is misinterpreted frequently. The mass M wields a gravitational-force F_g on m with a magnitude of:

$$F_g = G\frac{Mm}{r^2} = \frac{mv^2}{2r} \tag{702}$$

The right expression is the centrifugal force F_Z of the mass M located in the orbit. We get after cancelling and rearrangement to r:

$$r = \frac{2MG}{v^2} \tag{703}$$

The track-radius just only depends on the velocity and on M, not on m. Similarly, it appears with the acceleration of gravity g, obtained by rearrangement of expression (702):

$$g = \frac{MG}{r^2} \tag{704}$$

Therefore equation (704) also is called the classic gravitational-field-strength. Since it's however based on the relativistic wrong relation $F=m\cdot g$, it is not the wanted exact expression. With distances of $r \gg 0{,}01R$ another problem comes into addition. This is given by the fact, that expression (700) no longer applies to two bodies in the distance r to each other ($\mathrm{grad}\,G \neq 0$). That means G is only the value observed off from the coordinate-origin (we), which is valid for two bodies standing locally close together in the distance r from that origin (close may indicate even the magnitude of an entire planetary system in this case). With it, G becomes a local quantity or with other words: Since the far distant area is, in terms of cosmology, younger, we even observe a smaller value of G. there.

If we want to determine the gravitational-constant, which comes into effect across the entire distance r, we have, purely formally, to replace r by dr in (700) and to integrate with respect to r afterwards. Since we are actually interested in the distance r only, we start from (703) immediately differentiating both sides first of all:

$$dr = \frac{2}{v^2}\, d(MG) \tag{705}$$

On this occasion, we have already factored out constant factors. This case corresponds to an „apportionment“ of the gravitational-constant to the intermediate line-elements dr, which already indicates a non-insignificant deviation from the classic model. According to this, a gravitational-action namely should propagate instantaneously. As a result of astronomic observations we however know, that even gravity propagates with speed of light only. The won result would not correspond to the physical facts with it. Because of the apportionment, we avoid some of the disadvantages connected with it. But we must not forget, that we look at one special case ($M \gg m$) only, which just agrees with the classic model, in this connection.

As next, we substitute the exact expressions for M (659) with v=0 and G (700). That means, if we find a solution for the distance r, so this is valid only then, when we get as result the distance-function with constant wave count vector (v=0). The expression dr is actually our line-element r_0. This increases according to $r_0 \sim Q_0 \sim t^{1/2} \sim \beta^{-2/3}$ Therefore, we must multiply it with $(1+t/T)^{1/2}$ in order to take the temporal dependence into account. We get the following expressions with it:

$$\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} dr = \frac{2}{v^2}\frac{\sin\alpha}{\sin\gamma_{\tilde{\gamma}}}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}}\left(1+\frac{t}{\tilde{T}}\right)\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) d(\tilde{M}\tilde{G}) \tag{706}$$

$$dr = \frac{2}{v^2}\frac{\sin\alpha}{\sin\gamma_{\tilde{\gamma}}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) d(\tilde{M}\tilde{G}) \tag{707}$$

Since r_0 is not infinitesimal (infinite structure) but has a certain minimum-size (finite structure), the laws of the differential calculus actually are applicable only then and even only approximatively, when r_0 is small in reference to the world-radius R. Since the ratio is given by the relation $R = Q_0 r_0 = Q_0^2 r_1$, thus we can apply differential calculus even only from a Q-factor of $Q_0 \geq 10^3$ on, according to the demanded precision. Then the value of both trigonometric functions is 1 however, so that they can be disregarded:

$$dr \approx \frac{2}{v^2}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) d(\tilde{M}\tilde{G}) \qquad \text{for } Q_0 > 10^3 \tag{708}$$

The accomplishment of the calculation for Q-factors $Q_0 < 10^3$ we totally could have spared ourselves, since the other physical conditions are so extreme then, that macroscopic bodies cannot exist at all. Additionally quantum-effects get the upper hand, so that it becomes useless at all, to talk about a „distance" between two „bodies". Therefore from now on, we use the equality-sign continuing with the following transformation of (708):

$$\frac{dr}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} = \frac{2}{v^2}\, d(\tilde{M}\tilde{G}) \tag{709}$$

$$\int \frac{dr}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} = \frac{2\tilde{M}\tilde{G}}{v^2} = \tilde{r} \tag{710}$$

We have already solved this integral in section 4.5.1. We make use of the same substitution:

$$\frac{3}{2}\tilde{R}\int \frac{r'^2}{a^2 - r'^2}\, dr' - \tilde{r} = 0 \qquad \text{with } r' = \left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}} \text{ and } a^2 = (1+t')^{\frac{1}{2}} \tag{711}$$

$$\frac{3}{2}\tilde{R}\left(a \,\text{artanh}\frac{r'}{a} - r'\right) - \tilde{r} = 0 \qquad \text{with } \tilde{r} = \frac{3}{2}\tilde{R}\left(\text{artanh}\,\tilde{r}' - \tilde{r}'\right) \tag{712}$$

With the substitution $r' = F\tilde{r}'$ we acquire the final solution:

$$a\,\text{artanh}\frac{\tilde{r}'F}{a} - \text{artanh}\,\tilde{r}' - \tilde{r}'(F-1) = 0 \qquad r(t) = \tilde{r}F^3(t) \qquad \text{q.e.d.} \tag{713}$$

This however is nothing other than our distance-function with constant wave count vector (322), our approach just has been correct. Particularly, we can draw the following important conclusions from it:

1. *A body, which doesn't move in reference to the metrics initially, will not do this (by itself) even in future.*

This statement is identical to the impulse-conservation-rule.

2. *The distance between two bodies, which don't move in reference to the metrics (free fall), rises according to the distance-function with constant wave count vector.*

3. *The equation-system to the calculation of the distance between two bodies is under-determined. Thus, there is an infinite number of possible solutions with the initial conditions* $v = v_0$.

The last statement is of particular importance, since it results directly from equation (659), in which we had set v=0. But any time-functions are possible in this place, which lead to the infinite number of possible solutions. This even cannot be different at all, otherwise each navigation would become impossible, each body, what is not the case as you know, would be bound to its hereditary place forever. Thus, it is also pointless to look for an universal solution for this problem. Of particular interest however is the examination of the conditions on bodies in the free fall, which we have taken up here.

Now at this point, we are started from the classic model for the special-case $M \gg m$ having considered the masses and the gravitational »constant« as a variable. At the same time however, we have succeeded to eliminate as well the masses M and m as G from the solution (713). And if these values can be eliminated with an orbit, this is working even with other track-forms. In consequence, we can say generalizing:

> *IX. For the cosmologic expansion of masses coupled by means of gravity, the properties of the involved masses are not responsible, but the qualities of the space exclusively. Thereat the shape of the tracks of the involved bodies is irrelevant. All average distances and proportions are changing according to the same function, the distance-function with constant wave count vector. This depends on the initial-distance.*

Then again even the question for the propagation-velocity of gravity becomes pointless with it. The case is interesting as well, when a macroscopic body is approaching a singularity with a velocity $v \neq 0$.

With strong curvature then, we have to consider the angles α and γ_γ after all. As a result the field-lines of the gravitational-field near a black hole are „rolled up", so that material bodies, in terms of cosmology, are „moving away" from the source not axially but warped around a certain angle. Since they are attracted at the same time, they finally fall into the singularity, when the approaching-velocity becomes greater than the expansion-velocity of space, which is essentially higher than usual there.

This case however we cannot treat exactly with the classic approach. This has been recognized by EINSTEIN already soon and he developed the universal relativity theory (URT) to which we will devote ourselves in the next chapter. In this connection the fact, that we have acquired a contradiction-free result in this work even with a strongly changed classic approach, does not indicate, by no means, that the statements of the URT are wrong. Rather, latter ones figure a „simpler" and more exact description of the same facts. For that purpose we must examine then again, whether the statements of this model are compatible with the URT (or vice-versa).

7. The universal relativity-principle

7.1. The fundamental values of the gravitational-field

7.1.1. Potential and field-strength per length unit

Before we employ deeper examinations in this section, we first want to deal with the fundamental values of the gravitational-field, since generally ignorance or confusion exists at this point concerning the individual quantities and names. Once again, we want to apply the approved method of the comparison with other physical field-quantities e.g. with the electric and with the magnetic field, even if a takeover 1:1 to the gravitational-field won't be possible because of it's particular properties.

Let's begin with the gravitational-potential: With the electric and the magnetic field in general, there is a potential Φ [V] as well as Ψ [A], at which point after division by a length unit 2πr (circumference of the field-line around an imagined punctual source) the expression for the field-strength per length unit is acquired (btw. even a second field-strength per surface unit exists). The unit [m] always is written in the denominator then, the field-strength results in units like [V/m] as well as [A/m] with it:

$$\mathbf{H} = \left(\frac{\psi}{\infty} - \frac{\psi}{2\pi r}\right) \mathbf{e_r} = -\frac{\psi}{2\pi r} \mathbf{e_r} \qquad \text{Magnetic field-strength} \quad \text{H-field} \qquad (714)$$

$$\mathbf{E} = \left(\frac{\phi}{\infty} - \frac{\phi}{2\pi r}\right) \mathbf{e_r} = -\frac{\phi}{2\pi r} \mathbf{e_r} \qquad \text{Electric field-strength} \quad \text{E-field} \qquad (715)$$

In this case, $\mathbf{e_r}$ is the unit-vector. With the magnetic field in general, ψ is to equate with the current i through a conductor. With it, the field-strength in the vicinity of a discrete conductor arises from the difference of the potential in the infinite, this is equal to zero (it however can be even another potential, e.g. that of a second conductor (≠0)), and the potential in the distance r. For this reason, the field-strength of a single punctual as well as of a linear source is negatively defined in general.

What does it look like with the gravitational field-strength however? The unit in the denominator probably would be [m] in turn. But what is written in the numerator then? The answer is: also a length. Then, the unit of measurement would be [m/m], that means [1]. About which length could it be here? Best suitable would be the PLANCK's fundamental length (r_0), which, as we have seen, figures a gauge for all local proportions. We however use the value $r_0/2$, which figures the smallest possible space-like vector. With it, the gravitational-potential, which we want to mark with **U** for the moment, would be defined as follows:

$$\mathbf{U} = \left(\frac{r_0}{2 \cdot \infty} - \frac{\cancel{2} r_0}{\cancel{2} r_0}\right) \mathbf{e_r} = \left(\frac{r_0}{\infty} - \frac{r_0}{r_0}\right) \mathbf{e_r} = -\mathbf{e_r} \qquad (716)$$

The factor 2π doesn't appear in this place, since gravity should not be joined with a rotation but with an elastic deformation of the individual line-elements. Now, from the preceding contemplations, we know that the maximum space-like distance in the universe is R/2. This actually is applied even to the electric and the magnetic field. Since both fields however are oriented in an inverse manner, i.e. time-like (the utmost time-like vector is R), the difference is microscopic. The corresponding term is just not exactly but only almost equal to zero then, not so at the gravitational-field. So, expression (716) reads correctly:

$$\mathbf{U} = \left(\frac{\cancel{2} r_0}{\cancel{2} R} - \frac{r_0}{r_0}\right) \mathbf{e_r} = \left(\frac{r_0}{R} - 1\right) \mathbf{e_r} = \left(\frac{1}{Q_0} - 1\right) \mathbf{e_r} \qquad (717)$$

$$-\mathbf{U} = \left(1-\frac{1}{Q_0}\right)\mathbf{e_r} \tag{718}$$

From the URT, we now know the relation for the g_{00} -component of the metric tensor, which has the form of expression (718) approximately. It applies:

$$-g_{00} = 1+\frac{2\Phi}{c^2}+O\left(\frac{v}{c}\right) \approx 1-\frac{2MG}{rc^2} \qquad \text{with} \quad \Phi = -\frac{MG}{r} \tag{719}$$

In this connection, Φ is NEWTON's classic gravitational-potential and *O(x)* a series converging against zero. In the approximation, with small curvature-values $O(x) \approx 0$ applies. It however has not been successful until now to determine this function exactly. Rather, it belongs to the most wanted expressions in the URT. In general the calculation is aborted behind the linear term. Therefore only estimations for the case of weak gravitational-fields can be stated.

Expression (719) on the left (g_{00}) is even wrongly called the relativistic gravitational-*potential*. The right name had to be gravitational-*strength* however. Then the gravitational-potential is, in terms of correctness, identical to the half PLANCK's fundamental length $r_0/2$ at the place of observation (frame of reference).

Using our model, we can specify the exact expression for g_{00} without problems however. By substitution of (695) we obtain at first:

$$-g_{00} = 1-2\frac{\dfrac{M}{r}}{\dfrac{m_0}{r_0}} \qquad \text{with} \quad \frac{r_0}{m_0} = \frac{G}{c^2} = \frac{R}{\hbar\mu_0\kappa_0} = \frac{r_0^2}{\hbar\varepsilon_0 Z_0} \tag{720}$$

a simple ratio mass/radius to the corresponding values of the MINKOVSKIan line-element. The right-hand expression of (720) equals, with the exception of a factor 8π, the coupling-constant in the field-equations of the URT:

$$G^{ik} = \frac{8\pi\, r_0^2}{\hbar\varepsilon_0 Z_0}T^{ik} = \frac{8\pi\, c r_0^2}{\hbar}T^{ik} \tag{721}$$

In this connection, G_{ik} is the geometry of space, T_{ik} the energy-impulse-tensor (inside the frame of reference). With it, gravity rather seems to be an electro-dynamic effect. However back to g_{00}. Since g_{00} is quadratic, we better use the value $(-g_{00})^{1/2}$. From the SRT we know that this value is identical to the reciprocal of the relativistic shrink factor β_γ. This appears even in the expressions of the LORENTZ-transformation. It is responsible for the relativistic red-shift of time- and space-like photons. In section 6.1.2.2. we had determined that this deviates from the classic value β:

$$\beta^{-1} = \sqrt{-g_{00}} = \sqrt{1-\frac{v^2}{c^2}} \qquad \text{Classic} \tag{722}$$

Really, the value β_γ:

$$\beta_\gamma^{-1} = \sqrt{-g_{00}} = \frac{v}{c}\cos\alpha+\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha} = \frac{\sin\gamma_\gamma}{\sin\alpha} \tag{723}$$

becomes effective, by which the reciprocal of the relativistic shrink factor β_γ becomes proportional to the phase rate β of the propagation-function of an EM-wave. That's correct, since the relation $\lambda = 2\pi/\beta$ directly turns out the wavelength. Thus we can say that (723) exactly applies. We only have to find a possibility to substitute the velocity v by $MGr^{-1}c^{-2}$ We get the solution by rearrangement of (703) with respect to v:

$$\sqrt{-g_{00}} \;=\; \sqrt{\frac{2MG}{rc^2}}\cos\alpha + \sqrt{1-\frac{2MG}{rc^2}\sin^2\alpha} \;=\; \frac{\sin\gamma_\gamma}{\sin\alpha} \tag{724}$$

$$\sqrt{-g_{00}} \;=\; \frac{\sin\gamma_\gamma}{\sin\alpha} \qquad \text{Gravitational field-strength} \quad \text{g-field} \tag{725}$$

But expression (724) only applies with disregard of c_M and for $v_M = 0$. On the calculation of the trigonometric function $\sin\gamma$ in (725) we must use the following substitution for the velocity v:

$$v \;=\; c_M + v_M + \sqrt{\frac{2MG}{r}} \tag{726}$$

With it, we would have clearly determined the function *O(x)* for the velocity, with the result, that it's no longer required, since we know the exact expression. However, expression still contains (726) the space-, time- and velocity-dependent values M and G, so that we cannot do much with (724) and (726). By substitution of (658) and (700) we acquire the following expression (v_M+$v_G = 0$):

$$\frac{2MG}{rc^2} = \frac{2\tilde{M}\tilde{G}}{rc^2}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)\frac{\sin\alpha}{\sin\gamma_{\tilde{\gamma}}} \tag{727}$$

But the variables r in the numerator and in the denominator of the right side are identical only then, when the mass-centre coincides with the zero of the coordinate-system. The navigation-gradient appears here once again. By comparison of coefficients with (718) we get for the Q-factor:

$$\tilde{Q}_0 = \frac{c^2}{2\tilde{M}\tilde{G}}\,\frac{r}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}}\,\frac{\sin\gamma_\gamma}{\sin\alpha} \tag{728}$$

$$Q_0 = \frac{c^2 r}{2\tilde{M}\tilde{G}}\frac{\sin\gamma_\gamma}{\sin\alpha} \;=\; \frac{r}{\tilde{R}_S}\frac{\sin\gamma_\gamma}{\sin\alpha} \tag{729}$$

R_S is the SCHWARZSCHILD-radius of M. Expression (729) applies because of (404) but only outside the mass-distribution. Thus the point $Q_0 = 1$ is not in the distance R_S but negligibly inside. With disregard of the trigonometric functions we now are able to rearrange (728) in the following manner:

$$\frac{2\tilde{M}\tilde{G}\tilde{Q}_0}{c^2} \;=\; \frac{r}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \;=\; \tilde{r} \qquad d\tilde{r} \;=\; \frac{dr}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \tag{730}$$

With larger values of r, we have to replace r by dr in turn, further see (710). With it, even here we acquire the same result as with our half-classic approach, the distance-function with constant wave count vector. Since the radius r ascends continuously during expansion, even the Q-factor in the proximate vicinity of a body moved with the metrics ascends continuously.

If we want to determine the exact solution (727) inclusive the trigonometric functions, we first require a solution for $\underline{c}=f(M, G, r)$. On this occasion, we use the relation $Q_0=2\omega_0 t$ applying (728) in (206) or (209). Since expression (729) is containing the function we actually want to determine, a variable-separation is impossible, there is only an implicit solution in turn, which can be calculated with the known numerical procedures. We expect a solution behaviour like that of the distance-function with constant wave count vector (322) with a limited validity range.

For the reasons already discussed in the preceded section, there is however, in terms of physics, no point in it, to determine the solution under inclusion of the trigonometric functions. By the way, these only have an effect on objects in the free fall in a distance of $r \cong R/2$, i.e. directly at the particle-horizon, so that we can calculate with the plain distance-function for the most part (99.99%).

After equate of (718) and (719) with the approach $g_{00}=U$ and comparison of coefficients we obtain with (723) an important relation:

$$\sqrt{-g_{00}} = \sqrt{\frac{1}{\tilde{Q}_0}}\cos\alpha + \sqrt{1-\frac{1}{\tilde{Q}_0}\sin^2\alpha} \qquad \text{Gravitational field-strength g-field} \quad (731)$$

$$\sqrt{-g_{00}} \approx \sqrt{\frac{1}{\tilde{Q}_0}} + \sqrt{1-\frac{1}{\tilde{Q}_0}} \approx \sqrt{1-\frac{1}{\tilde{Q}_0}} \qquad \text{Approximation} \quad (732)$$

That means nothing other, than that the value is identical to the frame of reference, as we already had suspected (α is a direct function of Q_0 and independent from v). Since even the velocity depends on the frame of reference, we get for:

$$\tilde{Q}_0 = \frac{c^2 r}{2MG} = \frac{c^2}{v^2} \qquad \text{with} \qquad v=c_M+v_M+v_G \quad (733)$$

Is in this connection is to be paid attention to the fact, that M and G depend on c_M and v_M at the same time. Now one could think, we would have solved even the problem from section 6.1.2.1. with it, namely in what extent the Q-factor depends on velocity *and* time *and* space? Unfortunately, this is not the case. If we set v_M and v_G to zero, namely only *approximatively* applies:

$$Q_0 = Q_0(\tilde{c}_M)\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) \approx \frac{c^2}{v^2}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) \quad (734)$$

It agrees with our approximative solution for a non-expanding universe (597) indeed, but it cannot be quite exact, since the Q-factor for an observer moved with the metrics could not become smaller than 1.378 in this case. At least (734) applies for Q-factors greater than 10 even for an expanding universe. For the area below we must come up wit something else, which is problematic in so far, as there is no explicit inverse function $Q_0(c_M)$ defined (the inverse function of the phase-angle $Q_0(\arg \underline{c})$ does). But if we regard the frame of reference as primary, expression (734) is no longer needed at all.

In the URT, space and time are equal dimensions. The definition of the gravitational strength as dimensionless quantity admits even another interpretation with it. Beside [m/m] even any other combinations are possible like e.g. [s/s], [kg/kg] or [Js/Js]. As is generally known, the gravitational-field affects the time lapse and even quantities like e.g. the PLANCK's quantity of action doesn't remain unaffected with it. Generally applies: The gravitational-field is connected to everything. Thus we should not be surprised, if e.g. the time appears in the denominator of an expression instead of a length unit. More in the next section.

7.1.2. Charge and field-strength per surface unit

In the electrotechnics, there is even another kind of the field-strength. This is defined as flux resp. charge per surface unit. The units of measurement are [Vs/m^2] for the magnetic induction as well as [As/m^2] for the electric charge-density, even called influence. The proportionality-factors for the calculation from **H** and **E** are μ_0 and ε_0 resp. μ and ε.

$$\mathbf{B} = \frac{d\varphi}{dA}\,\mathbf{e_r} = \mu_0 \mathbf{H} \qquad \text{Induction} \quad \text{B-field} \qquad (735)$$

$$\mathbf{D} = \frac{dq}{dA}\,\mathbf{e_r} = \varepsilon_0 \mathbf{E} \qquad \text{Influence} \quad \text{D-field} \qquad (736)$$

These are exactly the factors of the COULOMB's and the FARADAY's rule (see table 6). Both have large similarity with the NEWTON's gravitational-rule. In this the gravitational-constant steps in place of ε_0 as well as of μ_0. Even in the gravitational-field there is a similar quantity, which we can compare with induction and influence, the NEWTON's gravitational field strength (acceleration of gravity). This is defined as follows:

$$\mathbf{a} = \frac{MG}{r^2}\,\mathbf{e_r} \qquad \text{Gravitation} \quad \text{a-field} \qquad (737)$$

We use better the letter a for the universal acceleration, since we cannot use the expression g-field twice. The unit of measurement is [m/s^2]. Here, a difference exists to the electric field-quantities however. But since space and time are equal dimensions, this is no contradiction. Looking at expression (732) more exactly, so there is a surface in the denominator even here. The numerator figures something like the gravitative „charge“ as well as the „flux“ then. By expanding with m^2, we can write the unit of measurement even as [$(m^3/s^2)/m^2$], at which point the bracketed expression corresponds to the product MG, and that without change of the physical content. Since we do not know exactly yet, what it is all about, we will call this product the gravitational »flux« Ψ for the moment.

$$\mathbf{a} = \frac{d\Psi}{dA}\,\mathbf{e_r} \qquad \text{Gravitation} \quad \text{a-field} \qquad (738)$$

A calculation from the field-strength (726) with the help of a coefficient, like in the electrotechnics, is unfortunately impossible. Now, we are able to declare both, the relations for the charge as well as for the flux:

$$\varphi = \oint \mathbf{B}\, d\mathbf{A} \qquad \text{Magnetic flux} \qquad (739)$$

$$q = \oint \mathbf{D}\, d\mathbf{A} \qquad \text{Electric charge} \qquad (740)$$

$$\Psi = \oint \mathbf{a}\, d\mathbf{A} \qquad \text{Gravitational »flux«} \qquad (741)$$

Now we want to examine, what's the physical meaning the expression Ψ. So, the unit of measurement [m^3/s^2] contains the length and the time, just only parameters of the space-time. Even with our semi-classic approach, we could observe the same. That well agrees with the statement of the URT that macroscopic bodies are moving on world-lines, for whose course the qualities of space carry responsibility. As a result the guess arises, that the actual gravitational-charge is not inside, but rather outside the involved bodies.

According to the classic theory, the mass is equal to the gravitational-charge. We want to maintain this name, since there is also a retroaction of the mass onto the metrics. The expression Ψ would be something like a description of the condition of the metrics outside the mass-distribution then, an „induction“ of the mass.

A comparison of the unit of measurement with (721) finally leads to the solution: Ψ is identical to the geometry G_{ik} of space. Because G_{ik} is a tensor however, we cannot directly equate it with Ψ (scalar). Thus we keep the symbol Ψ. From the same reason, the application of Ψ is unusual. Instead, the classic NEWTON's gravitational-potential Φ (719) is being used. Nevertheless we can excellently calculate with Ψ. Here just some examples:

$$\mathbf{a} = \frac{\Psi}{r^2}\,\mathbf{e_r} \qquad R_S = \frac{2\Psi}{c^2} \qquad \text{with} \quad \Psi = MG \tag{742}$$

R_S is the SCHWARZSCHILD-radius again. And even the NEWTON's gravitational rule has the same shape as the COULOMB's rule then (proportionality-factor in the denominator, see table 6). Thereat however, we must not forget, that the mass itself is depending on the properties of the surrounding space at the same time.

Field quantity	Magnetic field		Electric field		Gravity field		Nomenclature
Description	MMF	--	EMF	--	MLE	--	--
Potential	ψ	[A]	ϕ	[V]	$\frac{r_0}{2}$	[m]	Planck's fund. length
Description	Magnet. fieldstr.	--	Electr. fieldstr.	--	Grav. fieldstr.	--	--
Fieldstr. 1	$H = \frac{\psi}{2\pi R} - \frac{\psi}{2\pi r}$	$\left[\frac{A}{m}\right]$	$E = \frac{\phi}{2\pi R} - \frac{\phi}{2\pi r}$	$\left[\frac{V}{m}\right]$	$g_{00} = \frac{r_0}{R} - \frac{r_0}{r_0}$ 3)	$\left[\frac{m}{m}\right]$	Gravity-potential
Description	Mag.motive frce	--	El. charge	--	Grav. charge	--	--
Charge	V	[V]	$q = \oint D dA$	[As]	M	[kg]	Mass
Description	Magn. flux	--	El. current	--	Geometry	--	--
Flux	$\varphi = \oint B dA$	[Vs]	I	[A]	$\Psi = GM$ $\Psi = \oint a dA$	$\left[\frac{m^3}{s^2}\right]$	Unusual
Description	Induction	--	Influence	--	Gravitation	--	--
Fieldstr. 2	$B = \frac{d\varphi}{dA}$ $B = \mu_0 H$	$\left[\frac{Vs}{m^2}\right]$	$D = \frac{dq}{dA}$ $D = \varepsilon_0 E$	$\left[\frac{As}{m^2}\right]$	$a = \frac{d\Psi}{dA}$ --	$\left[\frac{m}{s^2}\right]$	Acceleration
Description	Faraday force	--	Coulomb force	--	Inertial force	--	--
Force 1	$F = \varphi H$ 1)	[N]	$F = qE$	[N]	$F = Ma$	[N]	Inertial force
Description	Faraday's rule	--	Coulomb's rule	--	Newtons grv.rule	--	--
Force 2	$F = \frac{1}{4\pi\mu_0}\frac{\varphi_1\varphi_2}{r^2}$ 1)	[N]	$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$	[N]	$F = \frac{1}{G}\frac{\Psi_1\Psi_2}{r^2}$	[N]	Attractive force
Description	M. charge dens.	--	El. Current dens.	--	Grav. Tension	--	--
Miscellaneous	$\Xi = \frac{dV}{dA}$ 2) --	$\left[\frac{V}{m^2}\right]$	$S = \frac{dI}{dA}$ $S = \kappa E$	$\left[\frac{A}{m^2}\right]$	$G_{00} = \frac{dF}{dA}$ --	$\left[\frac{N}{m^2}\right]$	Geometry

Table 6
Field-quantities of the electric, magnetic and gravitational-field in the comparison

1) Physically pointless
2) Permanent magnet
3) $Q_0 \geq 10^5$

With the action of the mass on the geometry, it's just really about a sort of induction. Although, this is only of 1st order, while the action at the EM-Field is of 2nd order. That has effects on the symmetry of the considered field-quantities. Because of the order 2 there is an electric counter-quantity to each magnetic quantity and vice-versa (cross-symmetry). With the gravitational-field, this is not the case. If there are any symmetries, then these exist to other quantities of the gravitational-field itself (self-symmetry).

More about it we can find in table 5, which specifically has been worked out, to uncover such symmetries. Indeed, some appear fetched far however. So, some relations apply only theoretically, as e.g. the expressions marked with a star (there are no magnetic point-charges). The magnetic charge-density (dipoles!) appears only with the permanent magnet and is dependent also from their orientation. The electric current-density actually belongs to the electric current-field and the gravitational-pressure is an unusual quantity. More final, one could describe as the pressure a mass-distribution exerts on the metrics, (applies only inside a mass-distribution).

However even the examination of the product MG is interesting. If we replace M by the expression $\hbar\omega_D/c^2$ (ω_D is the DEBROGLIE- angular frequency of a particle) and G by (695), we acquire the following relations:

$$\Psi = MG = \frac{c}{\mu_0\kappa_0}\frac{\omega_D}{H} = r_1c^2\frac{\omega_D}{H} = r_0c^2\frac{\omega_D}{\omega_0} = r_0^2c\omega_D \tag{743}$$

$$R_S = \frac{2\Psi}{c^2} = \frac{2}{\kappa_0 Z_0}\frac{\omega_D}{H} = 2r_1\frac{\omega_D}{H} = 2r_0\frac{\omega_D}{\omega_0} = 2\frac{r_0^2}{c}\omega_D \tag{744}$$

Except for the frequency ω_D only fundamental values of the metrics and the subspace appear even here. With it, we can say, the gravitational »constant« is actually only an artificial mathematical structure, in contrast to μ_0 and ε_0 as genuine fundamental physical constants.

How could the gravity work however? The masses interact with the metrics, not however together. The gravitative action itself is wielded by the metrics or more simply, without metrics no mass and no gravity. In absence of the metrics, any bodies or particles would be subject to the strong interaction only, since this is mediated by the subspace. On the other hand, the presence of the metric wave-field prevents the particles to be subject to the strong interaction across larger distances.

We already had determined, that the inert mass is nothing other, than the resistance, with which the metrics counters the body during acceleration. On the other hand, one also can imagine the active and passive gravitating mass to be caused by the action of the mass on the metrics as well as vice-versa.

If a mass-distribution exist at a place in the metrics, so this consists, for one thing, of a certain number of particles (fermions) with the DEBROGLIE-frequency ω_D. We had worked out a model in section 4.6.4.2.5. explaining the redshift of masses and the symmetry-breaking between normal and antiparticles. According to this model, the particles actually have a very much larger mass, than we can observe through the metrics, at which point normal particles are associated with a frequency smaller than, antiparticles on the other hand, with a frequency greater than ω_0.

During the interaction of a particle with another across the metrics, only the energy $\hbar\omega_D$ becomes effective then and even to the shape of a discrete particle only this amount is required. The left-over should be added by the metrics. With the pair production however (even virtually) we require no additional energy at all. The energy-transfer between particles and metrics happens by means of space-like photons.

So simply as expected, the relations the relations doesn't seem to be however. For one thing, the dimensions of the particles are essentially greater than r_0, so that there is a large number of line-elements within a particle. Both, as well the particle as the metrics, however are wave-functions too, which overlay each other, so that, because of the non-linearity, the difference-frequency $\omega-\omega_D$ occurs with „normal", the summary frequency with antiparticles indeed. Then, this summary- respectively difference-frequency determines our „actually very much larger mass" and with it even the dimensions of r_0 within the particle, at which point a lower frequency corresponds to a higher value of r_0, (larger Q-factor, larger dimensions).

These larger line-elements however occupy more space than usual, so that in the effect there are even less line-elements within a macroscopic body, than usual. Line-elements are quasi pressed out off the body. In order to find place, there's going to be a compression of the PLANCK's fundamental length outside the body, which corresponds to a smaller Q-factor as well as a higher curvature. Only with increasing distance the value r_0 re-adapts to the average of the universe. As a result of the contraction there's going to be an attraction between the involved bodies. The pressing out itself is not the induction but the gravitation of the mass then.

This model is contradiction-free for „normal" particles, but it demands the existence of negative masses (with antiparticles the relations are inverse, Ψ is negative), which is not a problem because of the line-theoretical contemplation of wave-propagation. Whether these negative masses exist in a sufficient quantity, we must answer with no however, since there was a symmetry-breaking caused by the upper cut-off frequency of subspace to the point of time $t_{1/4}$ (input coupling), the point of time, at which most fermions have been formed. In this case, the shape of particles with the (higher) summary frequency (antiparticles) has been less probably than that of normal particles with the (lower) difference-frequency. Then, after the unavoidable annihilation the supernumerary „normal" particles survive.

7.2. The nature of gravity

We have succeeded successfully until now in avoiding the usage of tensors. This will be different from this point on. The reasons are the properties of gravity, which in contrast to the EM-field, does not shall be connected with a rotation but with an elastic deformation of the metric space-lattice (crystal) [1].

And this just not can be processed with a purely vectorial contemplation. For that purpose, the mathematical tool of the tensor-algebra has been created, originally used to the calculation of tensions in crystals. Thus, it appears quite reasonable to use this tool even for the processing of gravity problems. Interestingly enough, even authors, who don't consider the space as a crystalline structure, are using the tensor-algebra for the same purpose.

Primarily, I intended to interrupt this work at this point in order to reserve a course in cryptology. Fortunately, d´INVERNO has published a textbook [30], in which the ways of solving such tasks are described in detail. Although these descriptions are evenly distributed across the whole book, so that we are bound to read everything.

Simultaneously, I recommend, to review the lecture of LANCZOS [1] as well as section 3.1.2. once again. This just in order to determine, in what extent we already have animated his model.

7.2.1. Once again the MINKOVSKIan line-element

Now, in the course of the work, we often used the expression MINKOVSKIan line-element (MLE) without going into it's actual meaning. Rather, we hitherto interpreted it as a physical object with certain characteristics, having an effect on the local condition of the universe. The reason is, that even LANCZOS used this expression in his model and there is yet no other name for this object, describing its physical content a quarter as good. So the expression PLANCK's fundamental length isn't out of the question if only because of that it's not only about a length but about much more. Some authors are using the expression graviton for it. I neither would like to use this then again, since the suffix -on in general is associated with a freely maneuverable particle (the MLEs on the other hand are fixed, they rather form the space itself) and even the prefix gravit- would be only a partial description, because the electromagnetic properties fall flat.

In the URT in contrast the concept MINKOVSKIan line-element (MLE) has to be understood in a some broader sense. So, there it is about a mathematical construct describing the local properties of the (empty) space. In [1] LANCZOS (and even EINSTEIN) is using expression (0.23) in the form:

$$s^2 = x^2 + y^2 + z^2 - \underline{c}^2 t^2 \qquad (745)$$

with the signature + + + –. which are the signs of the individual components of a fourfold-vector. This signature is generally used in the SRT, and the standard in the URT is + – – –. On this occasion, even the sorting-sequence is reordered ($\underline{c}t$ is at the first position). In general, the differential form of (740) is used, which leads to the expression stated in [30]:

$$ds^2 = dt^2 - dx^2 - dy^2 - dz^2 \qquad (746)$$

Here we are unfortunately concerned once again with the standard notation of the SRT and URT, veiling the correlations by setting c=1 which makes the whole nice mathematical construct a priori unusable for further contemplations (predetermined structure). Now however, we had sworn ourselves from the beginning to don't participate in this fashion but rather to fully write out all variables and constants. Expression (746) had to be correctly then:

$$ds^2 = d(\underline{c}t)^2 - dx^2 - dy^2 - dz^2 \qquad \text{resp.} \qquad (747)$$

$$ds^2 = d(x^0)^2 - d(x^1)^2 - d(x^2)^2 - d(x^3)^2 = \eta_{ab} dx^a dx^b \qquad (745)$$

with $(dx)^2 = dx^2$. And just this ds^2 figures the actual MINKOWSKIan line-element then, whereby the indices of the discrete $(x^i) = (\underline{c}t, x, y, z)$ are written inside the brackets (superscript), in contrast to the normal approach (subscript). Thus, the component x^0 is correctly $\underline{c}t$ (length) and not t. For once, I applied the complex phase velocity $\underline{c}$ instead of c at this point (for zero vectors applies $\underline{c}=c$). If an expression should contain more than one superscripted characters, so the outer one always is used for numeration, at which point it is to be added-up across duplicate appearing indices additionally.

In terms of mathematics all three expressions in (748) are identical, i.e. they describe the same, namely the MINKOWSKIan line-element. Although, only the right expression admits direct calculations with tensors (matrices). The expression η_{ab} is called as well *metrics* as *metric tensor*, at which point the letter η is reserved to the MINKOWSKIan metrics only. Thus, a tensor is always a matrix, whereas a matrix is not automatically a tensor. Here it's about a tensor of 2nd grade. Tensors of 1st grade are being vectors, whereas scalars even can be interpreted as zero grade tensors.

Using another metrics (e.g. spherical coordinates) in general the letter *g* is applied, written as g_{ab} or g_{ik}. The index-letters can be chosen freely, but taking its pattern from LANCZOS we will use g_{ik} in future.

The difference between the URT and our model now consists in the fact that as well the MLE itself, as the metrics have got a physical content. Furthermore, the increments dx^i are infinitesimal in the URT (indefinite structure), whereas they have the quantity r_0 in this model (definite structure).

Because of the extreme smallness of r_0 however the difference does not carry weight. If we have spoken of the metrics until now, we always meant the metric wave-field with it. In the URT in contrast, the expression η_{ab} is meant, which is defined as follows:

$$\eta_{ab} \equiv \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} = \text{diag}(1,-1,-1,-1) \tag{749}$$

The individual elements of the matrix are called η_{00}, η_{01}, η_{02}, η_{03}, η_{10}, η_{11},… η_{33} at which point the line is specified by the first, the column by the second number. In this case, only the elements η_{00}, η_{11}, η_{22} and η_{33} are different from zero.

The rules of calculating with matrices are applied, whereby addition, subtraction, multiplication, the partial derivative (with matrices even called common derivative) and the so-called covariant derivative are defined [30]. There is no division. Instead, one executes a multiplication with the inverse matrix η^{ab} then. It applies: $\eta_{ab}\,\eta^{ab} \equiv (1)$. The expression (1) marks the unit-(diagonal-)matrix diag(1, 1....., 1) at this point.

Another notation is $\eta_{ab}\eta^{bc} = \delta_a^c$. The expression on the right-hand side is the KRONECKER-symbol, which yields 1 always then, when a and c are equal. As for the rest, it has the value zero.

In section 4.3.4.3.3. we were already engaged with the MLE. There, we had used spherical coordinates $(x^i) = (t, r, \vartheta, \phi)$ however. The reason was that the distance r with smaller Q-factors traces a simple linear function (figure 27) by which the calculation essentially simplifies in reference to Cartesian coordinates. Then, the MINKOWSKIan metrics g_{ik} in spherical coordinates looks as follows:

$$g_{ik} \equiv \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -r^2 & 0 \\ 0 & 0 & 0 & -r^2\sin^2\vartheta \end{bmatrix} = \text{diag}\left(1,-1,-r^2,-r^2\sin^2\vartheta\right) \tag{750}$$

The transition to Cartesian coordinates is defined in the following manner:

$$\underline{c}t = \underline{c}t \qquad x = r\sin\vartheta\cos\phi \qquad y = r\sin\vartheta\sin\phi \qquad z = r\cos\vartheta \tag{751}$$

Then, the line-element written out becomes to:

$$ds^2 = d(\underline{c}t)^2 - dr^2 - r^2 d\vartheta^2 - r^2\sin^2\vartheta\, d\phi^2 \tag{752}$$

$$ds^2 = d(x^0)^2 - d(x^1)^2 - d(x^2)^2 - d(x^3)^2 = g_{ik}dx^i dx^k \tag{753}$$

In this connection the g_{00}-component of the metrics (this is equal to η_{00}) plays a quite special role. In terms of physics it corresponds to the temporal share and it is identical to our frame of reference, as we have already noticed in the previous section. Therefore, it is also decisive on coordinate-transformations and the LORENTZ-transformation as factor $(-g_{00})^{1/2}$.

In the matrix (749) and (750) there is on position (0,0) the factor 1 in each case. That indicates a genuine MINKOWSKIan line-element in turn and corresponds strictly speaking to the zero vector ct. In the URT, the zero vector plays an important role, it declares the surface of the beam separating the different types of vectors from each other after all. In this model we however did a quite extraordinary assumption at the beginning, namely that the speed of light (c) should be constant only in reference to the subspace. Thus within the metrics, and we are finally within, there are no zero vectors at all, only time-like and space-like vectors, which are rectangular to each other in the approximation. Therefore, in section 4.3.4.3.3. we did not apply c but the complex propagation-velocity c̲ of the metric wave-field (252). Then, with expression (257) we got the following expression (now in new notation):

$$ds^2 = -\frac{4\dot{r}_0^2\,dt^2}{1-(A(\phi)-jB(\phi))^2} - dr^2 - r^2 d\vartheta^2 - r^2 \sin^2\vartheta d\varphi^2 \qquad (754)$$

On this occasion, we could observe the sign-switch at the x^0-component, already predicted by LANCZOS, which arose from the addition-theorems of the trigonometric functions. Apparently, we did a bad turn with the change to the signature-convention of the URT, because now the entire right-hand side is negative. In terms of mathematics however it's irrelevant, so that we want to stick to it.

In this connection g_{00} is the (0,0)-component of the metric tensor T_{ik} which is marked in the same way. With rigid contemplation, we see that the expression is not only negative but complex at the same time, by which the negative sign is relativized in turn. What however means an imaginary share of x^0? According to the prevalent doctrine, this is identical to a rotation of the vector into the tangentially-space, which puts up at each point of the universe. Now we yet earlier had ascertained that always only the real-part can be seen by an observer, whereas the imaginary-part can be detected only indirectly e.g. as rotation of the polarization-plane. Therefore, it's necessary, to transform expression (754), so that really only the real-part appears. First, we must determine the value and the phase-angle to it. We consider the x^0-component only; the calculation submits:

$$\left|(dx^0)^2\right| = \frac{c^2 dt^2}{\omega_0^2 t^2 \sqrt{(1-A^2+B^2)^2+4A^2B^2}} = \frac{c^2 dt^2}{\rho_0^2 \omega_0^2 t^2} \qquad (755)$$

$$\arg((x^0)^2) = -\arctan\frac{2AB}{1-A^2+B^2} = \arctan\theta \qquad (756)$$

Because of the quadratic function, even the duplicate phase-angle θ appears here. Considering the value-function (755) more exactly, so there our non-rectangular triangle (figure 94) is actually already implicitly included. This is an universal characteristic of the Hankel function. Furthermore congruences with (552) and (587) can be found.

With the comparison of $-g_{00}$ from (755) with expression (732), immediately attracts attention, that both components are strongly differing in the magnitude. While $-g_{00}$ in (732) is about equal to 1, the value in (750) at least for the present-day values of Q_0 is extremely close to zero. Obviously we did a mistake in the approach in section 4.3.4.3.3., which doesn't mean that the whole calculation has been for nothing. So (732) describes the dependence of the time-coordinate in the surroundings of a mass (when applying (728)), whereas in (754) the time-coordinate of the metric wave-field is meant.

Nevertheless, the deviation cannot turn out so extremely, because if M would be chosen sufficiently small, both solutions should show the same result approximately. Also we just know, that gravity is propagating with light speed, so that we can assume (754) to be incorrect respectively partially correct only. If we apply expression (733) instead of (728) with (732), we likewise get a value close to 1, as long as the velocity v is small in reference to c.

If we now assume that the angle between the zero vector and the metric vector amounts to π/2 approximately, then we can make the guess that (754) actually has the following form:

$$ds^2 = \left(1-\frac{1}{\rho_0^2\omega_0^2 t^2}\right) c^2 dt^2 - dr^2 - r^2 d\vartheta^2 - r^2 \sin^2\vartheta\; d\varphi^2 \qquad (757)$$

$$(dx^0)^2 = \left(1 - \frac{1}{\rho_0^2\omega_0^2 t^2}\right) c^2dt^2 \approx \left(1 - \frac{c_M^2}{c^2}\right) c^2dt^2 \rightarrow \left(1 - \frac{v^2}{c^2}\right) c^2dt^2 \tag{758}$$

The right-hand expression corresponds to (731). That means, it's valid for time-like photons (g_{00}). To it applies the reciprocal of the bracketed expression. Now, the angle α is not a right one as you know then again, so that (757) and (758) not can be accurate at all. On the other hand, in the mentioned expressions the same angles occur, as in figure 94, so that it seems to be quite practicable, to slide the contemplations made thereto in the specification of our line-element.

Also we have noticed that there are no real zero vectors for an observer trapped in the metrics, at most almost-zero vectors. And just such a vector we had already found in section 5.1. (478). It's about the time-like vector $\mathbf{c}_\gamma$, which, measured by its qualities, approximates c close enough, if only the Q-factor is sufficiently large ($>10^5$).

Hitherto, with the measurement of the velocity of light always was the saying from the speed of light c generally. For the electrical engineer however also the question arises, which velocity specifically is meant? The answer is: The phase velocity. This is equal to c only with respect to the classic MAXWELL theory for a loss-free medium.

That this classic model can be correct only approximatively, shows the fact of the occurrence of the cosmologic red-shift alone, which doesn't have stated with it. If we now assume an anomalous phase velocity being smaller than c, the red-shift states by itself. So, the amplitude with a certain phase-angle just needs somewhat more time than according to the classic theory, in order to arrive at the observer.

The phase straggles, by which the entire wave-train spreads out. Just an enlargement of the wavelength occurs. In principle, even the wave-front hangs behind, only we cannot ascertain this because of the special relativity-principle, which we just have used in order to synchronize our clocks, and/or to determine the distance to the source. The special relativity-principle triumphs, exactly as anticipated by LANCZOS.

The result of our contemplations is: we really measure the phase velocity $\mathbf{c}_\gamma$. Because of the for the time being high Q-factor $Q_0 \approx 10^{60}$ we cannot at all detect the microscopic difference to c, since it's far outside the measuring-precision. Also we will measure exactly the value c nevertheless, because our measuring-equipment consists of fermionic matter, which is as such actually within the subspace and it is permeated by the metric wave-field *at the same time*. Thus, the physical fundamental values will always change in such a manner that the variance cancels out then again. Even our brain works with fermionic sensors (eye) and depicts the environment with the help of zero vectors (light).

If we want to place $\mathbf{c}_\gamma$ into our line-element, we have to figure it as a function of c. The corresponding expression is (479). As we have determined with the antecedent contemplations, it's identical to the function $\sin\gamma_\gamma/\sin\alpha$ For time-like photons, we use the expression for time-like photons (625) usefully. In this case (wavelength!) applies the reciprocal however.

With neutrinos in contrast (626) is applied. Then however, we are concerned with four different line-elements at the same time, or better, with three line-elements, because $\sin\gamma_{\bar{\gamma}}$ is definitely assigned to the component g_{11}. At this point we want to leave the answer to the reader, in what extent a neutrino-based line-element should be considered as reasonable. Most likely, we require just only one, which describes as well the temporal component g_{00} (time-like photons) as the spatial component g_{11} (space-like photons).

Thus, both components are subject to the relations of the red-shift already worked out in this work, namely to the spatial, temporal and geometrical share as well. Therefore we can write:

$$g_{ik} \equiv \operatorname{diag}\left(\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}\left(1+\frac{t}{\tilde{T}}\right)^{-1}, -\frac{\sin^2\alpha}{\sin^2\gamma_{\tilde{\gamma}}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^2, -r^2, -r^2\sin^2\vartheta \right) \tag{759}$$

Considering bodies in the free fall only, so (759) simplifies once again:

$$g_{ik} \equiv \operatorname{diag}\left(\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}\left(1+\frac{t}{\tilde{T}}\right)^{-1}, -\frac{\sin^2\alpha}{\sin^2\gamma_{\tilde{\gamma}}}\left(1+\frac{t}{\tilde{T}}\right), -r^2, -r^2\sin^2\vartheta \right)_{v_M+v_G=0} \tag{760}$$

Overall, we are no longer concerned with a genuine MINKOWSKIan— this only applies to the subspace—but with an almost-MINKOWSKIan line-element. Usually this transition is associated in the URT with the occurrence of matter (the genuine MLE describes a mass-free empty space), whereas the line-element of this model differs from the genuine one already without matter. That means, in this model, the space is curved even without matter, whereby the curvature is caused by the metric wave-field almost exclusively. Thus for once, we can put ad acta the *Principle of the Minimum Gravitative Coupling,* because it's useless. According to d´INVERNO [30] we however should take it with a pinch of salt anyway.

> *X. Principle of the Minimum Gravitative Coupling (doesn't apply!):*
> *No terms, which contain the curvature tensor explicitly, should be added on the transition from the special to the universal theory.*

This principle is generally used, in order to set a boundary between the SRT, which has been stated for an empty space, and the URT, which applies in a space with mass-distribution. According to the 1st MACH's principle the curvature the space arises only from the distribution of the masses within the universe or shorter: *The matter-distribution determines the geometry*.

If the masses are shifted somehow, the qualities of space change too. But if there is no empty space at all for any arbitrary observer (all are within the metrics), there is no more reason, to perpetuate this distinction. With it, even this last boundary has been fallen and we must reflect, how to transform the inherent laws of the SRT in order to give consideration to the existence of the metric wave-field.

We have done this in the preceded sections. Then, as result, we obtain a so-called „special URT" which unifies the inherent laws of SRT and URT. In this the macroscopic metrics of space is determined by the metric wave-field only, exactly, as anticipated by LANCZOS because the energy-density of the metrics is about magnitudes greater than the one of local matter-distributions. An arbitrary mass-distribution affects only the local metrics with it in form of an infinitesimal interference of the metric wave-field. However these interferences can become quite as large to force a body onto an elliptical track or an orbit.

During cosmologic contemplations, the existence of matter can be completely ignored. With it it's about a pure radiation-cosmos. Thus, all three MACH's principles apply on condition that we also consider the metric wave-field as matter (energy = matter).

There is another more difference between this model and the standard-model. Most authors already in their approach assume the gravitational »potential« to vanish in the infinite. In this model there is no infinite distance at all and the proper potential according to (718) does not vanish anyway. And just this non-vanishing share turns out to be extremely important for the curvature of space at the place of the observer.

7.2.2. The line-element as a function of mass, space, time and velocity

Although the curvature in the cosmologic scale is determined by the metric wave-field exclusively, there is still the local influence of a mass-distribution. Therefore we require a function, which describes the local characteristics of the space not only in dependence on time, distance and velocity (734), but even on an existing mass-distribution. Now, we must find a way to bring these expressions somehow together. The reason is, that we have resigned the Principle of the Minimum Gravitative Coupling. Therefore we must define a new principle describing this dependence.

In section 7.1.1. with expression (724) we had already found such a relation. Considering this expression more exactly then again, so it fulfills the requests of the URT with a mass of M=0 indeed. That means, the curvature vanishes and the line-element becomes exactly MINKOWSKIan. But according to our model that should be unlike. The basic-curvature of space, caused by the metric wave-field itself, still remains here. We just have to think up a relation fulfilling this additional condition, which turns out expression (719) in case of minor masses coincidently (approximation).

During the study of the special relativity-principle, we already had found a similar problem. The problem was, to unify the basic-curvature of space with an arbitrary relative-velocity in one expression. We solved it by adding the metric vector of the relative-velocity $\mathbf{v_M}$ to the likewise metric vector of the propagation-velocity $\mathbf{c_M}$ of the metric wave-field, whereby both point exactly into the same direction.

Now the question arises, whether we cannot proceed similarly in the case of the existence of a mass-distribution. We must find just only a metric velocity $\mathbf{v_G}$, whose magnitude depends on the mass and the distance to the centre of that mass. Thus, we only must add these to the two already existing speed-vectors obtaining a relation, which takes into account even the existence of the mass-distribution. As additional-condition arises that this velocity must become zero, if the mass M is zero.

There is really such a velocity. If we split the approximate expression (719) by analogy with $1-v_G^2/c^2$ we obtain with (v, M and G depend on the frame of reference):

$$v_G^2 = \frac{2\tilde{M}\tilde{G}}{r} \qquad\qquad v_G = \pm\sqrt{\frac{2\tilde{M}\tilde{G}}{r}} \tag{761}$$

the expression for the escape-velocity or the 1st cosmic velocity. That's the minimum-velocity, which a body must have, in order to move on an orbit with the radius r around a body with the mass M, without falling back on the surface. Generally one applies the radius of the body for r, since the starting point is usually on the surface of the body. But in the orbit, the velocity must be only as large, as the solution of (761) with the radius of the orbit turns out.

And exactly this velocity we must add to the other two velocities and we have got the wished expression with it. It applies $v = c_M + v_G + v_M$. In the approximation for velocities $v \ll c$, with small curvatures as well as with disregard of the spatial share we can write then:

$$\sqrt{-g_{00}} = \frac{\sin\gamma_\gamma}{\sin\alpha} = \frac{v}{c}\cos\alpha + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha} \approx +\sqrt{1-\frac{v^2}{c^2}} \tag{762}$$

$$-g_{00} \approx 1-\frac{1}{c^2}\left(\frac{c}{\rho_0\omega_0 t}+\sqrt{\frac{2\tilde{M}\tilde{G}}{r}}+v_M\right)^2 \tag{763}$$

To a body with a fixed position at the surface, applies $v_M = 0$ and the following expression:

$$-g_{00} \approx 1 - \frac{1}{c^2}\left(\frac{c}{\rho_0 \omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{r}}\right)^2 \qquad (764)$$

$$-g_{00} \approx 1 - \frac{2\tilde{M}\tilde{G}}{rc^2} \qquad \text{for } M \gg 0 \text{ and/or } Q_0 \gg 1 \qquad (765)$$

With it, also the condition for $M \to 0$ is filled, the basic-curvature of the metric wave-field really remains:

$$-g_{00} \approx 1 - \frac{1}{\rho_0^2 \omega_0^2 t^2} \approx 1 - \frac{1}{\tilde{Q}_0} \qquad \text{for } M \to 0 \qquad (766)$$

It would be favorable for the component g_{11}, if we could replace $\sin \gamma_{\tilde{\gamma}}$ by $\sin \gamma_{\gamma}$. Usefully, we use the relations (621) and (623) for it. It applies without the navigation-gradient again:

$$\sqrt{-g_{11}} = \frac{\sin\alpha}{\sin\gamma_{\tilde{\gamma}}} = \frac{1}{\frac{v}{c}\cos\alpha - \sqrt{1 - \frac{v^2}{c^2}\sin^2\alpha}} = \frac{\frac{v}{c}\cos\alpha + \sqrt{1 - \frac{v^2}{c^2}\sin^2\alpha}}{\frac{v^2}{c^2} - 1} = -\frac{1}{1 - \frac{v^2}{c^2}}\frac{\sin\gamma_{\gamma}}{\sin\alpha} \qquad (767)$$

Here, also the conversion-factor β between space-like and time-like distance appears, as already anticipated with (280). For the approximation by analogy with (765) we get the following expression:

$$\sqrt{-g_{11}} \approx -\left(1 - \frac{2MG}{rc^2}\right)^{-1}\sqrt{1 - \frac{2MG}{rc^2}} = -\left(1 - \frac{2MG}{rc^2}\right)^{-\frac{1}{2}} \qquad (768)$$

$$g_{11} \approx -\left(1 - \frac{2MG}{rc^2}\right)^{-1} \qquad (769)$$

After substitution in (760) we approximately obtain the SCHWARZSCHILD line-element as - solution. Re-applying the velocities, we can see even here, why the relativistic dilatation-factor β comes into effect with time-like vectors, but the reciprocal β^{-1} with space-like vectors.

Thus we can expand the relations for the angle δ and the several angles γ about the expressions for the mass-influence. To the angle δ applies generally:

$$\delta = \arcsin\left(\left(\frac{1}{\rho_0 \omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{rc^2}} + \frac{v}{c}\right)\sin\alpha\right) \qquad (770)$$

and to the angle γ according to the kind of photon:

$$\gamma_\gamma = \arg \underline{c} + \arccos\left(\left(\frac{1}{\rho_0\omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{rc^2}} + \frac{v}{c}\right)\sin\alpha\right) + \frac{\pi}{4} \quad \text{Time-like photons} \qquad (771)$$

$$\gamma_{\bar{\gamma}} = -\arg \underline{c} - \arcsin\left(\left(\frac{1}{\rho_0\omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{rc^2}} + \frac{v}{c}\right)\sin\alpha\right) + \frac{\pi}{4} \quad \text{Space-like photons} \qquad (772)$$

$$\gamma_\nu = -\arg \underline{c} + \arcsin\left(\left(\frac{1}{\rho_0\omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{rc^2}} + \frac{v}{c}\right)\cos\alpha\right) - \frac{\pi}{4} \quad \text{Neutrinos} \qquad (773)$$

$$\gamma_{\bar{\nu}} = \arg \underline{c} - \arccos\left(\left(\frac{1}{\rho_0\omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{rc^2}} + \frac{v}{c}\right)\cos\alpha\right) - \frac{\pi}{4} \quad \text{Antineutrinos} \qquad (774)$$

Then, the classic NEWTON's gravitational potential is defined in the following manner:

$$\Phi = \frac{1}{2}\left(\frac{1}{\rho_0\omega_0 t} + \sqrt{\frac{2\tilde{M}\tilde{G}}{rc^2}} + \frac{v}{c}\right)^2 \qquad \text{with} \quad a = -\operatorname{grad}\Phi \qquad (775)$$

As next, we want to examine the relation for the escape-velocity (761) more exactly once again. According to the kind, it's about a propagation-velocity too. After substitution of G by (695) and of $M=\hbar\omega_D/c^2$ we obtain the following relation:

$$v_G = \sqrt{\frac{2\tilde{M}\tilde{G}}{r}} = c\sqrt{\frac{\tilde{R}}{r}\frac{\omega_D}{\omega_1}} = c\sqrt{\frac{\tilde{r}_0}{r}\frac{\omega_D}{\tilde{\omega}_0}} = c\sqrt{\frac{\tilde{r}_0}{r}\frac{\omega_0-\tilde{\omega}_0}{\tilde{\omega}_0}} \qquad (776)$$

In this case, ω_D is the DEBROGLIE- angular frequency of an arbitrary particle. We had already determined that „normal" particles (fermions) are reducing the frequency of the metric wave-field within the body. That means, the length r_0 inside the body is stretched (larger Q-factor—smaller propagation-velocity). Outside the body, and this area we now look at, the relations are the other way round. Here, the length r_0 is compressed (smaller Q-factor—larger propagation-velocity). Therefore, the positive sign applies here. But how does the situation look like, when the body consists of antimatter? According to this model, it would have a negative mass and the regions of the stretching and compression would be reordered in turn. Expression (776) for antimatter would read then as follows:

$$v_G = -\sqrt{\frac{-2\tilde{M}\tilde{G}}{r}} = -c\sqrt{\frac{\tilde{R}}{r}\frac{-\omega_D}{\omega_1}} = -c\sqrt{\frac{\tilde{r}_0}{r}\frac{-\omega_D}{\tilde{\omega}_0}} = -c\sqrt{\frac{\tilde{r}_0}{r}\frac{\tilde{\omega}_0-\omega_0}{\tilde{\omega}_0}} \qquad (777)$$

The negative sign of the root-function is applied to antimatter. Expression (777) well agrees with the doctrine, that antimatter even possesses a negative energy. Only, in this model it's about a negative difference energy, which is to be accepted much more easily. Therefore, we must insert the negative sign into the expressions (770-775) whenever the mass is negative. Thus, we are concerned even here with a symmetry-breaking between „normal" and antimatter, which never carries weight because of the nowadays extremely small value of c_M. For the time just after big bang however the magnitude of c_M cannot be disregarded, so that the symmetry-breaking became essential for the further expansion of the universe.

To the conclusion, we already want to examine the influence of the speed-component v_M. This cannot be chosen freely in general, unless, it's about a spacecraft. We want to attempt a gedankenexperiment to it. As already determined any observer is always in the centre of the universe. This is correct in so far, as it is about an empty space (I want to exclude the observer itself). But what does it look like, when this space is not empty, just when the observer is positioned inside the gravitational-field of a body?

Then, we must distinguish two cases. The first case is that where the body in the free fall is unable to move in reference to the attracting body, like e.g. an observer on the earth's surface (inhibited free fall). This is subject to the full influence of the gravitational-field then. There is an attraction, which is identical to a lower Q-factor (= compressed metrics) outside the body. In this case, we must add the value of the escape-velocity to the propagation-velocity c_M of the metric wave-field. The space is just more strongly curved, as normal.

The second case is that of a body in the non-inhibited free fall. This is the legendary elevator-experiment [30]. In this case of course, except for a minor angular aberration to the mass-centre, there is no difference to an observer in an empty space, (only c_M applies). The same case applies to an observer moving in the orbit with the 1st cosmic velocity. Also this is a free case, even associated with the phenomenon „weightlessness".

In this case, only the share c_M may come into effect to the observer. But it can be achieved only, when the speed-component v_M becomes negative. Now however, for an observer in the centre of the universe, always only positive velocities are possible. These are defined toward the world-radius (margin), which is equally far away irrespective of the direction. Thus, all forces exerted on the observer by the marginal singularity cancel themselves, so that the observer remains in the centre.

Now, we had already posed the question, what a negative velocity, if there should be such a one, actually could mean. This is per definitionem a velocity directed from the margin to the centre of the universe, which is only possible, when the observer is outside the centre. We can draw the conclusion from it that an observer being in a gravitational-field but not in the free fall, neither is in the centre of the universe (then, the centre of gravity of the system mass-observer steps in place of this position) or vice-versa:

> *XI. An observer in the free fall stands always in the middle of the universe.*
> *His relative-velocity in reference to the metrics is equal to zero.*

But for an observer in the orbit this is applied only to the radial, not to the tangential component of velocity. For generic speed-vectors, we must already multiply the amount with the cosine of the angle to the radius r. Since almost all matter in the universe is in the free case, it's moving with the metrics (constant wave count vector).

To the better overview, the three cases empty space, gravitational-field and free fall are presented in figure 126 once again. It's about the relations for a mass-system, consisting of „normal" matter.

In the case, that the gravitating mass consists of antimatter, the relations are (with respect to this model) completely different. Now the escape-velocity is negative, as we can recognize in figure 127. That means, an observer (of antimatter) in the free case must have a positive velocity, whereas a freely navigating body of antimatter is moving with a negative velocity.

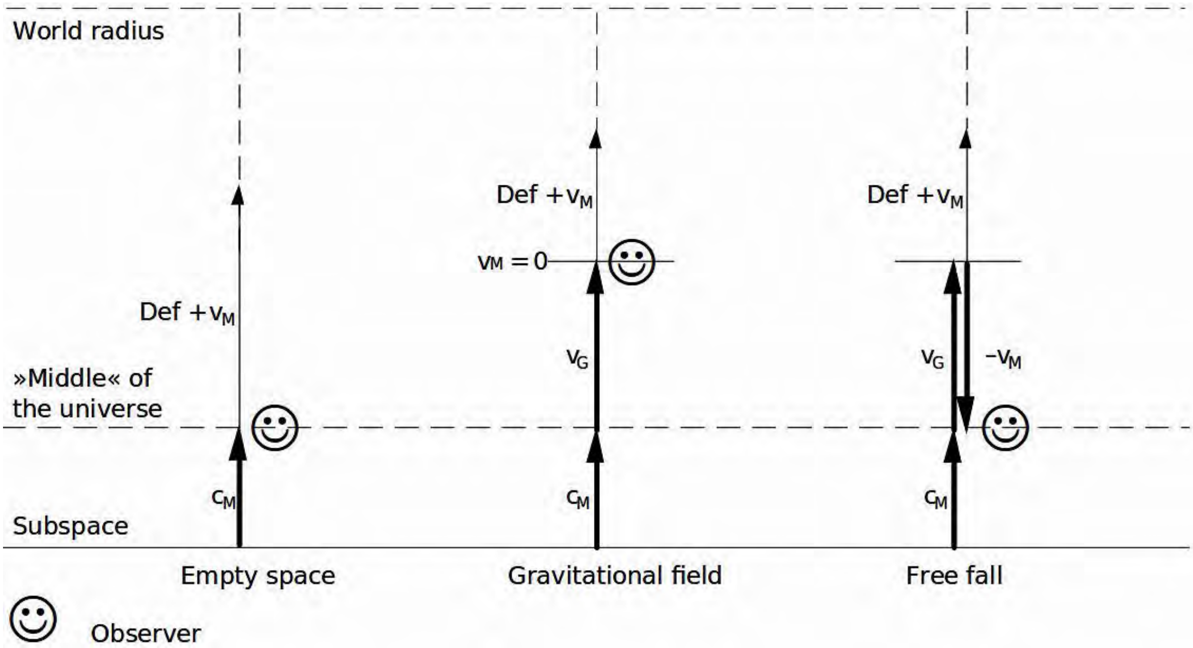


Figure 126
Definition of the velocity and the centre of the universe for the cases empty space, body in the gravitational-field and free fall for „normal" matter

Let's think exactly once again. The velocity c is defined as $c=\omega_0 r_0$ whereas for an any velocity v the expression $v=\omega_V r_0$ applies.

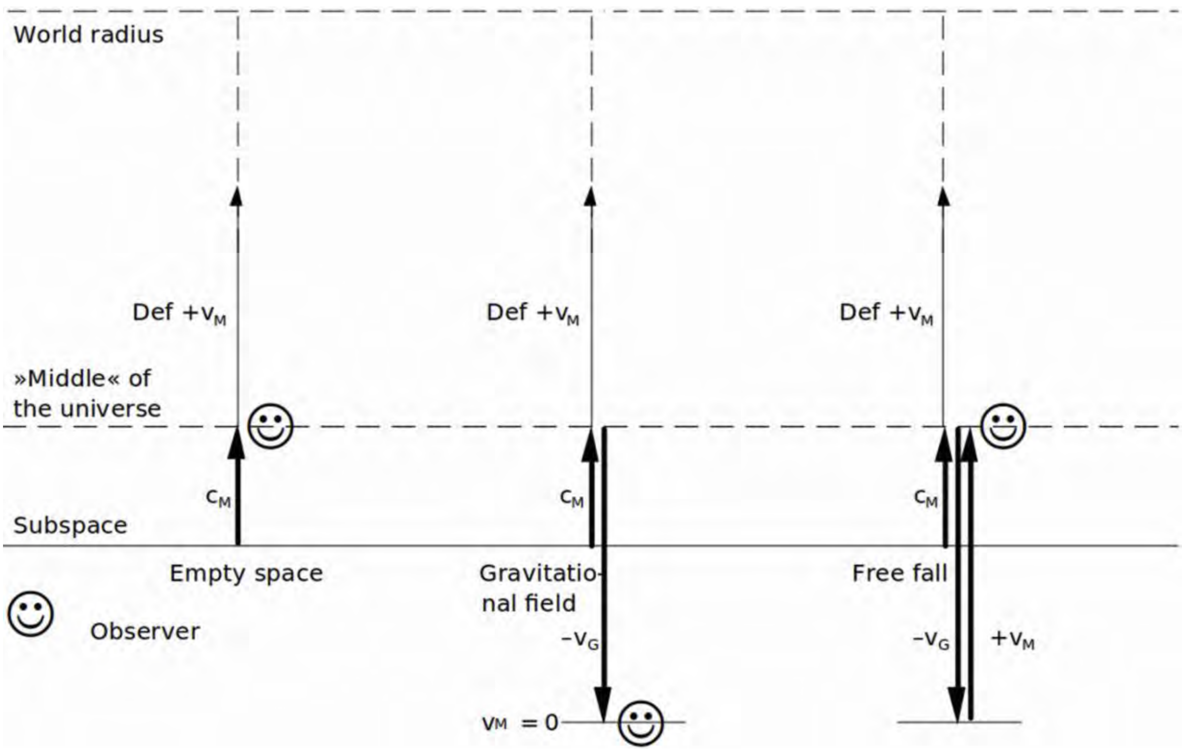


Figure 127
Definition of the velocity and the centre of the universe for the cases empty space, body in the gravitational-field and free fall for antimatter

Thus, we obtain a frequency ω_V which is equal to the number of line-elements, a body with the velocity v within a certain time period „streaks". As we know, bodies of antimatter are having a negative (difference-)energy. Thus, the difference-frequency becomes negative too, which leads to the result, that material bodies of antimatter are moving with a negative velocity — opposite to „normal" bodies. This is a generally accepted statement.

The summary-speed of a body in the free fall in reference to the metrics (as well of matter as of antimatter) in both cases turns out zero. Only the temporal share ct remains then, i.e. almost all bodies are moving on plain time-like world-lines in the average, whose propagation is caused by the continuous increase of the phase-angle $2\omega_0 t$ Another conclusion is that two bodies, the first of matter, the second of antimatter, would repel each other.

7.2.3. LORENTZ-transformation and addition of velocities

With (759) we have formulated the line-element of this model. Before further examination we must still deal with another problem, which actually belongs to the preceding section, the transformation and addition of velocities. From the SRT, we know a relation for the addition of velocities, which is liked to consult as example for the opinion, that velocities greater than c are impossible. In terms of physics, this is wrong however. In reality, such velocities are possible perfectly well and they are prohibited by no means. According to the classic EINSTEIN theory, these can never be achieved, because the energy $W = Mc^2$ contained in the matter is not enough for that purpose. With 100-percent efficiency c is exactly achieved in that moment, when all fuel, inclusive drive etc. and even the crew, just the entire mass M has been converted to radiation.

Now, we did not used the addition-theorem for velocities in the previous section but added airily all three vectorial part-velocities in fact. This has a specific reason, which applies even in accordance with the classic theory: All three velocities are defined in reference to the same frame of reference. But the addition-theorem applies only, when the velocity v′ is defined in reference to another frame of reference, which in turn is moving with a velocity v, in reference to the observer:

$$v'' = \frac{v + v'}{1 + \frac{vv'}{c^2}} \qquad \text{Classic speed-addition} \qquad (778)$$

Does this relation now apply in our model too? This is an important question, which we have to answer here and now. It is closely connected with the coefficient of the LORENTZ-transformation $\beta = (-g_{00})^{-1/2}$ (SRT-sign-convention). Therefore, we want to deal with this at first. According to [30] β is equal to the cosine of the angle ξ describing the rotation of the coordinate-system in the (x,t)-plane, which is caused by the velocity v:

$$\cos\xi = \frac{1}{\sec\xi} = \frac{1}{\sqrt{1 + \tan^2\xi}} = \frac{1}{\sqrt{1 - v^2/c^2}} \qquad (779)$$

This expression is identical to the classic dilatation-factor of the SRT and can be figured as special-case of this model, when the angle θ (209) is equal to –π/4, just with very large Q-factors. In order to answer the question asked above, we will derive the relation exactly once again, whereby we closely want to follow [30].

Two inertial-systems S and S′ (free fall) are starting point, whose coordinate-origins are of line at the beginning. In both frames of reference, the clocks are synchronized (t = t′ = 0). Mathematically, the problem is described by the coordinate-transformation:

$$S'[t',x',y',z'] = \mathcal{L}\{S[t,x,y,z]\} \tag{780}$$

at which point the system S′ should move with the velocity v in reference to S. This transformation is even called LORENTZ-transformation ($\mathcal{L}$). If we now send out a light-flash from the origin, so this will propagate with the velocity c, whereby we will observe it differently in both systems. Since it is about the same event, the problem can be traced back on the equating of the two (real) MINKOWSKIan line-elements, whereby we will always use the sign-convention of the SRT in this section:

$$x^2 + y^2 + z^2 - c^2t^2 = x'^2 + y'^2 + z'^2 - c^2t'^2 \tag{781}$$

In an isotropic space and if the motion of S′ takes place only in x-direction, applies $y' = y$ and $z' = z$, which reduces the problem to the relation:

$$x^2 - c^2t^2 = x'^2 - c^2t'^2 \qquad \text{resp.} \qquad r^2 - c^2t^2 = r'^2 - c^2t'^2 \tag{782}$$

In contrast to [30] we want to work on with the second relation (polar-coordinates) which, in terms of mathematics does not make any difference. Thus, the model can be brought much better in accord with our new photon-model, when the r-axis coincides with the r-axis of the expansion-graph. In contrast to [30] in turn we will exchange the axes however. Never fear, we will get the same result nonetheless. Furthermore, we introduce imaginary time-coordinates,

$$T = jct \qquad T' = jct' \tag{783}$$

which are perpendicular to the other, already existing coordinates of the expansion-graph and put up an additional tangentially-space at each point. Thus, we have answered the question, whereabouts the sum of the plenty speed-vectors we have introduced until now, actually aims in. They don't run along the expansion-graph but into the tangentially-space. Therefore it also makes no odds, if they move away from the expansion-graph all-too much. The exact relations ($\alpha = \pi/2$) are presented in figure 128.

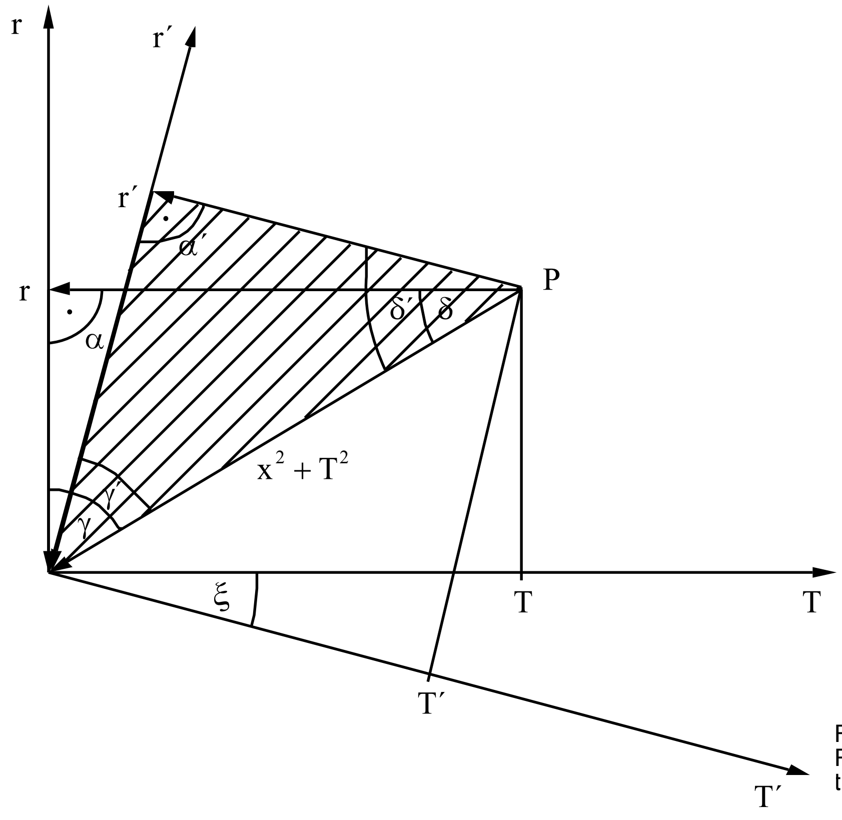


Figure 128
Rotation in the (T,r)-plane during the LORENTZ-transformation

After insertion of (783) in (782) we obtain the following expression:

$$r^2 + T^2 = r'^2 + T'^2 = \rho^2 \tag{784}$$

For $v=0$ both frames of reference coincide and the angles are equal to the angles α, γ and δ of the preceding sections. With it, we have been able to bring in accord the classic case with our new photon-model. In this case, r corresponds to the metric vector c_M, T to the time-like vector c_γ and ρ to the zero vector c. This is inevitably alike in both systems. Let's have a look at (784) more exactly, so it's about the relation for the radius ρ of a circle and this points on the point P. Now, let's rotate the coordinate-system S' , instead of the point P, at which point the size of ρ doesn't change. In this connection, the rotatory-angle is represented by ξ.

Now, the observer B' should move together with his frame of reference with the velocity v in reference to S, whereby r specifies the distance between S and S' . Therefore, the velocity v' of S' in reference to the inherent frame of reference S' and with it even the distance r' of the observer B' in reference to the coordinate-origin of S' is equal to zero. It applies:

$$r' = 0 \qquad r = vt \qquad r = -j\frac{v}{c}T \tag{785}$$

We obtain the right expression by insertion of (783) into the middle expression. Now, with a rotation of the coordinate-system according to [21] the following relations apply:

$$r' = r\cos\xi + T\sin\xi \qquad T' = -r\sin\xi + T\cos\xi \tag{786}$$

$$0 = r\cos\xi + T\sin\xi \qquad \text{because of (785)} \tag{787}$$

The angle ξ is actually negative however. If we define it positive from now on, after substitution of the right expression of (785) applies for r:

$$0 = -j\frac{v}{c}T\cos\xi - T\sin\xi \qquad \text{resp.} \qquad j\frac{v}{c}\cos\xi = \sin\xi \tag{788}$$

$$\tan\xi = j\frac{v}{c} \qquad \text{resp.} \qquad \xi = \arctan j\frac{v}{c} = j\,\mathrm{artanh}\frac{v}{c} \tag{789}$$

$$\cos\xi = \frac{1}{\sqrt{1+\tan^2\xi}} = \frac{1}{\sqrt{1-v^2/c^2}} = \frac{1}{\sqrt{-g_{00}}} = \beta \tag{790}$$

If we take up a comparison of coefficients, we get the following important expressions:

$$\cos\xi = \frac{1}{\cos\delta} \qquad \xi = j\,\mathrm{artanh}\sin\delta = j\,\mathrm{artanh}\frac{v}{c} \qquad \sin\delta = \frac{v}{c} \tag{791}$$

The relations for the LORENTZ-transforms finally can be determined by rearrangement of (786) and substitution of (785):

$$r' = \cos\xi(r + T\tan\xi) = \beta[r + jct(jv/c)] = \beta(r - vt) \tag{792}$$

$$T' = jct' = \cos\xi(-r\tan\xi + T) = \beta[-r(jv/c) + jct] \qquad |:jc \tag{793}$$

$$t' = \beta\left(t - vr/c^2\right) \tag{794}$$

and in summary:

$$t' = \beta\left(t - vr/c^2\right),\ r' = \beta(r - vt), \quad \vartheta' = \vartheta, \quad \phi' = \phi \qquad \text{Classical} \tag{795}$$

Now, according to [30] he sum of two velocities arises from the addition of the angles ξ. By analogy with the addition-theorem of the area-functions applies:

$$j\left(\operatorname{artanh}\frac{v}{c} + \operatorname{artanh}\frac{v'}{c}\right) = j\operatorname{artanh}\frac{\frac{v}{c}+\frac{v'}{c}}{1+\frac{vv'}{c^2}} \tag{796}$$

$$\tan\xi'' = j\frac{v''}{c} = j\frac{\frac{v}{c}+\frac{v'}{c}}{1+\frac{vv'}{c^2}} \qquad \text{as always} \tag{797}$$

It becomes interesting, when the angle α is unlike $\pi/2$, as in our model. For that purpose, let's have a look at the expressions for the LORENTZ-transformation next in turn. If we assume, that a rotation of the coordinate-system into the tangentially-space, which is described by the relations (786) occurs even here, we must look once again for an expression for the angle ξ describing this rotation. Inevitably this will differ from (789). In the special-case $\alpha = \pi/2$ however it must turn out the same solution. The substitution (783) applies even in this case, since we want to work with a rectangular coordinate-system.

From the examinations done in the antecedent sections, we know that

$$\cos\xi \equiv \frac{1}{\sqrt{-g_{00}}} = \beta_\gamma \approx \beta \tag{798}$$

must apply. If we just assume, that this is the case, using the component g_{00} from our line-element (759) we get the following expressions for the trigonometric functions and the value of the angle ξ:

$$\cos\xi \equiv \frac{1}{\sqrt{-g_{00}}} = \frac{\sin\alpha}{\sin\gamma_\gamma} = \beta_\gamma \approx \beta \tag{799}$$

$$\sin\xi \equiv j\sqrt{\frac{1}{-g_{00}} - 1} = j\sqrt{\frac{\sin^2\alpha}{\sin^2\gamma_\gamma} - 1} \tag{800}$$

$$\tan\xi \equiv j\sqrt{1+g_{00}} = j\sqrt{1 - \frac{\sin^2\gamma_\gamma}{\sin^2\alpha}} \approx j\frac{v}{c} \tag{801}$$

$$\xi \equiv j\operatorname{artanh}\sqrt{1+g_{00}} = j\operatorname{artanh}\sqrt{1-\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}} \approx j\operatorname{artanh}\frac{v}{c} \tag{802}$$

To the determination of the LORENTZ-transform we proceed by analogy with the classic case:

$$r' = \cos\xi(r + T\tan\xi) = \frac{1}{\sqrt{-g_{00}}}\left(r + jT\sqrt{1+g_{00}}\right) = \frac{1}{\sqrt{-g_{00}}}\left(r - ct\sqrt{1+g_{00}}\right) \tag{803}$$

$$T' = jct' = \cos\xi\left(T - r\tan\xi\right) = \frac{1}{\sqrt{-g_{00}}}\left(jct - jr\sqrt{1+g_{00}}\right) \qquad |:jc \tag{804}$$

$$t' = \frac{1}{\sqrt{-g_{00}}}\left(t - \frac{r}{c}\sqrt{1+g_{00}}\right) \tag{805}$$

and in summary:

$$t' = \frac{1}{\sqrt{-g_{00}}}\left(t - \frac{r}{c}\sqrt{1+g_{00}}\right), \quad r' = \frac{1}{\sqrt{-g_{00}}}\left(r - ct\sqrt{1+g_{00}}\right), \quad \vartheta' = \vartheta, \quad \phi' = \phi \tag{806}$$

Btw. these relations apply independently from our model and using „our“ g_{00} even simultaneously for influences of velocity, matter-distribution, distance and time, just in general (SRT+ART). In the special-case $\alpha=\pi/2$ (806) yields the classic solution of the LORENTZ-transform. With velocities $v \ll c$ the solution graduates into the one of the GALILEI-transformation. We have found a contradiction-free solution, which fills the made requests, with it.

Now, we want to deal with the addition-theorem of the velocities. One can assume that the individual angles ξ will add up again even here. Thus, the following relation applies $\xi'' = \xi + \xi'$, respectively:

$$\xi'' = j\left(\operatorname{artanh}\sqrt{1+g_{00}} + \operatorname{artanh}\sqrt{1+g'_{00}}\right) = j\operatorname{artanh}\frac{\sqrt{1+g_{00}} + \sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}} \tag{807}$$

$$\sqrt{1+g''_{00}} = \frac{\sqrt{1+g_{00}} + \sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}} \tag{808}$$

$$-g''_{00} = 1 - \left(\frac{\sqrt{1+g_{00}} + \sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}}\right)^2 = X^2 \tag{809}$$

$$\sqrt{-g''_{00}} = \frac{v''}{c}\cos\alpha'' + \sqrt{1 - \frac{v''^2}{c^2}\sin^2\alpha''} = X \tag{810}$$

$$\sqrt{1 - \frac{v''^2}{c^2}\sin^2\alpha''} = X - \frac{v''}{c}\cos\alpha'' \qquad \frac{v''^2}{c^2} - 2\left(X\cos\alpha''\right)\frac{v''}{c} + \left(X^2 - 1\right) = 0 \tag{811}$$

$$\frac{v''_{1,2}}{c} = X\cos\alpha'' \pm \sqrt{1 - X^2\sin^2\alpha''} \tag{812}$$

The upper sign is applied to time-like vectors

$$\frac{v''_{1,2}}{c} = \sqrt{1 - \left(\frac{\sqrt{1+g_{00}} + \sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}}\right)^2}\cos\alpha'' \pm \sqrt{1 - \left(1 - \left(\frac{\sqrt{1+g_{00}} + \sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}}\right)^2\right)\sin^2\alpha''}$$

(813) ↑

For $\alpha''=\pi/2$ the solution (813) turns out the classic expression (778). In contrast to (806) applies (813) but not independently from our model, but (808) applies. The reason is, that we have reduced the left side with respect to v'' and this depends on the used line-element of course. Combining (808) with the line-element of this model even problems of the URT can be solved with it. A good example is the special-case on the three-body-problem, if all three bodies are in a line (opposition or conjunction). Then the shares add up linearly only then, when the curvature is not all too large.

Even if one does not see it so clearly, a problem turns out here, which there is none in the classic case raising a whole lot of more questions. So, we require from the frame of reference, which is moving with v, additionally to the detail of the velocity v' also the angle α', which results from the conditions in the system S′. These however depend on the velocity v, with which this system is moving in reference to the frame of reference S. In contrast, the angle α is well-known. To the calculation of (813) we already require the angle α'' in addition. This is unknown too.

Before we want to examine the different solving-options, we will do a gedankenexperiment first of all: If we assume, that the observer in S is in the free fall, so he is in the middle of the universe, he doesn't move in reference to the metrics and he is positioned on the expansion-graph, at which the angle α is defined at the same time. The second observer should now be located in the system S′. If he moves in reference to S with a velocity greater than determined by the distance-function, so he is now in the tangentially-space outside the expansion-graph seen from S. Thus, each observer, who is not in the free fall, is always in the tangentially-space. Now, we come to an important question:

Where is the observer in S′ situated seen by himself?

We cannot answer this question without further ado. There are several options, which are closely connected with the definition of the angle α':

1. *The angle α is the same for all observers and only a function of time.*

   In this case, all observers would be located on the same point of the expansion-graph. This would be the classic case of the genuine MINKOWSKIan line-element. Then, different velocities have only a different rotation of the various coordinate-systems to the consequence. This case obviously disagrees with relation (734) as per which the Q-factor and with it α depend on the distance.

   Status: rejected.

2. *The angle α depends only on distance (and time).*

   Then the observer in S and with it each observer, seen by itself, always would be situated on the expansion-graph. But this disagrees with the above mentioned statement, that an observer being not in the free fall is always in the tangentially-space. When both conditions shall be coincidently fulfilled, an observer, seen by itself, would have to be always in the free fall, which is not correct (conditions at the earth's surface). Also one could say that we would introduce an absolute frame of reference with it. But since there is an inherent „absolute“ frame of reference for each observer, which is different from the others, the special relativity-principle is not violated.

   Status: not impossible but not very probable.

3. *The angle a depends on the time, distance and the velocity.*

   Then an observer, seen by itself, would be on the expansion-graph only then, when he is in the free fall. In all other cases, he would be in the tangentially-space. This case appears to be most probable. Then however, there should be an expression for the Q-factor as a function of the velocity. But since the Q-factor (phase-angle) also determines the size of the angle α, even this would depend on the velocity with it. Another question results from it then again: Does the value of α arise from the conditions before or after the addition of the other velocity-components? At least it is to be understood that an observer sees even the size of r_0 shortened, since with motion with the velocity v all distances are observed shortened about the factor $\approx\beta^{-1}$. Since the value of r_0 is linked via the relation $r_0 = r_1Q_0$, also Q_0 changes with it (r_1 is fixed). Against a fixation of α before the addition of the other components speaks, that these would no longer be equal then. But this is really the case, because we can cancel the shares $\mathbf{v}_G$ and $\mathbf{v}_M$, in that we move with negative velocity indeed, but the share $\mathbf{c}_M$ not at all. Latter one actually sticks out on it's own into the tangentially-space, even if the velocity with respect to the metrics is zero.

Status: very probable.

We just want to favour the third option. But we want for a function, which figures the dependence of Q_0' on the velocity, to it. This should redeem certain requirements. So, in the approximation with large initial-Q_0, relation (597) should apply. If the velocity is equal to c, a Q-factor of 1 should turn out and there should be a certain asymmetry with small initial-Q-factors ($Q_0(c)$ only ≈ 1). With (596) in section 6.1.2.1. we already found such a function, although on a system without expansion. But if we limit the validity of the sought relation to a time period dt—with small Q-factors each frame of reference lapses after a short time anyway—then (596) can be used even in the case of a metrics with expansion, because for the time period dt the expansion plays no role.

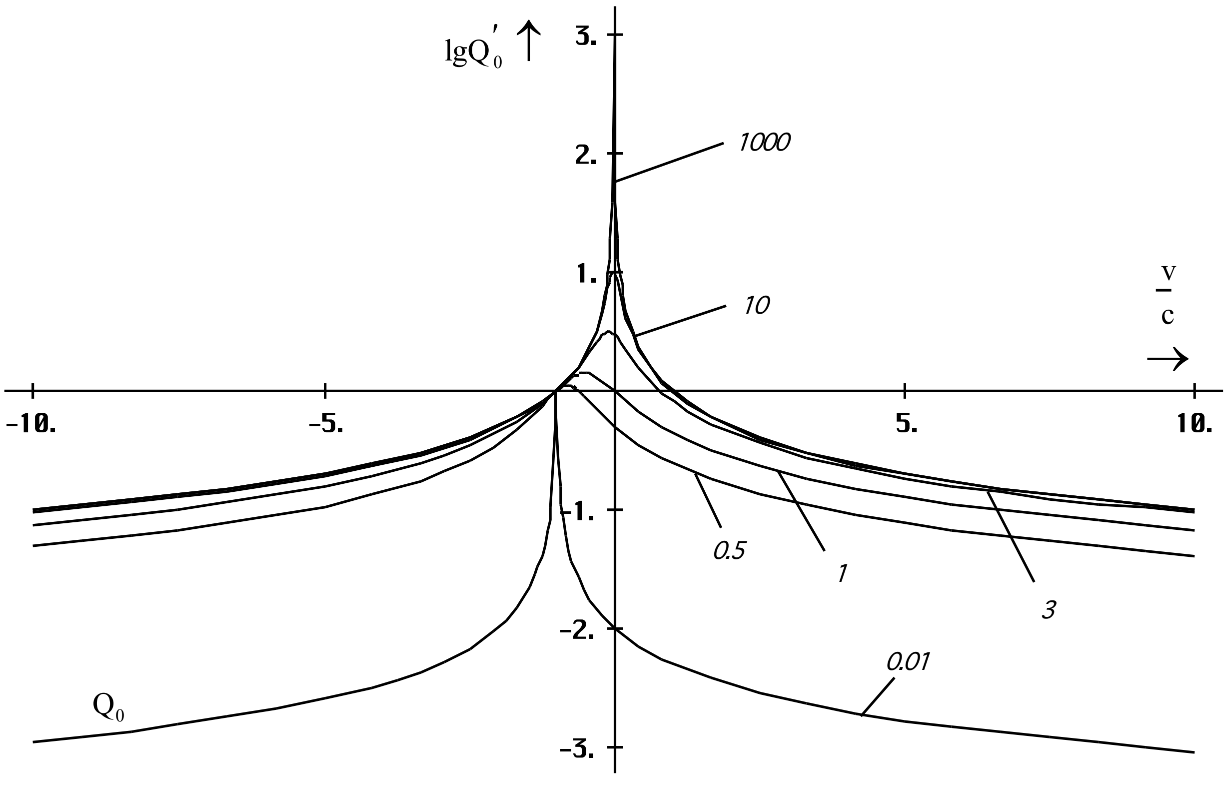


Figure 129
Course of the Q-factor being relevant for the system S´ with respect to the velocity in reference to the system S (metrics) for $Q_0 \leq 10^3$.

But since Q_0' additionally should depend on distance and time, yet the navigation-gradient must be integrated in (596). It applies:

$$\tilde{Q}_0' = \frac{\tilde{Q}_0}{\sqrt{\left(1+\frac{v}{c}\right)^2+\tilde{Q}_0^2\frac{v^2}{c^2}}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) \qquad \text{Velocity vs. metrics} \qquad (814)$$

That means, at the „edge of the universe“ the Q-factor turns to zero. If we once have determined the initial-Q-factor Q_0' for the system S′, we are able to determine all other corresponding values without any difficulties too, including the angle α'. The logarithmic course of (814) for several initial-Q-factors is presented in figure 129.

What does it look like however with the angle α''? In terms of figures, we not necessarily require this to the solution of (813), since α'' even somehow depends on v''. However there is no explicit solution then. In order to describe the exact relations during the addition of velocities according to (813), the effect of different angles $\alpha^{(n)}$ is pictured in figure 130 by means of vectors.

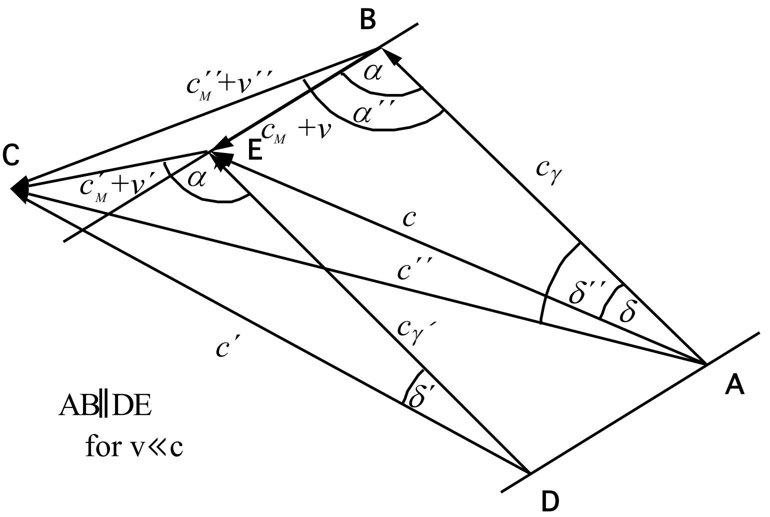


Figure 130
Effect of different angles α on the addition of speed-vectors (schematic presentation)

Input variables are the vectors BE and EC as well as the angles α and α' at this place. Wanted is the vector BC and the associated angle α''. But figure 130 merely describes the effect of the different angles α on the velocity-addition in the subspace. The rotation of the coordinate-systems S′ and S″ caused by the share $\tan\xi$, is unaccounted for in this place. Therefore, the distance BC doesn't equal the real velocity v'' which is observed from inside the system S. Therefore, figure 130 neither can be used for the determination of this velocity with the help of trigonometrical relations. The same is applied even to the angle α''. To determine this, there is more than one option. One proceeding to determine the value of α'' is the repeated application of (814), using Q_0' and v' as input variable on the second run. This way, we first get the value Q_0'' with whose help all other associated values can be determined in turn, including α''. The whole issue works even if the observers are exchanged, although only under the condition, that the Q-factor really depends on the velocity.

A so far unknown problem however arises with application of (814). So, the velocity in (814) is defined with respect to the metrics. Now however, all relativistic relations always refer to the matter of fact, that the speed of light is constantly c. Since we have done the assumption in the first sections, that the speed of light in this model is also constantly c in fact, but not in reference to the metrics but in reference to the subspace, a contradiction arises here concerning the velocity v.

If we have applied the expression v for the velocity anywhere, so this is always related to the subspace with it. Since there is no subspace known in the SRT therefore always the velocity in reference to a frame of reference is meant, which usually (but not always) is assumed as resting. In general (if no rotation comes into play) this is associated with the free fall. But by analogy with our model the free fall is being granted, whenever an observer/body/particle doesn't move in reference to the metrics. Now, this observer in the free fall, according to this model, still is moving in reference to the subspace ($\mathbf{c_M}$) then again, for which reason we added the share $\mathbf{c_M}$(v=0) to a velocity defined in reference to the metrics (only this can be measured) in all cases with the exception of figure 119, which leads to the shifting of the functions towards a negative v, as we can well recognize e.g. in figure 107-110.

Now of course, it's possible to calculate even with the velocity in reference to the subspace. Then, (814) would have to be altered in the following manner:

$$\tilde{Q}_0' = \frac{\tilde{Q}_0}{\sqrt{\left(1+\frac{v-\tilde{c}_M}{c}\right)^2 + \tilde{Q}_0^2\,\frac{\left(v-\tilde{c}_M\right)^2}{c^2}}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) \qquad \text{Velocity vs. subspace} \qquad (815)$$

In both cases there is however another essential circumstance to take into account. If the relativistic mass-increase is calculated with e.g. the help of the relativistic dilatation-factor β $\dot{\gamma}$, at which point the velocity is referred to the subspace, so, beside v as further input variable even the rest mass m_0 is needed. According to the SRT, this is defined as the one mass a body owns, when it doesn't move in reference to the frame of reference. In this case however, this frame of reference is the subspace and the body cannot be in rest to it, because the metrics, even if the body remains in rest to the metrics, still is moving with the velocity $\mathbf{c_M}$ in reference to the subspace. And this share neither can be balanced by a negative velocity, since the body is in the centre of the universe simultaneously, so that only positive velocities are defined, directed onto the world-radius.

With small initial-Q-factors, this share $\mathbf{c_M}$ can take on a magnitude, which no longer can be disregarded, so that $\beta\dot{\gamma}$ already at v=0 in reference to the metrics has a value, which strongly differs from 1. Now let's apply the „classic“ value, determined in accordance with the SRT, i.e. with a velocity of zero in reference to the metrics, so we'll get a wrong result, because with v=0 the relativistic mass should have to be equal to m_0 then. But this is not the case. Although, with normal conditions, this difference appears only from the 30th decimal place on, we cannot disregard it.

In order to reduce this contradiction, we are forced to redefine the quantities rest mass, rest-length, rest-period etc. From now on, we want to mark the value in effect with a velocity of zero in reference to the subspace as UR-rest-mass/-length/-period etc. and, since already many times used, we want to maintain the designations m_0, x_0, t_0… for them. The „classic“ value for a velocity of zero in reference to the metrics on the other hand, we will mark as SR-rest-mass/-length/-time period from now on, using the variables m_*, x_*, t_*… *… etc. for them. Whereas there is no need to redefine the SR-rest-mass/-length/…, to the UR-rest-mass/-length/… the following definitions apply:

> *The UR-rest-mass/-length/... etc. is equal to the mass/length/... etc. at a gravitational field strength (gravitational potential $-g_{00}$) of 1.*

These would be the conditions in a true MINKOWSKIan space. So, the UR-rest-mass/… even could be called the MINKOWSKIan rest-mass/… Although, this is not identical to the rest-mass/… at the point of time $T\rightarrow\infty$, since then the cosmologic red-shift, caused by the expansion of the metrics, would not have been considered. Both, UR- as well as SR-rest-mass/… still remain reference-frame-dependent quantities with it.

Because of the two options of definition for the velocity v and the two rest masses/-lengths… with it four different combinations turn out on the calculation of the relativistic mass/length… etc. We want to consider this at the example of the relativistic mass-increase more exactly. Based on (612) and (655) applies:

$$m = m_0 \frac{\sin\alpha}{\sin\gamma_{\tilde{\gamma}}(v-\tilde{c}_M)} \qquad \text{v-subspace UR-rest-mass} \qquad (816)$$

According to (612) $\mathbf{c_M}$ is already contained in $\gamma_{\tilde{\gamma}}$. Therefore, we must subtract this part. The function-course of β_x ($x=\gamma, \overline{\gamma}, \nu, \overline{\nu}$) distinguishes itself by the fact, that all graphs at v=0 go through the point 1 and there is no shifting in v-direction. If we define the velocity in reference to the metrics, which is the normal case, so we have to modify (816) as follows:

$$m = m_0 \frac{\sin\alpha}{\sin\gamma_{\tilde{\gamma}}(v)} \qquad \text{v-metrics UR-rest-mass} \qquad (817)$$

If not separately declared, all formulae and graphic representations in this work are based on this combination. Examples are presented in the figures 107…110, 113 and in figure 114. What does it look like however, if we do not want to work with the UR-rest-mass, which is only an imagined value, but with the SR-rest-mass, which one can really measure? Is there a relation, with whose help both can be converted in one another? This is the case indeed, there are actually four relations in sum:

$$m_0 = m_* \frac{\sin\gamma_{\tilde{\gamma}}(0)}{\sin\alpha} = m_* \frac{\sin\tilde{\gamma}_{\tilde{\gamma}}}{\sin\alpha} \qquad \text{Mass space-like}$$

$$x_0 = x_* \frac{\sin\alpha}{\sin\gamma_\gamma(0)} = x_* \frac{\sin\alpha}{\sin\tilde{\gamma}_\gamma} \qquad \text{Length time-like}$$

$$\lambda_0 = \lambda_* \frac{-\cos\alpha}{\sin\gamma_\nu(0)} = \lambda_* \frac{-\cos\alpha}{\sin\tilde{\gamma}_\nu} \qquad \text{Wavelength neutrino} \qquad (818)$$

$$\lambda_0 = \lambda_* \frac{\cos\alpha}{\sin\gamma_{\bar{\nu}}(0)} = \lambda_* \frac{\cos\alpha}{\sin\tilde{\gamma}_{\bar{\nu}}} \qquad \text{Wavelength antineutrino}$$

In this connection, the velocity is referred to the metrics once again. With the neutrinos it's to be recognized that the difference between both wavelengths under normal-conditions (Q_0) is vast. Now, using the first expression of (818) in (816) and (817) we obtain the missing two combinations:

$$m = m_* \frac{\sin\gamma_{\tilde{\gamma}}(-\tilde{c}_M)}{\sin\gamma_{\tilde{\gamma}}(v-\tilde{c}_M)} \qquad \text{v-subspace SR-rest-mass} \qquad (819)$$

$$m = m_* \frac{\sin\gamma_{\tilde{\gamma}}(0)}{\sin\gamma_{\tilde{\gamma}}(v)} = m_* \frac{\sin\tilde{\gamma}_{\tilde{\gamma}}}{\sin\gamma_{\tilde{\gamma}}} \qquad \text{v-metrics SR-rest-mass} \qquad (820)$$

It shows, the expressions sinα cancel each other, because the vectors $\mathbf{c_M}$ and $\mathbf{v_M}$ point into the same direction and the angle α always derives from the frame of reference ($\mathbf{c_M}$) The same applies even to the time-like expressions and to the neutrinos by the way, even if the reciprocal comes into effect for them. At the neutrinos, instead of sinα the value cosα cancels out including the sign. Thus, simplifying we can say, only the expression sinα as well as ±cosα must be replaced by the equivalent $\sin\gamma_x$ ($x=\gamma, \overline{\gamma}, \nu, \overline{\nu}$), if we want to use the SR-rest-value instead of the UR-rest-value. Btw. this applies even to expressions being differentiated or integrated, as e.g. the tensor-expressions at the end of this work, because α and $\tilde{\gamma}$ are constants.

After all, these relations apply independently, whether the Q-factor Q_0' depends on the velocity or not. In combination of this dependence with the determination of it's commendable to calculate with expression (820). Therefore this combination carries a particular weight. Therefore, the course of $\beta_{\tilde{\gamma}}$ for certain Q-factors $Q_0 \leq 10^3$ is shown in figure 131 once again, in order to work out the difference to figure 108 more exactly. With larger Q-factors there is no difference anyway (identical to figure 105). In terms of physics, it's about the same phenomenon however. The different courses are caused by the different definition of velocity and rest mass only.

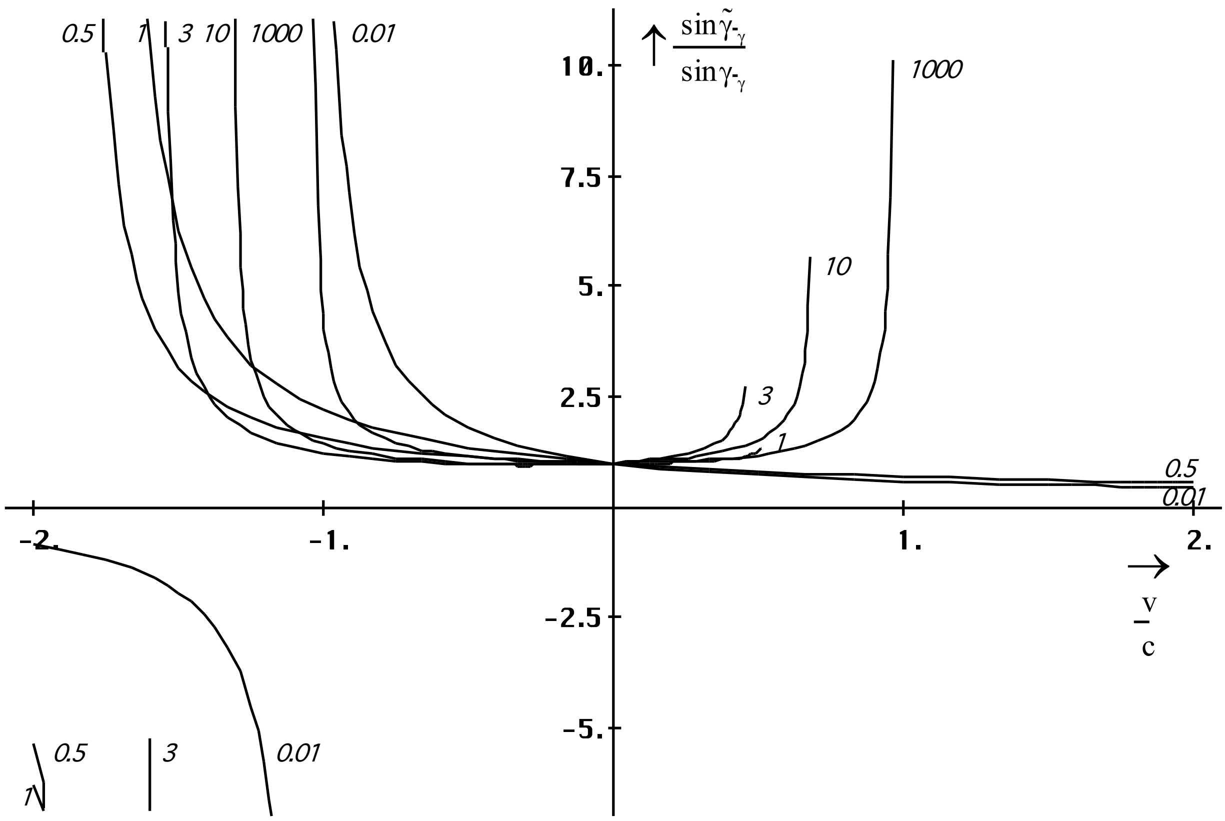


Figure 131
Course of the relativistic mass-increase in dependence of the velocity in reference to the metrics under application of the SR-rest-mass for Q-factors $Q_0 \leq 10^3$.

Since even this problem has been solved now, another question remains open: What like is the speed-component $\mathbf{v_G}$, caused by the gravitative action of a nearly located mass-affected body, to be classified? This share is to assign to the metric share $\mathbf{c_M}$ definitely, because the properties of space outside this body really change in such a manner, as if there would be a lower Q-factor. This applies independently from the fact, that this share (at least temporarily up to the impact) can be evened out by a negative velocity. Let's recapitulate once again. We said, that a lot of the MLE´s inside the body are quasi pressed-out by the space-demanding action of the particles from which it consists. As a result the metric lattice outside is compressed, which leads to a smaller value of the PLANCK's fundamental length r_0. These are however exactly the qualities of a space-segment with smaller Q-factor.

If the Q-factor really should depend on the velocity, another last, further effect arises. If a body is moving with the velocity v in reference to the frame of reference S and we put the centre of the frame of reference S′ into the centre of this body, so the velocity of S′ in reference to the subspace must be of the same size, irrespective of the frame of reference on which the observation takes place. If the velocity in reference to S has a value v, so the velocity v′ of S′ in reference to the metrics does not have the value zero, as expected, even if assuming the value Q_0' for S′. Rather, it has a value different from zero. This is based on observations and on the fact that c_M never can be greater than 0.851661c. Another reason is, that S′ is no longer in the middle of the universe then. We just can say, only a body in the free fall, which is in the centre of the universe, doesn't move in reference to the metrics. That means furthermore, the value Q_0 measured at an arbitrary position, applies everywhere. It figures something like an universal frame of reference. But the relativity-principle is not injured nevertheless, since there is a quasi infinite number of these „universal" frames of reference, at which point no one of them is marked.

That means, if I accelerate a body, being in rest to the metrics (system S) initially, onto a velocity v in reference to the metrics, so it will move even in its inherent frame of reference with a definite velocity in reference to the metrics.

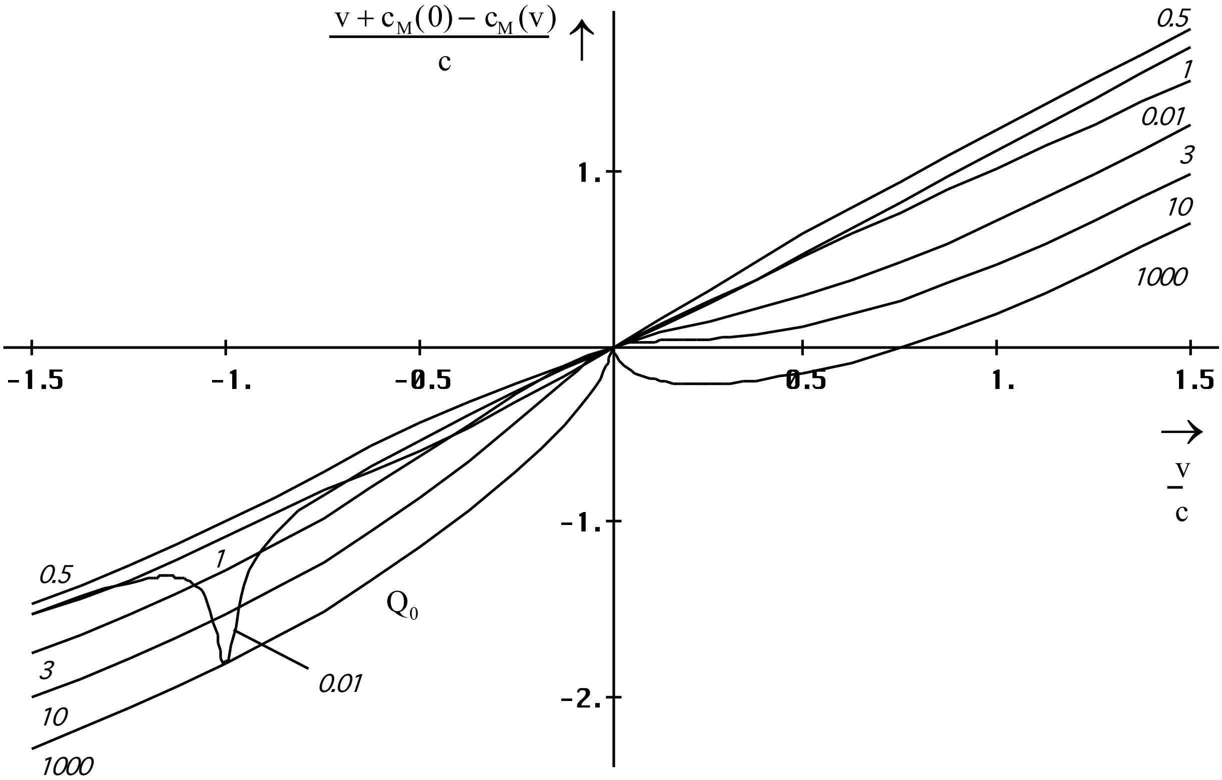


Figure 132
Entrainment-effect during acceleration: Course of the difference-velocity to the metrics in S′ in dependence of the velocity v in reference to the metrics in S for Q-factors $Q_0 \leq 10^3$

The fact, that he measures a lower Q-factor in its inherent system, also means then again that the velocity c_M' is greater than c_M in S, whereat the velocity in reference to the subspace remains constant ($c_M+v=c_M'+v'$). With acceleration so to speak, the body picks up a part of the metrics, it accelerates these. Therefore, I would like to call this effect the entrainment-effect. This is caused by the interaction between body and metrics, which is mediated by the space-like photons. During acceleration the metrics counters the body with a certain resistance (inert mass). As a countermove, on overcoming of this impedance (force), the body entrains a part of the metrics accelerating it in turn (c_M').

During acceleration of the body, just the difference-velocity $v+c_M(0)–c_M(v)$. is changing. The course of the difference-velocity with certain initial-conditions is diagramed in figure 132. In this connection, the velocity v is defined in reference to the metrics and it shows, the difference even can become negative. But with most calculations this can be ignored in peace. One must only know that the velocity in reference to the subspace is constant.

I don't want to brush a possible fourth alternative under the carpet at this point, which means that this model is wrong. Maybe, I have overlooked something…

7.2.4. Principle of the Maximum Gravitative Coupling

We have seen that there are essentially no fundamental contradictions with the idea of the universal relativity, considering this model. Also, we have seen that and why we get involved in a row of additional problems, if we abandon the principle of the minimum gravitative coupling.

Now there is a multiplicity of other models which, already in the formation, are incompatible with the statements done in this model. These are the ones particularly, which are based on a disappearance of the gravitational-»potential« in the infinite. But this is not applied to the statements done by EINSTEIN, because these have been formulated so universally, that they are applicable even to a pure radiation-cosmos and that's about here. If we just want to calculate e.g. the curvature of space, we only must insert the corresponding values of the metric wave-field as output variables.

For a minimum gravitative coupling applies: The mass determines the geometry, but the geometry does not determine the mass. It reigns something like the „free market economy“, the inherent laws of the SRT are independent from those of the URT and therefore we don't require such relation at all. But now, we have the inverse case on hand: The geometry (r_0) determines mass, time, energy, wavelength etc. in all.

Now one could think, there should be even the inverse dependence, namely that, where the mass determines the (local) geometry. Although, the mass is just determined by the relation $M = \hbar\omega_D/c^2$ whereby as well $\hbar$ as ω_D depend on the frame of reference (r_0) in turn. The mass just already somehow is contained in the energy-impulse-tensor of the metric wave-field from which arises, that the field-equations of the URT are filled automatically, a fact, which already d'INVERNO pointed out in [30]. That means, not the mass determines the geometry but only the existence of particles within the metrics, at which point the metrics (the metric wave-field) dictates, how much mass these particles have.

So, all quantities seem to be coupled somehow together. Therefore, I would like to name this new principle the *Principle of the Maximum Gravitative Coupling*. With IX. in section 6.2.7. we already formulated something similar. Here some more detailed:

> *XII. Principle of the Maximum Gravitative Coupling: All physical quantities like space, time, mass, energy, wavelength etc. form a canonical ensemble, at which point the exact values are determined by the phase-angle of the metric wave-function (Q-factor) only. The progression of the phase-angle is synonymous with the progression of time (tics). The existence of fermionic particles resp. particle-concentrations as space-demanding interference of the metric wave-field as well as its existence is cause for the gravitative effects. The boundary between special and universal relativity-theory is annulled.*

7.2.5. Metric functions

After we have formulated the line-element for this model having made even deeper contemplations about the angles in the triangle as well as about their physical meaning and dependences of the discrete coordinates, it's opportune to calculate certain values, which carry a great weight in the SRT. Basis for it is always the metric tensor resp. the line-element, which in terms of physics both characterize the same phenomenon.

7.2.5.1. The metric connection

One of these „certain values“ is the RIEMANN curvature tensor. In order to calculate it, we require a function Γ^{a}_{bc} called the metric connection. According to [30] this is defined as follows:

$$\Gamma^{a}_{bc} = \frac{1}{2} g^{ad}\left(\partial_b g_{dc} + \partial_c g_{db} - \partial_d g_{bc}\right) \tag{821}$$

On this occasion, g^{ad} is equal to the component g_{ad} of the inverse matrix g^{ab} and ∂_b equal to the partial differential-operator $\partial/\partial b$. The rest remains incomprehensible for the reader with „normal“ engineer-education first of all. Unfortunately, one does not go more into detail in literature more often than not.

But since we want to determine the values of our line-element, we don't get around an exact calculation of (821). The simplest way, to understand an expression exactly, is, to try, to automate the calculation. Then, one usually does even no errors, unless, the formula is wrong.

As tool for it, we use the program »Mathematica« in turn, which is, among other things, even able, to calculate the partial derivative (D[f(x),x]). As input-values we are concerned first of all with the matrix of the metric tensor, which we assign to the variable Mx. Furthermore, we require the inverse matrix, which we can compute with the built-in function Inverse[Mx] and another function Di, with whose help, on the basis of the subscript, we can infer the coordinate, with respect to which shall be differentiated. For the genuine MINKOWSKIan line-element we obtain then:

```
Mx={{1, 0, 0, 0}, {0, -1, 0, 0}, {0, 0, -1, 0}, {0, 0, 0, -1}};     (822)
Inx=Inverse[Mx];                                                   (823)
Di=Function[Part[{ct,x,y,z},#+1]];                                 (824)
```

In order to access the individual components of Mx resp. Inx, we define another function MPart[Mx,a,b], whereby the individual coefficients can take on the value $0 \leq a \leq 3$ in each case (Part[x,n] is implemented in »Mathematica«).

The function of the metric connection itself we want to name with MGamma[a,b,c,Mx]. With it, the values a, b, c and Mx a priori are fixed as input variables.

But what's about the component d? This is first no input variable. It's value arises from the EINSTEIN summation convention, which implies, that there is always to be added up across doubly (or multiple) appearing indices, at which point the value-range arises from the input variables, (here 0…3). That means we have to calculate (821) four times in total, whereby the value of d is incremented by one each time, beginning with zero, adding up the results afterwards. That looks as follows in »Mathematica«-notation then:

```
MPart=Function[Part[Part[#1,#2+1],#3+1]];                          (825)
MGamma=Function[For[Mg=0;n=0,n<4,n++,                              (826)
Mg+=(1/2 (MPart[Inverse[#4],#1,n] ) (D[MPart[#4,n,#3],Di[#2]]+
D[MPart[#4,n,#2],Di[#3]]-D[MPart[#4,#2,#3],Di[n]] ))]; Simplify[Mg]];
```

The function Simplify[x] only is used to simplify the result (summarizing of equivalent expressions). Thus, this function has been uniquely defined and we can begin with it's calculation. Altogether there are 64 possible solutions whereby in general only a part of them will be different from zero. Because $\Gamma^a_{bc} = \Gamma^a_{cb}$ applies, it can be derived directly from (821), there are merely 16 independent solutions (bb=bb). But before we'll determine the solutions of our line-element, it's opportune, to calculate first the solutions of the MINKOWSKIan line-element.

With (822) we obtain $\Gamma^a_{bc} = 0$ as solution(s), i.e. all connections vanish. This is synonymous with the disappearance of the RIEMANN curvature tensor, as we will already see, or said more popularly, at the MINKOWSKIan line-element the curvature is equal to zero. Then, we are concerned with an even or flat metrics.

This statement well agrees with the cited facts in [30], our program seems to be just right. How does it look like with spherical coordinates however? This question is important, since our line-element is using spherical coordinates too.

In [30] it states to it: »… In an universal coordinate-system won't necessarily vanish the connection-components however. For example, we find in spherical coordinates that Γ^a_{bc} is having the non-vanishing components

$$\left.\begin{array}{ll} \Gamma^1_{22} = -r; & \Gamma^1_{33} = r\sin^2\vartheta \\ \Gamma^2_{12} = r^{-1}; & \Gamma^2_{33} = -\sin\vartheta\cos\vartheta \\ \Gamma^3_{13} = r^{-1}; & \Gamma^3_{23} = \cot\vartheta \end{array}\right\} \qquad (8.5\ [30])$$

Annotation: $\theta \rightarrow \vartheta$

Let's calculate the RIEMANN Curvature tensor however, so we find $R^a{}_{bcd} = 0$ in turn, as demanded by the theorem (§6.11 [30]).« This appears plausible, but it's unfortunately not correct. In [30] namely there is a misprint. Using the corresponding spherical initial values instead of (822) and (824)

```
Mx={{1, 0, 0, 0},{0, -1, 0, 0},{0, 0, -r^2, 0},{0, 0, 0,-(r^2*Sin[theta]^2)}};
Di=Function[Part[{ct,r,theta,phi},#+1]];
```
(827)

we obtain with the exception of the component Γ^1_{33} the same results, as in (8.5 [30]). The negative sign is missing with Γ^1_{33}. With the exact values:

$$\left.\begin{array}{ll} \Gamma^1_{22} = -r; & \Gamma^1_{33} = -r\sin^2\vartheta \\ \Gamma^2_{12} = r^{-1}; & \Gamma^2_{33} = -\sin\vartheta\cos\vartheta \\ \Gamma^3_{13} = r^{-1}; & \Gamma^3_{23} = \cot\vartheta \end{array}\right\} \qquad (828)$$

the RIEMANN curvature tensor really vanishes. Before however, we first have to compute it. We will do this in the next section.

7.2.5.2. The RIEMANN curvature tensor

This is commonly marked with the symbol $R^a{}_{bcd}$. It is just about a 4^4-matrix with 256 components overall. We take over the definition of the individual components from [30] in turn hoping, that it is correct:

$$R^a{}_{bcd} = \partial_c\Gamma^a_{bd} - \partial_d\Gamma^a_{bc} + \Gamma^e_{bd}\Gamma^a_{ec} - \Gamma^e_{bc}\Gamma^a_{ed} \qquad (829)$$

We name the function to the determination of an individual component of the RIEMANN curvature tensor with Rabcd[a,b,c,d,Mx], at which point the upper-case A should refer to a superscript index (RAbcd≠Rabcd).

Thus, the values a, b, c, d and Mx are input variables. We add-up across e. Please add-up only the two last products, since only they are containing e. I would have been able to spare unnecessary work and four weeks endless searching, if I would have taken this into account from the beginning. Furthermore, we must be careful, that we don't use the same symbols for the loop-variables and we obtain as »Mathematica«-program:

```
RAbcd=Function[For[RA=0;m=0,m<4,m++,RA+=
MGamma[m,#2,#4,#5] MGamma[#1,m,#3,#5]-
MGamma[m,#2,#3,#5] MGamma[#1,m,#4,#5]];                    (830)
Simplify[RA+D[MGamma[#1,#2,#4,#5],Di[#3]]-
D[MGamma[#1,#2,#3,#5],Di[#4]]]];
```

With the genuine MINKOWSKIan line-element with Cartesian and spherical coordinates all solutions become zero. According to [30] the solutions must fill the relation $R^a{}_{bcd} = -R^a{}_{bdc}$ which is the case indeed (trivial). The program seems to be just right.

The RIEMANN-tensor vanishes, but what does it look like with the RICCI-tensor R_{ab} or with the curvature-scalar R? In order to compute them, first of all let's have a look at the lowered tensor R_{abcd}. By analogy with [30] we obtain it with the help of the following relation:

$$R_{abcd} = g_{aa} R^a{}_{bcd} \tag{831}$$

The following permutation-rules apply:

$$R_{abcd} = -R_{bacd} = -R_{abdc} = R_{badc} \qquad R_{abcd} = R_{cdab} \tag{832}$$

It becomes more difficult with it to sort out the dependent components. Expression (831) can be transformed into the following simple program:

```
Rabcd=Function[MPart[#5,#1,#1] RAbcd[#1,#2,#3,#4,#5]];     (833)
```

A summation doesn't take place here. With Cartesian coordinates, all results are equal to zero, as well with spherical coordinates. The conditions (832) are filled trivially. Also R_{abcd} vanishes with it. Thus, we can set about to compute the RICCI-tensor.

7.2.5.3. The RICCI-tensor

This is marked with the symbol R_{ab}. Thus, it's about a 4^2-Matrix with 16 components overall. According to the definition in [30] applies:

$$R_{ab} = R^c{}_{bcd} = g^{cd} R_{dacb} \tag{6.83 [30]}$$

Even this expression cannot be correct like that. Now I found a second source indeed, unfortunately just there the middle part, which is of immense importance, has been calculated by another way namely with the help of the KRONECKER-delta-function, being easily to program on the one hand, being unhelpful on the other hand, since D'INVERNO does not provide any further information, whether and in what extent is to be added-up. Therefore we want to proceed the other way in that we compute R_{ab} without the aid of R_{abcd}. According to my opinion, expression (6.83 [30]) should correctly read:

$$R_{ab} = R^c{}_{acb} = g^{cd} R_{dacb} \tag{834}$$

Let's just start from (834) and define the function Rab[a,b,Mx] to:

```
Rab=Function[For[Ri=0;n1=0,n1<4,n1++,Ri+=RAbcd[n1,#1,n1,#2,#3]];
Simplify[Ri]];
```
(835)

In both cases, the result is zero for all components again. To the conclusion still the scalary curvature $R=g^{ab}R_{ab}$ remains, even called RICCI-scalar. Here, the definition in [30] is correct in turn. In »Mathematica« the value arises to:

```
RaB=Function[MPart[Inx,#2,#2] Rab[#1,#2,#3]];                         (836)
Rr=Function[For[R1=0;n2=0,n2<4,n2++,R1+=RaB[n2,n2,#]];Simplify[R1]];  (837)
```

RaB is the raised tensor $R_a^{\ b}=g^{bb}R_{ab}$. The value of the scalary curvature for the genuine MINKOWSKIan line-element in Cartesian and spherical coordinates is equal to zero.

7.2.5.4. Solutions for this model without navigation-gradient

Now, let's take an observer being in the free fall and in the point (T, 0, 0, 0). With it applies R=0. Considering the current condition, we can also set t=0. Thus, the navigation-gradient becomes equal to one and can be disregarded.

In terms of physics, we look at the observer in his frame of reference. Then, the metric tensor is defined as follows:

```
Mx={{(Sin[GammaPQV[Q,0]]/Sin[AlphaQ[Q]])^2, 0, 0, 0},
{0, -(Sin[GammaPQV[Q,0]]/Sin[AlphaQ[Q]] )^2/(1-RhoQ[Q]^2)^2, 0, 0},   (838)
{0, 0, -r^2, 0}, {0, 0, 0, -(r^2*Sin[theta]^2)}};
Inx=Inverse[Mx];                                                      (839)
```

For reasons of simplification we reckon with the angle γ_γ only. Therefore, we must still multiply g_{11} with β^2. Since the angle α depends on the frame of reference, being a constant with it, we must not define on the function AlphaQ. The same is applied even to RhoQ(c_M), which depends on the frame of reference too.

Then, we obtain the following independent solutions, different from zero, for the connections Γ^a_{bc}:

$$\left.\begin{aligned}
&\Gamma^1_{22}=-r\,\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}; &&\Gamma^1_{33}=-r\,\sin^2\vartheta\,\frac{\sin^2\gamma_{\dot\gamma}}{\sin^2\alpha}\\
&\Gamma^2_{12}=\ r^{-1}; &&\Gamma^2_{33}=-\sin\vartheta\cos\vartheta\\
&\Gamma^3_{13}=\ r^{-1}; &&\Gamma^3_{23}=\ \cot\vartheta
\end{aligned}\right\}\tag{840}$$

Just only Γ^1_{22} and Γ^1_{33} are involved. All other solutions resemble those of the MINKOWSKIan line-element. As next, we want to specify the solutions, different from zero, for the RIEMANN curvature tensor $R^a{}_{bcd}$:

$$R^2{}_{323}=-R^2{}_{332}=\sin^2\vartheta\left(1-\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right)\qquad R^3{}_{223}=-R^3{}_{232}=-\left(1-\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right)$$

All solutions fill the demand $R^a{}_{bcd}=-R^a{}_{bdc}$ with it. Particularly the bracketed expression, which corresponds to the difference $1-g_{11}$ is interesting. It appears in all expressions and can be traced back, based on (762), on the following approximation:

$$1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \;=\; 1-g_{11} \;\approx\; \left(\frac{1}{\tilde{Q}_0}+\frac{v^2}{c^2}+\frac{2\tilde{M}\tilde{G}}{rc^2}\right) \tag{841}$$

Therefore, from here on, we will not state explicitly any approximative solutions. To the calculation of the lowered tensor R_{abcd} we use the formula (833) as well as the input-values (838) and (839). We get only one single independent, component, different from zero. It reads:

$$R_{2323} = -R_{2332} = -R_{3223} = R_{3232} = -r^2\sin^2\vartheta\left(1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \tag{842}$$

For the RICCI-tensor R_{ab} we obtain the following solution:

$$R_{ab} = \begin{vmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & \left(1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) & 0 \\ 0 & 0 & 0 & \sin^2\vartheta\left(1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \end{vmatrix} \tag{843}$$

Applying the present-day values, all components are directed to zero, which agrees with the observation very well. To the conclusion still the scalary curvature. This arises to:

$$R \;=\; -\frac{2}{r^2}\left(1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \qquad \text{Scalary curvature} \tag{844}$$

Interestingly enough, the factor 2 in (844) cancels out with the factor 1/2 in (0.25). Even here, the curvature tends against zero, if we apply the current values. But if r is very small, i.e. it tends against the value r_0, the curvature no longer vanishes but ascends very quickly. This shows very good, if we apply the approximation for the bracketed expression in (844):

$$R \;\approx\; -\frac{2}{r^2\tilde{Q}_0} \qquad \text{Scalary curvature approximation} \tag{845}$$

If we assume a certain distance r in the microscopic range, so this also depends on Q_0, i.e. on our frame of reference. It applies: $r \sim Q_0$ and with it $R \sim Q_0^{-3}$. Thus, we have described the curvature for microscopic dimensions. But if we move far, far away from the coordinate-origin, coming into the proximity of the world-radius, the curvature should increase too. Also this varies with time, which doesn't have derived from the former relations. For that purpose, we must include the navigation-gradient into our contemplations.

7.2.5.5. Solutions for this model with navigation-gradient

We reconsider only the solution for a test-body in the free fall to the point of time T+t in the distance r of the coordinate-origin without presence of matter (vacuum-solution). The following expressions apply locally with it, not however across the entire distance. Then, we would be forced again to integrate with respect to r, obtaining only an implicit solution like with the gravitational-»constant«. Since the test-body is in the free fall, it doesn't move in reference to the metrics. Else, the solution would be even more complicated, because the distance r would depend on time and way additionally then. In terms of mathematics, such a solution would not be impossible, but we don't want to pursue it in this place, since it would go beyond the scope of this work.

Another option would be the inclusion of point-masses resp. mass-distributions, when the body is not in the free fall. On this occasion, we should have to insert the sum c_M+v_G instead of v, making the solution much more complicated in turn (the angle γ_γ should have to be co-included into the derivatives), so that we neither want to examine this case any longer. Rather, this could be object of an autonomous work being published to a later point of time.

Just let's begin in that we define the metric tensor Mx and it's inverse matrix Inx. We take expression (759) as template. Since now there is a cross-over-dependence between r and t, we must move the speed of light c from the 00-coordinate to the metrics itself:

```
Mx={{(c*Sin[GammaPQV[Q,0]]/Sin[AlphaQ[Q]])^2/(1+t/T), 0, 0, 0},
{0, -(Sin[GammaPQV[Q,0]]/Sin[AlphaQ[Q]])^2/(1-RhoQ[Q]^2)^2*
((1+t/T)^(1/2)-(2r/R)^(2/3))^2, 0, 0},
{0, 0, -r^2, 0}, {0, 0, 0, -(r^2*Sin[theta]^2)}};                  (846)
Inx=Inverse[Mx];                                                    (847)
```

From reasons of performance, it's opportune, to calculate expression (847) only once, and to replace it with a fixed definition then. Otherwise the expression is recalculated with each call and the computing-time for the determination of the scalary curvature can amount to 24 hours now and then. We just replace (847) by:

```
Inx={{(1/c*Sin[AlphaQ[Q]]/Sin[GammaPQV[Q, 0]] )^2*(1+t/T ), 0, 0, 0},
{0, -(Sin[AlphaQ[Q]]/Sin[GammaPQV[Q,0]] )^2*(1-RhoQ[Q]^2)^2/         (848)
((1+t/T)^(1/2)-(2r/R)^(2/3))^2, 0, 0},
{0, 0, -r^(-2), 0}, {0, 0, 0, -(1/(r^2*Sin[theta]^2))}};
```

With it changes even our function Di, giving the parameter, with respect to which should be differentiated:

```
Di=Function[Part[{t,r,theta,phi},#+1]];                             (849)
```

By the way, the function Simplify should be applied as early as possible. Unfortunately it is not almighty, so that we doesn't come around to post-simplify by hand. In the following calculations, the chain-rule is applied repeatedly to the differentiation with the effect, that the results strongly increase in their complexity. Since the differentiation takes place automatically at this point, each human error is ruled out a priori. If errors should appear nevertheless, so these are to be attributed to the manual simplification.

At first, we want to compute the independent metric connections again. To the simplification of the *representation*, we will take up following substitutions:

$$t = \left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \qquad r = \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}_{\text{macroscopically}} \qquad r = \left(\frac{2r-\tilde{r}_0}{\tilde{R}}\right)^{\frac{2}{3}}_{\text{exactly}} \tag{850}$$

More final expression arises directly from (236). To the calculation of the solutions, we can work with the left-hand expression then again, at which point we can substitute only when exercising in such ranges whose dimensions are in the proximity of r_0 and in all strongly degenerate conditions. The validity of the following solutions is not restricted thereby, because r_0 is a reference-frame-dependent constant. Then, we get for the metric connections:

$$\left.\begin{array}{ll}
\Gamma^0_{00} = -\mathrm{H}\,; & \Gamma^0_{11} = \dfrac{\beta^4}{\tilde{\mathrm{R}}\mathrm{c}}\, t(t-r) \\[2ex]
\Gamma^1_{01} = \tilde{\mathrm{H}}\dfrac{1}{t(t-r)}\,; & \Gamma^1_{11} = -\dfrac{2}{3}\mathrm{r}^{-1}\dfrac{r}{t-r} \\[2ex]
\Gamma^1_{22} = -\mathrm{r}\,\dfrac{1}{(t-r)^2}\dfrac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\,; & \Gamma^1_{33} = -\mathrm{r}\sin^2\vartheta\,\dfrac{1}{(t-r)^2}\dfrac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \\[2ex]
\Gamma^2_{12} = \mathrm{r}^{-1}; & \Gamma^2_{33} = -\sin\vartheta\cos\vartheta \\[2ex]
\Gamma^3_{13} = \mathrm{r}^{-1}; & \Gamma^3_{23} = \cot\vartheta
\end{array}\right\} \qquad (851)$$

Please pay attention to the italic notation by all means. From security-reasons however, the italic parameters t and r are always collected in an individual partial expression in all expressions, so that a mix-up with t and r becomes nearly impossible. Furthermore, we benefit from the following relations:

$$\tilde{\mathrm{H}} = \frac{1}{2\tilde{\mathrm{T}}} \qquad \mathrm{H} = \frac{1}{2(\tilde{\mathrm{T}}+\mathrm{t})} \qquad \tilde{\mathrm{R}} = 2\mathrm{c}\tilde{\mathrm{T}} \qquad \mathrm{R} = 2\mathrm{c}\,(\tilde{\mathrm{T}}+\mathrm{t}) \qquad (852)$$

as well as from (767). The expression β is the classic relativistic dilatation-factor $(1-v^2/c^2)^{-1/2}$, in which we apply the propagation-velocity of the metric wave-field c_M in place of v. In the normal case, the value is extremely close to one. For t = 0 (nowadays) even t in italics is one and it applies $r(0)=0$. Then solution (851) passes into in (840), which is an evidence for that we have calculated correctly.

To the further saving of computer-time, even the connections can be defined as functions. Then, the associated »Mathematica«-program looks like this:

```
MGamma=Function[Which[
{#1,#2,#3}=={0,0,0},-1/(2(T+t)),
{#1,#2,#3}=={0,1,1},(1+t/T)^(1/2)*((1+t/T)^(1/2)-(2r/R)^(2/3))/
                    (2*T*c^2*(1-RhoQ[Q]^2)^2),
{#1,#2,#3}=={1,0,1},1/(2T)/((1+t/T)^(1/2)*((1+t/T)^(1/2)-(2r/R)^(2/3))),
{#1,#2,#3}=={1,1,0},1/(2T)/((1+t/T)^(1/2)*((1+t/T)^(1/2)-(2r/R)^(2/3))),
{#1,#2,#3}=={1,1,1},-2/(3r)*(2r/R)^(2/3)/((1+t/T)^(1/2)-(2r/R)^(2/3)),
{#1,#2,#3}=={1,2,2},-r/((((1+t/T)^(1/2)-(2r/R)^(2/3))^2)*
                (Sin[AlphaQ[Q]]/Sin[GammaPQU[Q,0]])^2*(1-RhoQ[Q]^2)^2,
{#1,#2,#3}=={1,3,3},-r*Sin[theta]^2/((((1+t/T)^(1/2)-(2r/R)^(2/3))^2)*    (853)
                (Sin[AlphaQ[Q]]/Sin[GammaPQU[Q,0]])^2*(1-RhoQ[Q]^2)^2,
{#1,#2,#3}=={2,1,2},1/r,
{#1,#2,#3}=={2,2,1},1/r,
{#1,#2,#3}=={2,3,3},-Cos[theta]*Sin[theta],
{#1,#2,#3}=={3,1,3},1/r,
{#1,#2,#3}=={3,2,3},Cos[theta]/Sin[theta],
{#1,#2,#3}=={3,3,1},1/r,
{#1,#2,#3}=={3,3,2},Cos[theta]/Sin[theta],
True,0]];
```

The number (853) doesn't belong to it of course. The formula has been checked with (826). Thus, as next, we can set about to determine the independent solutions for the RIEMANN curvature tensor $R^a{}_{bcd}$. To the better check and because I have made the effort now and then, we want to present all dependent and independent solutions ($\neq 0$):

$$R^{0}{}_{212} = -\frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_{\gamma}}$$

$$R^{0}{}_{221} = \frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_{\gamma}}$$

$$R^{0}{}_{313} = -\frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\sin^2\vartheta\,\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_{\gamma}}$$

$$R^{0}{}_{331} = \frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\sin^2\vartheta\,\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_{\gamma}}$$

$$R^{1}{}_{220} = -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{202} = \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{212} = -\frac{2}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{221} = \frac{2}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{330} = -\tilde{\mathrm{H}}\mathrm{r}\sin^2\vartheta\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{303} = \tilde{\mathrm{H}}\mathrm{r}\sin^2\vartheta\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{313} = -\frac{2}{3}\sin^2\vartheta\,\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{1}{}_{331} = \frac{2}{3}\sin^2\vartheta\,\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}$$

$$R^{2}{}_{012} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{2}{}_{021} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{2}{}_{102} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{2}{}_{120} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{2}{}_{121} = -\frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

$$R^{2}{}_{112} = \frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

$$R^{2}{}_{332} = -\left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)\sin^2\vartheta$$

$$R^{2}{}_{323} = \left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)\sin^2\vartheta$$

$$R^{3}{}_{013} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{3}{}_{031} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{3}{}_{103} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{3}{}_{130} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^{3}{}_{131} = -\frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

$$R^{3}{}_{113} = \frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

$$R^{3}{}_{223} = -\left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)$$

$$R^{3}{}_{232} = \left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)$$

All remaining components are zero. The solutions fill the demand $R^{a}{}_{bcd} = -R^{a}{}_{bdc}$ in turn, albeit there are more than before. That's not astonishing, because g_{11} depends both on the time t, as on the distance r.

For the lowered RIEMANN curvature-tensor R_{abcd} we obtain the following solutions, different from zero:

$$R_{0212} = -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \qquad R_{0221} = \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)}$$

$$R_{1202} = -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \qquad R_{1220} = \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)}$$

$$R_{2021} = -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \qquad R_{2012} = \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)}$$

$$R_{2120} = -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \qquad R_{2102} = \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)}$$

$$R_{0313} = -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \qquad R_{0331} = \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)}$$

$$R_{1303} = -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \qquad R_{1330} = \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)}$$

$$R_{3031} = -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \qquad R_{3013} = \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)}$$

$$R_{3130} = -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \qquad R_{3103} = \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)}$$

$$R_{1221} = -\frac{2}{3}\,\frac{r}{t-r} \qquad R_{1212} = \frac{2}{3}\,\frac{r}{t-r}$$

$$R_{2112} = -\frac{2}{3}\,\frac{r}{t-r} \qquad R_{2121} = \frac{2}{3}\,\frac{r}{t-r}$$

$$R_{1331} = -\frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta \qquad R_{1313} = \frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta$$

$$R_{3113} = -\frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta \qquad R_{3131} = \frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta$$

$$R_{2323} = -\mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \qquad R_{2332} = \mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)$$

$$R_{3232} = -\mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \qquad R_{3223} = \mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha}\right)$$

The related components have been collected to the better overview. So we can better see, that condition (832) is filled. Particularly interesting is, that a part of the solutions are velocities (escape-velocity Hr) having even a physical meaning without doubt.

For the RICCI-tensor R_{ab} now we get the following solutions, which unfortunately no longer can be presented in matrix-form, unless in the landscape view:

$$R_{01} = \frac{1}{\tilde{T}} r^{-1} \frac{1}{t(t-r)} \qquad R_{10} = \frac{1}{\tilde{T}} r^{-1} \frac{1}{t(t-r)} \qquad R_{11} = -\frac{4}{3} r^{-2} \frac{r}{t-r}$$

$$R_{22} = \left(1 - \left(\frac{1}{(t-r)^2} + \frac{2}{3}\frac{r}{(t-r)^3}\right)\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha}\right) \qquad \text{RICCI-tensor} \qquad (854)$$

$$R_{33} = \left(1 - \left(\frac{1}{(t-r)^2} + \frac{2}{3}\frac{r}{(t-r)^3}\right)\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha}\right)\sin^2\vartheta$$

The rest is equal to zero. If we apply the present-day values, so all components incline to zero in turn. Thus, the metrics behaves approximately in a MINKOWSKIan manner, exactly, as anticipated by LANCZOS. For the scalary curvature applies:

$$R = -\frac{2}{r^2}\left(1 - \left(\frac{1}{(t-r)^2} + \frac{4}{3}\frac{r}{(t-r)^3}\right)\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha}\right) \qquad \text{Scalary curvature} \qquad (855)$$

The course of the scalary curvature for several initial-Q-factors under application of the complete expression (850) is presented in figure 133. It is here only about relative values in comparison with the world-radius, i.e. it's possible to infer on the course of the curvature, but the values aren't comparable with each other.

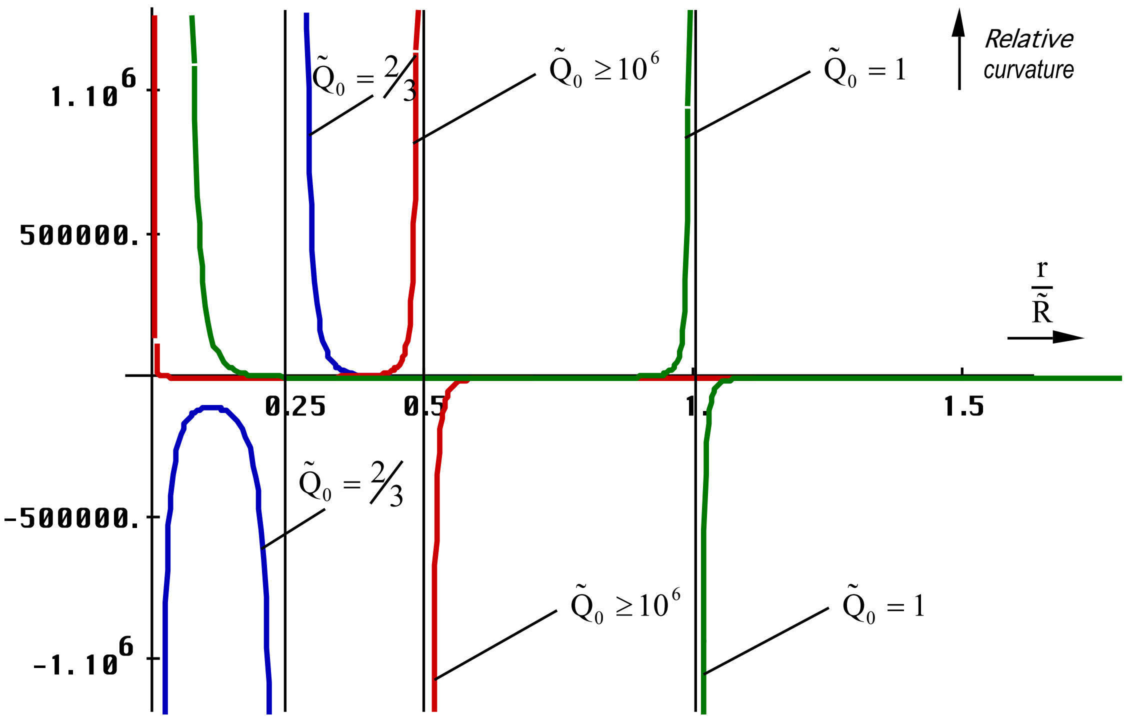


Figure 133
Relative scalary curvature for various initial-Q-factors

Particularly interesting is the course for an initial Q-factor $>10^6$, which corresponds to the standard-case of an observer in a space of vanishing curvature (nowadays). Here it shows again the ascend in the microscopic range, which we could already observe in the previous section. But in contrast, the curvature escalates too, when approaching the half world-radius.

To the better overview, the course for $Q_0 > 10^6$ for positive (space-like) and negative (time-like distances) has been separately presented once again in figure 134. In principle, no difference appears there, only a small asymmetry around the point zero.

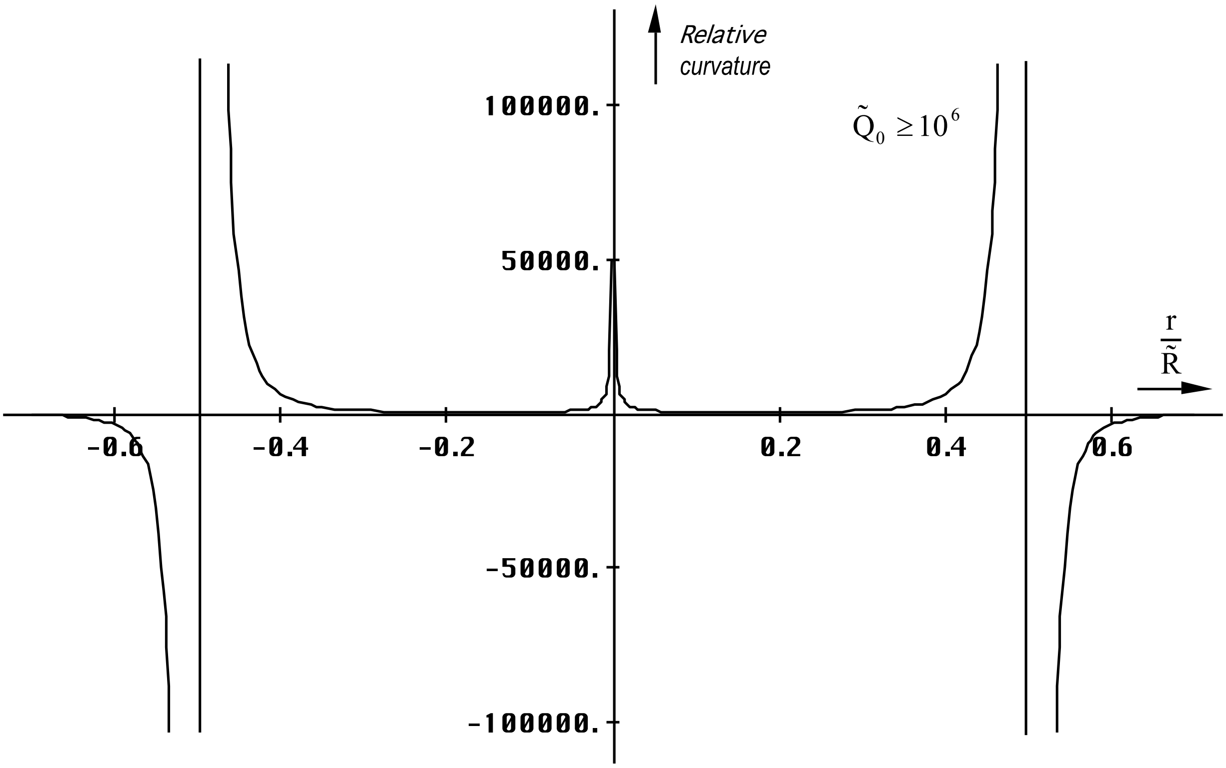


Figure 134
Relative scalary curvature for
the standard-case $Q_0 > 10^6$

The curvature within the „limits" of the universe is positive, i.e. the space is closed as well at the microscopic as at the macroscopic end. A singularity resides at both ends. Outside, the space is open, in so far as an „outside" should exist at all.

It will be interesting, when the initial factor becomes minor, e.g. if we put the origin of our frame of reference into an area of high curvature or if we simply go back on the time-scale to a point of time just after the big bang. Now the macroscopic singularity moves from R/2 to the point R at $Q_0 = 1$, This corresponds to the conditions directly at the SCHWARZSCHILD-radius, which well agrees with our prevision of a phase jump to that point of time. This must include the entire universe in order to be complete.

If we go back any farther, so we come upon an open universe with negative curvature. In the chosen case $Q_0 = 2/3$ the singularity is at the point R/4, however only for positive (space-like) distances. Just a not negligible asymmetry appears here. The exact course is presented in figure 135, under use of the exact expression of (850) in turn. Which exact physical conclusions can be derived therefrom, I would like to leave to the reader. In any case I believe, that there will be a lot of them, since the last-named case corresponds to the conditions within the SCHWARZSCHILD-radius of a black hole.

To the conclusion we already want to specify the determinant of the metrics, as it is frequently used, namely in the form $(-g)^{1/2}$. We use the built-in function Det[M] for it. It applies:

$$\sqrt{-g} = c r^2 \sin^2 \vartheta \, \frac{t-r}{t} \, \frac{\sin^2 \alpha}{\sin^2 \gamma_{\bar{\gamma}}} \qquad \text{Determinant} \qquad (856)$$

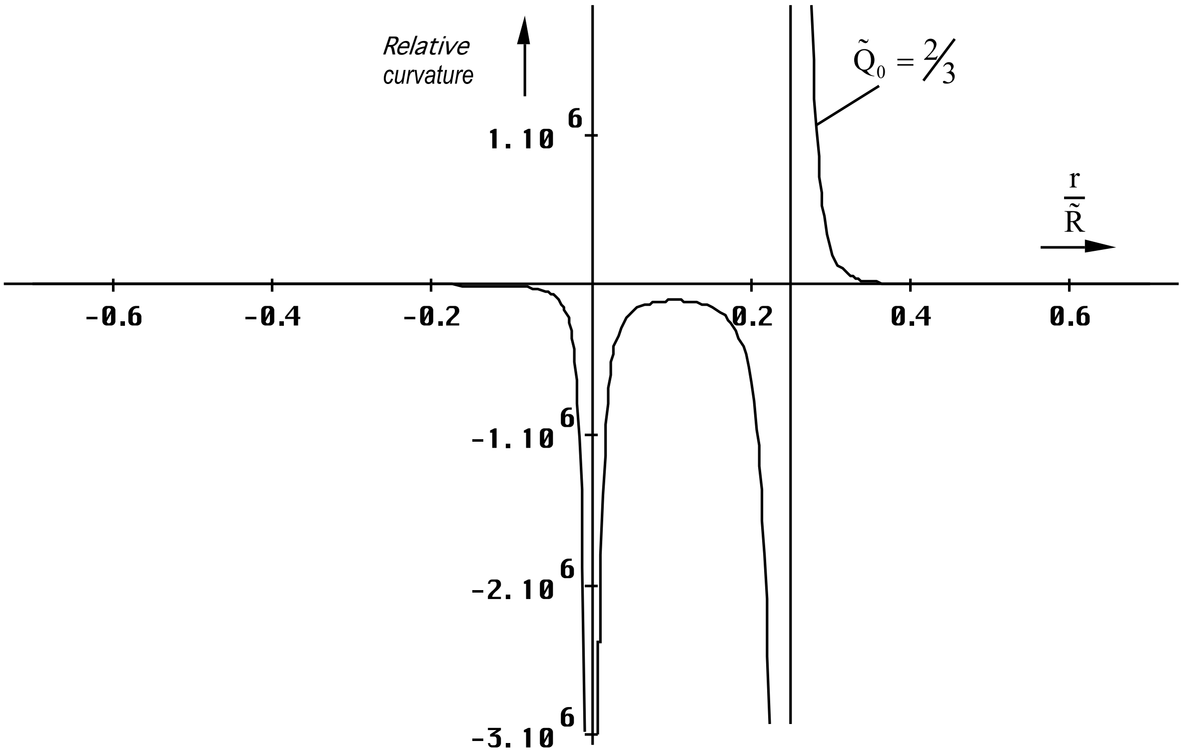


Figure 135
Relative scalary curvature
for the case Q0 =2/3

Thus, we have established a sound basis, in order to compute the energy-impulse-tensor of the vacuum, based on this model.

7.2.6. The energy-impulse-tensor

At first we compute the lowered tensor T_{ik} namely for a body in the free fall, i.e. the vacuum-solution. To the calculation, we can use the famous EINSTEIN equation (0.25) which is generally valid. Expression (0.25) means at the same time, that the so-called cosmologic constant λ is equal to zero. As input variable, we require the metrics and the therefrom derived functions RICCI-tensor and the scalary curvature.

$$R_{ik} - \frac{1}{2} R g_{ik} = T_{ik} \tag{0.25}$$

For the calculation, we use the program »Mathematica« in turn and the following script:

```
Rr00=-2/r^2*(1-(1/(tt-rr)^2+4/3*rr/(tt-rr)^3)*Sin[Al]^2/Sin[GaGa]^2*beta^-4);

Mx={{c^2*Sin[GaGa]^2/Sin[Al]^2/tt^2, 0, 0, 0},
{0, -Sin[GaGa]^2/Sin[Al]^2*beta^4*(tt-rr)^2, 0, 0},
{0, 0, -r^2, 0}, {0, 0, 0, -(r^2*Sin[theta]^2)}};                    (857)

Rik={{0,1/(T*r)/(tt*(tt-rr)),0,0},{1/(T*r)/(tt*(tt-rr)),-4/(3*r^2)*rr/(tt-rr),0,0},
{0,0,(1-(1/(tt-rr)^2+2/3*rr/(tt-rr)^3)*Sin[Al]^2/Sin[GaGa]^2*beta^-4),0},
{0,0,0,(1-(1/(tt-rr)^2+2/3*rr/(tt-rr)^3)*
Sin[Al]^2/Sin[GaGa]^2*beta^-4)*Sin[theta]^2}};
```

The calculation itself takes place by the execution of the following line:

```
Simplify[Rik-1/2*Rr00*Mx]                                              (858)
```

Since it is about the multiplication with a scalar, the asterisk is written here and not the point (the * even can be omitted). After the simplification by hand, we get the following components different from zero:

$$T_{00} = -\frac{1}{\beta^4}\frac{c^2}{r^2}\left(\left(\frac{1}{(t-r)^2}+\frac{4}{3}\frac{r}{(t-r)^3}\right)-\frac{\sin^2\alpha}{\sin^2\gamma_{\tilde{\gamma}}}\right)\frac{1}{t^2}$$

$$T_{01} = -\frac{1}{\tilde{T}}\,r^{-1}\frac{1}{t(t-r)} \qquad T_{10} = -\frac{1}{\tilde{T}}\,r^{-1}\frac{1}{t(t-r)} \tag{859}$$

$$T_{11} = \frac{1}{r^2}\left(1-(t-r)^2\frac{\sin^2\alpha}{\sin^2\gamma_{\tilde{\gamma}}}\right)$$

$$T_{22} = \frac{2}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\tilde{\gamma}}}{\sin^2\alpha} \qquad T_{33} = \frac{2}{3}\sin^2\vartheta\,\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\tilde{\gamma}}}{\sin^2\alpha}$$

Please pay attention again to the italic variables, which have been defined in the previous section (852). Since no more differentiation takes place, we can work on with these from now on. An examination of the units of measurement leads to the interesting result that we are concerned here neither with energetic nor with impulse-units. This is just right, because the energy-impulse-tensor is not called so, because it describes energy or impulse on any way but because it, among other things, results from the energy- and impulse-distribution in space. Indeed, the components are containing all these information, including the probable existence of one or more mass-distributions, the mass of the test-body, its impulse, velocity and direction of motion. More final although not in (859), since these components are applied only to a body in the free fall. Thus, also the existence of an any mass-distribution cancels out then (equivalence-principle).

If we would want to co-include all these values into the calculation, we would have to calculate all expressions anew, incipient from the line-element, now applies $r = f(t,s)$ and $\sin\gamma_\gamma = f(v,r,m)$ additionally. Because of the multiple derivatives, then additionally expressions appear in the results like the acceleration a, the integral across the way s and the way s itself. Because of the pathway-dependence and the infinite number of options of matter-arrangement therefore no universal solution can be given, so that we have to determine all tensors and scalars for each problem anew. By no means the solutions will be simple, even the vacuum-solution in the free fall is already complicated enough.

In terms of mathematics however, we have put all fundamentals in order to reach an explicit solution, unless we have to integrate across a larger distance r at the end in order to get a not-local result. Then there is no explicit solution, as we have already seen. Fortunately this case plays no role, if we consider bodies in the free fall only. These, that is to say, don't move in reference to the metrics and the distance-function with constant wave count vector is known.

Now however back to the energy-impulse-tensor. As next, we will calculate the inverse tensor T^{ik}, which we require to the determination of the geometry G^{ik}. Now please don't get the idea, to calculate the inverse tensor directly with the help of the »Mathematica«-function Inverse[Tik]. You still get a result indeed, but this is so complicated, that you cannot use it in this form. The simplification with the help of Simplify[Inverse[Tik]] finally breaks down because of memory-lack.

The solution is in following approach: First, we generally calculate the inverse tensor under exploitation of the fact, that, on the one hand, a bulk of the components is zero and, on the other hand, $T_{01} = T_{10}$ applies. After subsequent simplification, we foist the component-definitions, in that we define them only now (use the function Clear[] for additional run). We do the following approach:

```
MPart=Function[Part[Part[#1,#2+1],#3+1]];
Tik1={{t00,t01,0,0},{t01,t11,0,0},{0,0,t22,0},{0,0,0,t33}};
```
(860)

```
TIK2=Simplify[Inverse[Tik1]]
```
(861)

```
         t11                t01
{{---------------, --------------, 0, 0},
       2               2
  -t01  + t00 t11  t01  - t00 t11

         t01                t00                 1                   1
  {--------------, ---------------, 0, 0}, {0, 0, ---, 0}, {0, 0, 0, ---}}
       2                 2                      t22                 t33
   t01  - t00 t11  -t01  + t00 t11
```

I just presented the result in the original-output-format, since it's only about an intermediate-solution, which speaks in behalf of itself. In any case, it's not all too complicated. Now, we foist the component-definitions:

```
t00=c^2/(tt^2*r^2)*(1-(1/(tt-rr)^2+4/3*rr/(tt-rr)^3)*beta^-4*
Sin[Al]^2/Sin[GaGa]^2)*Sin[GaGa]^2/Sin[Al]^2;
t01=-1/T*r^-1/(tt*(tt-rr));
t11=1/r^2*(1-(tt-rr)^2*beta^4*Sin[GaGa]^2/Sin[Al]^2);
```
(862)

We can dispense with T_{10}, T_{22} and T_{33} since we can write down the result immediately. We get the other components by execution of:

```
Simplify[MPart[TIK2,i,k]]
```
(863)

The results must be simplified by hand once again and are being pretty complex. To the simplification of the representation and avoidance of errors, we take up a substitution again, namely as follows:

$$\mathrm{A}^2 = \frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha} \qquad \mathrm{B}^2 = \frac{4}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \tag{864}$$

The components, different from zero, of the inverse energy-impulse-tensor T^{ik} are then:

$$T^{00} = \tilde{\mathrm{T}}^2\frac{1-\mathrm{A}^2}{\mathrm{A}^2}\frac{t^2\,(t-r)^2}{1+\dfrac{1}{\beta^4 r^3}\dfrac{\left(1-\mathrm{A}^2\right)\left(\left(1-\mathrm{A}^2\right)-\mathrm{B}^2\right)}{\mathrm{A}^4}} \tag{865}$$

$$T^{01} = -\mathrm{r}\tilde{\mathrm{T}}\frac{t\,(t-r)}{1+\dfrac{1}{\beta^4 r^3}\dfrac{\left(1-\mathrm{A}^2\right)\left(\left(1-\mathrm{A}^2\right)-\mathrm{B}^2\right)}{\mathrm{A}^4}} \tag{866}$$

$$T^{11} = -\frac{\tilde{\mathrm{R}}^2}{4}\frac{\dfrac{1}{\beta^4}\dfrac{\left(1-\mathrm{A}^2\right)\left(\left(1-\mathrm{A}^2\right)-\mathrm{B}^2\right)}{\mathrm{A}^2}}{1+\dfrac{1}{\beta^4 r^3}\dfrac{\left(1-\mathrm{A}^2\right)\left(\left(1-\mathrm{A}^2\right)-\mathrm{B}^2\right)}{\mathrm{A}^4}} \tag{867}$$

$$T^{10} = T^{01} \qquad T^{22} = \frac{2}{\mathrm{B}^2} \qquad T^{33} = \frac{2}{\mathrm{B}^2}\sin^{-2}\vartheta \tag{868}$$

As it shows, the components of the inverse energy-impulse-tensor are already quite complex however. They will simplify with the calculation of the geometry G_{ik} then again. The examination of the components T^{0k}. For a MINKOWSKI-world namely applies:

$$\partial_k T^{0k} \equiv 0 \tag{869}$$

This expression is generally [30] interpreted as the energy-conservation-rule. It can be easily shown, that expression (869) doesn't apply for this model. Is this perhaps a fundamental error of this model? This is not the case, because according to [5], the energy-conservation-rule is »only an empirical rule, thus it could be violated by yet unknown physical phenomenons«. There is just no definite proof for its universal validity and indeed with e.g. the cosmologic red-shift it seems to be about an effect, by which the energy-conservation-rule is violated. Here, energy quasi is discreated by the increase of the wavelength of the cosmic background-radiation.

Now, one could modify the rule in such a manner that energy can be discreated indeed, however not recreated from the nothingness. But including the primordial impulse into the contemplation, we would have to reject even this weakened form. The primordial impulse according to this model just results from the inherent-solution (initial-value = 0) of the corresponding differential equation. Furthermore, this model permits even imaginary energies as well as masses. It would be possible with it that energy „vanishes“ temporarily (being inactivated), in order to „reappear“ later on. An example would be the weak interaction in form of the neutrino-capture.

Altogether it's possible to say that no arguments can be derived from the violation of the energy-conservation-rule in order to discard this model.

7.2.7. Solution of the field-equations of the relativity-theory

7.2.7.1. The coupling-constant

After we have completed all pilot surveys and specified the energy-impulse-tensor of the vacuum for test-bodies in the free fall, finally remains, to compute the associated geometry G_{ik}. According to [30] this arises to:

$$G^{ik} = \kappa T^{ik} \tag{870}$$

In this connection, κ is a proportionality-factor, which is even marked as the coupling-constant of the URT. It must not be mixed-up with the specific conductivity of the subspace κ_0. Its value arises from the NEWTON's borderline case, which, of course, must be filled also for this model. But before simply substitute here we want to re-engage with the substantiation of (870), as it has been presented in [30] from p.189 on.

We first of all assume, that the energy-impulse-tensor in MINKOWSKI-coordinates fills the conservation-equations:

$$\partial_k T^{ik} = 0 \tag{871}$$

However we are concerned neither with MINKOWSKI-coordinates, nor (871) is fulfilled, as we have seen exactly in the previous section. Now D´INVERNO assumes that the principle of the *minimum* gravitative coupling suggests the universal-relativistic generalization:

$$\nabla_k T^{ik} = 0 \tag{872}$$

(covariant derivative). Furthermore, the Einstein-tensor should vanish because of the contracted Bianchi-identity:

$$\nabla_k G_i^k \equiv 0 \qquad \text{therefrom follows} \qquad \nabla_k G^{ik} \equiv 0 \tag{873}$$

The condition (873) is really filled, as from the properties of the RIEMANN curvature tensor in section 7.2.5.5. under application of

$$\nabla_a R_{debc} + \nabla_c R_{deab} + \nabla_b R_{deca} \equiv 0 \qquad \text{([30] 6.82)}$$

easily can be shown. From (872) and (873) concludes D´INVERNO, that both tensors must be proportional to each other. The problem now seems to be, that D´INVERNO with the derivative of (872) refers on the principle of the *minimum* gravitative coupling, which we just have declared as invalid for our model. Instead, we have replaced it with the principle of the maximum gravitative coupling, which as such demands the proportionality of both tensors even much more strongly. That's tantamount to the statement: „The matter determines the geometry“, so that there don’t should be any problem in this sense.

A question however remains open with respect to the classic interpretation, respectively it results from the principle of the maximum gravitative coupling additionally. Whereas, according to the classic theory, we can write down the coupling-constant immediately after it's determination with the help of the NEWTON’s borderline case (→[30]), there are two options available with this model:

$$\kappa = 8\pi \frac{G}{c^2} \qquad \text{or} \qquad \kappa = 8\pi \frac{\tilde{G}}{c^2} \tag{874}$$

On this occasion, the choice is not necessarily easy for, since the (local) gravitational-constant, according to this model, is a function of space and time once again. By the following gedankenexperiment however we acquire the right solution: When the principle of the maximum gravitative coupling truly is so much more powerful, the proportionality must be guaranteed (870) always and everywhere, otherwise the NEWTON’s borderline case would be fulfilled only in the point $r=0$. But since the energy-impulse-tensor already contains a space-temporal dependence, only the right-hand expression (874) remains as single option. Therefore, after substitution of (700) applies:

$$\kappa = \frac{8\pi\tilde{R}\tilde{Q}_0}{\mu_0\kappa_0\hbar_1} = \frac{8\pi\tilde{R}}{\mu_0\kappa_0\tilde{\hbar}} = \frac{8\pi\ c\tilde{r}_0^2}{\tilde{\hbar}} \tag{875}$$

Since expression (875) contains reference-frame-dependent values ($\tilde{R}$, $\tilde{r}_0$, $\tilde{\hbar}$) the geometry now depends additionally on the frame of reference, a fact, which actually goes without saying, if we rescind the limit between SRT and URT. Considering a body from another frame of reference, we will observe not only the condition-variables of the body itself by different means but also the geometry of the space around, since it now owns a structure. In the classic relativity-theory, one assumes, that the universe, with exception of matter and radiation, is filled by »NOTHING«. And a »NOTHING« doesn't change because of that it's observed from another frame of reference. We can write therefore:

XIII.	*The geometry is determined by matter and the frame of reference.*

Now we want to continue in that we compute the geometry, associated to the energy-impulse-tensor. The geometry G_{ik} is also known as EINSTEIN-tensor.

7.2.7.2. The geometry of the vacuum

After the determination of the inverse energy-impulse-tensor and the coupling-factor, we must only form the product of both, in order to get the (inverse) geometry G^{ik}. Since this is trivial in terms of mathematics, the results should not extra be presented.

We however do not actually look for the inverse geometry G^{ik}, whatever should be that, but for the geometry G_{ik}. Furthermore we have seen that the inverse energy-impulse-tensor alone consists of very complex expressions. If we now try to calculate the normal geometry from the inverse geometry (under application of the function Inverse[GIK]), so we are right next to the limits of the program »Mathematica« in turn. These express themselves in it that the computer-time rises into the immeasurable. But I did not watched for the result at all. Instead I have been concerned about, whether the calculation of G_{ik} can take place even more simply and particularly more quickly. Expression (870) in combination with Inverse[GIK] namely is not especially well-suited for the calculation of G_{ik}. With a similar approach like in the previous section now can be shown, that G_{ik} can be calculated directly from T_{ik}. For symmetrical tensors applies then:

$$G_{ik} = \frac{1}{\kappa} T_{ik} \tag{876}$$

As it looks like with asymmetrical tensors and universal matrices, we do not need to examine in this place, since T_{ik} is always symmetrical. Then, we get for the geometry:

$$\begin{aligned}
G_{00} &= -\frac{1}{8\pi}\frac{\tilde{\hbar}\tilde{\omega}_0}{\tilde{r}_0}\frac{1}{\beta^4 t^2}\left(\left(\frac{1}{(t-r)^2}+\frac{4}{3}\frac{r}{(t-r)^3}\right)-\frac{\sin^2\alpha}{\sin^2\gamma_{\dot{\gamma}}}\right)\frac{1}{\mathrm{r}^2} && \left[\frac{\mathrm{N}}{\mathrm{m}^2}\right]\\
G_{01} &= -\frac{1}{4\pi}\frac{\tilde{\hbar}}{\tilde{\mathrm{R}}\tilde{\mathrm{r}}_0^2}\,\mathrm{r}^{-1}\frac{1}{t(t-r)} && \left[\frac{\mathrm{Ns}}{\mathrm{m}^3}\right]\\
G_{10} &= -\frac{1}{4\pi}\frac{\tilde{\hbar}}{\tilde{\mathrm{R}}\tilde{\mathrm{r}}_0^2}\,\mathrm{r}^{-1}\frac{1}{t(t-r)} && \left[\frac{\mathrm{Ns}}{\mathrm{m}^3}\right]\\
G_{11} &= \frac{1}{8\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{\mathrm{R}}}\frac{1}{\mathrm{r}^2}\left(1-(t-r)^2\frac{\sin^2\alpha}{\sin^2\gamma_{\dot{\gamma}}}\right) && \left[\frac{\mathrm{kg}}{\mathrm{m}^3}\right]\\
G_{22} &= \frac{1}{12\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{\mathrm{R}}}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha} && \left[\frac{\mathrm{kg}}{\mathrm{m}}\right]\\
G_{33} &= \frac{1}{12\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{\mathrm{R}}}\sin^2\vartheta\,\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\dot{\gamma}}}{\sin^2\alpha} && \left[\frac{\mathrm{kg}}{\mathrm{m}}\right]
\end{aligned} \tag{877}$$

On this occasion, I applied all possible transformations from the premier sections. Also the units of measurement have been presented, so that you can imagine, at least approximately, which physical content do the individual components have. This fact is also the reason, why the work cannot be continued at this point. Indeed, it's possible to calculate a stuff, but that does not satisfy anyway, especially since we already have gone off on a tangent from the standard-model.

Particularly interesting at (877) are the components G_{00} (pressure) and G_{11} (density). More final only can be the density of the empty gravitational-field without matter. Unfortunately, all interesting components depend on the distance r_S. For a test, we just want to calculate the density for the entire universe (r = R/2). Then, we get:

$$G_{11}(\tilde{R}/2) = \frac{1}{2\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{R}^3} = 1.443.10^{-29}\,\text{kgdm}^{-3} \qquad (878)$$

This value is about 3 magnitudes above the matter-density of $1.845\cdot10^{-31}\,\text{kg}\cdot\text{dm}^{-3}$, determined in section 4.6.4.2.5., which may be regarded as proof, that we are concerned with a radiation-dominated universe or said else, the matter is only of local influence, being irrelevant for processes, which include the entire universe. Therefore, it even does no sense, to search-on for „hidden" masses.

7.2.7.3. The 3-layer-model of the metrics

Considering the expressions of (877) once again, so it shows, that they are containing (partially hidden) quantities of the subspace (μ_0, κ_0, c), the metric wave-field (ω_0, r_0), the quantum-theory ($\hbar$) and quantities of the macrocosm (T, R) at the same time. In this connection, all quantities, marked with a tilde (~) including $\hbar$ are part of the same canonical ensemble, called the frame of reference. All these quantities have influence on the geometry of the universe. On the other hand (877) describes only the upper level or layer, the macroscopic metrics, that is the space or better the space-time, we live in.

To the better understanding the basic construction of the metrics is presented in figure 136 once again. It consists of three overlapping layers. Therefore, I would like to name this model the 3-layer-model of the metrics.

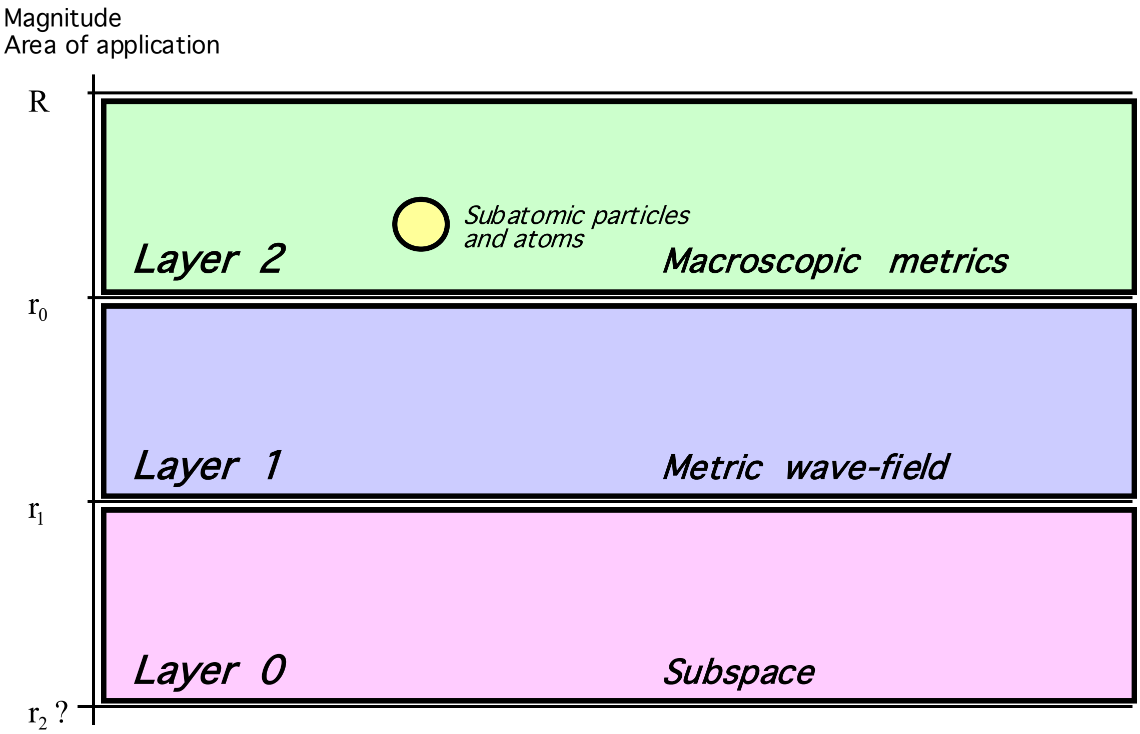


Figure 136
The 3-layer-model of the metrics

The magnitude of the individual layers, the scale is logarithmic, is logged at the left margin. Therefore it is possible that the subspace owns a lower limit and a structure too. Unfortunately, we can only suspect this. The only one we know about subspace is, that it owns the physical properties μ_0, ε_0, Z_0 and c. That means, the speed of light in reference to the subspace is always c constantly.

Above, there is the metric wave-field, described by the relations in the premier sections. The PLANCK's fundamental length r_0 forms the upper ending.

All processes, running in areas of larger dimensions than r_0, are described by the macroscopic metrics g_{ik}. For the sake of completeness, the location of the atoms and subatomic particles is presented within this macroscopic metrics as well. But since these are independent spherical symmetrical solutions of the field-equations, they appear only in passing at this point, as interferences, the gravitative effects are caused by.

The deeper we go down, all the greater the field-energy, which is masked by quantum-effects in reference to the superjacent layer. Such a quantum-effect e.g. is the spin of the MLE, which compensates the energy of the metric wave-field in reference to the macroscopic metrics (T = 0K). This structure figures an essential advantage in reference to other models. It just allows the existence of areas with negative (difference-)energy, which e.g. LANCZOS disclaims as unphysical. Also the question would be become clear, where the energy comes from to the production of virtual particle-antiparticle-pairs. This „borrows" the universe from the subjacent layer.

The whole matter becomes more interesting, if we extend the contemplation to the underlying subspace. If this should own inherent energy too, so it's density should be even more essential above the one of the metric wave-field, namely in the magnitude of the primordial impulse. On the other hand this would explain, from where its energy could come. Then, similar to the processes with the (quantum-)pair production (virtual or real), it may be, that there are analog effects within the subspace, allowing the pair production of whole universes. In this sense, I only hope that we don't live in a virtual universe… *Quantum theory is very strange.*

7.3. Even gravitational-waves

D´INVERNO reminds in [30] on the possibility of the existence of even-frontal gravitational waves. Now, we could try, based on the relations of this model, to define such a wave-function, especially since D´INVERNO presents an usable approach for it. Although I am of the opinion that such a wave-function would not correspond to the realities, since we have already found a metric wave-function. Such a course of action would be approximately comparable with the attempt, to define a wave-function for the envelope of an amplitude-modulated radio-signal, when the wave-function of the carrier wave is already known. Here it's much more opportune, to assign the transportation-function (wave-function) to the carrier wave and to consider the envelope only as a function of it's own. And with the macroscopic metrics it's the same. This can be compared with the envelope, whereas the transportation takes place by the metric wave-field.

Nevertheless we should not reject the explanations of D´INVERNO, because they still contain a lot of interesting information. Also, they aren't flatly to be regarded as wrong.

Based on the linearized form of the field-equations and with the help of the calculus of variations D´INVERNO draws the conclusion that these waves should consist of two independent components (h_{22} and h_{23}) having transversal character, and whose polarization-planes are oriented in the angle of 45° to each other.

Furthermore, the amplitude of the h_{23}-component should be about the factor $1/\sqrt{2}$ smaller than that of the h_{22} one. I would not like to go more in detail (these you can look up in [30] looks). but only examine, in what extent our model turns out to be compatible with the statements of D´INVERNO. In figure 1 we had already pictured the crystalline structure of the metric wave-field, just as predicted by LANCZOS. If we look for independent components, filling the conditions named above, so we find the subsystems painted in figure 137 and 138, which are twisted to each other about an angle of 45° in all three spatial dimensions indeed, and also the geometrical „dimensions" are right. The metric wave-field of this model could just really be the legendary gravitational waves.

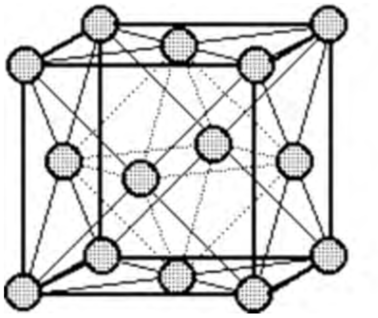


Figure 137
h_{22}-component of an oscillating even-frontal gravitational wave (+ polarization)

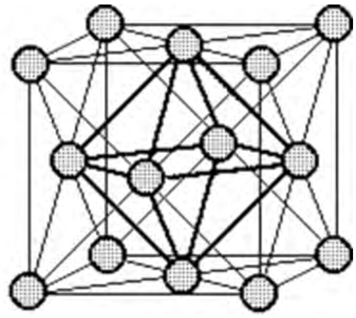


Figure 138
h_{23} - component of an oscillating even-frontal gravitational wave (× polarization)

By the way, our model avoids some inconsistencies addressed by D´INVERNO. One of it is the problem with colliding even-frontal gravitational-shock waves. D´INVERNO draws the conclusion that these no longer remain even-frontal then, just that the shape of intrinsic singularities must actually occur, which never have been detected. All together, the problem is elusive, mathematically and physically.

This disadvantage is avoided by our model. The reason is, that the metric wave-field forms the space itself, being everywhere and always and it's isotropic besides. Therefore, not at all there's going to be a „collision" of two waves and the problem is not a real one. Thus, also the search for gravitational (shock-)waves does not make any sense. And we can relativize even another statement of D´INVERNO. On p. 373 namely he writes: »Although such solutions—as infinitely extended objects—are extremely unphysical, so one however hopes that they describe some characteristics of real waves of isolated sources in the long-distance-zone...«. Now the expansion of course is not infinite but nearly infinite only. But if there is a grain of truth at this model, so such waves would not be unphysical by no means then.

7.4. Experimental tests

To each reasonable theory normally the verification belongs on the basis of experimental tests. Now, it is not always easy, as a general rule with cosmologic problems actually impossible to enforce experiments at all. Thus, in the end only the standard-set remains, consisting of following components:

1. *The gyration of perihelium of the Mercury*
2. *The light-distraction in the gravitational-field*
3. *The gravitative red-shift*
4. *The delay of light*
5. *The Eötvös-experiment*

These are all described in [30] in detail. But the exact verification we could have spared ourselves in this case. The reason is, that we have come to relations or statements in our model, which match those of the classic EINSTEIN theory in the *approximation*. But since the measuring results of the above mentioned experiments are partially quite inaccurate, we will come to the result that our model is (can be) right automatically, exactly as the classic EINSTEIN model. Partially, the measuring-precision is not even enough thereto. Since maximally one of both model can be right (minimally none), it's about no exact proof therefore. The only experiments as well as measurements, which could result in a proof, may be:

6. *Proof and determination of the value of the specific conductivity of the vacuum by measurement on the basis of quantum physical effects (e.g. superconductivity, ratio between gravity and strong interaction). Status: didn't take place. Chance of success: low, because value too extreme.*

7. *Determination of the exact value of the electron charge as a function of q_0 on the basis of quantum-electro-dynamic contemplations using the exact curvature-function. See section 6.2.2. The result however still differs negligibly, possibly the QED-differences must be accepted durably.*

8. *Determination of the value of the HUBBLE-parameter on the basis of locally measurable quantities. See section 7.5.*

9. *Determination of the value of the HUBBLE-parameter on the basis of the exact temperature of the cosmic background-radiation. See section 7.5.3.*

10. *Verification of the value of the HUBBLE-parameter, calculated according to this model, with the help of exact astronomic measurements. The value determined in section 4.3.4.4.6. is already quite passable. In section 7.5.5. is taken up a comparison with more actual measurements.*

Maybe, the proof even takes place in a completely different domain.

7.5. Relations between the HUBBLE-parameter and locally measurable quantities

7.5.1. EDDINGTON's numbers and the unity of the physical world

On the occasion of the then 100th birthday of A. S. EDDINGTON in [32] an article has been published, in which his efforts were appreciated, to develop an uniformly built physics . So, EDDINGTON assumed, that „all structures (and the corresponding operators) can be referred on one unique »operand«, namely the universe“. Because from the basic-constants of the physics dimensionless numbers can be formed, of which some directly regard the ratio of micro- and macrocosm. Particularly, we are interested in the following value, given by him:

$$C = \frac{1}{4\pi\varepsilon_0 G}\frac{e^2}{m_e m_p} \tag{879}$$

Of course, EDDINGTON had withhold ε_0 and the factor 4π at that time, „as these are equal to one“. However, for the sake of completeness, we insert it at this point because we would get a wrong result otherwise. Expression (879) is equal to the ratio of electric and gravitative attraction between an electron and a proton, just at a hydrogen-atom. It's about a dimensionless number with the value $2.26903\cdot10^{39}$ resp. $2.85135\cdot10^{40}$, when omitting the factor 4π. Now it would appear, that C somehow corresponds with a dimensionless number of this model. Here the Q-factor $Q_0\approx7.5419\cdot10^{60}$ would offer itself, which is equal to the phase-angle of the metric's wave-function being identical to the frame of reference. In order to test, whether such a relation is possible, we first of all proceed like with the examination of the fine-structure-constant. We replace the electron charge e by the charge of the MLE q_0, as well as the electron mass m_e and the proton mass m_p by the mass of the MLE m_0 under application of (29), (31), (36) and (37):

$$C = \frac{1}{4\pi\varepsilon_0 G}\frac{q_0^2}{m_0^2} = \frac{1}{4\pi\varepsilon_0 G}\frac{\hbar G}{Z_0\hbar c} = \frac{1}{4\pi} \tag{880}$$

Exactly like with the fine-structure-constant we obtain the geometrical factor $1/4\pi$ even here. Therefore we can assume C to be really suitable for this purpose. Since the electron charge and –mass at $Q_0=1$ are equal to the charge and mass of the MLE in the approximation and this and C also would have to be equal to one then (in reality it is the case at $Q_0=2/3$), we leave out the factor $1/4\pi$ in future considering the value:

$$C = \frac{1}{\varepsilon_0 G} \frac{e^2}{m_e m_p} = 2.85135 \cdot 10^{40} \tag{881}$$

This equals to $Q_0^{2/3}$ approximately, as a comparison with the astronomic value [] shows:

$$C^{\frac{3}{2}} = \left(\frac{1}{\varepsilon_0 G} \frac{e^2}{m_e m_p} \right)^{\frac{3}{2}} = 4.81478 \cdot 10^{60} \qquad [7.5419 \cdot 10^{60}] \tag{882}$$

Now, with the help of $H = \frac{\omega_0}{Q_0}$ (54) the HUBBLE-parameter can be calculated:

$$H(C^{\frac{3}{2}}) = 118.885 \ \mathrm{kms^{-1}Mpc^{-1}} \qquad [75.9] \tag{883}$$

Obviously, the left-hand value doesn't match the astronomic observations. Maybe there is a constant factor, to multiply expression (882) with, in order to find out a better matching result. With a constant factor (we already omitted 4π) the expression still can be used in the thought manner, because it's a constant. During the determination of H for a constant wave count vector we had also noticed, that the HUBBLE-parameter H_1 for the entire universe (R/2) is exactly 3/2 times greater than the local value H_0. Let's give a try to 2/3 therefore:

$$\frac{3}{2} C^{\frac{3}{2}} = \frac{3}{2} \left(\frac{1}{\varepsilon_0 G} \frac{e^2}{m_e m_p} \right)^{\frac{3}{2}} = 7.222169 \cdot 10^{60} \qquad [7.5419 \cdot 10^{60}] \tag{884}$$

$$H_0 = \frac{2}{3} \sqrt{\frac{c^5}{G\hbar}} \left(\frac{\varepsilon_0 G m_e m_p}{e^2} \right)^{\frac{3}{2}} = 79.2566 \ \mathrm{kms^{-1}Mpc^{-1}} \qquad [75.9] \tag{885}$$

Now the result fits the value determined in section 4.3.4.4.6. ($75.9 \ \mathrm{kms^{-1}Mpc^{-1}}$) very well. But this match can be a pure coincidence. Therefore, we must examine, whether the temporal shift as well as the shift with Q_0 of the values, used in (884), are being consistent with the shift of H_0. Therefore we combine (884) with (29) and (54) under consideration of the following dependences:

$$H_0 = \frac{2}{3} \omega_0 \left(\frac{\varepsilon_0 G m_e m_p}{e^2} \right)^{\frac{3}{2}} \quad Q_0 \sim T^{\frac{1}{2}} \quad H_0 \sim Q_0^{-2} \quad G \sim Q_0^3 \quad \omega_0 \sim \hbar \sim e^2 \sim Q_0^{-1} \quad m_x \sim Q_0^{-\frac{5}{2}} \tag{886}$$

Applying these dependences to the left expression, we get the following:

$$H_0 \sim Q_0^{-\frac{5}{2}} \ \text{Actual as per expression (886)} \qquad H_0 \sim Q_0^{-\frac{4}{2}} \ \text{Reference due to } H_0 = \frac{1}{2T} \tag{887}$$

Once again to the information: T is the local age, a time-constant of this model, and not to be mixed-up with the total-age 2T. What like however to interpret this difference? The most simply it would be to argue that it is really about a coincidence, when the left value of (885) matches the observations. But we don't want to make it so simple. Therefore let's return to the supposition of EDDINGTON, that „all structures (and the corresponding operators) refer to one unique »operand«, namely the universe“ (as a whole). What would it mean, when expression (886) really would describe the properties of the universe as a whole?

In the course of this work, we have worked out the dependencies of the various quantities on Q_0. And in section 4.5.2. we determined, that the expansion-velocity for distances greater than 0.01R is not given by H_0r, but by Hr, at which point H, according to the distance, takes on values between 1/(2T) and 3/(4T) (330). For the universe as a whole (distance R/2) applies H=3/(4T) then. This arises from the demand that for such distances the distance-function with constant wave count vector is applied. Now, also explains the excessive value of (883) and why we had to multiply it just with 3/2. This alone could already be regarded as appearance-proof. But further applies:

$\frac{r_0}{2} \sim Q_0^{\frac{2}{2}}$	*Local metrics*	$\frac{R}{2} \sim Q_0^{\frac{3}{2}}$	*Universe as a whole*
$x \sim Q_0^{\frac{3}{2}}$	*Material bodies*	$\lambda \sim Q_0^{\frac{3}{2}}$	*Wavelengths*
$a_0 \sim Q_0^{\frac{3}{2}}$	*Atomic distances*	$r_e \sim Q_0^{\frac{3}{2}}$	*Electron radius*

As it shows, all quantities, except for the local metrics, which determines also the distances between bodies, connected by means of gravity in the local area (<0.01R), expand according to the same function of the universe as a whole. Neither this can be else. If really all quantities, including the local metrics, would expand according to the same function, no expansion would be detectable at all. Here turns out a weak point of all so-called standard-models: They either all work with a linear metrics or with a patchwork as metrics and thereat actually should be to be detected no expansion at all. Therefore the universe may own only a non-linear metrics, as described in this work. Calculating the expansion-velocity as well locally as for the universe as a whole, so we obtain:

$$v = H_0 r = \tilde{H}_0 \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{4}{2}} \tilde{r} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{2}{2}} = \tilde{v} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{2}{2}} \sim Q_0^{-1} \sim t^{-2} \qquad (888)$$

$$v = H_1 \frac{R}{2} = \tilde{H}_1 \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}} \frac{\tilde{R}}{2} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{3}{2}} = \tilde{v} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{2}{2}} \sim Q_0^{-1} \sim t^{-2} \qquad (889)$$

It can be shown, that this is applied to any distances between $r_0/2$ and R/2. The expansion-velocity just changes according to the same function, irrespective how far away the considered area is. As a result, the structural integrity of the universe remains intact. The contradiction has been solved.

With it, we have proven, that expression (886) according to this model is really suitable to the determination as well of H_1 (universe as a whole) as of H_0, at which point the more final value always amounts to 2/3 of H_1.

Do we must worry about our metering rule? The answer is no. Since at present, the meter is defined on the basis of the speed of light and a time-etalon oriented at atomic scales and these all trace the universe as a whole, the same is applied even to the metering rule. But there should still be specialists, who reckon with miles...

Now, we have found a possibility to determine H_0 with the help of locally measurable quantities. This is based on the hydrogen-atom. The question is, is there yet another one? Indeed. In (888) we can read, that the fundamental length r_0 and the electron radius r_e are varying according to different functions on Q_0. Thus, also should have to be determined Q_0 and with it H_0 too. Under application of (3), (27) and (687) applies:

$$\frac{3}{2}\frac{r_e^3}{r_0^3} = \frac{3}{2}\left(\frac{1}{4\pi}\frac{e^2 Z_0}{m_e}\sqrt{\frac{c}{G\hbar}}\right)^3 = 7.95178\cdot 10^{60} \qquad [7.5419\cdot 10^{60}] \qquad (890)$$

This on the other hand corresponds to a value of H_0:

$$H_0 = \frac{2}{3}\frac{32\pi^2\varepsilon_0 G h m_e^3}{\mu_0^2 e^6} = 71.9845\ \mathrm{kms^{-1}Mpc^{-1}} \qquad [75.9] \qquad (891)$$

This value is based only on the electron and the metrics and is proportional to $Q_0^{-5/2}$. Thus, this is been suitable to the determination of Q_0 and H_0 too. Interestingly enough, the just determined value differs from the first one, namely about 10.102%, which corresponds to the average QED-correction-factor. Obviously, the usual QED-specific inaccuracies, which result from the logarithmic periodicity of the universe, appear here in turn.

Even this value fits the one, determined with the help of the propagation-function of this work, this is compatible with the distance-function with constant wave count vector, and can be brought in accord with the astronomic measurements in the next section too. Even if we have gotten two different results, we already are able to specify H_0 more exactly than the astronomers. But that is not yet enough. Combining both values, the first amounts to approximately 10^{40}, the r_e/r_0-based to approximately 10^{20}, we acquire an especially simple relation:

$$Q_0 = \frac{3}{2}\frac{r_e}{r_0}\frac{1}{\varepsilon_0 G}\frac{e^2}{m_e m_p} \quad \text{with} \quad r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}, \quad \frac{1}{r_0} = \sqrt{\frac{c^3}{G\hbar}} \qquad (892)$$

$$Q_0 = \frac{3}{8\pi}\frac{e^4}{\varepsilon_0^2 m_e^2 m_p}\frac{1}{\sqrt{G^3\hbar c}} \quad \text{with} \quad H_0 = \frac{\omega_0}{Q_0} = \frac{1}{Q_0}\sqrt{\frac{c^5}{G\hbar}} \qquad (893)$$

$$H_0 = \frac{8}{3}\pi\frac{G}{\mu_0 Z_0}\frac{m_e^2 m_p}{e^4} = 76.7544\ \mathrm{kms^{-1}Mpc^{-1}} \qquad [75.9] \qquad (894)$$

$$H_1 = 4\pi\frac{G}{\mu_0 Z_0}\frac{m_e^2 m_p}{e^4} = 115.132\ \mathrm{kms^{-1}Mpc^{-1}} \qquad (895)$$

Here, even the factor 4π has been taken into account, being omitted in (881). The expressions are proportional to $Q_0^{-5/2}$ in turn and do not contain the PLANCK's quantity of action surprisingly (no QED-difference?). In the numerator are only mechanical, in the denominator only electric quantities. The coverage is with $Q_0 \geq 10^3$, i.e. starting with the time just after big bang. Since the expression also form a sort of median value between the two other relations and both, the relations in the atom and in the vacuum are considered at the same time, I would mark it as precise. Whether that is correct, we will see. To the comparison once again all three results in table-form:

Expression	**Q_0**	**H_0**	**H_0**	**H_1**	**H_1**	**QED**		**V**
	[1]	$[s^{-1}]$	$[\mathrm{kms^{-1}Mpc^{-1}}]$	$[s^{-1}]$	$[\mathrm{kms^{-1}Mpc^{-1}}]$	Correct. factor		?
(884)	$7.2222\cdot10^{60}$	$2.569\cdot10^{-18}$	79.257	$3.853\cdot10^{-18}$	118.885	1.10102	ξ^3	$\bar{\gamma}$
(892)	$7.4576\cdot10^{60}$	$2.487\cdot10^{-18}$	76.544	$3.731\cdot10^{-18}$	115.132	1.06626	ξ^2	H
(890)	$7.9518\cdot10^{60}$	$2.333\cdot10^{-18}$	71.985	$3.499\cdot10^{-18}$	107.977	1.00000	ξ^0	γ

Table 7
HUBBLE-parameters as a funktion
of local quantities (overview)

7.5.2. Distance-vectors

Due to the progress in the technical domain taken place in the most recent time, the astronomers are able to look into the universe deeper and deeper and with it even farther back in time. The farther one looks however, all the more the structure of the universe becomes notably and must be taken into consideration on the interpretation of the measuring results. Otherwise the much money would have been poured down the drain.

But before expanding further, just let's have a look at a so simple quantity, like the distance respectively the spacing to a stellar object. The astronomer just sits in front of his telescope, observing an object and he tries to determine with different methods, how far away it is. And before he can determine the HUBBLE-parameter, he must determine the distance respectively the spacing to the object of course. And the first problem already appears here: What do we actually mean by distance as well as spacing? And what do we really want to determine?

In the close-up range this question can be answered relatively simply: The spacing is equal to the distance and the light from the object has covered this, when it has arrived at the observer. But if we leave the close-up range, looking at objects farther away, it's no longer like this. At first, we look at the object by means of photons, which have moved from the object into our direction. Thus, in reference to the metrics, it's about an (incoming) time-like vector (figure 139 and 140 r_T red pictured), a negative distance. We call it *time-like distance*. It corresponds to the constant wave count vector of the metrics. On this occasion, we however actually observe the zero vector and not the time-like vector. With vanishing curvature both coincides indeed. As it looks like, when there is a curvature, will be presented later.

But the object, we observe nowadays, is already located at a completely different position, as our observation-data want to make believe, since these are already totally „outdated", when they reach us. One feature of this model is now, that this is not the case. Even when the signals are already very old, the object really resides in reference to the observer's R^4-coordinate-system at that very position, where he observes it. The length of the vector from the object to the observer however cannot be influenced by him, because he is just only observer.

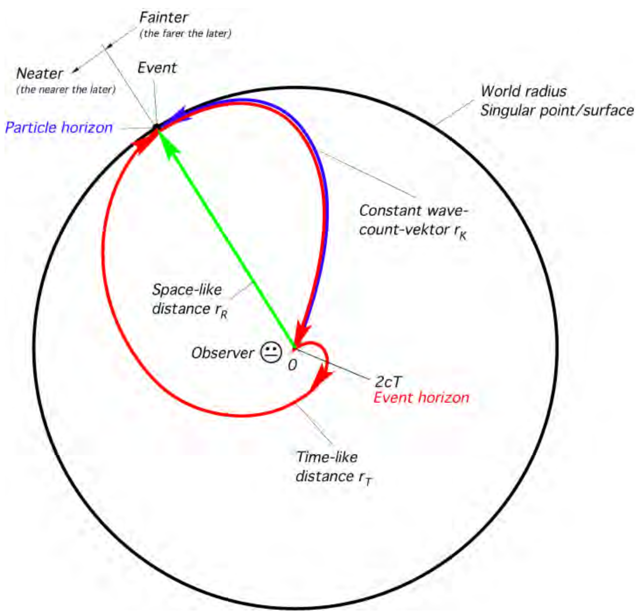


Figure 139
Distance-vectors with an object
at the edge of the universe (schematized)

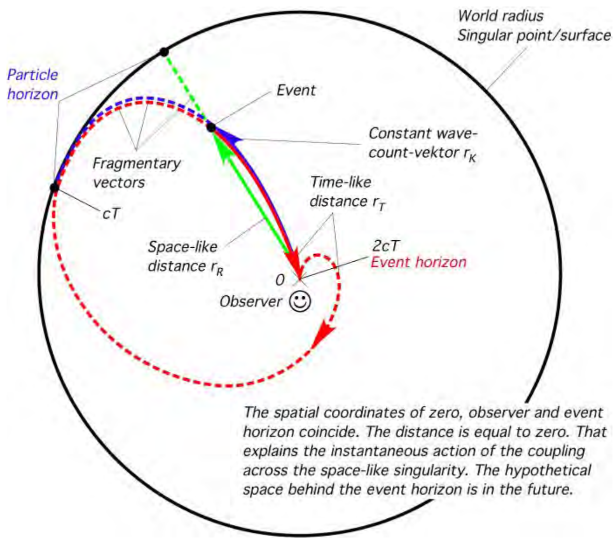


Figure 140
Distance-vectors with an object
in the close-up range of the observer (schematized)

But if the observer has the intent, to visit the object, that would be an (outgoing) space-like vector then, a positive distance/spacing, this cannot take place on the same way, which the ray of light has covered, because the observer would have to move with c thereto and each zero vector is unique. Now, another distance/spacing is applied to him.

To the difference between *distance* and *spacing*: These are (approximately) equal in the close-up range only. With larger distances, objects in the free fall remove themselves according to the distance-function with constant wave count vector. That would be the real *spacing* (r_K blue pictured). With it, also the definition of the *space-like distance* arises (r_R green pictured). This is the shortest way between the observer or better the traveler and the object. It is an imagined line and coincides with the coordinate r of the coordinate-system. Locally, it is equal to the space-like vector of the metrics.

But this way, the destination cannot be reached in the free fall, as an analogy from the navigation suggests, the difference between latitudinal and great-circle-distance. When start and destination are on the same latitude and if it's not exactly about the equator, the great-circle-distance is always smaller than the latitudinal-circle-distance. During great-circle-navigation however, the captain must change the course continually, just accelerate, whereas he could theoretically continue his journey without acceleration on the latitudinal circle, just in the free fall, when the water-widthstand would be zero. Thus, the voyager has the chance, to influence the distance, namely by means of navigation. To the better overview the definitions once again:

1. The *zero vector* r_N is the way, a ray of light covers, at which point the velocity in reference to the subspace is c constantly. In the local range it is equal to the geometrical sum of space- and time-like vector.
2. The *time-like distance* r_T is the way, a ray of light, starting from the source, has covered, when it has been arrived at the observer. In the local range, it corresponds to the time-like vector of the metrics. But actually the zero vector r_N is observed.
3. The *spacing* r_K is the distance between two objects in the free fall. The vector proceeds along the field-lines of the gravitational-field and varies according to the spacing-function with constant wave count vector. It corresponds to the zero vector r_N of the metrics.
4. The *space-like distance* r_R is the shortest vector between a traveler and his destination. It's about an imagined line. It is identical to the coordinate r of the coordinate-system. In the local range, it corresponds to the space-like vector of the metrics. If one wants to travel along this line, permanent navigation (acceleration) is necessary.

But let's descend to *the time-like distance* once again. This is the distance, the astronomer determines, when he analyzes incoming light- or radio-signals (zero vectors). They are subject to a red-shift according to the propagation-function in section 4.3.5.4.3. resp. 5.3.2. The *time-like distance* is limited to the maximum *time-like distance*, which results from the total-age 2T. It applies $r_{Tmax} = R = 2cT$. In the course of this work, we had learned that the maximum *space-like distance* amounts to only the half of it: $r_{Rmax} = R/2 = cT$. Furthermore we had demonstrated that, on the basis of the efforts of EINSTEIN it's possible to convert both distances in one another namely according to (280):

$$r_T = -\frac{r_R}{\sqrt{1-\frac{4r_R^2}{R^2}}} \qquad\qquad r_R = -\frac{r_T}{\sqrt{1+\frac{4r_T^2}{R^2}}} \tag{280}$$

Considering the two expressions now, one recognizes that these fail at the „edge“ of the universe. The left-hand expression submits a negative infinite *time-like distance* for R/2, the right-hand expression a *space-like distance* of $0.447214R=0.894427cT$ for –R/2. Actually, a value of $0.5R=cT$ should arise however. In section 4.3.5.3. on the other hand we have learned, that the maximum propagation-velocity of the metric wave-field is 0.851661c and not c to the point of time $0.748514t_1$. With it, the maximum *space-like distance* would actually have the value 0.851661cT only and not 0.894427cT respectively cT. Are EINSTEIN’s expressions useless because of that? I say no.

The reason for the discrepancy is, that „edge“ of the universe is not simply an edge but, according to it's nature, a SCHWARZSCHILD-radius and a singularity resides behind it. As determined in section 4.3.5.3. the maximum propagation-velocity of the metric wave-field amounts to 0.851661c indeed, namely to the point of time 0.748514 t_1. At the same time we have learned, that the metric wave-field already existed before, having propagated with a lower velocity. What actually has happened to this part of the universe? Definitely, it should have to be „passed“ somehow by the later, more quickly propagating part.

On the other hand we know that the physical relations differ in this part from those of the other one, namely to the effect that the more aged part is spatially closed, whereas the junior part is spatially open (Q_0>1). That means, the part of the universe we live in, is not the whole thing. There is a small part, which is neither accessible, nor observable for us. Thus, derived from a known SF-series, I would like to call it hyperspace. In figure 141 I just tried to demonstrate the relations at the „edge“ of the universe.

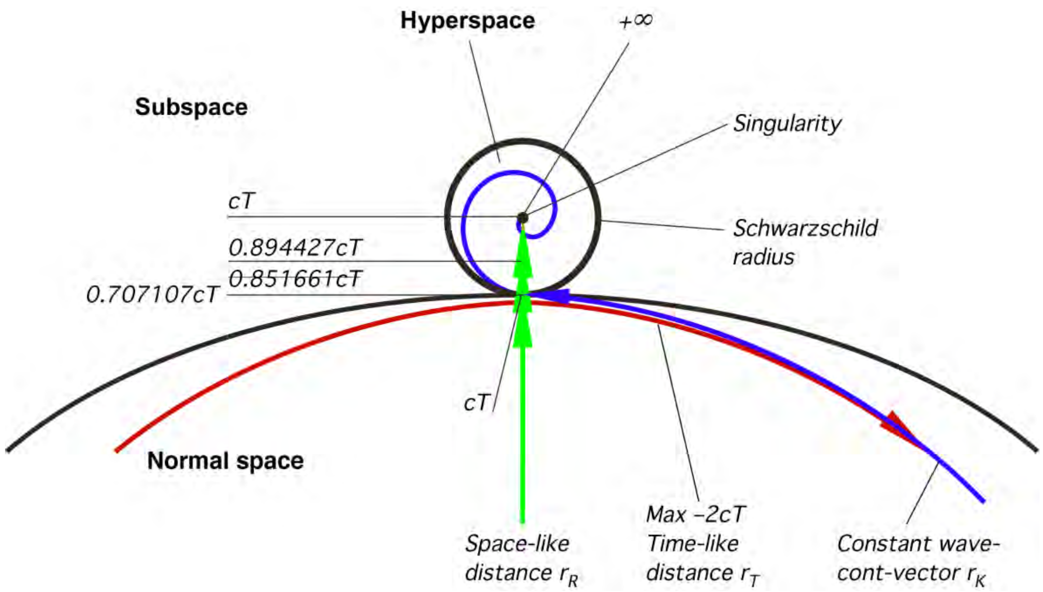


Figure 141
Relations at the edge of the universe

With the *time-like vector* is to be paid attention to the following: This can be both, an incoming (negative distance), as well as an outgoing vector (positive distance). An observer always is concerned with an incoming vector, whose length is limited to –2cT. The light has traversed the entire universe then and has been rearrived at it's starting point, a time-like singularity (event horizon). The farthest starting point of an incoming time-like vector is in the distance –cT. The maximum length of an outgoing time-like vector on the other hand is unlimited because it directs to future. Of course, it is even subject to the parametric attenuation. It's impossible to send signals back in time.

For that reason it's also impossible, to look back simultaneously up to the point of time –T (reckoned from now on) and up to a distance –R/2, because the elder signals have passed us long ago. What we see, are all junior signals, maximally half as old as the universe. Spatially, we can look back up to the „edge“ –cT with it, temporally not at all (see also figure 69). The signals directly from the big bang –2T form an exception. These have reached their starting point again and are to be observed as cosmic background-radiation, although with extreme red-shift. The picture, which it generates, is really the view from the point of observer to the point of time –2T, however mirror-inverted in all four dimensions (an outgoing time-like vector becomes an incoming one). The range between –2T and –T is also accessible indeed, but these signals come from areas at the opposite end, with a lower distance than –R/2, at which point the signal is coming „from behind“ on a detour. In this case applies, the older the signal, the nearer the source (neater).

Concerning the *space-like vectors* an observer in the free fall resides on a space-like singularity, even if he does not take notice of it. This expresses itself to the effect, that no negative distances are defined for him. As comparison, the North-pole may act in this place.

Being situated on this, all ways lead southward, the individual does not take notice of it however. The maximally possible spatial distance would be –cT with it. Thus, time-like vectors from the past and space-like vectors would be approximately equally long.

In that regard, the result of the left-hand expression of (280), which we get for a *time-like distance* –cT, namely $-\infty$, is not really wrong. Since this spacing borders directly on a SCHWARZSCHILD-radius no light from there can reach the observer. However, the expression submits a wrong result for a distance of –0.851661 cT. And similarly it's with the right expression of (280).

With it, both expressions are been suitable only conditionally for the calculation of problems involving the universe as a whole. Nevertheless they are perfectly enough for the calculation of astronomic data, since only objects with a fraction of the spacing –cT can be observed until now. For deeper contemplations however, we require the correct expression, which results from section 6.1.2.1.2.:

$$r_T = \frac{r_R}{\frac{2r_R}{R}\cos\alpha - \sqrt{1-\left(\frac{2r_R}{R}\right)^2 \sin^2\alpha}} \qquad r_R = -\frac{r_T}{\sqrt{1+\left(\frac{2r_T}{R}\right)^2 - \frac{4r_T}{R}\cos\alpha}} \tag{896}$$

The angle α is given by (482) in connection with (206). The expressions don't shall be presented again but the course as a function of Q_0.

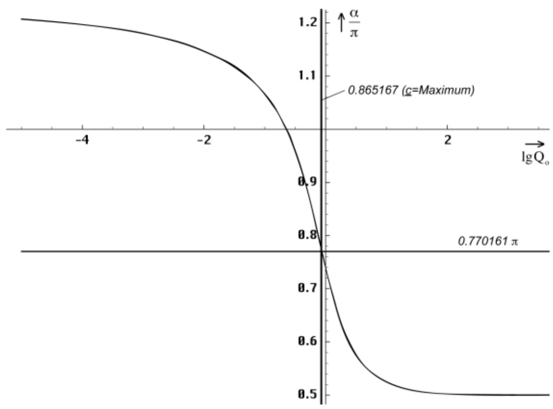


Figure 142
Angle α as a function of Q_0

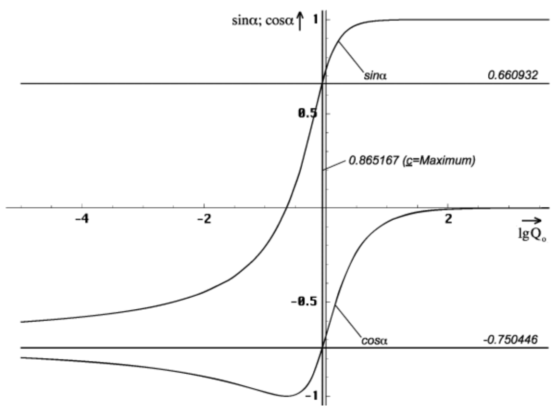


Figure 143
Functions $\sin\alpha$ and $\cos\alpha$ as a function of Q_0

As it shows, both trigonometric functions from a value of $Q_0>10^2$ on are equal to one resp. zero, so that (896) coincides with (280). But this value is first underrun almost directly at the SCHWARZSCHILD-radius so that (280) can be used as approximation almost for the entire universe. For the point with the maximum propagation-velocity, the so-called wave-front, we get with the help of (53) a value of $Q_0=0.865167$ and for $\alpha=2.41953$. Thus, it's within the SCHWARZSCHILD-radius ($Q_0=1$) and cannot be observed.

For an angle $\alpha=\pi/2$ in expression (896) on the right we obtain for the *space-like distance* a value $r_R(-cT)=cT/\sqrt{2}$, as presented in figure 141. This value is indeed somewhat lower, than the maximally possible *space-like distance* $r_{Rmax}=0.851661\,cT$, which indicates, that the wave-front is moving resp. has moved on a curvilinear track. The value for r_T, we have inserted, however is not exact. It only applies „almost at the edge“. Directly at the SCHWARZSCHILD-radius applies $Q_0=1$ and the angle α has another value. The exact behaviour of the distance-vectors is presented in figure 144 and 145.

What does it look like however with the *spacing with constant wave count vector*? From figure 140 emerges that this, with small distances, must be equal to the other two vectors (approximately). Directly at the SCHWARZSCHILD-Radius it should exactly amount to cT according to our model. If we look for a conversion-function turns out, that (280) which we already wanted to discard, is been suitable for it very well, however with r_K instead of r_T:

$$r_K = \frac{r_R}{\sqrt{1-\frac{4r_R^2}{R^2}}} \qquad\qquad r_R = \frac{r_K}{\sqrt{1+\frac{4r_K^2}{R^2}}} \tag{897}$$

Both expressions are defined positively only and apply even exactly. For r_K and r_T applies:

$$r_T = -r_K\left(\frac{2r_K}{R}\cos\alpha + \sqrt{1+\left(\frac{2r_K}{R}\right)^2\cos^2\alpha}\right) \qquad r_T = -r_K \quad \text{für} \quad \alpha = \frac{\pi}{2} \tag{898}$$

$$r_K = -\frac{r_T}{\sqrt{1-\frac{4r_T}{R}\cos\alpha}} \qquad r_K = -r_T \quad \text{für} \quad \alpha = \frac{\pi}{2} \tag{899}$$

For an angle $\alpha\approx\pi/2$ just almost in the entire universe, the constant wave count vector coincides with the (negative) time-like distance-vector. Therefore it also seems to be that a conversion can be taken up with the classic relations of the SRT from space-like into time-like coordinates. The SRT describes nothing other than observation-phenomenons of moved bodies by means of photons. Simultaneously, we can see here, why the SRT fails with strong gravitational-fields (e.g. black holes) and with it even at the edge of the universe, because there the vectors diverge, and that all.

And some more we see: Because of the coincidence of the constant wave count vector with the time-like distance-vector, of course also the gravity propagates on the same way like the photons, namely as zero vector, that means with light speed. Otherwise, even no real R^4- coordinate-system would be possible. We have found a contradiction-free solution with it. Our guess (897) had been right. In the close-up range and even far in excess actually all three vectors coincide. For example with 400 Mpc distance, the difference between r_R and r_T is about 2% and with it far below the observation-error.

Now we want to try to demonstrate, like the three distance-vectors behave at the „edge“ of the universe in general and specifically. For reasons of recognizability, we want to display the distance-quantities as a function of the Q-factor Q_0. For that purpose indeed, we require a function of the *space-like distance* with respect to the Q-factor. With (606) we already had found the inverse function $Q_0(r_K)$ (all functions, hitherto occurring in the course of this work are always based on $r=r_K$). Disregarding the time t applies:

$$Q_0 = \tilde{Q}_0\left(1-\left(\frac{2\tilde{r}_K}{\tilde{R}}\right)^{\frac{2}{3}}\right) \qquad Q_0 = \tilde{Q}_0\left(1-\sqrt[3]{\frac{4\tilde{r}_R^2}{\tilde{R}^2-4\tilde{r}_R^2}}\right) \tag{900}$$

$$\tilde{r}_r = \frac{\tilde{R}}{2}\frac{1}{\sqrt{1+\left(\frac{\tilde{Q}_0}{\tilde{Q}_0-Q_0}\right)^3}} \qquad \tilde{Q}_0 \gg 1 \tag{901}$$

Applied in (896) and (897) under consideration of the angle α, according to (482) and (206) with $2\omega_0 t=Q_0$ we obtain the courses shown in figure 144 and 145.

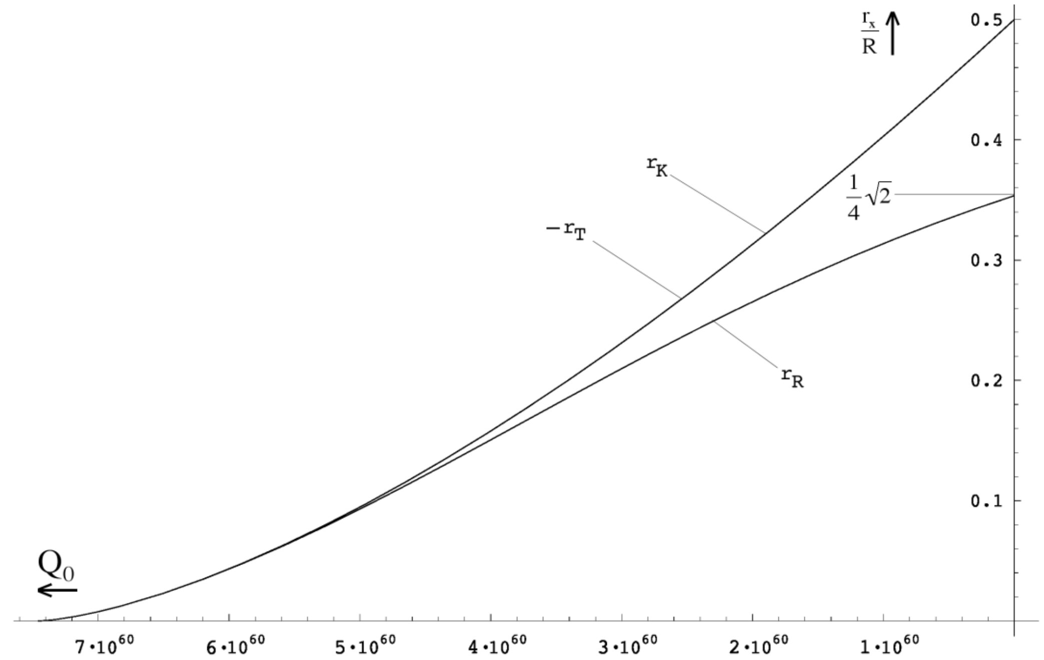


Figure 144
Length of the distance-vectors r_R, r_K and r_T as a function of the phase-angle (Q-factor Q_0) at the location of the signal-source

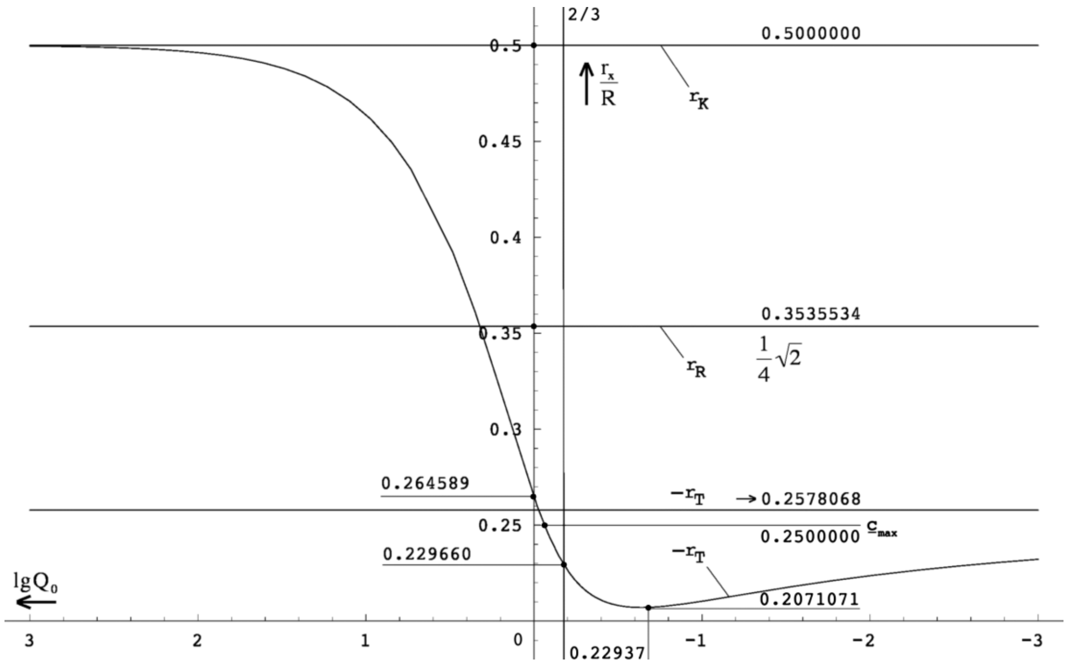


Figure 145
Course of the distance-vectors r_R, r_K and r_T at the SCHWARZSCHILD-radius ($Q_0=10^0$)

Whereas all vectors in the large scale proceed in the same way as expected, the time-like vector deviates just before the SCHWARZSCHILD-radius and takes a different course. Interestingly enough, only the time-like vector is influenced by the singularity. This is even no miracle, is it about a temporal singularity after all (no values t<0 defined). In this connection is to be paid attention to the fact, that the light is actually a zero vector and disposes as well of a space-like, as of a time-like component. When only the time-like vector is influenced, it means that the wavelength changes admittedly, but not the propagation-velocity c, a known phenomenon. But actually the zero vector has the value c only in reference to the subspace. however, the difference is not measurable at all, because it's all too little. Therefore, an observer, who doesn't move in reference to the metrics (free fall), always measures the time-like vector. Under regular conditions (Q_0) however, the difference is not measurable at all, because it's all too little.

At the SCHWARZSCHILD-radius the time-like distance shortens locally on –0.264589R and sinks to –0.25R in the point of the maximum propagation-velocity of the metrics, the wave-front. This point is an inflexion point at the same time. Finally, r_T achieves a minimum of –0.2071071R, reascends and tends toward a value of –0.2578068R. Even in accordance with the SRT, at a singularity a shortening should occur, however boundless with the exception of the value zero. Although, at that time EINSTEIN did not reckon with the possibility, that the right angle α could vary. The same behaviour as in the distance R/2 would be to observe also at the SCHWARZSCHILD-radius of a black hole, if we could take up measurements there.

7.5.3. Determination of the HUBBLE-parameter with the help of the CMBR-temperature

In section 4.6.4.2.6. with (405) we already formulated a relation between the phase-angle/Q-factor of the metrics Q_0 and the resulting temperature of the cosmic background-radiation. With the astronomically specified value of the HUBBLE-parameter of section 4.3.5.4.6. (75.9 $\mathrm{kms^{-1}Mpc^{-1}}$) and the value $Q_0=7.5419\cdot 10^{60}$ resulting from it arises a temperature of 2.86632K for the cosmic background-radiation. Because of a calculation error in a former edition I made use of $H_0=76.7545\ \mathrm{kms^{-1}Mpc^{-1}}$ temporarily. Thus it's possible, that this value still appears in one or the other graphic. But one cannot see the difference, since it's near by 75.9.

Interestingly enough, this value is close to the value of 3.18K already predicted 1896 by GUILLAUME and EDDINGTON ($=82.63\,\mathrm{kms^{-1}Mpc^{-1}}$). Both assumed at that time, that in the 10pc-surroundings of a star there are (converted) 2000 stars on average with the magnitude 1^{m}. The energy emitted by these stars leads to an energy-density, which corresponds to a radiation-temperature of 3.18K. See [39] for details.

Although, the calculation contained an essential error. One assumed in those days that the supposed average star-density should be available throughout the whole universe, because the existence of external galaxies did not have been commonly accepted as well as was known until 1924.

Fortunately, now we are in a better situation. So, we don't need to calculate the radiation-temperature but we can measure it absolutely accurate. The average radiation-temperature, determined with the help of the COBE-satellite, is about 2.72548 ± 0.00057K (Wikipedia). Now, it's no problem of course, to determine the corresponding values Q_0 and H_0 by rearrangement of (405b). Indeed it is to be pointed out, that neither ω_1 nor $\hbar_1$ are exactly defined by locally measurable quantities. Rather, they depend on Q_0 as well as H_0 themselves, the values, we actually want to determine. We however know the values $\hbar$ and ω_0. It applies $\omega_1=Q_0\omega_0$ and $\hbar_1=Q_0\hbar$:

$$T_k = \frac{\hbar_1\omega_1}{18\mathrm{k}}Q_0^{-\frac{5}{2}} = \frac{\hbar\omega_0}{18\mathrm{k}}Q_0^{-\frac{1}{2}} \qquad \omega_1 = \frac{\kappa_0}{\varepsilon_0} \tag{902}$$

$$Q_0 = \left(\frac{\hbar\omega_0}{18\mathrm{k}T_k}\right)^2 \qquad \omega_0 = \sqrt{\frac{c^5}{G\hbar}} \tag{903}$$

$$Q_0 = 0.0030864198\left(\frac{\hbar\omega_0}{\mathrm{k}T_k}\right)^2 = \frac{1}{324}\left(\frac{\hbar\omega_0}{\mathrm{k}T_k}\right)^2 \qquad H_0 = \frac{\omega_0}{Q_0} \tag{904}$$

$$H_0 = \omega_0 \left(\frac{\hbar\omega_0}{18kT_k} \right)^{-2} \qquad H_0 = 324\,\omega_0 \left(\frac{\hbar\omega_0}{kT_k} \right)^{-2} \tag{905}$$

All equations are based on the approximation $2\sqrt{2}$ for the proportionality-factor of WIEN's displacement law. Applying the above-mentioned measured value 2.72548K, we get a value of von $8.3415 \cdot 10^{60}$ for Q_0. This corresponds to a value $H_0 = 68.6215\,kms^{-1}Mpc^{-1}$. This value most likely match our solution (890), but it's somewhat too low, since the latest studies submitted H_0 to be somewhere between 71 and $75\,kms^{-1}Mpc^{-1}$ (FREEDMAN, KIENZLER 72). But it may be, that the CMBR-temperature, for which reasons ever, is simply lower as it actually should be. Possibly, beside expansion and cosmologic redshift, there are yet other effects, leading to an additional cooling. Adsum, as one possibility [40.1] shall be mentioned.

Value	Q_0	H_0	H_0	Temperature CMBR	Absolute offset	Relative offset
	[1]	[s^{-1}]	[$kms^{-1}Mpc^{-1}$]	[K]	[K]	[%]
(884)	$7.2222 \cdot 10^{60}$	$2.569 \cdot 10^{-18}$	79.2562	2.92907	+0.20359	+7.46988
(892)	$7.4576 \cdot 10^{60}$	$2.487 \cdot 10^{-18}$	76.7545	2.88247	+0.15699	+5.76009
(TAB1)	$7.5419 \cdot 10^{60}$	$2.460 \cdot 10^{-18}$	75.8966	2.86632	+0.14084	+5.16753
(890)	$7.9518 \cdot 10^{60}$	$2.333 \cdot 10^{-18}$	71.9843	2.79146	+0.06598	+2.42086
(COBE)	$8.3415 \cdot 10^{60}$	$2.224 \cdot 10^{-18}$	68.6215	2.72548	±0.00000	±0.00000

Table 8
Calculated and measured CMBR-temperature in comparison with the values of the HUBBLE-parameter determined in section 7.5.1.

To the conclusion, we want to determine the real difference to our calculated temperature (890). Inserting (890) into (902) we get a nominal temperature of 2.79146K. With it, the measured temperature is about 0.06598K lower than the calculated. For solution (892) a temperature of 2.88247K would be necessary, for (884) even 2,92907K, which shows up both as less realistic. Therefore, we can assume solution (890) with $71.985\,kms^{-1}Mpc^{-1}$ to be the most probable one.

In table 8 all values, even the ones used in former sections, are recapitulated. For the fact, that the measured CMBR-temperature is about 0.06598K smaller than the calculated one, I would like to blame the *gray body*. Indeed we considered the coefficient of absorption ε_ν, at the *gray body* it depends on the frequency however. Please find the exact calculation in [47] resp. here in the annex. In any case, the measured value is smaller than the calculation. If it had been larger, the model would have been refuted. That's not the case. A delta of only $+2.42086 \cdot 10^{-2}$ with a time span of 13.5839 billion years, an in-coupling temperature of $2.6864 \cdot 10^{153}$K, as well as of a redshift z_{11} of $1.42701 \cdot 10^{92}$, overall, this can be seen as a complete success. I would say, the model predicts the temperature very precisely. To the verification of the favoured value we will make a comparison with astronomical observations in the next section.

7.5.4. The supernova-cosmology-project

Another option to choose the correct one from the three solutions, is the comparison with the latest astronomic observations. The most important project of late has been the supernova-cosmology-project. One observed a lot of type Ia supernovae, which all own the particular property, to have the same luminosity approximately, so that they can be used as a standard-candle. Aim of the research [45] was the determination of the HUBBLE-parameter and of course, to determine, which of the world-models stated until today comes closest to the reality. The examination indeed has caused more confusion, than that it has led to rational results, as we will see yet. Reason however is not the research itself but the missing of a correct world-model, as I intended to make it with this work.

Before we go on into detail, at first another section, which deals with the fundamental values of observation being focused to physicists, astronomers and technicians, which work with different units of measurement as known and it's difficult to understand one another therefore.

7.5.4.1. Measurands and conversions

Since we want to deal only with one concrete project, only the quantities, which are specifically relevant for the supernova-cosmology-project, should be exemplified. In reality, in physics, astronomy and radio-astronomy there is yet a large number of further quantities. Whom it interests, I recommend [44], which also the declarations, done in this section, are based on.

Initially with the project, astronomic objects, supernovae of the type Ia, which appear to the observer as punctual objects with a certain luminosity, have been observed. The measured luminosities have been compared with the red-shift z (307) and have been collated with the luminosities predicted by the various world-model. What however do we mean by luminosity?

In astronomy there are four types thereof at all, once the apparent brightness, the bolometric brightness, the absolute and the absolute bolometric brightness. It is given in magnitudes [m, m_b, M, M_b]. It is about a logarithmic unit of measurement, which is defined historically. With the bolometric brightness, the entire frequency domain in accordance with the STEFAN-BOLTZMANN radiation-rule is considered, it's about the logarithm of the quotient of the two values power and surface [Wm^{-2}], which the physicist marks as POYNTING-vector **S** . In the astronomy, this value is called flux F, in the technical department field-strength **S**. With the non-bolometric values the unit of measurement [$Wm^{-2}Hz^{-1}$] is used. The measurements are dependent on frequency and bandwidth then. But for us only the bolometric values are of note. Another important value is the (bolometric) luminosity L. In the physics and in the technical domain it is marked as power P as well as level p. Unit of measurement is the Watt [W] as well as the decibel [dB]. Thus, we can define:

$$M_b = -2.5\lg\frac{F}{F_0} = -2.5\lg\frac{L/4\pi r^2}{L_0/4\pi r^2} = -2.5\lg\frac{L}{L_0} \qquad \text{Brightness} \qquad (906)$$

As usual with logarithmic units of measurement, always a reference-quantity F_0 as well as L_0 is needed. The values has been taken from [42] and [44] and read as follows:

$$F_0 = 2.51\cdot 10^{-8}\,Wm^{-2} \qquad L_0 = 3.09\cdot 10^{28}\,W \qquad (907)$$

A star with the luminosity L_0 has exactly 0 magnitudes (written 0^M). The absolute brightness (flux) is defined in a distance of 10pc of the source, but it has no meaning for us. Even in the technical domain there is such a logarithmic dimension, the dB (decibel):

$$S = P = 10\lg\frac{S}{S_0}\,dB = 10\lg\frac{P/4\pi r^2}{P_0/4\pi r^2}\,dB = 10\lg\frac{P}{P_0}\,dB \qquad \text{Field-strength/level} \qquad (908)$$

Another, more rarely used logarithmic unit of measurement is the Neper p[Np]=ln(P/P_0). The original definition of P_0 comes from the telecommunication and is defined as a power P=1mW on 600Ω. But in the radio-technology and with it even in the radio-astronomy this value is not used, since we are concerned there with much smaller quantities in general. Therefore, the following relative values are used:

$$S_0 = 1\,pWm^{-2} = 10^{-12}\,Wm^{-2} \qquad P_0 = 1\,pW = 10^{-12}\,W \qquad (909)$$

In order to avoid a mix-up with the historic definition, instead of dB mostly the unit $dBpWm^{-2}$ or dBpW as well as $dBpWm^{-2}Hz^{-1}$ or $dBpWHz^{-1}$, when there is not the entire spectrum included. The power P at the input of a receiver with adaptation simply results from the POYNTING-vector **S**, the effective surface A of the antenna used and the gain G of the antenna:

$$P[dBpW] = S[dBpWm^{-2}] + 10\lg A[m^2] + G[dB] \tag{910}$$

Since the decibel is also a logarithmic unit, a simple conversion is possible into the astronomic units. For P[dBpW], M_b[M], S[$dBpWm^{-2}$], m_b[m], L[W], F[Wm^{-2}] applies:

$$P = 404.9 - 4M_b \qquad M_b = 101.225 - 0.25P \qquad \text{Power, Absolute bolom. brightness} \tag{911}$$

$$S = 44 - 4m_b \qquad m_b = 11 - 0.25S \qquad \text{Poynting-vector, Apparent bolom. brightness} \tag{912}$$

$$P = 120 + 10\lg L \qquad L = 10^{0.1P-12} \qquad \text{Power, Luminosity} \tag{913}$$

$$S = 120 + 10\lg F \qquad F = 10^{0.1S-12} \qquad \text{Poynting-vector, Flux} \tag{914}$$

$$L = 10^{28.5-0.4M_b} \qquad M_b = 71.225 - 2.5\lg L \qquad \text{Luminosity, Absolute bolom. brightness} \tag{915}$$

$$F = 10^{-7.6-0.4m_b} \qquad m_b = 19 - 2.5\lg F \qquad \text{Flux, Apparent bolom. brightness} \tag{916}$$

All obscurities should be removed with it, so that we can turn to the results of the supernova-cosmology-project.

7.5.4.2. Results of the supernova-cosmology-project

The results of the project have been published by PERLMUTTER in [45] in detail. To the better understanding, what's actually a supernova of the type Ia, I recommend the work of HERRMANN [42]. The most important is, a SN Ia has a maximum absolute brightness, which results from its structure. If the star is greater, a supernova of other type, which can be recognized by its characteristic, develops. Therefore it's possible to use a SN Ia as a standard-candle, at which point the brightness mostly is something smaller than the maximum indeed, because not all SN Ia achieve the maximum brightness.

The apparent bolometric brightness at the observer has been compared by PERLMUTTER in a diagram with the associated red-shift z. Even HERRMANN [42] and HEBBEKER [43] are using the same diagram, at which point in [43] is deferred in detail to the common standard-big-bang-model once again, being based on the classic EINSTEIN evolution-equation with and without cosmologic constant.

The observations now submitted, that further (older) SN Ia appear somewhat darker, as they actually should be according to the standard-model without cosmologic constant (Λ=0). The case Λ=0 just doesn't fits the observations. The option, that SN Ia earlier could have had other qualities, is being excluded by all authors and even by myself.

Rather the discrepancy is interpreted in such a manner, that Λ should have a value different from zero, which means, that the expansion-rate of the universe, just the HUBBLE-parameter, doesn't decrease, as always assumed until now, but increases on the contrary. Thus, the observed SNae would be farther away, than it would arise from the measured red-shift z. The lower brightness would be explained with it. Although this leads to incongruities with other observations. In order to avoid these, a complicated construct is used, which demands extremely exact synchronizations to the point of time T=0 and even afterwards, which appears to be pretty implausible, because nobody can exactly say, on which physical phenomenon this effect should be based on.

While PERLMUTTER contents himself with the hint on the option $\Lambda\neq 0$, HERRMANN and HEBBEKER even demand the existence of „dark matter“ with hitherto yet unknown qualities and of an effect with the name „quintessence“ which should be the cause for the increasing expansion-rate, quasi a sort of anti-gravity. For my part however, I consider this hypothesis to be off the point, since the discrepancy can be explained even more simply, only with the help of known physical rules (Ockham's razor). Only, one must have the courage then to use an alternative model. The standard-big-bang-model has failed for a long time, even in other points. Unfortunately, the common view latterly seems to tend more and more into the direction „dark matter“ and „quintessence“, which can be regarded as criterion, that the proponents of the standard-model are at their wit's end.

But when the HUBBLE-parameter should decrease on and the observed objects should be located in the correct distance, as only explanation remains, that the photons during their propagation are subject to an additional attenuation, not known until now. And exactly this is an essential quality of the model on hand[1].

In section 4.3.4.4. we had worked out the propagation-function for a loss-affected medium with expansion and overlaid wave. Different from the propagation-function for a loss-free medium there the attenuation rate α is different from zero. It has the value 1/R. Therefore we want to forecast the observed brightness of SNae Ia with the help of this function. For the graphic representation, we need the function $m_b(z)$. Based on (906) we obtain for the apparent brightness m_b then:

$$m_b = -2.5\lg\frac{F}{F_0} = -2.5\lg\frac{L_{Ia}}{4\pi r^2\cdot 2.51\cdot 10^{-8}\,\mathrm{Wm}^{-2}} \qquad (917)$$

In doing so we notice, that the value L_{Ia}, the luminosity (power) of the standard-candle supernova Ia is missing. And indeed, neither in [42], [43], [44] nor in [45] such a one is specified. Fortunately, the colleague Wolfgang Hillebrandt from the Max-Planck-Institute for Astrophysics (MPA) Garching could help me with this problem. According to his information, the maximum luminosity of a SN Ia has a value of 10^{36}W approximately. That's the upper limit. If we put it into (917) still the distance r is missing Since we look at the matter starting from the source toward the observer, we obtain it with the help of (309a) without correction-term. It applies:

$$m_b = -2.5\lg\frac{10^{36}\mathrm{m}^2}{4\pi r^2\cdot 2.51\cdot 10^{-8}} = -2.5\lg\left(\frac{1}{\tilde{R}^2}\frac{10^{44}\mathrm{m}^2}{2.51\,\pi}\frac{1}{\left((z+1)^{\frac{4}{3}}-1\right)^2}\right) \qquad (918)$$

$$m_b = -2.5\lg\left(\frac{\tilde{H}_0^2}{c^2}\frac{10^{44}\mathrm{m}^2}{2.51\,\pi}\frac{1}{\left((z+1)^{\frac{4}{3}}-1\right)^2}\right) = -2.5\lg\left(1.41103\cdot 10^{26}\mathrm{s}^2\frac{\tilde{H}_0^2}{\left((z+1)^{\frac{4}{3}}-1\right)^2}\right) \qquad (919)$$

That is the function $m_b(z)$ without consideration of the additional attenuation. Since also the z-axis must have a logarithmic scale, we apply the value 10^w with $-2\leq w\leq 0$ instead of z. Now, PERLMUTTER has published all measurements in [45] indeed, but since I do not dispose of any procedure, to present it so nice, including the tolerance-limits, I made the decision, to take up the comparison with (919) by overlay of both charts.

In figure 146 are presented the relative brightness, calculated with the help of (919), in comparison with the observations of the supernova-cosmology-project. Also to be seen are the courses calculated by PERLMUTTER for various adjustments of the standard-big-bang-model. The overlay-markers (+) are to be seen at all corners except for left above.

[1] Of course, already previously models existed (e.g. tired light) which work with an additional attenuation. All they have failed however, since they wanted to attribute the attenuation to the particle properties of the photons only. But the wave properties are the cause in reality. Nevertheless, the tired-light-hypothesis appears essentially more plausible, than the assumption of the existence of dark matter and quintessence..

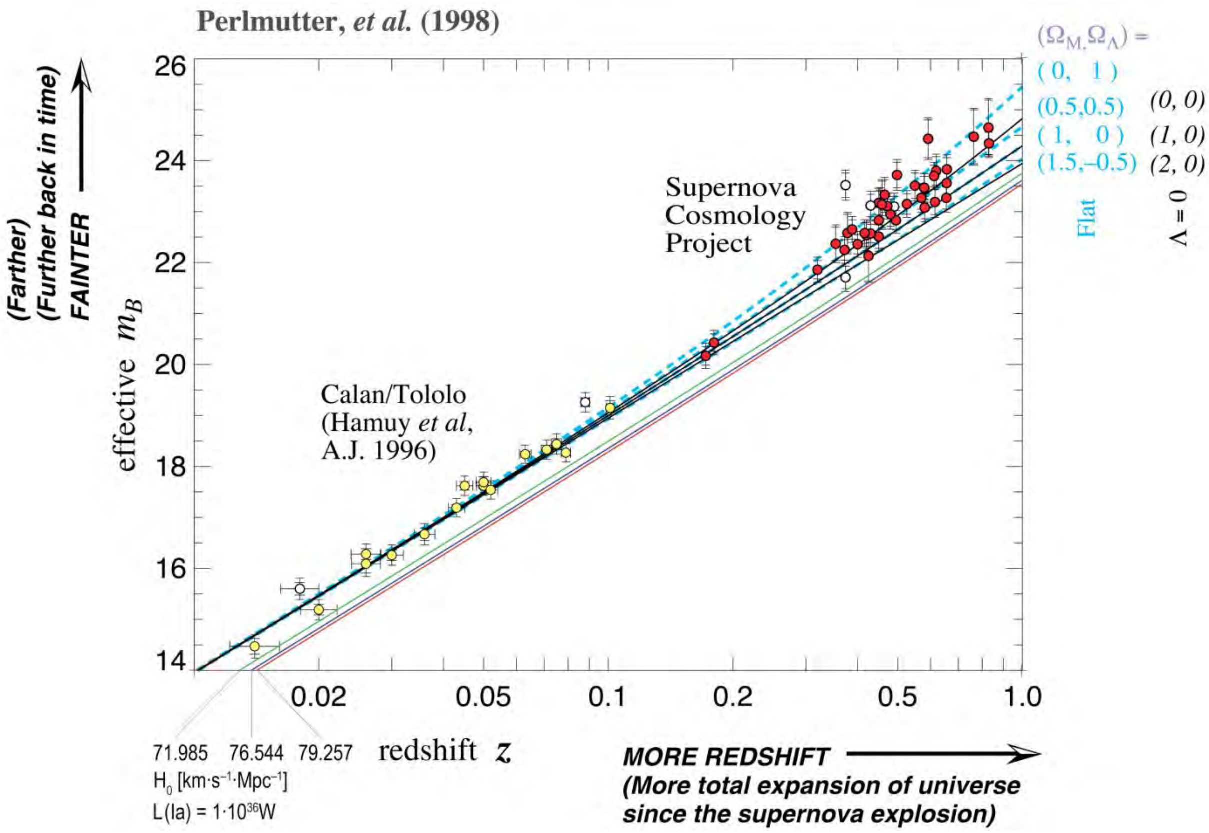


Figure 146
Calculated apparent bolometric brightness for the three values of the HUBBLE-parameter in comparison with the observations of the supernova-cosmology-project (standard-candle = maximum)

In the presentation meets the eye that the three brightness-functions (according to this model without consideration of the parametric attenuation) are below the observed values, just they have been computed too bright. This is even no miracle, since we used the maximum-value as standard-candle. Figure 146 also shows, that solution (890) with 71.985 $\mathrm{kms^{-1}Mpc^{-1}}$ for the HUBBLE-parameter comes closest to reality in turn, since it's located at the outer margin of the error-tolerance-corridor. Therefore we'll use this value for the further contemplations. We determine the real value of the standard-candle, which is the statistical median value of all SNae Ia, numerically with the help of (890) for a value at the lower end of the z-axis to $L_{Ia} = 6.1097 \cdot 10^{35}\,\mathrm{W}$. We apply it in (919) obtaining:

$$m_b = -2.5\lg\left(\frac{\tilde{H}_0^2}{c^2}\frac{6.11\cdot 10^{35}\mathrm{m}^2}{2.51\cdot 10^{-8}\pi}\frac{1}{\left((z+1)^{\frac{4}{3}}-1\right)^2}\right) = -2.5\lg\frac{4.6916\cdot 10^{-10}}{\left((z+1)^{\frac{4}{3}}-1\right)^2} \qquad (920)$$

$$m_b = -2.5\lg 4.6916\cdot 10^{-10} + 2\cdot 2.5\lg\left((z+1)^{\frac{4}{3}}-1\right) = 23.32 + 5\lg\left((z+1)^{\frac{4}{3}}-1\right) \qquad (921)$$

We need the function $m_b(z)$ with parametric attenuation as well. On this occasion we have to consider the factor $e^{-r/R} = 10^{-r/R\cdot\lg e}$ from the propagation-function (305). It applies:

$$m_b = -2.5\lg\left(\frac{\tilde{H}_0^2}{c^2}\frac{6.11\cdot 10^{35}\mathrm{m}^2}{2.51\cdot 10^{-8}\pi}\frac{e^{-\frac{r}{R}}}{\left((z+1)^{\frac{4}{3}}-1\right)^2}\right) = -2.5\lg\left(\frac{4.6916\cdot 10^{-10}}{\left((z+1)^{\frac{4}{3}}-1\right)^2}e^{-\frac{1}{2}\left((z+1)^{\frac{4}{3}}-1\right)}\right) \qquad (922)$$

$$m_b = -2.5\lg\left(\frac{4.6916\cdot 10^{-10}}{\left((z+1)^{\frac{4}{3}}-1\right)^2}10^{-\frac{1}{2}\left((z+1)^{\frac{4}{3}}-1\right)\lg e}\right) \qquad (923)$$

$$m_b = 23.32 + 5\lg\left((z+1)^{\frac{4}{3}}-1\right) + 0.5429\left((z+1)^{\frac{4}{3}}-1\right) \qquad \text{With param. attenuation} \qquad (924)$$

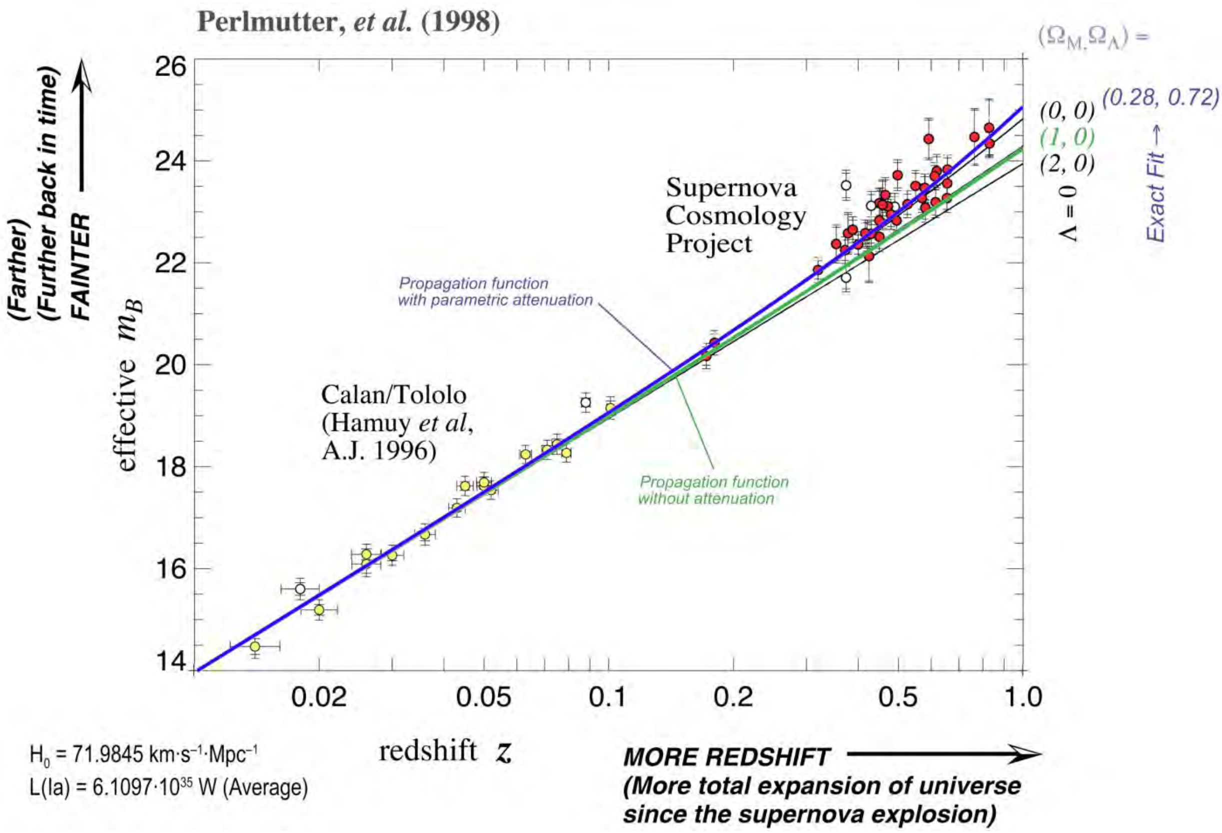


Figure 147
Calculated apparent bolometric brightness for solution (890) of the HUBBLE-parameters in comparison with the observations of the supernova-cosmology-project (standard-candle = average)

Figure 147 shows the graphs of expression (921) and (924) in comparison with the measurements of the supernova-cosmology-project for solution (890) of the HUBBLE-parameter. The thin black lines show the expectation-values of the standard-model for $\Lambda=0$ with a mass-energy-density $\Omega_M=0$, 1 and 2. For one time, it is an empty universe (0), for the other time an universe with „normal“ energy-density (1) and at last an universe with double energy-density (2). In this connection, the standard-BB-solution for the „normal“ universe covers the propagation-function for a loss-free medium (921). That is also no miracle, because both have the same exponent 4/3 in (309a). This case however is not confirmed by the observations, just as little an empty universe. For $\Lambda=0$ even an universe with negative mass-energy-density (filled with antimatter) would be necessary. For the optimal conformity, we already have to successfully ignore EINSTEIN's conclusion „the introduction of the cosmologic constant was the greatest foolishness, which I ever have done“. Then, according to [45] the best match is with $\Omega_M=0.28$ and $\Omega_\Lambda=0.72$. Thereat, all along, the sum of both values must always be equal to one. The value Ω_Λ is the so-called „dark energy-density“ which indeed could be identical to our metric wave-field (0K = absolutely dark).

As I said, the whole issue sounds rather improbable indeed, especially since „coincidentally“ this optimal course is exactly described by our function (924) (blue graph in figure 147), and the whole thing only with the help of known physical objects and relations. It fits!

XIV. The observation-data of the supernova-cosmology-project are exactly described by the propagation-function (305) under consideration of the geo-metrical and parametric attenuation (284). The assumption of the existence of any new exotic kind of matter or unknown physical effects is not necessary.

There is neither dark matter, quintessence nor increasing expansion!!

The only dark matter there is in the heads, that once had to be said. But since science requires always new, even more unique evidence, I computed the expectation-values of the apparent brightness for SNae Ia, which are even farther away, than the ones, observed within the framework of the supernova-cosmology-project, with the help of (921) and (924). They are presented in figure 148. Surely, the opportunity arises in the closer or farther future, to observe such an object.

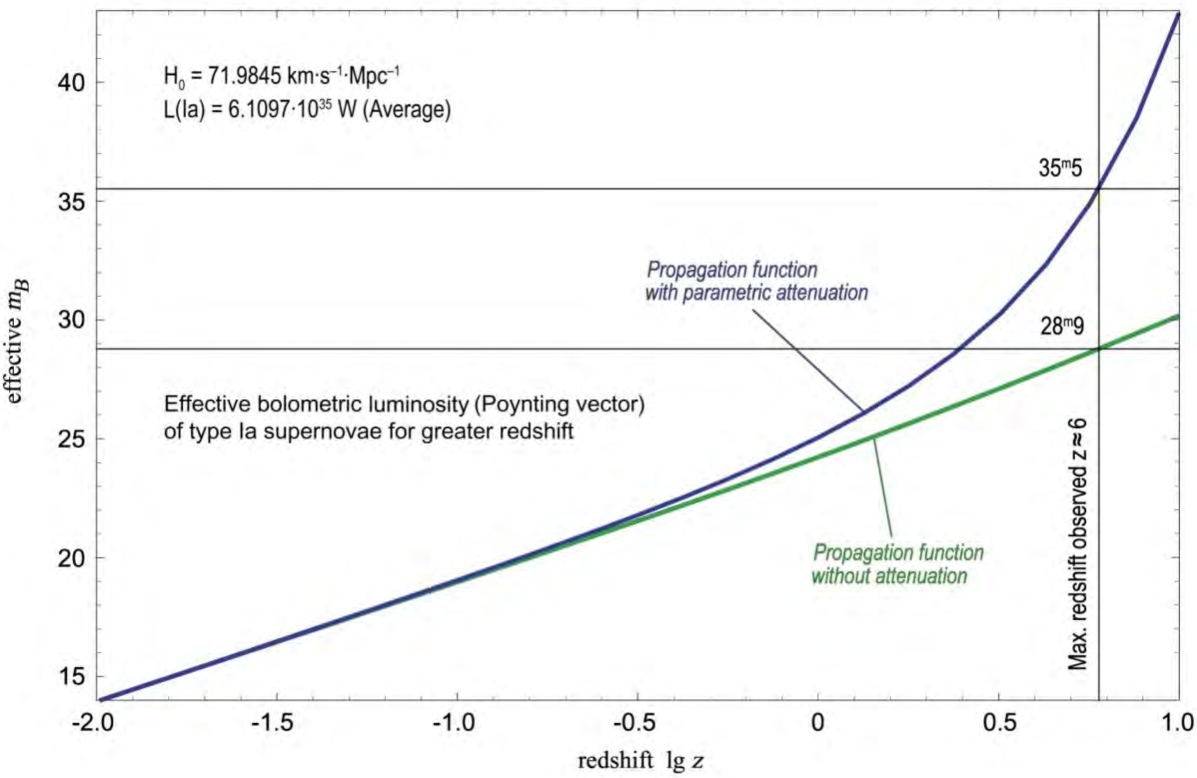


Figure 148
Calculated apparent bolometric brightness for solution (890) of the HUBBLE-parameter for farther SNae Ia

The only true quintessence is, that the present model has been confirmed by the observations of the supernova-cosmology-project. Thus, the current value of the HUBBLE-parameter amounts to 71.985 kms^{-1}Mpc^{-1} exactly. That corresponds to solution (890).

7.5.5. The meaning of the second and third solution

After we had tried to calculate the HUBBLE-parameter with the help of locally measurable universal constants in section 7.5.1. we found with (884), (890) and (892) not only one but even three solutions with different values. In the preceded sections, we verified expression (890) as the best corresponding with the observations. Assuming it as the proper value for H0, the question arises for the meaning of the second and third solution. Also there is properly speaking only one metric wave-field with only one metric wave-function and this has even only maximally one actual phase-angle, i.e. there is only one value Q_0.

Since the difference between solution (884) and (890) amounts to only 10.102%, which approximately corresponds to the effect of the various correction-factors of the fine-structure-constant in the QED, one could assume, that it is about another QED-phenomenon. This however would disagree with the above-mentioned assumption, because the precision of the value H_0 calculated with (890) wouldn't be guaranteed then. In the QED namely we never get an exact result at all. Now however, it may be possible that even the second two results are of a certain physical meaning, that a still unknown inherent law is assigned to the difference between the three results. This in turn, would not be part of, but the solution of the problem. To this purpose, we want to analyze the three results more exactly.

Dividing all three values by each other, we find out that the variation can be explained by a factor ξ, which appears once in the zeroth, once in the first and once in the third power (see table 7). In that sense, yet a fourth solution would be possible then, which we however want to sort out as „artificial" in this place, since we would have to multiply the root of (890) with the square of (884) to get it. In contrast (892) as the product of both expressions figures a sort of geometrical mean. The factor ξ e.g. can be determined, in that we form the quotient of (884) and (892). We obtain:

$$\xi = \frac{1}{4\pi}\frac{e}{q_0}\sqrt{\frac{m_p}{m_e}} = 1.0326001 \qquad \xi^2 = 1.0662629 \qquad \xi^3 = 1.1010232 \qquad (925)$$

$$\frac{1}{\xi^2} = \delta = \frac{4\pi\hbar}{m_p r_e c} = 0.9378550 \qquad (926)$$

Since there are only quotients of quantities in (925), which vary temporally according to the same function, the value ξ is reference-frame-independent. Interestingly enough, the expression δ (926) is already introduced in the QED. It describes the conditions in the hydrogen-atom. Looking at solution (890), which has been confirmed by astronomic observations and with the help of the temperature of the CMBR, just by the observation of time-like photons, so it shows, that only quantities of the electron and the free space are contained there. For this reason we can assume, that expression (890) is not only the solution for time-like photons but also for the electron, which belongs to the group of the leptons, because the electrons should expand too.

Considering figure 96 more exactly, so it shows that the time-like vector $\underline{c}_\gamma$ at the space-like photons is inverted to that of the time-like photons. That means, it has another value, because the metric vector remains unchanged and the zero vector is equal to c constantly. That even leads to a different expansion-rate then. Therefore we suppose, that solution (884) and/or (892) are describing the HUBBLE-parameter and with it the expansion-rate for space-like photons.

In contrast to solution (890), in (884) and (892) the proton mass is contained. Therefore we can assume, that one of both solutions applies to free, the other one to protons bound in the atomic nucleus, since both interact by means of space-like photons with the metrics.

As further difference, expression (884) contains PLANCK's quantity of action, expression (892) not. Thus, solution (884) would be significant for space-like photons and the free proton. Because of the absence of $\hbar$ (no quantum-effects), because of (926) and since it's about a geometric mean, I would assign solution (892) to the whole atoms, i.e. for atoms and for all macroscopic bodies there is an own expansion-rate.

In section 7.5.1. we had learned furthermore, that all wavelengths, also that of the DEBROGLIE-matter-waves, follow the expansion-rate of the universe as a whole (888). It applies $\lambda \sim Q^{3/2}$. Now however, the reference point of the time-like photons is at Q=1/2, the one of the space-like photons at Q=2/3 in contrast, at which point both points reside at the periphery of the universe, the observer, on the other hand, in the centre (applies to a whatever observer everywhere).

Now, the expansion of the universe as a whole is determined by the expansion-rate (expansion-velocity plus propagation-velocity of the metric wave-field) at its periphery, since the largest values are achieved there. Interestingly enough however, it is negligibly greater at Q=2/3, than at Q=1/2, as we can see in figure 22 with somewhat good will, which leads to the higher expansion-rate for space-like photons. On that basis the value ξ^3, the offset between (884) and (890), can be calculated relatively simply:

$$\xi^3 = \left(\frac{Q_{2/3}}{Q_{1/2}}\right)^{\frac{1}{3}} = \left(\frac{2/3}{1/2}\right)^{\frac{1}{3}} = \left(\frac{4}{3}\right)^{\frac{1}{3}} = 1.1006424 \qquad \Delta = -4 \cdot 10^{-4} \tag{927}$$

The difference to ξ^3 (926) amounts to $-4{\cdot}10^{-4}$ only, for what we may already use the equality-sign in the QED. Even the value δ can be derived similar to (927), whereupon the difference is with $+5{\cdot}10^{-3}$ something greater indeed:

$$\delta = \frac{1}{\sqrt{2}}\frac{Q_{2/3}}{Q_{1/2}} = \frac{1}{\sqrt{2}}\frac{2/3}{1/2} = \frac{1}{\sqrt{2}}\frac{4}{3} = 0.942809 \qquad \Delta = +5 \cdot 10^{-3} \tag{928}$$

But then a low difference between particles and antiparticles should exist, expressing itself e.g. in the average diameter or the mass. In contrast to the different expansion-rate, for which the difference between 1/2 and 2/3 at the edge of the universe is bearing responsibility, with them it's about local values, which depend on the essentially higher value ($\approx 10^{60}$) of the phase-angle/Q-factor Q_0 at the place of the observer. That means, the smaller diameter and the higher mass at the reference point are being observed reduced about a value 10^{30}. And then the low difference between 1/2 and 2/3 suddenly becomes unverifiable.

Because of the expansion-rates however the values of particles and antiparticles approach more and more, so that they coincide to the point of time T=∞. The central idea thereat is, that the bearer of the effect is the proton. In the proton, there is an unknown „information“, an energy-difference, which leads to the different results[1]. Therefore it's possible to assume, that the expressions containing the proton mass, do not submit the correct result (890) by no means. As usual in the QED, they must be multiplied with a correction-factor.

Leaving out this, we definitely get a result valid for protons only. There are yet a good deal more subatomic particles however. If solution (890) applies for time-like photons and electrons, how does it look like with the other leptons then? To the leptons, all kinds of neutrino, the myon and the tauon belong besides the electron as well, just as all corresponding anti-particles.

In section 5.3.1. we had determined that also the neutrinos are having their reference point at Q=1/2, but not the antineutrinos with Q=2/3. Since also the space-like photons as anti-particles (not antiparticles!) of the time-like photons should have their reference point at Q=2/3 but already have been assigned to solution (884), we could assume, that solution (890) applies to time-like photons and all leptons, solution (884) to space-like photons, the proton and all anti-leptons.

Which applies to the proton, even applies to the neutron and all baryons and mesons, just for all hadrons, then. Solution (884) applies with it for space-like photons, all hadrons and all anti-leptons. How does it look like with the anti-hadrons then again? From reasons of symmetry, solution (890) should apply to them, which leads to the conclusion, that these interact, else than „normal“ hadrons, by means of time-like photons with the metrics and by means of space-like photons among each other. But since they move as true antiparticles contrary to the normal time-direction, this is no contradiction.

Because of the inverse relations, for anti-atoms and macroscopic bodies consisting of antimatter however a different geometric mean would arise, for which instead of (892) the 4th potential solution would offer itself, which we still had excluded further above. This should not extra be presented at this point. It can be determined very simply with the help of x after all. For the expansion-rate itself applies, such as in the macroscopic scale the HUBBLE-parameter H_1 (890) multiplied with the average diameter of the particle. In table 9 are presented the corresponding values and it's validity:

---

[1] In contrast to the electron the proton and all other hadrons consist of several quarks, so that they have a higher mass, than the quarks alone (if this would be possible), because of the binding energy..

Solution	$\dot{r}/r$	Applies to
	[s⁻¹]	Kind of particle
$H_1(890)\cdot\xi^3$	$3.853\cdot10^{-18}$	Space-like photons, hadrons, anti-leptons
$H_1(890)\cdot\xi^2$	$3.731\cdot10^{-18}$	Macroscopic bodies of matter, atoms
$H_1(890)\cdot\xi^1$	$3.613\cdot10^{-18}$	Macroscopic bodies of antimatter, anti-atoms
$H_1(890)\cdot\xi^0$	$3.499\cdot10^{-18}$	Time-like photons, anti-hadrons, leptons

Table 9
Expansion rates of particles

Now however attracts attention, that the expansion rates of the particles/antiparticles with the leptons are swapped with that of the hadrons. The reason is, that these interact directly with the metrics and not by means of space-like respectively time-like photons, like the hadrons. For the myons and tauons, I would not like to put the hand into the fire however. Also table 9 figures only one option of interpretation and should even only be regarded as suggestion.

The value ξ appears in the form of $\delta=\xi^{-2}$ also as correction-factor in the QED, namely always then, when there is at least one proton in the proximity of an interaction. If we e.g. look at the interaction of a photon with an electron in the electron shell of an atom, the fine-structure-constant is applied. Let's have a look, what happens, when we multiply the fine-structure-constant with δ:

$$\alpha=\frac{1}{4\pi}\frac{e^2}{q_0^2}\quad\text{without correction factor}\qquad \alpha\delta=\frac{\xi^{-2}}{4\pi}\frac{e^2}{q_0^2}\quad\text{with correction factor }\delta \tag{929}$$

Inserting (925) in (929) shows, that the charges cancel out. Only the ratio between electron- and proton-mass remains, multiplied with a geometrical factor 4π:

$$\alpha\delta = 4\pi\frac{m_e}{m_p} = 6{,}84386\cdot10^{-3} \approx \frac{1}{146} \qquad \frac{m_e}{m_p}\approx\frac{1}{1836} \tag{930}$$

This ratio of two masses is evident for energetic contemplations, with which the impulse p=mv is used. Expression (930) is also the starting point for contemplations about the electromagnetic interaction between a photon and the electron in a hydrogen-atom. With it, the term δ^{-1} is applied to the hydrogen-atom ^{1}H only and represents, taken for itself, the correction between a raw, thought system of a proton and an electron and the real conditions in the hydrogen-atom. In all other cases, with heavier nucleuses and higher energy-conditions, even more correction-terms come into addition (the exact relativistic corrections, the correction of the kinetic energy and the spin-track-interaction).

7.6. Conclusion

I would like to finish this work at this point, because I have filled the task put by myself at the start, to determine the exact value of the HUBBLE-parameter On the side, a new model of the universe arose never being in contradiction to already saved knowledge, which dispenses with such fuss as e.g. dark matter and new, yet unknown and not saved effects. The model exactly could be verified on the basis of 8 of 10 tests, at which point 5 of them are filled automatically indeed, because of the large similarity with EINSTEIN's model. The current value of the HUBBLE-parameter amounts to exactly:

$$H_0 = \frac{2}{3}\frac{32\pi^2\varepsilon_0 G h m_e^3}{\mu_0^2 e^6} = 2.33283\cdot10^{-18}\,s^{-1} \qquad \text{or} \tag{931}$$

$$H_0 = 71.9845 \text{ kms}^{-1}\text{Mpc}^{-1}$$

When analyzing the temperature of the cosmic background-radiation there was found a small downward difference of 0.2431K to the observed value in comparison with the calculated one. With high probability, this is to be attributed to other interactions, so that we can regard even this point as filled with a small discrepancy. This problem will be examined more detailed in [46].

The technical determination of the value of the specific conductivity of subspace is still open (superconductivity) which probably will remain unfeasible even in the remote future because of it's extremely high value. At least, this value can be determined exactly on the basis of other relations:

$$\kappa_0 = \frac{3}{8}\frac{e^6 c}{4\pi\varepsilon_0^2 G^2 h^2 m_e^2} = 1.30605 \cdot 10^{93}\ \text{Sm}^{-1} \tag{932}$$

This is the only one essentially new quality of the subspace. In table 10 the most important fundamental values are abstracted once again, being referred to the newly determined value of the HUBBLE-parameter, because this affects the most other values. In order to guarantee an accurate verification, a »Mathematica«-program, in which these quantities and their relations to one another are specified, finds in the appendix as well. Then, if we modify just one single value, which occurs several times, it can easily happen, that one of them will be forgotten. Then, we get strange, anomalous results and the search will start.

I hope, that some new thoughts were contained in the work on hand. Thus I ask for an active discussion. Furthermore, I ask for understanding that I didn't extend the contemplation to all domains, e.g. black holes, formation of the stars/planets etc. as usual. In the case of doubt, I the classic doctrine. This work also contains sections, with which you will disagree. Nevertheless, I ask the reader to don't discard everything because of that.

THE END

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Constant	Symbol	C	Value	Unit of measurement
Speed of light	c	◦	$2.99792458\cdot10^{8}$	$m\ s^{-1}$
Induction-constant	μ_o	•	$4\pi\cdot10^{-7}$	$Vs\ A^{-1}m^{-1}$
Influence-constant	ε_o	•	$8.854187817\cdot10^{-12}$	$As\ V^{-1}m^{-1}$
Conductivity-constant	κ_o	•	$1.30605\cdot10^{93}$	$A\ V^{-1}m^{-1}$
Boltzmann-constant	k	•	$1.380658\cdot10^{-23}$	$J\ K^{-1}$
Planck's init. quant. of action	$\hbar_1$	•	$8.38572\cdot10^{26}$	$J\ s$
Planck's quantity of action	$\hbar$		$1.05457266\cdot10^{-34}$	$J\ s$
Gravitational-constant (init.)	G_1		$1.32722\cdot10^{-193}$	$m^3kg^{-1}s^{-2}$
Gravitational-constant (Nwt.)	G		$6.6732\cdot10^{-11}$	$m^3kg^{-1}s^{-2}$
Poynting-vector metrics (init.)	S_1		$4.417142\cdot10^{426}$	$W m^{-2}$
Poynting-vector metrics	S_o		$1.38938\cdot10^{122}$	$W m^{-2}$
Fine-structure-constant	α		$7.2973530\cdot10^{-3}$	1
Q-factor/phase metrics ($g_{00}{}^{-1}$)	Q_o		$7.95178\cdot10^{60}$	1
Planck's mass	m_o		$2.17661\cdot10^{-8}$	kg
Planck's energy	W_o		$1.95624\cdot10^{9}$	J
Planck's length	r_o		$1.61612\cdot10^{-35}$	m
Planck's time-unit	t_o		$2.6954\cdot10^{-44}$	s
Circular frequency of metrics	ω_o		$1.85501\cdot10^{43}$	s^{-1}
Wave impedance vacuum	Z_o	◦	$376.73 \approx 2\pi\cdot60$	Ω
Cut-off frequency vacuum	ω_1	◦	$1.47506\cdot10^{104}$	s^{-1}
Smallest time-unit vacuum	t_1	◦	$3.38969\cdot10^{-105}$	s
Smallest length vacuum	r_1	◦	$2.0324\cdot10^{-96}$	m
Hubble parameter	H_o		71.9854	$km\ s^{-1}Mpc^{-1}$
Hubble parameter	(ω_{-1})		$2.33283\cdot10^{-18}$	s^{-1}
Total age	$2T$		$1.35839\cdot10^{10}$	a
Local age	T		$6.79193\cdot10^{9}$	a
Local age	(t_{-1})		$2.14332\cdot10^{17}$	s
Local world-radius	$R/2$		2.08234	Gpc
Local world-radius	(r_{-1})		$6.42552\cdot10^{26}$	m

Table 10: Actual values of the fundamental constants for solution (890)

Definitions of Fundamental Constants depending on Q_0

For usage with Mathematica

```
(*Units*)

km=1000;
Mpc=3.08572*10^19 km;
minute=60;
hour=60 minute;
day=24*hour;
year=365.24219879*day;


(*Basic expressions*)

ep0=8.854187817*10^-12;                          (*Permittivity of vacuum*)
my0=4 Pi 10^-7;                                  (*Permeability of vacuum*)
k=1.380658*10^-23;                               (*Boltzmann constant*)
G=6.6732*10^-11;                                 (*Gravity constant Bruker*)
hg=1.05457266*10^-34;                            (*Planck constant slashed*)
qe=1.60217733*10^-19;                            (*Elementary charge*)
me=9.1093897*10^-31;                             (*Electron rest mass*)
mp=1.6726231*10^-27;                             (*Proton rest mass*)
mn=1.6749286*10^-27;                             (*Neutron rest mass*)
ma=1.66057*10^-27;                               (*Atomic mass unit*)


(*Composed expressions*)

c=1/Sqrt[my0 ep0];                               (*Speed of light*)
Z0=Sqrt[my0/ep0];                                (*Field wave impedance of vacuum*)
qn=Sqrt[hg/Z0];                                  (*Planck charge*)
Q884=3/2*(qe^2/ep0/G/me/mp)^(3/2);               (*Phase angle/Q-factor Solution 884*)
Q892=3/8/Pi*qe^4/(ep0^2*me^2*mp*Sqrt[G^3*hg*c]); (*Phase angle/Q-factor Solution 892*)
Q890=3/2*(1/4/Pi*qe^2*Z0/me*Sqrt[c/G/hg])^3;     (*Phase angle/Q-factor Solution 890*)
Q0=Q890;                                         (*Phase angle/Q-factor MAIN SWITCH*)
Om1=ka0/ep0;                                     (*Cutoff frequency of subspace*)
Om0=Sqrt[c^5/G/hg];                              (*Planck's frequency*)
H0=Om0/Q0;                                       (*Hubble parameter local*)
H1=3/2*H0;                                       (*Hubble parameter whole universe*)
r1=1/(ka0 Z0);                                   (*Planck's length subspace*)
r0=Q0 r1;                                        (*Planck's length vacuum*)
R=Q0^2 r1;                                       (*World radius*)
t1=1/(2 Om1);                                    (*Planck time subspace*)
t0=1/(2 Om0);                                    (*Planck time vacuum*)
T=1/(2 H0);                                      (*World time constant*)
TT=2T/year;                                      (*The Age*)
ka0=c^3/(my0 G hg H0);                           (*Conductivity of vacuum*)
G1=G/Q0^3;                                       (*Gravity constant initial*)
h=hg*2*Pi;                                       (*Planck constant unslashed*)
h1=hg*Q0;                                        (*Planck constant initial slashed*)
alpha=1/(4 Pi)*qe^2/qn^2;                        (*Fine structure constant*)
m0=Sqrt[hg c/G];                                 (*Planck mass*)
W0=Sqrt[hg c^5/G];                               (*Planck energy*)
S1=h1 Om1^2/r1^2;                                (*Poynting vector metric initial*)
S0=S1/Q0^5;                                      (*Poynting vector metric actual*)
```

10. Abbreviations

*

·	Labeling of the first temporal derivative
··	Labeling of the second temporal derivative
^	Labeling of a peak value
*	Labeling of a conjugate complex value
~	Labeling of a reference-frame-dependent quantity (constant) without labeling it's about a variable

A

a	Acceleration
a_0	Bohr's hydrogen-radius
a_i	Factor i
A	Factor, amplitude
A(ω)	Amplitude response
α	Angle, attenuation rate
α_γ, $\alpha_{\bar{\bar{\nu}}}$, α_ν, $\alpha_{\bar{\nu}}$	Angle in the metric triangle

B

B	Induction
$\mathbf{B_0}$	Induction in the MLE
B	Factor
B(ω)	Phase response
β	Angle, phase rate, relativistic dilatation-factor $(1-v^2/c^2)^{-1/2}$
β_0	Phase rate of the metric wave-field

C

c	Speed of light (constant in reference to the subspace)
c̲, **c̲**	Complex wave-propagation-velocity
c_M	Propagation-velocity of the metric wave-field
C	Capacity
C_0	Capacity of the ball-capacitor in the MLE
CMBR	Cosmic microwave background-radiation

D

D	Electric charge-density (influence)
δ	Phase-angle of the MLE, angle
δ_k^i	Kronecker-symbol
∂	Partial differential-operator
∂_b	Partial differential-operator ∂/∂b

E

E, **E̲**	Electric field-strength
$\mathbf{E_0}$	Electric field-strength in the MLE
e	Electron charge, Euler constant (2.71828...)
$\mathbf{e_r}$	Unit-vector on r
ε	Angle
ε_0	Dielectric constant of the subspace (vacuum)
ε_ν	Coefficient of absorption of the *gray body*
η	Factor
η_{ab}	Minkowskian metrics (math.)

F

f	Function
F	Function
F, **F**	Force
F_g, $\mathbf{F_g}$	Gravitational-force
F_m, $\mathbf{F_m}$	Lorentz-force
F_z, $\mathbf{F_z}$	Centrifugal force
${}_0F_1$	Hypergeometric function
ϕ	$2\omega_0 t - \underline{\gamma} r$, electric potential
φ	Angle of intersection of the metr. speed-vector with the x-axis
φ_0	Magnetic flux in the MLE (momentary value)
φ_i	Initial value of φ_0
Φ	NEWTON's gravitational-potential
$\Phi(\omega)$	Phase-shift during wave-propagation

G

g	Acceleration of gravity
g_{ik}, g^{ik}	Metrics (mathematical object)
G	Gravitational-constant (not fixed)
G_0	Specific conductance per meter
G_1	Gravitational-constant with $Q_0=1$
γ_γ, $\gamma_{\bar{v}}$, γ_n, $\gamma_{\bar{v}}$	angle in the metric triangle
$\underline{\gamma}$	Complex propagation rate
Γ	Gamma-function
Γ^a_{bc}	Metric connection

H

h_{ik}, h^{ik}	Fourfold-vectors
H, H_0, H_1	HUBBLE-parameter
$H^{(1)}_n(x)$	HANKEL function of n'th order $J_n(x)+jY_n(x)$
$H^{(2)}_n(x)$	Konj. complex Hankel function of n'th order $J_n(x)-jY_n(x)$
H, $\underline{\mathbf{H}}$	Magnetic field-strength
$\mathbf{H_0}$	Magnetic field-strength in the MLE
$\hbar$	PLANCK's quantity of action (not fixed)
$\hbar_1$	PLANCK's quantity of action with $Q_0=1$
$\hbar_i$	PLANCK's quantity of action initial-value

I

i	Electric current (momentary value)
i_0	Electric current in the MLE (momentary value)
i_1, i_2, i_3	Partial currents in the MLE-model
I	Electric current
Im(x)	Imaginary-part

J

j	Imaginary unit $\sqrt{-1}$
J_0	Mass-moment of inertia of the MLE
$J_0(x)$	BESSEL function of zeroth order
$J_n(x)$	BESSEL function of n'th order

K

k	BOLTZMANN-constant

κ	Coupling-constant of the URT
κ_0	Specific conductivity of the subspace
κ_{0R}	Specific conductivity of the metrics (vacuum)

L

l	Length
L	Inductivity
L	Moment of momentum
L_0	Inductivity of the MLE
L(x)	LAGRANGE's function
$\mathscr{L}$ (x)	LAPLACE transform
lg	$\log_{10}$
ln	$\log_e$
lx	LAMBERT's W-function $\mathrm{lx}(xe^x) = 1$ (ProductLog)
λ	Wavelength
Λ, $\mathbf{\Lambda}$	Wave count vector

M

m	Factor, mass
m_*	SR-rest-mass
m_0	Mass of the MLE, UR-rest-mass
m_e	Electron mass
m_p	Proton mass
M	Mass
MLE	Minkowskian line-element (physical object)
μ	Induction-constant generally ($\mu_0\mu_r$)
μ_0	Induction-constant of the subspace (vacuum)

N

n	Quantity, factor
ν	Neutrino, frequency

O

0_0 (x)	Series, tending against zero
0_2 (x)	Series, tending against zero
Ω	Relative frequency $\omega/(2\omega_1)$ resp. $\omega/(2\omega_0)$

P

p	Laplace-operator
P	Power, point
P_0	Power dissipation of the MLE
P_v	Power dissipation generally
π	Ratio of circumference and diameter at the circle (3.1415....)
ψ	Magnetic potential
Ψ	Product MG
$\Psi(\omega)$	Share of the attenuation-factor α, caused by the amplitude response

Q

q	Charge (momentary value)
q_0	Charge of the ball-capacitor in the MLE
Q_0	Q-factor **and** phase-angle ($2\omega_0 t$) in the MLE
QED	Quantum-electrodynamics
QM	Quadratic median

R

r	Radius absolute
r′	Radius after substitution
r	Radius relative $\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}$
r_0	Planck's fundamental length (radius)
r_1	Planck's fundamental length for Q_0=1 (subspace-constant)
r_C	Radius of the ball-capacitor in the MLE
r_e	Electron radius according to the classic opinion
R	World-radius 2cT
R	Scalary curvature
R_0	Shunt-resistor in the MLE-model
R_{0R}	Series-resistor in the MLE-model
R_s	Schwarzschild-radius
R_{ik}, R^{ik}	RICCI-tensor
$R^{aa}{}_{bcd}$, R_{abcd}	RIEMANN's curvature tensor
Re(x)	Real part
ρ	Density
$\rho_0(x)$	Function (209)

S

s	Way
S	Entropy, electr. current-density
S, S_b	Entropy
S, $\mathbf{S_k}$	Power-density (Poynting-vector)
σ(t)	Dirac-impulse
σ_i	Eigenvalues

T

t	Time absolute (in the frame of reference)
t	Time relative $\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}$
t_1	Period of the oscillation of the MLE with Q_0=1
T	Local age, total-age = 2T
T_{Ph}	Phase delay
T_{Gr}	Group delay
T_ω	Period of the function sinω
T, T_b	Temperature
τ, τ_0, τ_1	Time-constants
θ	Trigonometric function (209)
ϑ	Angle in the coordinate-system

U

u	Voltage (momentary value)
u_0	Voltage in the MLE-model (momentary value)
U	Voltage
U	Gravitational-potential (new definition)

V

v	Velocity
v_M	Velocity in reference to the metrics
v_{Ph}	Phase velocity

v_{Gr}	Group velocity
V	Detuning (oscillatory circuit), magnetomotive force

W

w	Energy-density
W	Energy
W_0	Energy of the MLE
ω	Angular frequency universal
ω_0	Angular frequency of the MLE
ω_1	Angular frequency of the MLE with $Q_0=1$
ω_D	De-Broglie-angular frequency of matter
ω_e	Angular frequency of emission of CMBR
ω_s	Angular frequency of immission of CMBR
ω_k	Angular frequency CMBR nowadays
ω_T	Thermal maximum CMBR

X

x	Way
$\tilde{x}$	Factor at WIEN's replacement law
ξ	Rotatory-angle with the LORENTZ-transformation
Ξ	Magnetic charge-density (permanent magnet)
$\Xi(r,t)$	Red-shift with wave-propagation

Y

y	Way
Y_0	Bessel function of zeroth order (von NEUMANN's function)
Y_n	Bessel function of n'th order (von NEUMANN's function)

Z

z	Way, factor, red-shift
$\underline{Z}$	Wave impedance
Z_0	Wave impedance of the vacuum ($\approx 2\pi\cdot 60\Omega$)
Z_F	Field-wave impedance complex

11. Affidavit

Herewith, I declare that I created this work off my own bat having used no other aids as stated. With section 3.1.2. it's about an original-citation [1]. Printing, duplication and publication of this part are allowed with the agreement of the publishing house only. The imprint of figure 74 takes place with friendly authorization of the author [29]. The chart doesn't equals to the original-condition, it has been supplemented.

With publications of this work in German language, a transcription according to the rules of the new orthography (1999 and later) is not allowed.

Is the course of the Planck's radiation-function the result of the existence of an upper cut-off frequency of the vacuum?

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1. Fundamentals

This article is based on a model I published in [1], the idea stems from Prof. Cornelius LANCZOS. It defines the expansion of the universe as a consequence of the existence of a metric wave-field. The time-function is based on the Hankel function, which consists of the sum of two Bessel functions (J_0 and Y_0) in turn. The particular qualities of the Bessel function lead to an increase of the wavelength, which is defined by the spacing between two zero-transits. Thus, the model leads to a quantization of the universe into discrete line-elements with particular physical characteristics. An individual line-element can be described by the model of a loss-affected oscillatory circuit with shunt-resistor. A special quality of the model consists in the fact, that the Q-factor of this oscillatory circuit is equal to the phase-angle $2\omega_0 t$ of the above-mentioned Bessel function. It applies $Q_0=2\omega_0 t$. The value ω_0 corresponds to the PLANCK's frequency on this occasion.

A special solution of the MAXWELL equations was found for the Hankel function with overlaid interference function, which describes the wave-propagation in the vacuum and co-includes the expansion. This special solution owns an inherent propagation-velocity in reference to the empty space (subspace) which is almost zero to the current point of time. Main-idea of the model is, that this propagation-velocity adds up geometrically to the propagation-velocity of an overlaid wave, at which point the total-velocity always amounts to exactly c in reference to the subspace. Thus, the cosmologic red-shift exactly can be described.

One conclusion from the model is the existence of an upper cut-off frequency of the vacuum, which could not be detected until now, because its value is about magnitudes greater than the technically feasible. Another conclusion of the model is the supposition that each photon is connected really or/and virtually with an origin at $Q_0=1/2$ That is the frequency, at which the excessive energy after the shape of the metric wave-function has been coupled into the very same one, as an overlaid wave, where it can be observed until now as cosmic background-radiation. Furthermore could be determined, that the bandwidth in the lower frequency range exactly matches the one of an oscillatory circuit with the Q-factor 1/2, which equals the conditions to the point of time of the input coupling. Hence the intention of this article is, to determine, whether the PLANCK's graph can be approximated by application of the frequency response given by the model, upon the spectrum of an oscillatory circuit with the Q-factor ½, furthermore to compare the calculated radiation-temperature with the measured one.

Since the cosmic background-radiation exactly follows the PLANCK's radiation-rule more or less, it should, because of the indistinguishability of individual photons, apply to a whatever black emitter. Therefrom arises the guess, that the existence of an upper cut-off frequency of the vacuum could be the cause for the decrease in the upper frequency range. In [1] already a simple attempt of an approximation has been taken up, at which point several values of the time-dependent frequency response $A(\omega)\cdot\cos\varphi$ have been multiplied with the source-function, which led to a quite good match, as measured by the simple procedure.

Another aim of this article is, to improve the proceeding any farther in order to make more precise statements. Attention should be paid to with the model that with some many exceptions (c μ_0, ε_0, κ_0, k) most of the fundamental physical constants are time- and reference-frame-dependent (~). And there is a conductivity of the subspace κ_0 different from zero. If you know these 5 values, you are able to calculate all other ones. The model is based on the PLANCK's units (e.g. ω_0) which can be obtained from the locally measured values. That points into one direction to the values of the universe as a whole (e.g. H_0), into the opposite direction to the (constant) values of the so called subspace (e.g. r_1). That is the medium the metric wave-field is propagating in. The proportionality factor is the phase angle of the temporal function $Q_0=2\omega_0 t$.

2. The WIEN displacement law and the source-function

During the examination of the WIEN displacement law meets the eye, that the displacement happens exactly at the lower wing pass of the PLANCK's radiation-function, which coincides with the wing pass of an oscillatory circuit with the Q-factor 1/2 in this section. Quite often in publications the curve is shown in another manner. I prefer the duplicate logarithmic presentation, then the curve turns into a straight line.

Considering the WIEN displacement law (902)[1] more exactly, the factor $\tilde{x}$ = 2.821439372 attracts attention particularly. With an oscillatory circuit of the Q-factor 1/2 rather the factor $2\sqrt{2}$ would be applicable for this, at which point the 2 stems from the source-frequency $2\omega_1$. The expression $\sqrt{2}$ arises from the rotation of the coordinate-system about $\pi/4$.

Now the validity of the WIEN displacement law in the time short after BB does not have been examined yet and neither PLANCK's radiation-rule nor the WIEN displacement law contain any information about the way, temperature varies, when it varies. In [1] I found the following relations for the calculation of temperature:

$$T_k = \frac{\hbar\omega_k}{\tilde{x}k} = \frac{\varepsilon_v}{\tilde{x}}\frac{\hbar_1\omega_1}{6k}Q^{-\frac{5}{2}} = 0.055693\frac{\hbar_1\omega_1}{k}Q^{-\frac{5}{2}} \qquad \tilde{x} = \begin{cases} 2.821439372 & \text{Exactly} \\ 2\sqrt{2} & \text{Approximation} \end{cases} \qquad ([1]\ 405)$$

$$T_k = \frac{\hbar\omega_k}{\tilde{x}k} \approx \frac{1}{3}\frac{\hbar_1\omega_1}{6k}Q^{-\frac{5}{2}} = \frac{\hbar_1\omega_1}{18k}Q^{-\frac{5}{2}} \qquad \varepsilon_v = \frac{2}{3}\sqrt{2} = 0.9428090416$$

$$T_k = \frac{\hbar_1\omega_1}{18k}Q_0^{-\frac{5}{2}} = \frac{\hbar\omega_0}{18k}Q_0^{-\frac{1}{2}} \qquad \omega_1 = \frac{\kappa_0}{\varepsilon_0} \qquad ([1]\ 902)$$

Expression ε_v is the *vacuum coefficient of absorption*. The calculation of T_k according to [1] turns out a value of 2.79146K, which is 0.06598K higher than the measured temperature of the CMBR (2.7250K).

During an investigation in the Internet, I found a detailed deduction of the WIEN displacement law [2]. The value of the proportionality-factor can be obtained by the identification of the maximum of PLANCK's radiation-rule as follows. We start from (382):

$$d\mathbf{S_k} = \frac{1}{4\pi^2}\frac{\hbar\omega^3}{c^2}\frac{1}{e^{\frac{\hbar\omega}{kT}}-1}\mathbf{e_s}\,d\omega \qquad \text{PLANCK's radiation rule} \qquad ([1]\ 382)$$

$$d\mathbf{S_k} = \frac{1}{4\pi^2}\frac{k^3T^3}{\hbar^2c^2}\left(\frac{\hbar\omega}{kT}\right)^3\frac{1}{e^{\frac{\hbar\omega}{kT}}-1}\mathbf{e_s}\,d\omega \qquad x = \frac{\hbar\omega}{kT} \qquad d\omega = \frac{kT}{\hbar}dx \qquad (1)$$

$$d\mathbf{S_k} = \frac{1}{4\pi^2}\frac{k^4T^4}{\hbar^3c^2}\frac{x^3}{e^x-1}\mathbf{e_s}\,dx \qquad \frac{d}{dx}\frac{x^3}{e^x-1} = 0 \qquad (2)$$

$$3\frac{x^2}{e^x-1} - \frac{x^3e^x}{(e^x-1)^2} = \frac{3x^2(e^x-1)-x^3e^x}{(e^x-1)^2} = 0 \qquad (3)$$

$$3x^2(e^x-1)-x^3e^x = 0 \qquad x^3e^x = 3x^2(e^x-1) \qquad (4)$$

$$e^x(x-3) = -3 \qquad y = x-3 \qquad x = 3+y \qquad (5)$$

[1] Three-digit numerations always refer to [1]

$$ye^{y+3} = ye^y e^3 = -3 \qquad\qquad ye^y = -3e^{-3} \tag{6}$$

$$x = 3 + \mathrm{lx}(-3e^{-3}) = 2.821439372 \qquad\qquad \mathrm{lx}(xe^x) = x \tag{7}$$

lx is LAMBERT's W-function (ProductLog [#]). Finally, after insertion into the middle expression of (1) WIEN's displacement law turns out:

$$\hbar\omega_{max} = 2.821439372\ kT \qquad \text{WIEN's displacement law} \tag{8}$$

On success in doing the same even for the source-function with Q=½, obtaining the same result, we would be a step forward in answer to the question: Is the course of the Planck's radiation-function the result of the existence of an upper cut-off frequency of the vacuum? First of all however, we have to bring the output-function into a form, suitable for further processing. We start with (380) with the substitution:

$$P_v = \frac{P_s}{1+v^2Q^2} \qquad v = \frac{\omega}{\omega_s} - \frac{\omega_s}{\omega} \qquad \omega_s = 2\omega_1 \qquad \Omega = \frac{\omega}{\omega_s} = \frac{1}{2}\frac{\omega}{\omega_1} \tag{9}$$

The expression stems from electrotechnics describing the power dissipation P_v of an oscillatory circuit with the Q-factor Q and the frequency ω (see [3]), v is the detuning. The Q-factor is known and amounts to Q=1/2 at $\omega_S=2\omega_1$. The right-hand expression results directly from the sampling-theorem. The cut-off frequency of the subspace ω_1 is the value ω_0 at Q=1. After substitution, we get the following expressions:

$$v = \Omega - \Omega^{-1} \qquad v^2 = \Omega^2 + \Omega^{-2} - 2 \qquad v^2Q^2 = \frac{1}{4}\Omega^2 + \frac{1}{4}\Omega^{-2} - \frac{1}{2} \tag{10}$$

$$P_v = \frac{P_s}{\frac{1}{4}\Omega^2 + \frac{1}{4}\Omega^{-2} + \frac{1}{2}} \cdot \frac{4\Omega^2}{4\Omega^2} = 4P_s \frac{\Omega^2}{\Omega^4 + 2\Omega^2 + 1} = 4P_s \left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{11}$$

You can find that expression more often in [1], among other things even with the group delay T_{Gr} however for a frequency ω_1. For a frequency $2\omega_1$ applies for T_{Gr} and the energy W_v:

$$T_{Gr} = \frac{dB(\omega)}{d\omega} = \frac{1}{\omega_1}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \qquad W_v = \frac{1}{6}P_s T_{Gr} = \frac{2}{3}\frac{P_s}{\omega_1}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{12}$$

The factor ⅙ comes from the splitting of energy onto 4 line-elements, as well as from the multiplication with the factor ⅔ because of refraction during the in-coupling into the metric transport lattice. It oftenly occurs in thermodynamic relations, which doesn't astonish. Thus, total-energy of the CMBR during input coupling is equal to the product of power dissipation and group delay, that is the average time, the wave stays within the MLE, but only for what it's worth. With the help of (11) we obtain:

$$P_v = 4b\ P_s \left(\frac{\Omega}{1+\Omega^2}\right)^2 \qquad\qquad P_v = 512b\ \hbar_1\omega_1^2 \left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{13}$$

b is a factor, we want to determine later on. Let's equate it to one at first. We determined the value Ps with the help of (394) using the values of the point of time Q=1/2. Interestingly enough, the HUBBLE-parameter H_0 at the time $t_{0.5}$ is greater than ω_1 and ω_0. For an individual line-element applies:

$$\omega_{0.5} = \frac{\omega_1}{Q_{0.5}} = \frac{\omega_1}{\frac{1}{2}} = 2\omega_1 \qquad\qquad H_{0.5} = \frac{\omega_1}{Q_{0.5}^2} = \frac{\omega_1}{\frac{1}{4}} = 4\omega_1 \tag{14}$$

$$P_s = \frac{\hat{\hbar}_i}{4\pi t_{0.5}^2 Q_{0.5}^4} = \frac{\hat{\hbar}_i}{2\pi}\frac{2^5}{4t_{0.5}^2} = 32\hbar_1 H_{0.5}^2 = 128\hbar_1\omega_1^2 \qquad \frac{\hat{\hbar}_i}{2\pi} = \hbar_1 = \frac{\hbar_{0.5}}{2} \tag{15}$$

Expression (13) is very well-suited for the description of the conditions at the signal-source. Here, the power makes more sense than the POYNTING-vector $\mathbf{S}_k$. But for a comparison with (382) we just need an expression for $\mathbf{S}_k$, quasi a sort of PLANCK's radiation-rule for technical signals with the bandwidth $2\omega_1/Q_{0.5} = 4\omega_1$. Then, this would look like this approximately:

$$d\mathbf{S_k} = 4bA\left(\frac{\Omega}{1+\Omega^2}\right)^2 \mathbf{e_s}\, d\Omega \tag{16}$$

We determine the factor A by a comparison of coefficients (3). We assume, the WIEN displacement law (8) would apply and substitute as follows:

$$A = \frac{1}{4\pi^2}\frac{k^4 T^4}{\hbar^3 c^2} \qquad\qquad c = \omega_1 Q^{-1} r_1 Q \tag{17}$$

We put in $2\sqrt{2}\omega_1$ as initial-frequency into the expression k^4T^4 That's advantageous, as we will already see. This frequency is not a metric indeed ($\omega_x \sim Q^{-1}$), but an overlaid frequency ($\omega \sim Q^{-3/2}$). During red-shift of the source-signal, likewise not the factor 2.821439372 but the factor $2\sqrt{2}$ becomes effective. Thus applies:

$$k^4T^4 = \frac{(2\sqrt{2})^4}{(2\sqrt{2})^4}\hbar_1^4 Q^{-4}\omega_1^4 Q^{-6} = \hbar_1^4\omega_1^4 Q^{-10} \qquad\qquad Q^{-10} = \frac{Q^{-8}}{Q^2} \tag{18}$$

$$A = \frac{1}{4\pi^2}\frac{\hbar_1^4\omega_1^4 Q^{-8}}{\hbar_1^3 Q^{-3}\omega_1^2 Q^{-2} r_1^2 Q^4} = \frac{1}{4\pi^2}\frac{\hbar^4\omega_0^4}{\hbar^3\omega_0^2 r_1^2 Q^4} = \frac{1}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2} \tag{19}$$

$$4A = \frac{4}{\pi}\frac{\hbar\omega_0^2}{4\pi r_0^2 Q^2} = \frac{4}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2} \qquad\qquad R \text{ for } Q \gg 1 \tag{20}$$

$$d\mathbf{S_k} = \frac{4b}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \mathbf{e_s}\, d\Omega \qquad\qquad R \text{ for } Q \gg 1 \tag{21}$$

Indeed, that submits only the expression without consideration of red-shift. We determine the actual values to the point of time of input coupling, in that we apply the values for Q=1/2 in turn. It applies:

$$A = \frac{1}{4\pi^2}\frac{\hbar_1^4\omega_1^4 Q^{-8}}{\hbar_1^3 Q^{-3}\omega_1^2 Q^{-2} r_1^2 Q^4} = \frac{2^{8-3-2+4}}{4\pi^2}\frac{\hbar_1^4\omega_1^4}{\hbar_1^3\omega_1^2 r_1^2} = \frac{128}{\pi}\frac{\hbar\omega_1^2}{4\pi r_1^2} \tag{22}$$

$$4A = \frac{512}{\pi}\frac{\hbar_1\omega_1^2}{4\pi r_1^2} \qquad\qquad d\mathbf{S_k} = \frac{512b}{\pi}\frac{\hbar_1\omega_1^2}{4\pi r_1^2} Q^{-7}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \mathbf{e_s}\, d\Omega \tag{23}$$

b will be determined later on. It shows, the POYNTING-vector is equal to the quotient of a power P_k resp. P_S and the surface of a sphere with the radius R (world-radius), exactly as per definition. Omitting the surface, we would get the transmitting-power P_V directly. In the above-mentioned expressions the parametric attenuation of 1Np/R, which occurs during propagation in space, is unaccounted for. This must be considered separately if necessary.

Now we have framed the essential requirements and can dare the next step, the proof of the validity of the WIEN displacement law in strong gravitational-fields. The basic-idea was just, that the Planck's radiation-rule (382) should emerge as the result of the application of the metrics' cut-off frequency (302) to the function of power dissipation P_V of an oscillatory circuit with the Q-factor Q=1/2 (13) We proceed on the lines of (2), in that we equate the first derivative of the bracketed expression (23) to zero. A substitution like in (1) is not necessary, because the expression is already correct. It applies:

$$\frac{d}{d\Omega}\left(\frac{\Omega}{1+\Omega^2}\right)^2 = \frac{2\Omega}{(1+\Omega^2)^2} - \frac{4\Omega^3}{(1+\Omega^2)^3} = \frac{2\Omega\left(1-\Omega^2\right)}{(1+\Omega^2)^3} = 0 \qquad (24)$$

$$2\Omega\left(1-\Omega^2\right) = 0 \qquad \Omega_1 = 0 \quad \text{Minimum} \qquad \Omega_{2,3} = \pm 1 \quad \text{Maximum} \qquad (25)$$

The first solution is trivial, the second and third is identical, if we tolerate negative frequencies (incoming and outgoing vector). Now, we must only find a substitution for Ω, with which (382) and (23) come to congruence in the lower range. This would be the displacement law for the source-signal then (22). Since the ascend of both functions has the same size in the lower range, there is theoretically an infinite number of superpositions, whereat only one of them is useful. Therefore, as another criterion, we introduce, that both maxima should be settled at the same frequency. The displacement law for the source-signal would be then as follows:

$$\hbar\omega_{max} = a\,kT \qquad \text{Displacement law source-signal} \qquad (26)$$

at which point we still need to determine the factor a. As turns out, we still have to multiply even the output-function itself, with a certain factor b, in order to achieve a congruence. The 4 we had already pulled out. We apply the value $2\sqrt{2}$and 2.821439372 for a one after the other and determine b numerically with the help of the relation and the function FindRoot[#] using the substitution 2x=ay:

$$\frac{\left(a\frac{y}{2}\right)^3}{e^{a\frac{y}{2}}-1} - 4b\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 = 0 \quad y=10^{-5} \qquad \begin{matrix} b\to 2 & \text{for } a=2\sqrt{2} \\ b\to 2.009918917 & \text{for } a=2.821439372 \end{matrix} \qquad (27)$$

The maxima overlap accurately in both cases. The lower value a is equal to the factor in (903). Thus it seems, that with references, except for those to the origin of each wave with $2\omega_1$, multiplied with $\sqrt{2}$, which is caused by the rotation of the coordinate-system about π/4, rather the approximative solutions with the factor $2\sqrt{2}$ apply. With lower frequencies, the factor 2.821439372 of the WIEN displacement law applies then again.

But to the exact proof of the validity of the WIEN displacement law in the presence of strong gravitational-fields this ansatz is not enough. We must also show that the maximum of the PLANCK's radiation-function behaves exactly according to the WIEN displacement law, that means the approximation and the target-function must come accurately to the congruence. Since the difference between a factor $2\sqrt{2}$ and 2.821439372 amounts to 0.5% after all, we will execute the examination with both values. Only the relations for $b=2\sqrt{2}$ are depicted. Now, we can set about to write down the individual relations:

$$\hbar\omega_{max} = 2\sqrt{2}\,kT \qquad \text{Displacement law source-signal} \qquad (28)$$

$$\Omega = \frac{1}{2}\frac{\omega}{\omega_1} = \frac{1}{2\sqrt{2}}\frac{\hbar\omega}{kT_k} = \frac{x}{a} = \frac{y}{2} \qquad y = \frac{\omega}{\omega_1} \qquad b=2 \qquad (29)$$

Thus, we have found our source-function. In y it reads as follows:

$$dS_k = \frac{16}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2}\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 \mathbf{e}_s\, dy \qquad R \ \text{for} \qquad Q \gg 1 \tag{30}$$

But we aren't interested in the absolute value but in the relative level only:

$$dS_1 = 8\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 dy \tag{31}$$

We want to mark the approximation with dS_2. For the target-function dS_3 we obtain:

$$dS_3 = \frac{\left(2.821439\,\frac{y}{2}\right)^3}{e^{2.821439\frac{y}{2}}-1}\, dy \tag{32}$$

In figure 1 are presented the course of the source-function and the PLANCK's graph.

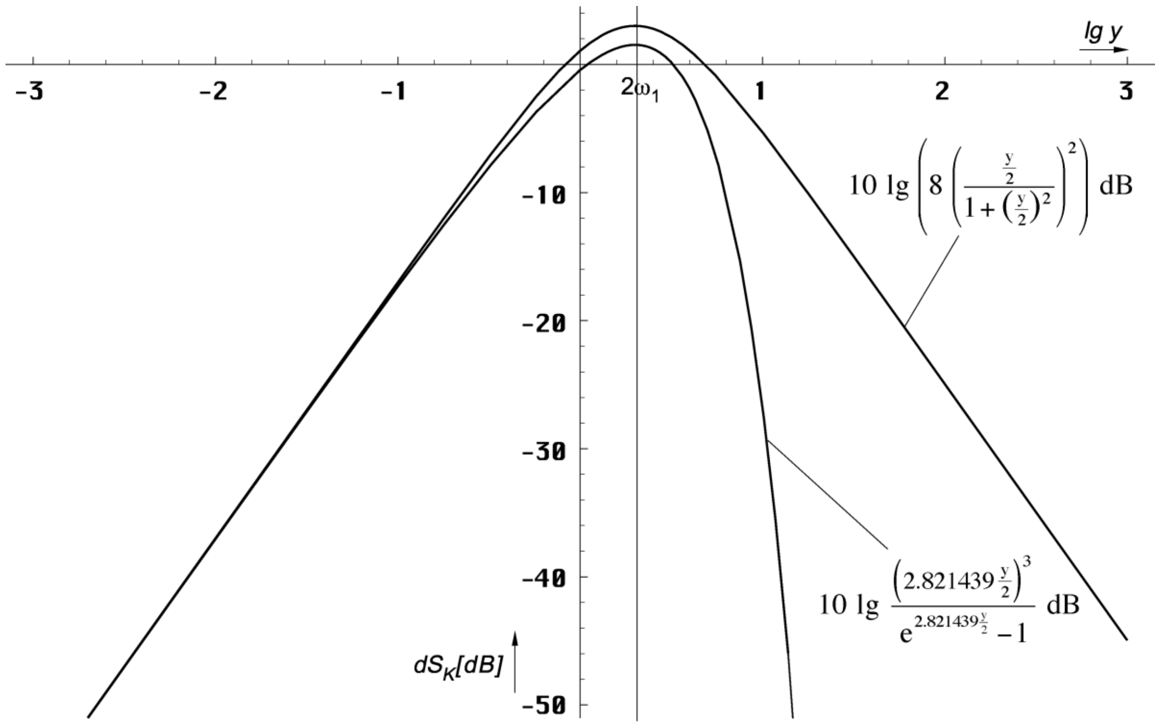


Figure 1
Planck's radiation-rule and source-function
in the superposition (logarithmic, relative level)

3. Solution and evaluation

Of course, there is no shift-information y(Q) contained in these relations. Since the considered system is a minimum phase system, we now have to multiply the source-function dS_1 with the product $A(\omega)\cdot\cos\varphi$ (frequency response). $A(\omega)$ is the amplitude response, the expression $\cos\varphi$ is for the active-share (real-part), because only this is being transferred. The result is our approximation dS_2. The frequency response is merely applied to a single line-element, which is traversed by the signal in the time r_0/c Thereat r_0 is equal to the PLANCK's length and identical to the wavelength of the above-mentioned metric wave-function. That means, we have to execute the multiplication with the frequency response as often as we like, unless the result (almost) no longer changes.

But thereat as well the frequency of the source-function as the cut-off frequency (frequency response) decrease continuously. Therefore it's opportune, to take up the displacement (frequency and amplitude) later on with the result dS_2 (approximation), instead of shifting on and on the location of the source-function. For the proof of our hypothesis indeed this last shift is not of interest, so that we won't take up it in this place.

There is another problem with the amplitude response $A(\omega)$ and with the phase-angle φ. Since the cut-off frequency $\omega_0 = f(Q, \omega_1)$ and the frequency ω are varying according to different functions, it causes difficulties to formulate a practicable algorithm. Thus we use the fact that there is no difference, whether we reduce the frequency of the input-function with constant cut-off frequency or if we shift upward the cut-off frequency with constant input-frequency. We choose this second way incl. the displacement of the approximation at the end of calculation. This all the more, since we would be concerned with two time-dependent quantities (input-frequency and cut-off frequency) otherwise. To the approximation applies:

$$dS_2 = 8\left(\frac{\frac{y}{2}}{1+(\frac{y}{2})^2}\right)^2 \prod_{½}^{Q_0} A(y)\cos(\varphi(y))\, đy\, dy \tag{33}$$

Expression (33) looks a little bit strange maybe. It's about a so called product integral, i.e. you have to multiply instead of summate. Then, the letter đ isn't the differential-, but the… let's call it d*ivisional*-operator. I don't want to amplify that, because we anyway have to convert expression (33) to continue. We use $Q_0 = 7.9518 \cdot 10^{60}$ as the current value of the Q-factor and the phase-angle of the metric wave-function[1]. It determines the upper limit of the multiplication resp. summation. Expression (33) possibly appears somewhat strange to the reader. Fortunately the frequency response can be depicted as e-function, so that the product changes into a sum. We simply have to integrate the exponent quite normally then. We obtain the frequency response inclusive phase-correction with the help of the complex transfer-function (150) to:

$$A(\omega)\cdot\cos\varphi = e^{\Psi(\omega)} \qquad \text{Frequency response of a line-element} \tag{34}$$

$$\Psi(\omega) = \frac{1}{2}\ln\left(1+\Omega^2\right) - \frac{\Omega^2}{1+\Omega^2} + \ln\cos\left(\arctan\Omega - \frac{\Omega}{1+\Omega^2}\right) \tag{[1] 302}$$

As next, we substitute Ω by y with the help of (29):

$$\Psi(\omega) = \frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right) - \frac{\left(\frac{y}{2}\frac{1}{\xi}\right)^2}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2} + \ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi} - \frac{\frac{y}{2}\frac{1}{\xi}}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}\right) \tag{35}$$

The value ω in the numerator of y figures the respective frequency of the cosmic background-radiation, for which we just want to determine the amplitude. It is identical to the ω in PLANCK's radiation-rule. Thereat it's about an overlaid frequency, which is proportional to $Q^{-3/2}$ in the approximation. Instead of the value ω_1 in the denominator actually the PLANCK's frequency ω_0 should be written with the frequency response. That is also the cut-off frequency for the transfer from one line-element to another. But with $Q=1$ the value ω_0 is right equal to ω_1, at which point ω_0 varies with the time; ω_1 on the other hand is strictly defined by quantities of subspace having an invariable value therefore. It applies $\omega_0 = \omega_1/Q$. The frequency ω_0 is exactly proportional to Q^{-1}, which means that even y depends on time, being proportional to $Q^{-1/2}$.

Now we however want to freeze the value ω, at least up to the end of the calculation, which has the consequence, that we must divide y by a supplementary function ξ, which is proportional to $Q^{1/2}$. It applies $\xi = cQ^{1/2}$ and

$$\Psi(\omega) = \frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right) - \frac{\left(\frac{y}{2}\frac{1}{\xi}\right)^2}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2} + \ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi} - \frac{\frac{y}{2}\frac{1}{\xi}}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}\right) \tag{36}$$

---

[1] The equality of the Q-factor Q_0 and the phase angle $2\omega_0 t$ is a special property of this function

The factor c arises from the initial conditions at Q=1/2 (resonance-frequency $2\omega_1$, cut-off frequency ω_1) to c=4:

$$y = \frac{\omega}{\omega_0} \sim \frac{2^{-\frac{3}{2}}}{2^{\frac{1}{2}}} = \frac{1}{4} \qquad \xi = 4\sqrt{Q} \quad \text{Approximation} \tag{37}$$

Thus, together with the 2 of y/2, we acquire exactly the same factor 8 as in the source-function (31). Then, the approximation dS_2 calculates as follows:

$$dS_2(y) = 8\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 e^{\int_{1/2}^{Q_0} \frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right) - \frac{\left(\frac{y}{2}\frac{1}{\xi}\right)^2}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2} + \ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi} - \frac{\frac{y}{2}\frac{1}{\xi}}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}\right) dQ} dy \tag{38}$$

For the determination of the integral, a value of 10^3 as upper limit suffices indeed. Over and above this, it changes very little. Therefore, I worked with an upper limit of $3\cdot 10^3$ in the following representations. The integral only can be determined numerically, namely with the help of the function NIntegrate[f(Q), Q, 1/2, 3×10^3]. The quotient of y/2 and ξ expression (37) however describes the dependency y(Q) in the approximation only. There is an exact solution as well. According to [1] (209), (299) and (509) applies:

$$\xi = \frac{a}{b}\frac{1}{Q}\frac{R(Q)}{R(\tilde{Q})}\sqrt{\frac{\beta_\gamma^4 - 1}{\tilde{\beta}_\gamma^4 - 1}} \qquad \text{with } \tilde{Q} = \frac{1}{2} \qquad \text{and} \tag{39}$$

$$R(Q) = 3r_1 Q^{\frac{1}{2}} \int_0^Q \frac{dQ}{\rho_0} \qquad \text{with } \rho_0 = \sqrt[4]{(1 - A^2 + B^2)^2 + (2AB)^2} \tag{40}$$

$$A = \frac{J_0(Q)J_2(Q) + Y_0(Q)Y_2(Q)}{J_0^2(Q) + Y_0^2(Q)} \qquad B = \frac{J_2(Q)Y_0(Q) - J_0(Q)Y_2(Q)}{J_0^2(Q) + Y_0^2(Q)} \tag{41}$$

The factor b arises from the demand, that the exact function ξ and its approximation should be of the same size with larger values of Q. The factor a we will determine later on in turn. The functions in (41) are Bessel functions. Problematic in (40) and (45) is the integral, which can be determined even only by numerical methods. In order to avoid the numerical calculation of an integral within the numerical calculation of another integral, it's opportune, to replace the integrand by an interpolation-function (BRQ1), and that inclusive the factor B. The value r_1 cancels itself because of (39). We choose sampling points with logarithmic spacing:

```
brq = {{0, 0}};
For[x = -8; i = 0, x < 25, (++i), x += .1;
 AppendTo[brq, {10^x, N[BRQP[10^x]/BGN/(2.5070314770581117*10^x) ]}]]
BRQ0 = Interpolation[brq];
BRQ1 = Function[If[# < 10^15, BRQ0[#], Sqrt[#]]];
```
(42)

The function BRQP is equal to the product of Q, root-expression and integral in the denominator of (45). The value BGN is equal to the initial value of the same product at Q=1/2. You'll find the complete program in the appendix. The factor b arises to 2.5(0703). According to (211), (482) and (623) applies further:

$$\beta_\gamma = \frac{\sin\alpha}{\sin\gamma_\gamma} \qquad \gamma_\gamma = \arg \underline{c} + \arccos\left(\frac{c_M}{c}\sin\alpha\right) + \frac{\pi}{4} \tag{43}$$

$$\alpha = \frac{\pi}{4} - \arg \underline{c} = \frac{3}{4}\pi + \frac{1}{2}\arg\left((1 - A^2 + B^2) + j2AB\right) \qquad c_M = |\underline{c}| \tag{44}$$

$$\xi \;=\; \frac{3}{0.56408}\,\frac{a}{b}\,Q^{-\frac{1}{2}}\sqrt{\beta_\gamma^4-1}\int_0^Q\frac{dQ}{\rho_0} \;=\; a\,\frac{3}{2}\sqrt{2}Q^{-\frac{1}{2}}\sqrt{\beta_\gamma^4-1}\int_0^Q\frac{dQ}{\rho_0} \qquad (45)$$

c̲ is the complex propagation-velocity of the metric wave-field. As next, we want to take up a comparison of the two functions $Q^{1/2}$ and BRQ1 (figure 2):

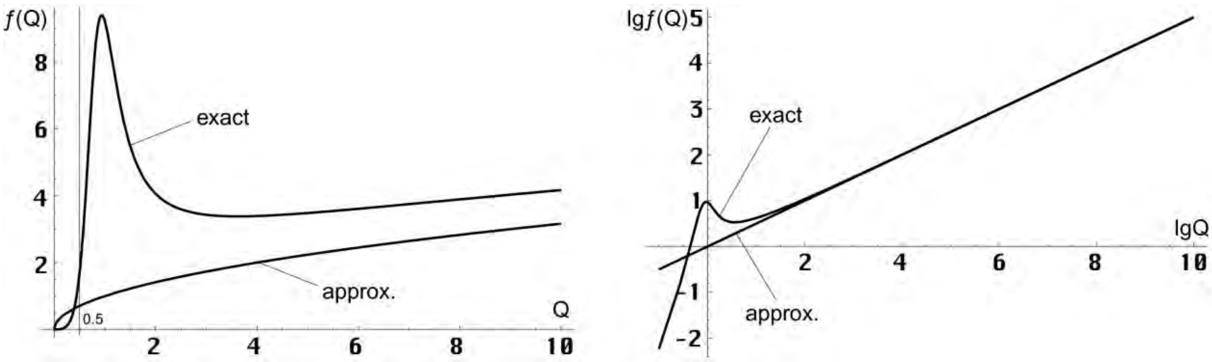


Figure 2
Function BRQ1 exactly and approximation

On the basis of the demand, that the result of both functions must be identical with Q» 1 we choose the factor a to $\sqrt{\pi}$. In this connection is to be remarked that the exact value is $\sqrt{3,5}$ in fact. But since we finally will not find, in any case, an exact fit in the course of both functions, this small „cheating" in the initial conditions should be allowed. The value $\sqrt{\pi}$ namely leads to the result with the smallest difference, so that we obtain the following final relation for ξ:

$$\xi = \frac{3}{2}\sqrt{2\pi}\left(Q^{-\frac{1}{2}}\sqrt{\beta_\gamma^4-1}\int_0^Q\frac{dQ}{\rho_0}\right) \qquad c=\frac{3}{2}\sqrt{2\pi}=3.756 \qquad (46)$$

For $\sqrt{3.5}$ a value of c=4 would arise. The bracketed expression corresponds to the factor $Q^{1/2}$ in the approximation. The course of the integral function in (38) as well as of the dynamic cumulative frequency response $A_{ges}(\omega)=e^{\int\Psi(\omega)dQ}$ you can see in figure 3 and 4. For your information the amount of the complex frequency response $|X_n(j\omega)|$ of subspace is plotted, that's the medium, in which the metric wave field propagates ($\Omega_U=\Omega$).

$$X_n(j\omega) \;=\; \frac{1}{2}\,\frac{1}{1+j\Omega}\left(1+\frac{1}{1+j\Omega}\right) \qquad \text{Complex spectral function} \qquad ([1]\ 459)$$

That applies to EM−waves propagating simultaneously with the metric wave field but not to the metric wave field itself. They achieve the aperiodic borderline case at Q=½.

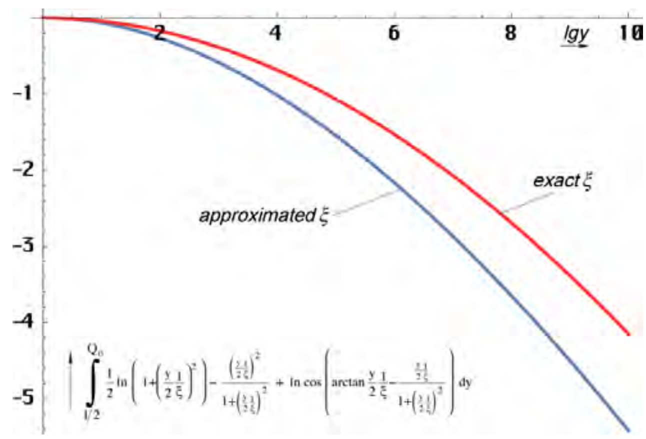
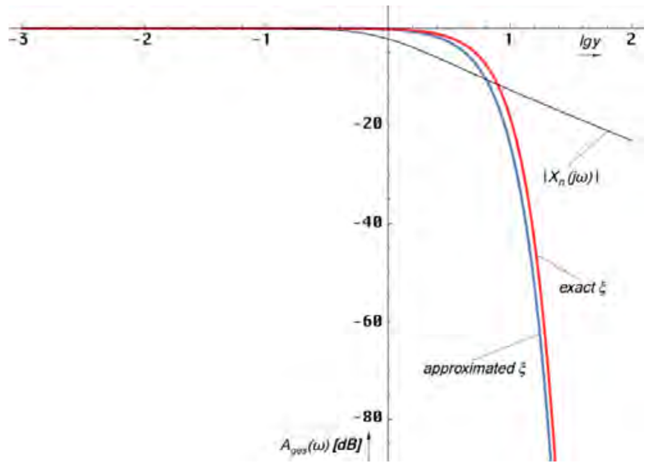


Figure 3
Course of the Integrals Ψ(ω) in (38) for the approximation and exact function ξ

Figure 4
Cumulative frequency response $A_{ges}(\omega)$ and $|X_n(j\omega)|$ of the metric wave field and subspace



Thus, all requirements are filled and we are able to demonstrate the course of the approximation (38) in comparison with the target-function (32) and that as well for the approximation as for the exact function ξ. We use a logarithmic scale with the unit decibel [dB] and, because it's about power per surface, with the factor 10.

Figure 5 shows the shape of the approximation using the approximation (37) for the function ξ (c=4). One can see, both curves doesn't match exactly. The maximum frequency $\Omega_{⫛}$ is downshifted by 18.29% (0.81707). Die maximum deviation of the amplitude $\Delta A_{\bar{\wedge}}$ is with +1.20 dB, between both maxima $\Delta A_{\wedge}$ with +0.4285 dB (+10%). That's comparatively seen, not very much. Altogether the function resembles the shape, shown in [1] section 4.6.4.2.3., obtained by multiplication of the source-function with only 4 choosed values of the frequency response. But there are disparities in the declining branch with higher frequencies.

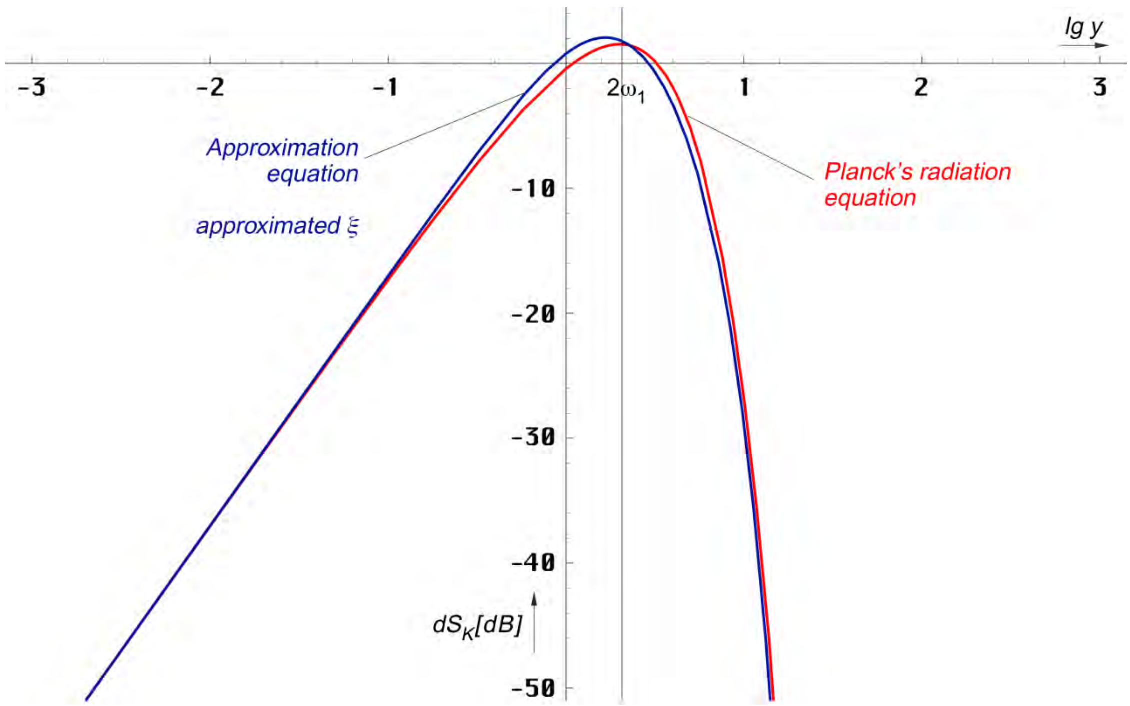


Figure 5
PLANCK's radiation-rule and approximation with approximation for the function ξ (relative level)

Figure 6 presents the course of the approximation under application of the exact function ξ (46) for c=3.756. With it, the best fit (without group delay correction) turns out (With c=4, there is only a minor difference to figure 5). But both functions don't overlap exactly neither in this place. Once again, the maximum frequency $\Omega_{⫛}$ is downshifted by 13.6% (0.86385). The maximum deviation of amplitude $\Delta A_{\bar{\wedge}}$ is about +1.29 dB, between both maxima $\Delta A_{\wedge}$ with +0.7835 dB (+19.8%).

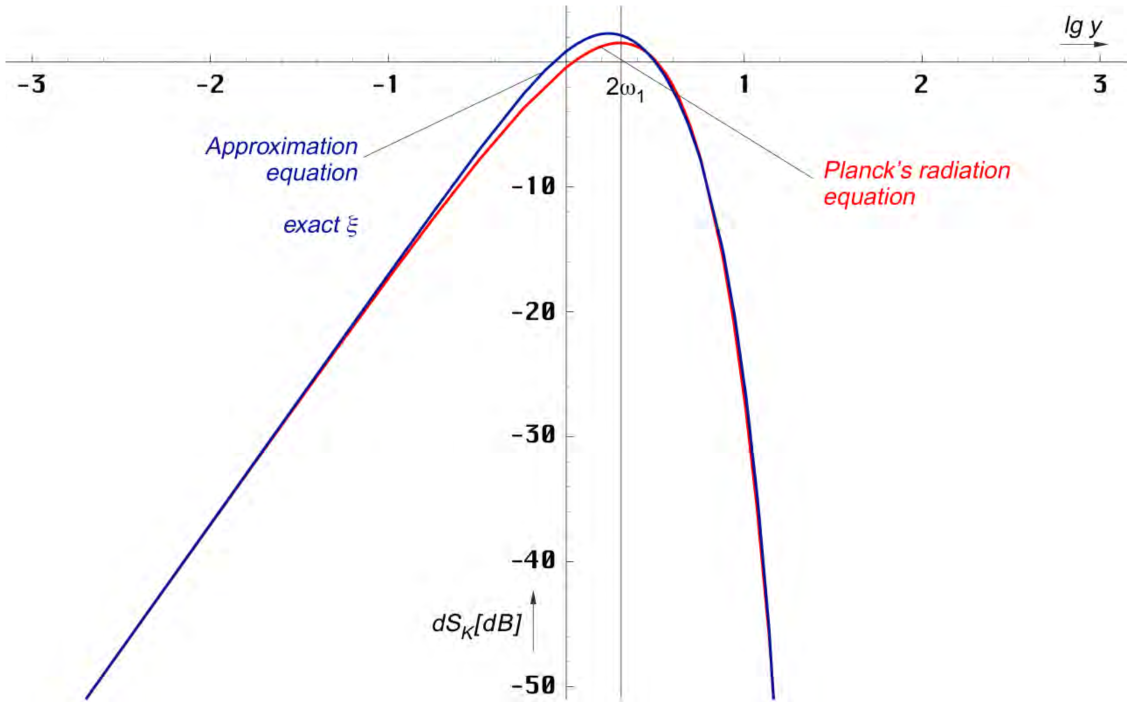


Figure 6
PLANCK's radiation-rule and approximation under application of the exact function ξ (relative level)

The course of deviation (logarithm of the quotient of approximation and PLANCK's radiation-rule) as a function of y is shown in figure 7. One sees, from ca. $10\omega_1$ on the relative deviation between both functions is strongly growing. But since the absolute level in this range is already microscopic (−50dB at the third zero), nobody will take notice of it. Even it seems rather to be about a small frequency shift, than about a deformation of the envelope.

Maybe, the downshift of the approximation's maximum could be a reason for the discrepancy between the CMBR-temperature calculated in 7.5.3. [1] to the measured COBE-value with the amount of +2.42086% (−2.36363% in the reciprocal case). Although, the form of the approximation-graph doesn't correspond to that of a black emitter and the value is too high. But during the COBE-experiment, they just have been ascertained, that the spectrum of the CMBR is exactly? black. Therefore, more forces are required in order to change the form in such a manner, that it equals that of a black emitter. In the next section we will see, which influences may come into consideration for that purpose.

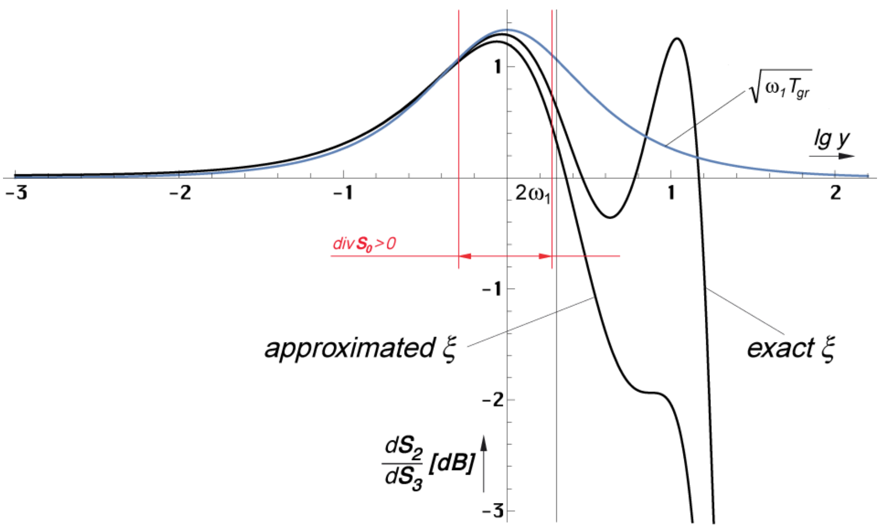


Figure 7
Relative offset between approximation and radiation-rule in dependency of the used function ξ

In figure 7 we can see that we yield an improvement if we use the exact function ξ. Nevertheless a certain left-over difference remains. If we take a look at the course in the 2nd quadrant, we can see a „gap“ where an already known function, multiplied with the factor $\sqrt{2}$, could slot right in there. That's the group delay T_{Gr} of the metric wave field of [1] section 4.3.2. Caution! The variable Ω there is differently defined, namely as $\Omega = \Omega_1 = \omega/\omega_1$. Thus, let's convert the definition to the form used here:

$$T_{Gr} = \frac{dB(\omega)}{d\omega} = 2\,\frac{\theta^2}{\omega_1} = \frac{2}{\omega_1}\left(\frac{2\Omega}{1+4\Omega^2}\right)^2 \qquad \text{([1] 152)}$$

As we can see in figure 7 (blue), the maximum is at ω_1 and not at $2\omega_1$. While group delay is equal to zero across nearly all decades, that's not the case in the proximity of ω_1 respectively ω_0 nowadays. But a frequency-dependent group delay always causes a distortion of the envelope curve. Hitherto, we considered the frequency response $A(\omega)$ and the phase delay $B(\omega)$, but a group delay correction $\Theta(\omega)$ is still missing. Rearranged for θ we obtain:

$$\theta = \frac{2\Omega}{1+4\Omega^2} = \frac{1}{2}\sqrt{2\omega_1 T_{Gr}} \qquad (47)$$

$$\Theta(\omega) = e^{-\sqrt{\omega_1 T_{Gr}}} = e^{-\sqrt{2}\theta} = 10^{-\sqrt{2}\theta\,\lg e} = 10^{-0.614185\,\theta} \qquad (48)$$

We can find the factor $\sqrt{2}$ in that we estimate the maximum deviation of +1.29393 dB. We have to experiment for a while to find the best match. The decimal power is important, if we want to calculate with dB. The course is depicted in figure 7. The group delay correction $\Theta(\omega)$ on dS_2 is applied only once:

$$dS_2 = 8\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 e^{\int_{1/2}^{Q_0} \frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right) - \frac{\left(\frac{y}{2}\frac{1}{\xi}\right)^2}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2} + \ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi} - \frac{\frac{y}{2}\frac{1}{\xi}}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}\right) dy - \sqrt{\omega_1 T_{Gr}}}\, dy \qquad (49)$$

The resulting functions with group delay correction for both ξ are shown in figure 8 and 9.

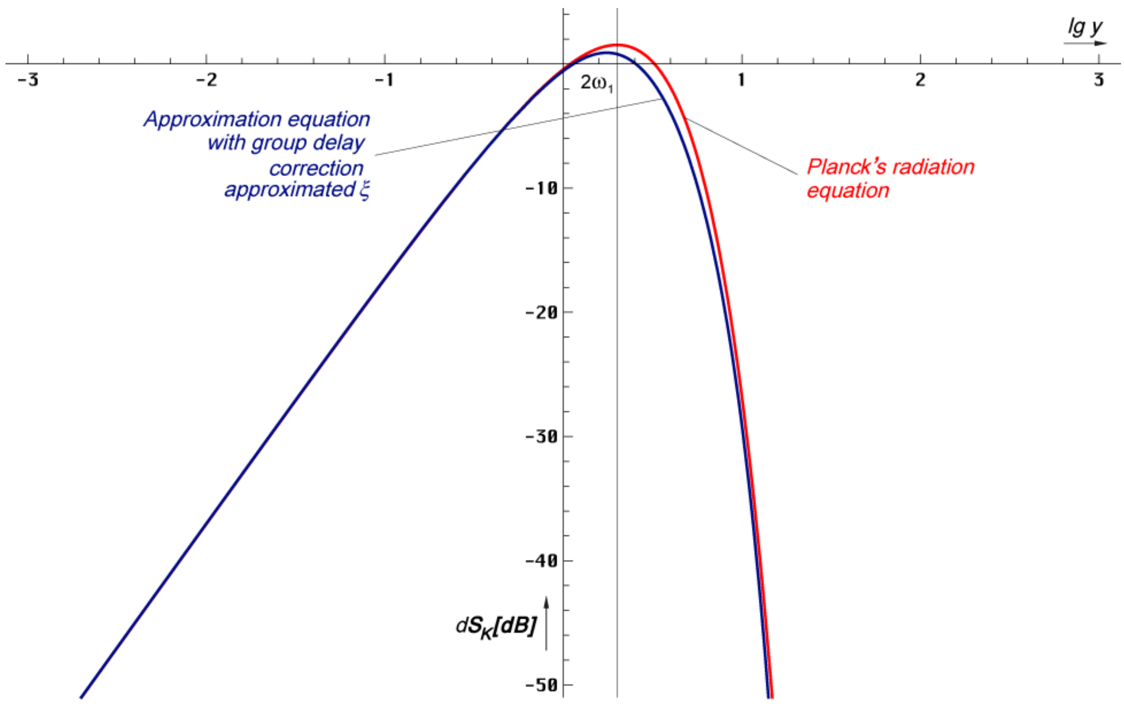


Figure 8
PLANCK's radiation-rule and approximation with group delay correction with approximation of the function ξ (relative level)

There is already a better fit of both graphs in figure 8, as we can see. Now the maximum $\Omega_{\pitchfork}$ of the frequency is downshifted about 14.3% (0.85714). The maximum deviation of amplitude $\Delta A_{\bar{\barwedge}}$ is irrelevant because of the curve progression. The difference between both peaks $\Delta A_{\barwedge}$ is with –0.74601dB (–15.8%).

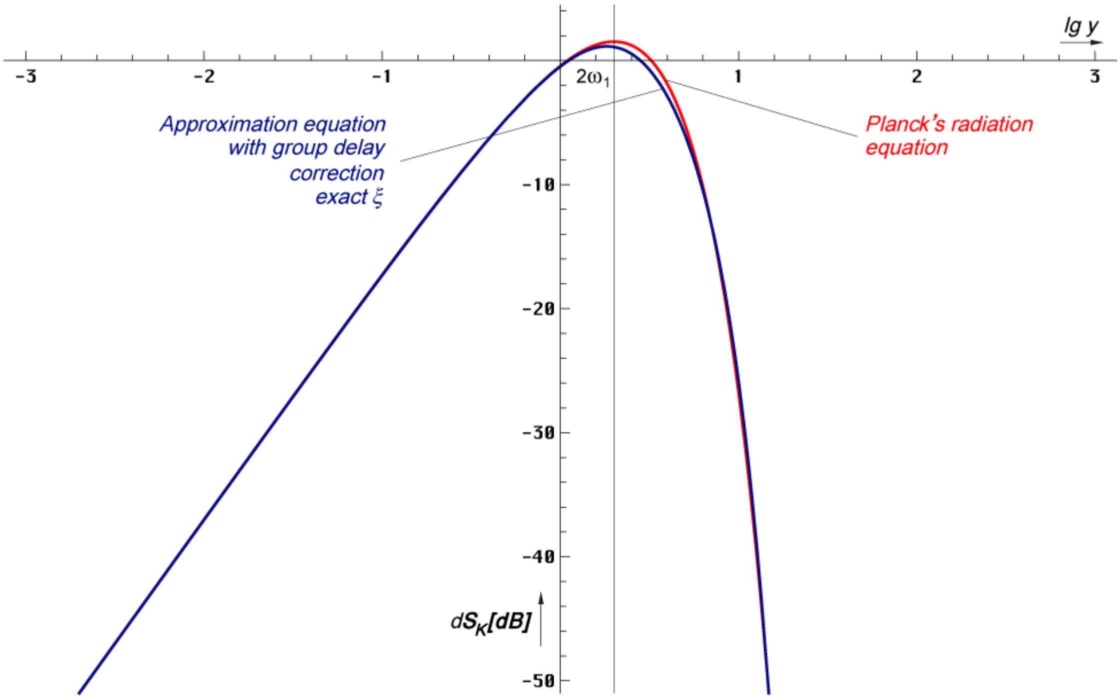


Figure 9
PLANCK's radiation-rule and approximation with group delay correction under application of the exact function ξ (relative level)

The best result we have got for the case exact ξ with group delay correction (figure 9). Now the maximum $\Omega_{\pitchfork}$ of frequency is downshifted about −8.831% (0.91169) only. That value is far in excess of the −2.36% deviation between measured and calculated CMBR-temperature. The maximum amplitude deviation $\Delta A_{\bar{\barwedge}}$ is at about +1.01 dB, between both maxima $\Delta A_{\barwedge}$ at −0.38246 dB (−8.430% i.e. 0.9157).

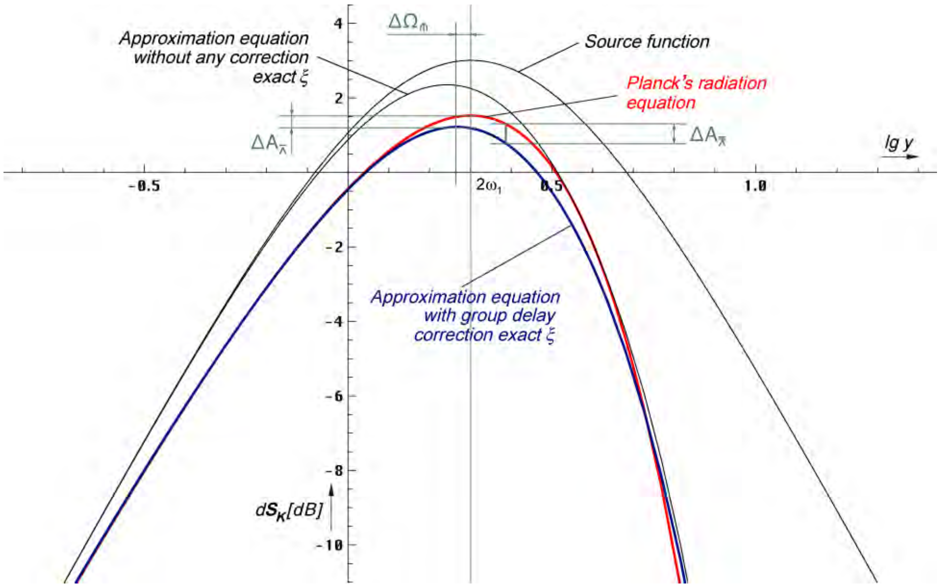


Figure 10
PLANCK's radiation-rule and approximation with group delay correction under application of the exact function ξ (relative level) high resolution

To the better clarity, the last case is depicted in figure 10 with higher resolution. You can find the exact results in table 1. Figure 11 shows a summary of the relative deviations of all solutions in comparison with the course of the absolute value of the complex frequency response $|X_n(j\omega)|$ of subspace.

Value	$\Omega_{\pitchfork}$	$\Delta\Omega_{\pitchfork}$	$A_{\bar{\wedge}}$	$\Delta A_{\bar{\wedge}}$	$\Omega_{\bar{\bar{\wedge}}}$	$\Delta A_{\bar{\bar{\wedge}}}$	$\Omega_{\bar{\bar{\wedge}}}$	$\Delta A_{\bar{\bar{\wedge}}}$
	[1]	[%]	[dB]	[dB]	[1]	[dB]	[1]	[dB]
Planck	1.00000	± 0.00	1.52727	±0.00000	--	--	--	--
Figure 5	0.81707	−18.29	1.95578	+0.42851	0.41943	+1.20007	--	--
Figure 6	0.86385	−13.61	2.28562	+0.75835	0.46495	+1.29393	5.43512	+1.25614
Figure 8	0.85714	−14.28	0.78126	−0.74601	0.05906	+0.04271	--	--
Figure 9	0.91169	− 8.83	1.14481	−0.38246	1.90966	−0.98101	5.50581	+1.01438

Table 1
Extreme values of PLANCK's radiation-function and approximation according to the function ξ used without and with group delay correction

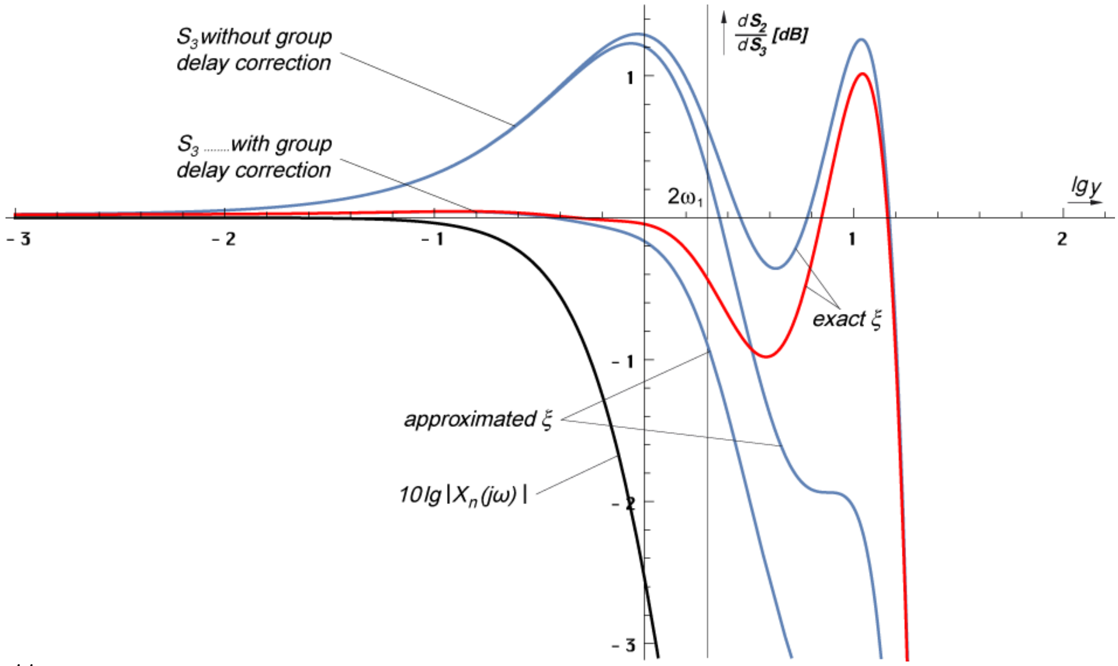


Figure 11
Relative deviation between approximation and radiation-rule according to the function ξ used without and with group delay correction

4. WIEN's Displacement

The solution as per figure 9 seems to best fit the observations, if it weren't for the unsightly dent. Let's suppose, that the ±1dB are „healed up" during the many billion years or have been „ironed out" by other influences not considered here – at the end, we must carry out, as promised, a WIEN-displacement. Starting with the in-coupling frequency $2\omega_1$, with the help of the expressions given in [1] section 2, we are able to calculate the temperature of the CMBR to compare it with the COBE-measuring:

Values from [1] $Q_0=7.9518\cdot10^{60}$, $\hbar_1=8.38572\cdot10^{26}$Js, $\omega_1=1.47506\cdot10^{104}\text{s}^{-1}$, ω_0=PLANCK's frequency

$$T_k = \frac{\hbar\omega_k}{\tilde{x}k} = \frac{\varepsilon_\nu}{\tilde{x}}\frac{\hbar_1\omega_1}{6k}Q^{-\frac{5}{2}} = 0.055693\frac{\hbar_1\omega_1}{k}Q^{-\frac{5}{2}} \qquad \tilde{x} = \begin{cases} 2.821439372 & \text{Exactly} \\ 2\sqrt{2} & \text{Approximation} \end{cases} \qquad ([1]\ 405)$$

$$T_k = \frac{\hbar\omega_k}{\tilde{x}k} \approx \frac{1}{3}\frac{\hbar_1\omega_1}{6k}Q^{-\frac{5}{2}} = \frac{\hbar_1\omega_1}{18k}Q^{-\frac{5}{2}} \qquad \varepsilon_v = \tfrac{2}{3}\sqrt{2} = 0.9428090416 \qquad ([1]\ 405)$$

$$T_k = \frac{\hbar_1\omega_1}{18k}Q_0^{-\frac{5}{2}} = (1.002476662)\frac{\hbar\omega_0}{18k}Q_0^{-\frac{1}{2}} \qquad \omega_1 = \frac{\kappa_0}{\varepsilon_0} \qquad ([1]\ 902)$$

Substituting the values specified above, we obtain in terms of figures a value of 2.79146K for the temperature T_k, exactly calculated (bracketed expression) even 2.79837K. But the measured value was 2.72548K±0.00057K. That yields a deviation of +0.06598K (+0.07289K) respectively +2.421% (2.675%). Now one could mean, that's an acceptable result, the model is quite accurate – far wrong. Not for nothing great efforts are being made in order to determine ω_K to decimal places as many as possible, since it's about a flat curve progression there and that takes significant effects on other values. Therefore, from now on, we will calculate with the exact numbers.

From ([1] 902) arises, that Q_0 depends on T_k first of all, $\hbar$ and ω_0 can be determined and calculated with the help of measurements. And most of the other quantities are strongly affected by Q_0. Obtaining a value of $Q_0=7.9518\cdot10^{60}$ for the calculated 2.79837K we would get $Q_0=8{,}38287\cdot10^{60}$ for 2.72548K. But Q_0 even affects the value of the HUBBLE-parameter:

$$H_0 \approx \omega_0\left(\frac{\hbar\omega_0}{18kT_k}\right)^{-2} \qquad H_0 = 322.4(010652877)\,\omega_0\left(\frac{\hbar\omega_0}{kT_k}\right)^{-2} \qquad ([1]\ 905)$$

H_0 would amount to $71.9843\,\mathrm{kms^{-1}Mpc^{-1}}$ for the calculated temperature of 2.79837K and only $68.2829\,\mathrm{kms^{-1}Mpc^{-1}}$ for 2.72548K. That's quite a significant difference, which neither cannot be solved by number games with the values from table 1. Thus, there must be another reason of deviation.

5. Possible reasons of deviation

Next we want to discuss possible reasons, which may lead to the deviation. The simplest and mostly unpleasant one would be, that this model is wrong. But at least, the result, somewhat well, coincides the predictions, so that we cannot approve it with sufficient certainty. But then there must be another reason. Therefore, the most probable shall be discussed as next.

Since the line-element is a minimum phase system, we computed the approximation function, by an iterative multiplication of the source-function with the just significant amplitude characteristic A(ω), as long as the result changes essentially. At the point the frequency of the signal-function has dropped far below the cut-off frequency, there is no more change to be observed. The factor cos φ emerges from the fact, that only the real-part is being transferred (φ=B(ω)).

That's the procedure with minimum phase systems in general. But according to [3] p. 340 it applies for *stable* minimum phase systems only! Because only with these, an explicit correlation exists between amplitude- and phase response curve, so that we can calculate with the amplitude response exclusively. At the line-element just after the input coupling (Q≈1), that is shortly after big bang however, it's not about a stable system at all. Rather, it shows its largest dynamics to that point of time, so that our approach may lead to an *inexact* result, as we can see.

If we want to get an exact result, we must also introduce a reference between amplitude and phase, quasi a phase-correction, because a phase-lag appears with unstable systems. At the observer the phase-lag manifests itself in the form, that the spectral shares with lower frequency are more redshifted, than the higher frequent ones. Indeed, the lower-frequent shares aren't older than the higher-frequent ones (we observe always the same point of time at the in-coupling with $Q_0=1/2$), but they have covered a longer distance. And that automatically leads to a higher redshift. But how this longer way can be explained? The lower-frequent shares simply took a different route, than the higher-frequent ones (different angle of emission). Because the lower-frequent shares, taking the same way, already have passed us. That leads to a kind of achromatism at the observer, which is hard to be detected, since the radiation arrives from all directions at once. Even with the propagation-function (306) such a phase-lag occurred, characterized by the term $\Phi(\omega)$. We considered that term and we also took a group delay correction. Hence, it cannot be that.

Let's go to talk about the high dynamics during the in-coupling process. Figure 12 shows the course of the energy flux-density vector div$\mathbf{S_0}$ of the metric wave field at that point of time. One sees, it's positive in the range $0.52549<Q<1.5975$. Thus, energy is radiated. The range is depicted even in figure 7. In the range below 0.52549 the field is been established, above 1.5975 the effect of parametric attenuation for overlaid waves can be seen.

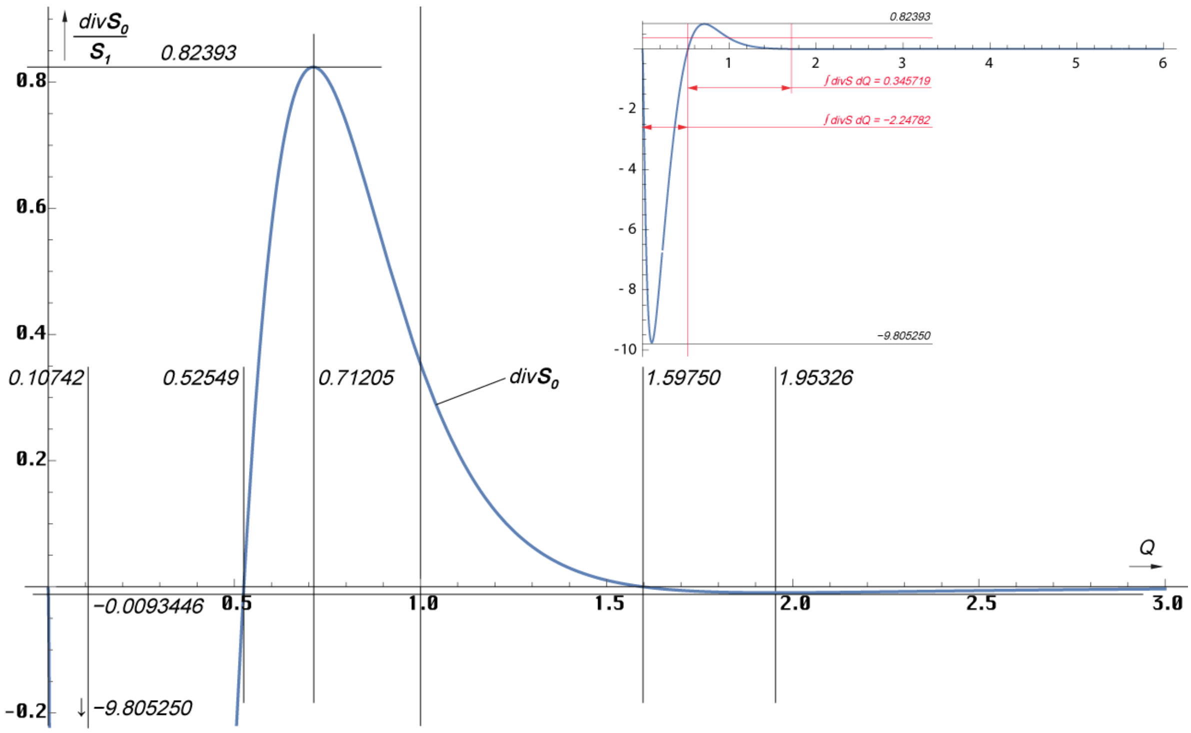


Figure 12
Course of the energy flux-density vector of the metric wave field as a function of Q

Hence, with the in-coupling process it's not about a sudden act with before → after, but it's a dynamic process. Energy is absorbed and partially re-emitted, deferred by the group delay time. At the same time the CMBR is coupled in, according to the frequency at different moments. Concerning the partial re-emission the share of absorbed energy depends on the area ratio of both left-hand sections. The numerical integration yields a value of 2.24784 for the absorbed, as well as of 0.345719 for the re-emitted energy share. The calculation 2.24784/(0.345719+2.24784) a value of 0.866700931 turns out in reference to Q. But we need the value in reference to the time t. Because $t^2\sim Q$, we must resolve the substitution t^2 on the x-axis in that we extract the root of the result. We obtain a value of 0.930967739. It corresponds, except for a deviation of 0.0118413026, to our *vacuum coefficient of absorption* ε_v=0,9428090416.

Thus, the deviation has something to do with the *gray body* [4]. Now, once we already considered ε_v indeed, but only as a constant and with the value at the time of in-coupling. But with the *gray body* ε_v depends on the frequency ω. If we want to consider that, we have to calculate an $\varepsilon_T(\omega)$ respectively a correction term $\varepsilon_K(\omega)$ to multiply ([1] 902) with, since ε_v is already included there. In [4] the following is denoted for ε_T: » Thereby ε_T correlates with the weighted averages of ε_v resp. ε_λ, which are equal:

$$\varepsilon_T = \frac{\int\int_0^\infty \varepsilon_\nu \cdot I(\nu)\cdot \mathrm{d}\nu \cdot \mathrm{d}\Omega}{\int\int_0^\infty I(\nu)\cdot \mathrm{d}\nu \cdot \mathrm{d}\Omega} = \frac{\int\int_0^\infty \varepsilon_\lambda \cdot I(\lambda)\cdot \mathrm{d}\lambda \cdot \mathrm{d}\Omega}{\int\int_0^\infty I(\lambda)\cdot \mathrm{d}\lambda \cdot \mathrm{d}\Omega} \qquad \text{from [4] «} \qquad (50)$$

But we don't want to make it as quite as complicated. Therefore we assume, that the root of the area ratio should equal the average of ε_v, i.e. be equal to ε_T. It applies: $\varepsilon_T = \varepsilon_v \varepsilon_K$, with $\varepsilon_v = ⅔\sqrt{2} = 0.942809$ and $\varepsilon_K = 0.987440402$. Multiplying the calculated $T_k = 2.79837$K with ε_K, we obtain a value of 2.76322K, which is about +0.0377K above the measured one. But is it correct, to apply ε_K resp. ε_T simply as a factor to WIEN's displacement law? The answer is no. It's about a factor from PLANCK's radiation-rule. Applying ε_T to (1)…(7), it cancels out at the end. Herewith the inclination 2 at WIEN's displacement rule ($\tilde{x}$ is the ratio slope/peak-line) also applies to the *gray body*. But even a constant of integration would be possible here. There are influences on the displacement indeed. But these depend on the shape of the envelope-curve and, with it, on the function $\varepsilon_v(\omega)$, which we do not know. Therefore we must improvise, contriving a function, which well-complies the requirements. Then, at least, we can see, which influence a frequency-dependent ε_v has onto the shape of the curve and with it even onto the displacement itself.

As a start the function before the in-coupling must have the value $\varepsilon_{vmax} = ⅔\sqrt{2} = 0.942809$. Furthermore it must vary somehow. We choose a simple change from one to another value. As inflection point we choose the moment of in-coupling with Q=1/2 resp. $2\omega_1$. Then $y = \Omega$ applies. The 0.930967739 from the area ratio of div$\mathbf{S_0}$ are our $\overline{\varepsilon}_T$. We use the function as per (51). Therefrom a lower limit of $\varepsilon_{vmin} = 0.920464$ arises. With it $\overline{\varepsilon}_T$ is a little bit smaller than the average, due to the function used. All that appears plausible on the whole, because the metric wave field mostly picks up energy before the in-coupling. Thus, it has a higher absorption coefficient as thereafter, when a share of energy is re-emitted. Even the offset of the zero-transition of div$\mathbf{S_0}$ of Q=0.52549 is mapped very well. If you don't like it, it's only a model and an optimized example function. Whether it really happens in that manner, is another matter.

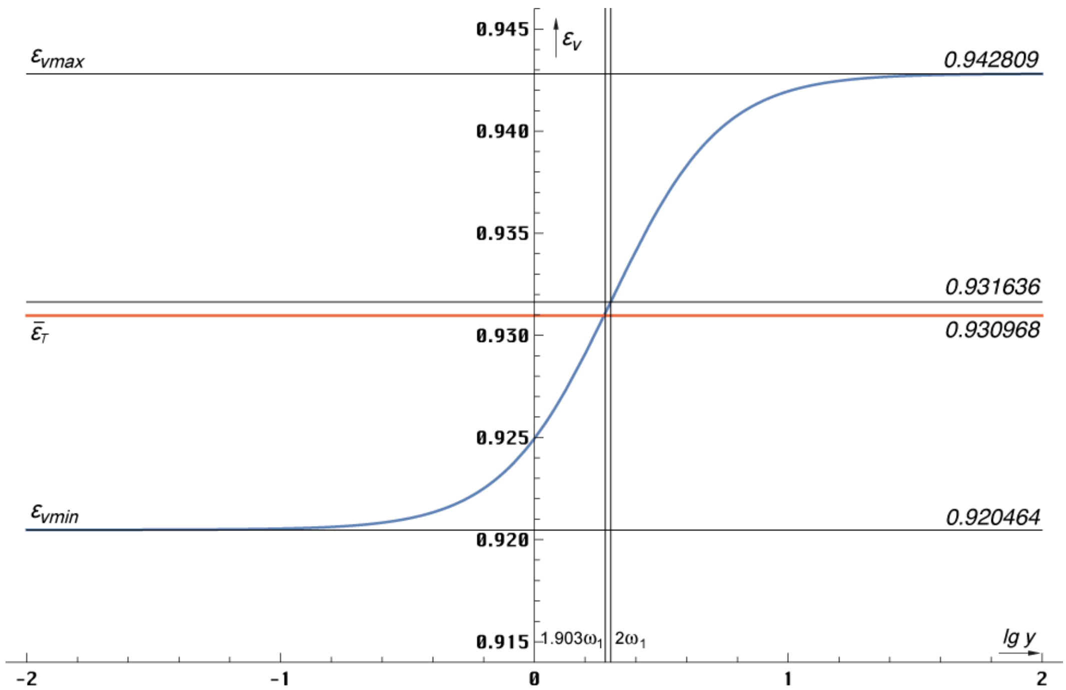


Figure 13
Vacuum coefficient of absorption ε_v as a function of ω

$$\varepsilon_\nu = \varepsilon_{\nu\,\max}\left(1 - 2\,\frac{\varepsilon_{\nu\,\max} - \bar{\varepsilon}_T}{1+\Omega^2}\right) \qquad \varepsilon_{\nu\,\min} = \varepsilon_{\nu\,\max}\left(1-2\left(\varepsilon_{\nu\,\max}-\bar{\varepsilon}_T\right)\right) \tag{51}$$

$$\varepsilon_T = \frac{2}{3}\sqrt{2}\left(1 - \frac{0.02368}{1+\Omega^2}\right) \qquad \varepsilon_K = 1 - \frac{0.02368}{1+\Omega^2} \qquad \begin{matrix}\varepsilon_{K\,\max} = 1.00000\\ \varepsilon_{K\,\min} = 0.97630\end{matrix} \tag{52}$$

Now we want to analyze the effect of ε_K on the envelope-curve. We believe in the „*self-healing powers*“ of the solution of figure 9 using a clean PLANCK-curve. Since the effect on (51) is hardly to be seen in the graphics, we use an additional, *exaggerated function* ε_{T5} to the better presentation.

$$\varepsilon_{T5} = \frac{2}{3}\sqrt{2}\left(1 - \frac{0.5}{1+\Omega^2}\right) \qquad \varepsilon_{K5} = 1 - \frac{0.5}{1+\Omega^2} \tag{53}$$

That corresponds to an $\bar{\varepsilon}_{T5}$=0.69281. We obtain the following course with it:

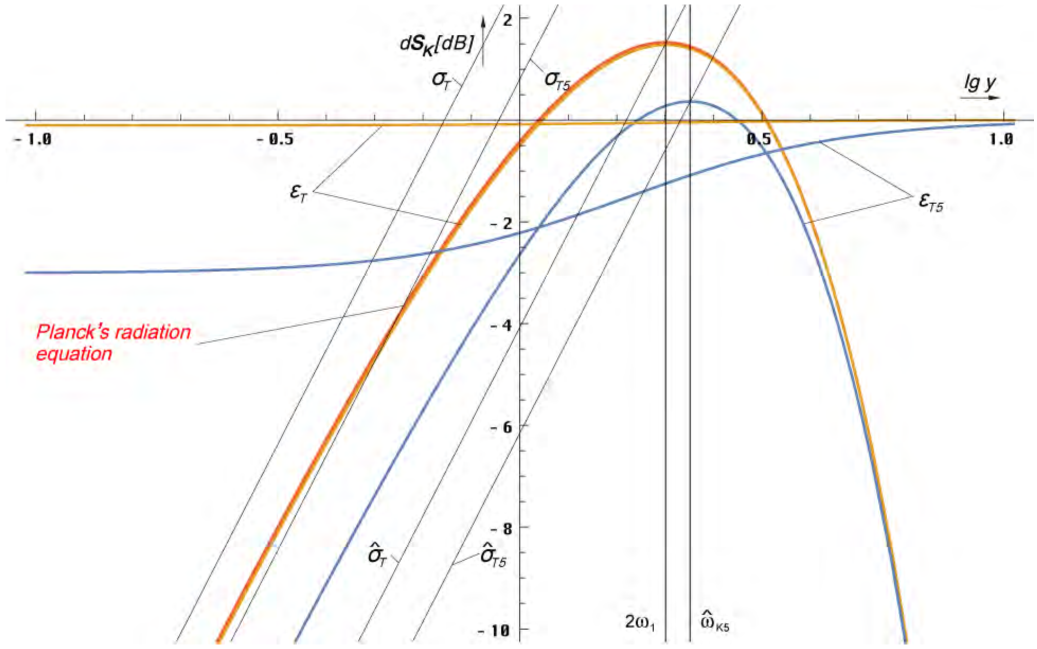


Figure 14
Effect of the absorption coefficient ε_ν
onto the envelope-curve, high resolution

One sees, the function (52) mostly affects the lower-frequent part of the envelope-curve. The maximum is up-shifted in frequency. But the inclination in the left part remains constant. That applies as I said to the example function only. Natural materials may distort the envelope-curve significantly even in this region. Then the regression line applies as a function of $\bar{\varepsilon}_T$ according to (50). Then it has the same inclination and even only, it's more or less amplitude-shifted (constant of integration!). B.t.w. the regression line σ_T resp. the lower-frequent slope is also the line, the WIEN displacement happens at. Here we can see the benefit of the duplicate logarithmic presentation, the curve becomes a line then.

The regression line σ_T can be determined by trying out most suitably. It applies y=Ω too. In the duplicate logarithmic presentation the following functions arise:

$$\sigma_T(\Omega) = 10(2\Omega + \lg(2\varepsilon_{K\,\min})) \quad [\mathrm{dB}] \qquad \text{Slope} \tag{54}$$

$$\hat{\sigma}_T(\Omega) = 10(2\Omega - \lg\tilde{x} + \lg\varepsilon_{K\,\min}) \quad [\mathrm{dB}] \qquad \text{Maximum} \tag{55}$$

$$\sigma_T(\Omega) = 2\varepsilon_{K\min}10^{2\Omega} = 2\varepsilon_{K\min}e^{2\ln 10\Omega} = 2\varepsilon_{K\min}e^{4.60517\Omega} \quad \text{Slope linearly} \quad (56)$$

That only applies to the example function used here. The 2 on the right side stems from the definition of Ω according to (9). To the *black body* and with it, even to the PLANCK-curve applies $\varepsilon_{Kmin}=\varepsilon_T=\varepsilon_{Kmax}=1$. With natural materials we must replace ε_{Kmin} by $\bar{\varepsilon}_T$ from (50). The course is shown in figure 15. Of course even a regression line for the maximum can be defined. With it ($\tilde{x}$), the circle closes to WIEN‘s displacement law. However expression (55) isn’t very accurate and the line may miss the maximum with smaller ε_{vmin}. But it applies exactly to the *black body* and to our example function. With natural materials even more than one maximum may occur. The more the envelope-curve differs from the ideal, the less reasonable is it, to speak of a radiation temperature.

From (55) arises, that we, nevertheless can define a WIEN’s displacement law for the *gray body*, at least for the example function and when the curve-shape do not differ too far from that of a *black body*:

$$T \approx \frac{1}{\tilde{x}\,\varepsilon_{K\min}} \frac{\hbar\omega_{\max}}{k} \quad \text{WIEN's displacement law for the } \textit{gray body} \quad (57)$$

With natural materials ε_{Kmin} must be replaced by $\bar{\varepsilon}_T$ again.

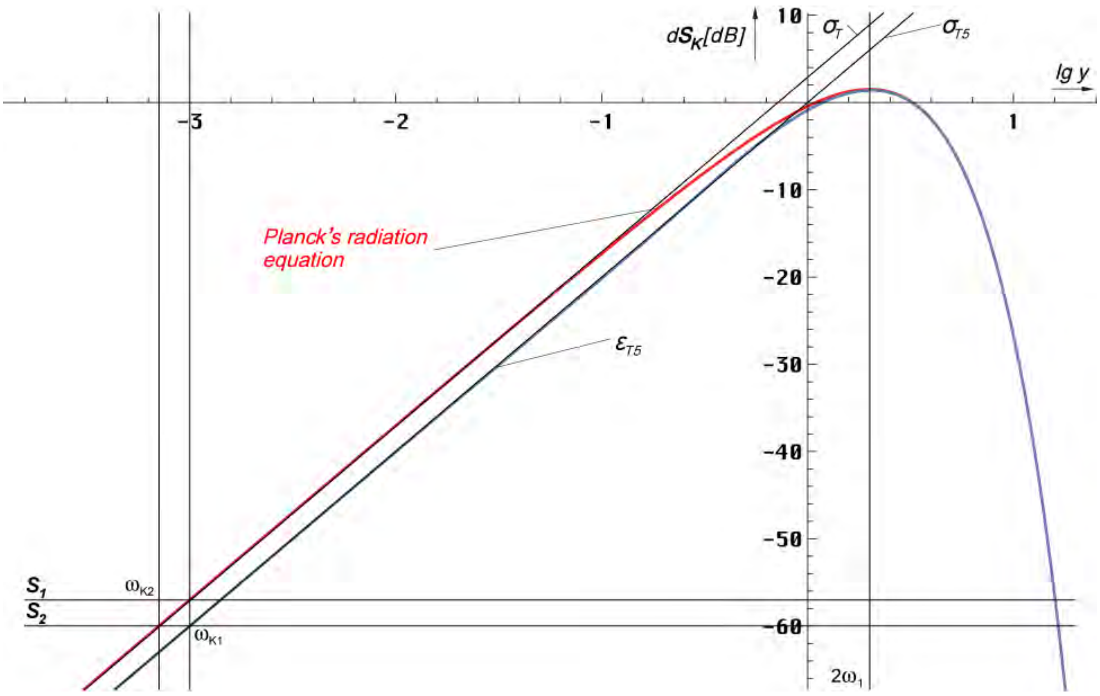


Figure 15
Displacement lines σ_T and σ_{T5}
as well as envelope-curves, low resolution

As next we want to determine the frequency-shift ω_{K2}/ω_{K1}. We choose the *exaggerated function* (53), since we cannot see anything otherwise. We want to navigate in the lower-frequent range, namely at $\omega_{K1}=0.5\cdot 10^{-3}\,\omega_{max}$. Therefore we can employ WIEN‘s radiation-rule:

$$d\mathbf{S_1} \approx \frac{1}{4\pi^2}\frac{\hbar\omega_{K1}^3}{c^2}\,e^{\frac{\hbar\omega_{K1}}{kT}}\,\mathbf{e}_s\,d\omega \quad \text{WIEN's radiation rule} \quad (58)$$

To the amplitude of $d\mathbf{S_2}$ applies ($T_1=T_2=T$) :

$$d\mathbf{S}_2 \approx \frac{\varepsilon_{K\,min}}{4\pi^2}\frac{\hbar\omega_{K1}^3}{c^2}e^{\frac{\hbar\omega_{K1}}{kT}}\mathbf{e}_s\,d\omega = \frac{1}{4\pi^2}\frac{\hbar\omega_{K2}^3}{c^2}e^{\frac{\hbar\omega_{K2}}{kT}}\mathbf{e}_s\,d\omega \qquad (59)$$

By equating we obtain the following expression:

$$\omega_{K2}^3 = \varepsilon_{K\,min}\omega_{K1}^3\,e^{\frac{\hbar\omega_{K1}}{kT}-\frac{\hbar\omega_{K2}}{kT}} = \varepsilon_{K\,min}\omega_{K1}^3\,e^{\frac{\hbar}{kT}(\omega_{K1}-\omega_{K2})} \qquad (60)$$

$$\frac{\hbar}{kT} = \frac{2.821439372}{\omega_{max}} = \frac{2.821439}{2\cdot10^3\,\omega_{K1}} = \frac{1.41072\cdot10^{-3}}{\omega_{K1}} \qquad (61)$$

$$\omega_{K2}^3 = \varepsilon_{K\,min}\omega_{K1}^3\,e^{1.41072\cdot10^{-3}\left(1-\frac{\omega_{K2}}{\omega_{K1}}\right)} \approx \varepsilon_{K\,min}\omega_{K1}^3 e^0 = \varepsilon_{K\,min}\omega_{K1}^3 \qquad (62)$$

$$\omega_{K2} = \sqrt[3]{\varepsilon_{K\,min}}\,\omega_{K1} = \sqrt[3]{0.97630}\,\omega_{K1} = 0.992037\,\omega_{K1} \qquad (63)$$

With it the frequency of our example function shifts downward by +0,8027% at the base. The offset of the maximum is +0,4860% (Function FindMaximum[#]). Just for information, with the *exaggerated function* ε_{T5} the base-shift is at +25,99%, at the maximum at +12,64%. Thus, in both cases a narrowing of the envelope-curve occurs, at which point the frequency shift at the base is nearly twice as large, as at the maximum. Because with the real values only fractions of a percent come into effect, it looks like the curve is *black*.

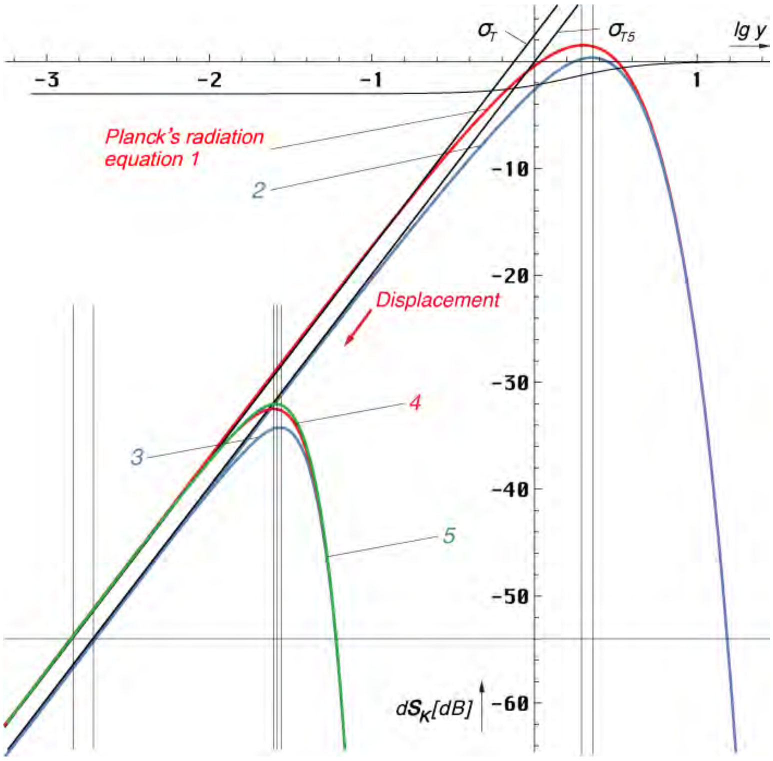


Figure 16
Possible error sources by misinterpretation of the curve-characteristic

Subsequently it's about errors in the interpretation of actual measured data only. The model itself is no issue and it's irrelevant, whether any universal natural constants change over time or not and how. Figure 16 shows what may happen, if we misinterprete the curve-characteristic, by a mistaken application of the *black body* mathematics to a *gray curve*. Curve #1 is the curve of a *black body* at the moment of in-coupling, curve #2 is the *gray curve*. The redshift z (displacement) takes place in the direction of arrow along the displacement line σ_T and σ_{T5}. You can perform it in a graphics program even manually in the following manner: At first duplicate the graph. Then scale it equably by shifting the corner point right above to the bottom left with pressed shift key, maintaining the contact with the displacement line left.

The result are the curves 3 and 4. Now, however the *gray curve* 3 can be „inflated" in such a manner, that it almost fits the *black curve* 4, that's curve 5 (green). This happens, when a too small redshift z is being assumed, a value, which we actually wanted to determine. One sees, it's possible to wangle a nearly perfect covering of the maxima. The difference is, in practice, nearly undetectable with ε_T-values near 1. The result is, that a too small z and a too small radiation temperature T_k is calculated, and that by half the offset at the base.

Presuming the calculated T_k-value in the amount of 2.79837K to be the *gray temperature,* under consideration of the interpretation error at the measured value of 2.72548K, the application of (57) a measured *gray temperature* of 2,79164K turns out. Then the calculated temperature is only +0.0067K above (+0.25%). Thus, in contrast to the hitherto +7.29%, the improvement wouldn't be insignificant. Of course, I could have configured the example function even such, that I hit the measured value exactly. But that would not have been very meaningful.

In any case, the effects of a possible *gray radiation-characteristic* should be considered, especially then, when we want to measure extremely accurate. But then we can forget the declared accuracy of ±0.00057K for the measured value resp. it applies only relatively and not absolutely.

6. Summary

In the course of this article, according to the model in [1], we succeeded in approximating the envelope-curve of PLANCK's radiation-rule as a function of a dynamic frequency response under application of a phase- and group-delay-correction with a residual deviation of ±1dB. Furthermore was shown, that the temperature calculated in [1] is in the proximity of the value measured by the COBE-satellite. By consideration of the gray characteristic of the CMBR, predicted by the model, could be shown, that and how the measured value is determined too low under misapplication of the black-body-mathematics to a gray radiation source. Under consideration of this issue the calculated CMBR-temperature would be only +0,0067K above the corrected, gray temperature. Whether the self-made gray radiation characteristic coincides with reality, remains unsettled. It's about an example here, just showing the conditions with the gray body. Altogether no contradictions have been found between the model and reality. Furthermore was shown, why the BOLTZMANN-constant has the known value and not another one. The reason is the curve inclination at an oscillating circuit with the Q-factor ½.

The results of the work on hand don't exclude the possibility, that the course of the PLANCK's radiation-rule could be the result of the existence of an upper cut-off frequency of the vacuum. Whether it's so or not, in both cases the classic deduction [2] would not be overruled. Both deductions are compatible and complement each other.

THE END

5. References

[1] **Dipl. Ing. Gerd Pommerenke**
E-Mail-Adresse: GerdPommerenke@arcor.de
The Shape of the Universe, Augsburg 2000-2013, 2020 *viXra:1310.0189*
4. strongly reworked edition, please update older versions

[2] **Ottmar Marti**
Institut für Experimentelle Physik, Universität Ulm
Strahlungsgesetze
http://wwwex.physik.uni-ulm.de/lehre/gk4-2005/node13.html#1474
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[3] **Prof. Dr. sc. techn. Dr. techn. h.c. Eugen Philippow**, TH Ilmenau
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(Last visit: 5. August 2020, 06:58 UTC)

Enveloppe Curve Approximation

Copy Friendly Version

Definitions

```
Off[General::"spell"]
Off[General::"spell1"]
Off[NIntegrate::inumr]
Off[NIntegrate::precw]
Off[NIntegrate::ncvb]

Hankel1=Function[BesselJ[0,#]+I*BesselY[0,#]];
Hankel21=Function[BesselJ[2,#]+I*BesselY[2,#]];

A=Function[(BesselJ[0,#]*BesselJ[2,#]+BesselY[0,#]*BesselY[2,#])/
 (BesselJ[0,#]^2+BesselY[0,#]^2)];
B=Function[(BesselY[0,#]*BesselJ[2,#]-BesselJ[0,#]*BesselY[2,#])/
(BesselJ[0,#]^2+BesselY[0,#]^2)];

RhoQ=Function[If[#<30,
Abs[-2*I/#/Sqrt[1-(Hankel21[#]/Hankel1[#])^2]],#^(-1/2)]];
Rho=Function[
  Abs[-2*I/Sqrt[#]/Sqrt[1-(Hankel21[Sqrt[#]]/Hankel1[Sqrt[#]])^2]]];
 (* Rho = Rho(t) c_ *)
InvRhoQ=Function[If[(Abs[#]>.851661),Infinity,If[Abs[#]<=.1,1/
#^2,0.346365+0.998383/#^2-2.50962*#+5.63857*#^2-4.39788*#^3]]];

PhiQ=Function[If[#>20,-Pi/4-3/4/#,N[Arg[-2*I/#/Sqrt[1-(Hankel21[#]/
Hankel1[#])^2]]]]];
InvPhiQ=Function[If[(((-#)>Pi)||((-#)<Pi/4)),Infinity,(*4%
Error*)If[((-3/4/(#+Pi/4))>6),-3/4/(#+Pi/4),3/4/(1/(#-0.5493137)+Pi/4)-
1.4578336150663990315 6]]];

RhoQQ=Function[If[#<30,Sqrt[Sqrt[(1-A[#]^2+B[#]^2)^2+(2*A[#]*B[#])^2]],2/
Sqrt[#]]];
 (* Arc length unequal RhoQ!!!*)
RhoQQQ=Function[Sqrt[Sqrt[(1-A[#]^2+B[#]^2)^2+(2*A[#]*B[#])^2]]];

rq={{0,0}};
For[x=(-8); i=0,x<4,(++i),x+=.01; AppendTo[rq,{10^x,N[1/RhoQQQ[10^x]]}]];
RhoQ1=Interpolation[rq];

RhoQQ1=Function[If[#<10^4,RhoQ1[#],.5*Sqrt[#]]];
AlphaQ=Function[N[Pi/4-PhiQ[#]]];
BetaQ=Function[Sqrt[#1]*((#2)^2+#1^2*(1-(#2)^2)^2)^(-.25)];
DeltaQ=Function[ArcSin[RhoQ[#]*Sin[AlphaQ[#]]]];

GammaPQ=Function[N[PhiQ[#]+ArcCos[RhoQ[#]*Sin[AlphaQ[#]]]+Pi/4]];
GammaPQa=Function[N[-PhiQ[#]-ArcSin[RhoQ[#]*Sin[AlphaQ[#]]]+Pi/4]];
GammaNQ=Function[N[-PhiQ[#]+ArcSin[RhoQ[#]*Cos[AlphaQ[#]]]-Pi/4]];
GammaNQa=Function[N[PhiQ[#]-ArcCos[RhoQ[#]*Cos[AlphaQ[#]]]-Pi/4]];

Rk=If[#1<1000,3Sqrt[#1] NIntegrate[RhoQQ1[x1],{x1,0,#1}],#1^2]&;
 (* Exact world radius/r1 *)

BRQP=Function[Rk[#] Sqrt[(Sin[AlphaQ[#]]/Sin[GammaPQ[#]])^4-1]];
BRQPa=Function[Rk[#] Sqrt[(Sin[AlphaQ[#]]/Sin[GammaPQa[#]])^4-1]];
BRQN=Function[Rk[#] Sqrt[(-Cos[AlphaQ[#]]/Sin[GammaNQ[#]])^4-1]];
BRQNa=Function[Rk[#] Sqrt[(Cos[AlphaQ[#]]/Sin[GammaNQa[#]])^4-1]];
BNQP=Function[0.4073456 #^(-6/4)];
BNQN=Function[0.282048 #^(-7/4)];
BGN=1/3 Sqrt[2]*BRQP[.5];
```

```
  brq={{0,0}};
  For[x=(-8); i=0,x<25,(++i),x+=.1;
AppendTo[brq,{10^x,N[BRQP[10^x]/BGN/(2.5070314770581117*10^x) ]}]]
  BRQ0=Interpolation[brq];
  BRQ1=Function[If[#<10^15,BRQ0[#],Sqrt[#]]];

  M1=Function[Abs[Hankel1[#]]];
  SGenau=Function[Pi/2*Rho[#]^2*Abs[Hankel1[Sqrt[#]]^2]];
  kk=Function[Expp[Sqrt[2]*Log10[E]*#/(1+#^2)]];
  AnU=Function[.5*1/Sqrt[1+#^2]*(1+1/Sqrt[1+#^2])];
  FG=Function[.5/(1+I*#)*(1+1/(1+I*#))];

  Xline=Function[10^33*(#1-#2(*Wert_x*))];
  Xlline=Function[33+(10^#1-Log10[#2](*Wert_x*))];

  Pom=Function[Print[StringJoin["x = ",ToString[10^Chop[First[xx/.Rest[%]],10^-
7]]," Om1","  (",ToString[.5*10^Chop[First[xx/.Rest[#]],10^-7]],
  " OmU)"]]];
  Pol=Function[Print["y = "<>ToString[First[#]]<>" dB   ("<>If[First[#]-
zzz>0,"+",""]<>
  ToString[First[#]-zzz]<>" dB)"]];
  Expp=Function[If[#<0,1/Exp[-#],Exp[#]]];
  (* Strictly needed to avoid calculation errors *)

  xtilde = N[3+ProductLog[-3 E^-3],16];
  c = xtilde^2;
  b=xtilde;
  S1 = 8*(#1/(2*((#1/2)^2 + 1)))^2 & ;
  S2 = (b*(#1/2))^3/(Expp[b*(#1/2)] - 1) & ;
  Psi0 = (1/2)*Log[1 + (#1/(c*Sqrt[#2]))^2] -
       (#1/(c*Sqrt[#2]))^2/(1 + (#1/(c*Sqrt[#2]))^2) +
       Log[Cos[ArcTan[#1/(c*Sqrt[#2])]] -
          #1/((c*Sqrt[#2])*(1 + (#1/(c*Sqrt[#2]))^
              2))]] & ;
  Psi1 = NIntegrate[(1/2)*Log[1 + (#1/(c*Sqrt[Q]))^2] -
        (#1/(c*Sqrt[Q]))^2/(1 + (#1/(c*Sqrt[Q]))^2) +
        Log[Cos[ArcTan[#1/(c*Sqrt[Q])]] -
           #1/((c*Sqrt[Q])*(1 + (#1/(c*Sqrt[Q]))^2))]],
       {Q, 0.5, 3000}] & ;
  Psi2 = NIntegrate[(1/2)*Log[1 + (#1/(c*BRQ1[Q]))^2] -
        (#1/(c*BRQ1[Q]))^2/(1 + (#1/(c*BRQ1[Q]))^2) +
        Log[Cos[ArcTan[#1/(c*BRQ1[Q])]] -
           #1/((c*BRQ1[Q])*(1 + (#1/(c*BRQ1[Q]))^2))]],
       {Q, 0.5, 3000}] & ;

  G=6.6732*10^-11;      (*Bruker*)
  qe=1.60217733*10^-19;
  me=9.1093897*10^-31;
  mp=1.6726231*10^-27;
  mn=1.6749286*10^-27;
  ma=1.66057*10^-27;
  anull=5.29177*10^-11 (* Bohrscher Wasserstoffradius *);
  re=2.81792*10^-15;
  km=1000;
  Mpc=3.08572*10^19 km;
  my0=4 Pi 10^-7;
  ep0=8.854187817*10^-12;
  ka0=c^3/(my0 G hg H) (*1.23879 10^93*);
  k=1.380658 10^-23;
  hg=1.05457266*10^-34;
  h=2 Pi hg;
  hi=4.99697*10^27;
  h1=hg*Q0;
  hb1=7.95297*10^26;
  hiSp=4.99697*10^27;
  Z0=Sqrt[my0/ep0];    (*2 Pi 60*)
```

```
Phi0=1.99383*10^-16;
Phi1=6.8626*10^14;
Q884=Function[3/2*(qe^2/ep0/#/me/mp)^(3/2)];        (* #=G *)
Q892=Function[3/8/Pi*qe^4/(ep0^2*me^2*mp*Sqrt[#^3*hg*c])];
Q890=Function[3/2*(1/4/Pi*qe^2*Z0/me*Sqrt[c/#/hg])^3];
c=1/Sqrt[my0 ep0];                             (*2.99792458 10^8*)
Om0=Sqrt[c^5/G/hg];
Om1=Om0 Q0;
Q0=Q890[G];
(*3/2*(qe^2/ep0/G/me/mp)^(3/2)                 "884"*)
(*3/2*(1/4/Pi*qe^2*Z0/me*Sqrt[c/G/hg])^3       "890"*)
(*3/8/Pi*qe^4/(ep0^2*me^2*mp*Sqrt[G^3*hg*c])"892"*)
(*7.5419 10^60 "Arbeit"*)
QTAB=7.5419 10^60;
Qrel=Function[Q0*(Sqrt[1+#1]-(2*#2)^(2/3))];
Qabs=Function[(Sqrt[2*ka0*#1/ep0]-Q0*(2*#2)^(2/3))];
H=Om0/Q0;
(*8/3*Pi*G/my0/Z0*me^2*mp/qe^4 2.45972*10^-18*)
r1=1/(ka0 Z0);
r0=Q0 r1;                                       (*1.596 10^-35*)
R=Q0^2 r1;
T=1/(2 H);                                      (*2.03275 10^17*)
t1=T/Q0^2;                                    (*3.57372 10^-105*)
qn=Sqrt[hg/Z0];
```

Source Function

```
(*b = xtilde; Figure 1 *)
Plot[{
Log10[(b*.5*10^y)^3/(Expp[b*.5*10^y]-1)],
Log10[ 8*(.5*10^y/((.5*10^y)^2+1))^2],
Xline[y,Log10[2]]},{y, -5, 3},PlotRange->{-10.1,.45}]
```

Expansion

```
Plot[{(*Log10[BRQP[10^qqq]/BGN/(2.5070314770581117*10^qqq)], Figure 2a *)
Log10[BRQ1[10^qqq]], Log10[Sqrt[10^qqq]]}, {qqq, -1, 10}]
Plot[{(*BRQP[qqq]/BGN/(2.5070314770581117*qqq), Figure 2b *)
BRQ1[qqq], Sqrt[qqq]}, {qqq, 0, 10}, PlotRange -> {-0.3, 9.6}]
Integral

 c=8; (*Factor 8 approx ξ Figure 3 *)
Plot[{Psi1[y],Psi2[y]},{y,0,10},
(*PlotRange->{-5.8,0.2},*)PlotStyle->RGBColor[0.91,0.15,0.25],PlotLabel-
>None,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}]

 c=8; (*Factor 8 approx ξ Skipped *)
Plot[{Expp[Psi1[y]],Expp[Psi2[y]]},{y,-4,4}(*,
PlotRange->{0,2.35}*),PlotLabel->None,LabelStyle->{FontFamily-
>"Chicago",10,GrayLevel[0]}]

 c=8; (*Factor 8 approx ξ Figure 4 *)
Plot[{10Log10[Expp[Psi1[10^y]]],10 Log10[Expp[Psi2[10^y]]]},{y,-3,2},PlotRange-
>{-88,2},LabelStyle->{FontFamily->"Chicago",12,GrayLevel[0]}];

 Plot[{10 Log10[Abs[FG[10^y]]]},{y,-3,2},PlotRange->{-88,2},PlotLabel-
>None,PlotStyle->RGBColor[0,0,0],LabelStyle->{FontFamily-
>"Chicago",10,GrayLevel[0]}];

 Show[%%,%]
```

Approximation 1

```
 c=8; (* Factor 8 approximated BGN exact Figure 5 *)
Plot[{10 Log10[S2[10^y]],10
(Log10[S1[10^y]*Expp[Psi1[10^y]]]),Xline[y,Log10[2]]},{y,-3,3},PlotRange->
```

```
  {-51,10.5},ImageSize->Full,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}]
(* Exakt exakt exakt Fehler max +1.3dB *)

   c=7.519884824; (* Sqrt[π] exact ξ Figure 6 *)
  Plot[{10 Log10[S2[10^y]],10 (Log10[S1[10^y]]
+Log10[E]*Psi2[10^y]),Xline[y,Log10[2]]},{y,-3,3},PlotRange->
  {-51,4.5},ImageSize->Full,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}]
```

Extreme Values 1

```
FindMaximum[10 Log10[S2[10^xx]],{xx, 0}];
(* Planck's curve *)
Print[StringJoin["x = ",ToString[(10^First[xx/.Rest[%%]])],
" Om1         (1.000000 OmU)"]]
Print[StringJoin["y = ",ToString[zzz = First[%%%]]," dB    (±0.000000 dB)"]]

FindMaximum[10 (Log10[S1[10^xx]*Expp[Psi1[10^xx]]])-10Log10[S2[10^xx]],{xx,1}] ;
(* Maximum deviation Psi1 *)
Pom[%]
Pol[%%]

FindMaximum[10 (Log10[S1[10^xx]*Expp[Psi2[10^xx]]])-10Log10[S2[10^xx]],{xx,0}];
(* Maximum deviation 1 Psi2 *)
Pom[%]
Pol[%%]

FindMaximum[10 (Log10[S1[10^xx]*Expp[Psi2[10^xx]]])-10Log10[S2[10^xx]],{xx,1}];
(* Maximum deviation 2 Psi2 *)
Pom[%]
Pol[%%]

FindMaximum[10 (Log10[S1[10^xx]]+Log10[E]*Psi1[10^xx]),{xx,-1}];
(* Deviation between maxima Psi1*)
Pom[%]
Pol[%%]

FindMaximum[10 (Log10[S1[10^xx]]+Log10[E]*Psi2[10^xx]),{xx,-3,2}];
(* Deviation between maxima Psi2 *)
Pom[%]
Pol[%%]
```

Deviation 1

```
 c=8; (*Factor 8 approx ξ Figure 7 *)
Plot[{10 Log10[S1[10^y]*Expp[Psi1[10^y]]/S2[10^y]],Xline[y,Log10[2]]},
{y,-3,2},PlotRange->{-3.1,1.35},ImageSize->Full,LabelStyle->
{FontFamily->"Chicago",10,GrayLevel[0]}];

 c=7.519884824; (* Sqrt[π] exact ξ *)
Plot[{10 Log10[S1[10^y]*Expp[Psi2[10^y]]/S2[10^y]]},{y,-3,2},
ImageSize->Full,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}];

 Show[%,%%%,PlotRange->{-3.1,1.35}]

 Plot[{10Log10[kk[10^x]]},{x,-3,2.2},PlotRange->{-0.6,3},
PlotStyle->RGBColor[0.06,0.52,0.]];

Show[%%,%,ImageSize->Full,LabelStyle->{FontFamily->"Chicago",12,GrayLevel[0]}]
```

Approximation 2

```
   c=8; (* Factor 8 approximated BGN exact Figure 8 *)
  Plot[{10 Log10[S2[10^y]],10 (Log10[S1[10^y]*Expp[Psi1[10^y]]])-10Log10[kk[10^y]],
  Xline[y,Log10[2]]},{y,-3,3},PlotRange->{-51,4.5},ImageSize->Full,LabelStyle-
>{FontFamily->"Chicago",10,GrayLevel[0]}]
```

```
 c=7.519884824; (* Sqrt[π] exact ξ Figure 9 *)
Plot[{10 Log10[S2[10^y]],10 (Log10[S1[10^y]]+Log10[E]*Psi2[10^y])-
10Log10[kk[10^y]],Xline[y,Log10[2]]},{y,-3,3},PlotRange->{-51,4.5},
ImageSize->Full,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}]
```

Extreme Values 2

```
FindMaximum[10 Log10[S2[10^xx]],{xx, 0}];
(* Planck's curve *)
Print[StringJoin["x = ",ToString[(10^First[xx/.Rest[%%]])],
" Om1         (1.000000 OmU)"]]
Print[StringJoin["y = ",ToString[zzz = First[%%%]]," dB    (±0.000000 dB)"]]

FindMaximum[10 Log10[(S1[10^xx]*Expp[Psi1[10^xx]]/kk[10^xx])/S2[10^xx]],{xx,0}];
(* Maximum deviation Psi1 *)
Pom[%]
Pol[%%]

FindMaximum[10 Log10[(S1[10^xx]*Expp[Psi2[10^xx]]/kk[10^xx])/S2[10^xx]],{xx,0}];
(* Maximum deviation 1 Psi2 *)
Pom[%]
Pol[%%]

FindMinimum[10 Log10[(S1[10^xx]*Expp[Psi2[10^xx]]/kk[10^xx])/S2[10^xx]],{xx,.5}];
(* Maximum deviation 2 Psi2 *)
Pom[%]
Pol[%%]

FindMaximum[10 Log10[(S1[10^xx]*Expp[Psi2[10^xx]]/kk[10^xx])/S2[10^xx]],{xx,1}];
(* Maximum deviation 3 Psi2 *)
Pom[%]
Pol[%%]

FindMaximum[10 Log10[S1[10^xx]*Expp[Psi1[10^xx]]/kk[10^xx]],{xx,0}];
(* Deviation between maxima Psi1 *)
Pom[%]
Pol[%%]

FindMaximum[10 Log10[S1[10^xx]*Expp[Psi2[10^xx]]/kk[10^xx]],{xx,0}];
(* Deviation between maxima Psi2 *)
Pom[%]
Pol[%%]

 Plot[{(* Figure 10 *)
10 Log10[S1[10^y]],
10 Log10[S2[10^y]],
10(Log10[S1[10^y]]+Log10[E]*Psi2[10^y]),
10 (Log10[S1[10^y]]+Log10[E]*Psi2[10^y]-Log10[kk[10^y]]),
Xline[y,Log10[2]]
},{y,-0.8,1.4},PlotRange->{-11,4.5},PlotLabel->None,ImageSize->Full,LabelStyle-
>{FontFamily->"Chicago",10,GrayLevel[0]}]
```

Deviation 2

```
 c=7.519884824; (* Sqrt[π] exact ξ Figure 11 *)
Plot[{10 Log10[S1[10^y]*Expp[Psi1[10^y]]/S2[10^y]]-10Log10[kk[10^y]],
10 Log10[S1[10^y]*Expp[Psi2[10^y]]/S2[10^y]]-10Log10[kk[10^y]]},{y,-3,2},
ImageSize->Full,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}];

 Show[%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%,%,PlotRange->{-3.1,1.35}]
```

Roots

```
FindRoot[10 (Log10[S1[10^y]]+Log10[E]*Psi2[10^y])-10Log10[kk[10^y]]-
10Log10[S2[10^y]]==0,{y,.5}]

FindRoot[10 (Log10[S1[10^y]]+Log10[E]*Psi2[10^y])-10Log10[kk[10^y]]-
10Log10[S2[10^y]]==0,{y,1}]

FindRoot[10 (Log10[S1[10^y]]+Log10[E]*Psi2[10^y])-10Log10[kk[10^y]]-
10Log10[S2[10^y]]==0,{y,2}]

N[10^0.846931]   (* Level at 2nd null *)
ToString[10 Log10[S2[%]]]<>" dB"

N[10^1.1612]     (* Level at 3rd null *)
ToString[10 Log10[S2[%]]]<>" dB"

N[10^1.4142]     (* Level after 3rd null *)
ToString[10 Log10[S2[%]]]<>" dB"

Plot[{(* Skipped *)
10 Log10[S1[10^y]],
10 Log10[S2[10^y]],
10(Log10[S1[10^y]]+Log10[E]*Psi2[10^y]),
10 (Log10[S1[10^y]]+Log10[E]*Psi2[10^y]-Log10[kk[10^y]]),
Xline[y,Log10[2]]},{y,-3,3},PlotRange->{-51,4.5},PlotLabel->None,
ImageSize->Full,LabelStyle->{FontFamily->"Chicago",10,GrayLevel[0]}]
```

Energy Flux Density Vector

```
w0g=Function[Sqrt[Pi^3/8]*M1[Sqrt[#]]^3*Rho[#]^3];
w0n=Function[#^-(3/2)];
w0nPunkt2Int=Function[-(w0n[#])^2+.897659];
w0gPunkt=Function[(w0g[#+.00001]-w0g[#])/.00001];
w0gPunkt2=Function[(w0g[#+.00001]^2-w0g[#]^2)/.00001];
w0gPunkt2Int=Function[-(w0g[#])^2+.897659];
ka0g=Function[Pi/4*M1[Sqrt[#]]^2*Rho[#]^2];
ka0g2=Function[Pi^2/12*M1[Sqrt[#]]^4*Rho[#]^4];
ka0g2n=Function[1/3*#^(-2)];
ka0g2Int=Function[NIntegrate[ka0g2[tt],{tt,0,#}]];
ka0g2nInt=Function[-1/(6*#1^(3/2))+1/(6*10^(3/2))+0.345818];

Plot[{-w0gPunkt2[t^2]-ka0g2[t^2]},{t,0,3},PlotRange->{-0.22,0.88}, (* Figure 12
*)
PlotLabel->None,ImageSize->Full,LabelStyle->{FontFamily-
>"Chicago",10,GrayLevel[0]}]
```

Displacement Line

```
b = xtilde;
Plot[{(* Skipped *)
Log10[S2[10^y]], Log10[S1[10^y]],Xline[y,Log10[2]],
   2*y + Log10[2], 2*y - Log10[xtilde]}, {y, -3.05, 3.05},
  PlotRange -> {0.55, -5.05}, ImageSize -> Full,
  LabelStyle -> {FontFamily -> "Chicago", 10,
    GrayLevel[0]}]

b = 2.821439;
Plot[{(* Skipped *)
N[(b*y)^3/(E^(b*y) - 1)], 10^N[2*Log10[y] + Sin[2]]},
{y, 0, 0.15}, PlotRange -> {0, 0.2}]
```

Gray body

Definitions

```
x=2.972456 10^-63;
y=8.6556 10^-64;
z=y 2^(1/6)/3^(2/3) Q0^-.5;fff=Function[1/(1+(#1/#2)^2)];
fff=Function[1/(1+(#1/#2)^2)];
ggg=Function[1/(1+((#1/#2)-(#2/#1))^2)];
hhh=Function[2*(#1/#2)/(1+(#1/#2)^2)];
Ek3=Function[1-0.0236820832fff[#1,#2]];
Ek5=Function[1-0.5fff[#1,#2]];            (* Ek5 over-scaled !!! *);
```

Absorbing Coefficient

```
 Plot[{
2/3Sqrt[2]Ek3[10^xxx,2Om0],0.942807,.920464,.930967739,
Xline[xxx,Log10[2Om0]]},
(* Epsilon T *)
{xxx,-2+ Log10[Om0],2+ Log10[Om0]},PlotRange->{0.91,0.95}]

 Plot[{(* Figure 13 *)
2/3Sqrt[2]Ek3[10^xxx,2],0.942807,.920464, 0.930967739,(0.942807+.920464)/2,
Xline[xxx,Log10[2]],Xline[xxx,Log10[1.903]]},
{xxx,-2,2},PlotRange->{0.914,0.946},ImageSize->Full,PlotLabel->None,
LabelStyle->{FontFamily->"Chicago",11,GrayLevel[0]}]
(* Epsilon T *)


aaa = Log10[2];
bbb = xtilde (*2*Sqrt[2]*);
ccc = 1;
Plot[{(* Figure 14 *)
  10*Log10[(bbb*10^(zzz - aaa))^3/(E^(bbb*10^(zzz - aaa)) - 1)],
  10*Log10[Ek3[10^(zzz - aaa), ccc]*((bbb*10^(zzz - aaa))^3/
       (E^(bbb*10^(zzz - aaa)) - 1))],
  10*Log10[Ek5[10^(zzz - aaa), ccc]*((bbb*10^(zzz - aaa))^3/
       (E^(bbb*10^(zzz - aaa)) - 1))], 10*Log10[Ek3[10^(zzz - aaa), ccc]],
  10*Log10[Ek5[10^(zzz - aaa), ccc]],
  Xline[zzz, Log10[2]],Xline[zzz,0.35271201428301324],
  10*(2*zzz + Log10[2]), 10*(2*zzz - Log10[xtilde]),
  10*(2*zzz + Log10[2*0.69281]),
  10*(2*zzz - Log10[xtilde] + Log10[(0.69281+.5)/2])
  }, {zzz, -1.02, 1.02}, PlotRange -> {-10.25, 3.25}, ImageSize -> Full,
  PlotLabel -> None, LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]
```

Extreme Values 3

```
 FindMaximum[10*Log10[S2[10^zzz]],{zzz,-1.02,1.02}]

 FindMaximum[10*Log10[(bbb*10^(zzz-aaa))^3/(Exp[(bbb*10^(zzz-aaa))]-1)],
{zzz,-1.02,1.02}]

 FindMaximum[10*Log10[Ek3[10^(zzz-aaa),ccc]*((bbb*10^(zzz-aaa))^3/
(E^(bbb*10^(zzz-aaa))-1))],{zzz,-1.02,1.02}]

 FindMaximum[10*Log10[Ek5[10^(zzz - aaa), ccc]*((bbb*10^(zzz - aaa))^3/
       (E^(bbb*10^(zzz - aaa)) - 1))],{zzz,-1.02,1.02}]

aaa = 0*Log10[2];
bbb = xtilde (*2*Sqrt[2]*);
ccc = 0.5 (* Q(max) *);
```

```
Plot[{(* Figure 15 *)
  10*Log10[S2[10^zzz]],
  10*Log10[Ek5[10^zzz, ccc]*S2[10^zzz]],
  Xline[zzz, Log10[2]], Xline[zzz,-3], 10*Log10[S2[10^-3]],
  10*(2*zzz + Log10[2(1-0.0268)]),
  10*(2*zzz + Log10[2(1-0.5)])
  (* 2 εKmin *)},
  {zzz, -3.8, 1.3}, PlotRange -> {-67.25, 10.25}, ImageSize -> Full,
  PlotLabel -> None, LabelStyle -> {FontFamily -> "Chicago", 12, GrayLevel[0]}]

aaa = 1*Log10[2];
bbb = xtilde;
ccc = 0.5;
Plot[{(* Figure 16 *)
     10*Log10[(bbb*10^(zzz - aaa))^3/(Expp[bbb*10^(zzz - aaa)] - 1)],
     10*Log10[Ek5[10^(zzz - aaa), ccc]*((bbb*10^(zzz - aaa))^3/
       (E^(bbb*10^(zzz - aaa)) - 1))], 10*Log10[Ek5[10^(zzz - aaa), ccc]],
     Xline[zzz, Log10[2]],Xline[zzz,0.35271201428301324]},
     {zzz, -3.8, 3.4}, PlotRange -> {-67.25, 5.25}, ImageSize -> Full,
     LabelStyle -> {FontFamily -> "Chicago", 10, GrayLevel[0]}]
Beep[]
Beep[]
Beep[]
```