# The Metric Universe

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## Abstract

Why is there a contradiction between SRT and GRT in strong gravitational fields? What is the cause of the relativistic effects? What is the contradiction in the expression $\hbar\omega = mc^2$ when considering the cosmological redshift? What is the cause of Planck's uncertainty principle? Can you really simulate the Big Bang inside a particle accelerator? Are the universal natural constants really constant? What is the meaning of the so-called Planck units? Are there references to the universal natural constants? Can the unexpected result of the Supernova Ia cosmology experiment also be explained without dark matter and increasing expansion? Why does the radiation curve of a black body have exactly this shape and no other? Is it possible to calculate the Hubble parameter and the CMBR temperature? Does the Mach-principle really apply?

All these questions and more are answered by the present model without dark matter, without inflation, with variable natural constants and expansion. Since some of the variable natural constants also affect the observer, i.e. he is affected by them himself, some of the changes cancel out. A *virtual relativity principle* applies. The laws of nature just *seem* to be the same in all frames of reference.

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## 1. Author-seminar paper

Primary purpose of this work was to determine the HUBBLE-parameter with other methods than astronomic ones and if necessary even to calculate it. With the improved technical methods, like the James-Webb-Telescope, it now succeeds to advance into space farther and farther obtaining new, more exact data. With it, it becomes visibly that it will be always more imperative to have an exact model of the universe as whole in order to interpret these data correctly, because the farther we look into the universe and with it, into the depths of time, the more effects appear, which can be hardly interpreted with the current models or not at all.

Object of this work was, to posit such a model, using data being locally available, which is accessible with the present-day technical methods. 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.

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. There is also an English source denoted in [1]. 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.

The result is a model with changing natural constants with expansion. This leads to a reduction of well-known contradictions, e.g. between the SRT and the ART with strong curvature, with the red-shift in relation to the expression $\hbar\omega = mc^2$ and many more. Since some of the variable natural constants also affect the observer, i.e. he is affected by them himself, some of the changes cancel out. A *virtual relativity principle* applies. The laws of nature just *seem* to be the same in all frames of reference.

However, the model also influences the metric system (SI). With the help of the electron mass and charge, the relations to the corresponding PLANCK units could be precisely determined. This makes it possible to calculate all natural constants outside the atomic nucleus as a function of the reference system or space and time to at least 10 decimal places, including the HUBBLE parameter and the CMBR temperature. Especially because of this influence I named the line element appearing in the model »Metric Line Element (MLE)«.

Furthermore, the model explains the unexpected results of the Supernova-Ia-Cosmology-Experiment as a consequence of a non-standard electromagnetic wave propagation function. Due to the expansion of the universe, there is a parametric damping that can only be detected at very large distances. At the same time, this leads to the appearance of an upper cut-off frequency, which is the cause of the specific waveform, the sharp descent at high frequencies, with the CMBR and, in general, any thermal radiation.

In contrast to other models based on the hydrogen atom, where the ratio $F_g/F_e$ is approximately $1{:}10^{40}$, this model is based on the PLANCK length with a ratio of 1:1. The theoretical electrotechnics custom notation is used in the work (j instead of i). Unusually, the letter $\beta$ is used for the Lorentz factor $\gamma$, since $\gamma$ is already heavily overused. A different definition of the PLANCK charge is used in the form $q_0 = \sqrt{\hbar/Z_0}$. 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.

## 2. Contents

# 3. Cosmologic model

## 3.1. Specification of the model

In this lecture, it is just assumed that the metrics is built like a cubic (regular) space-lattice of Metric 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 in future, we want to call them Metric Line-Elements with the abbreviation MLE.

Object of the further contemplations should be the question, how such a Metric 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 cosmologic 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.

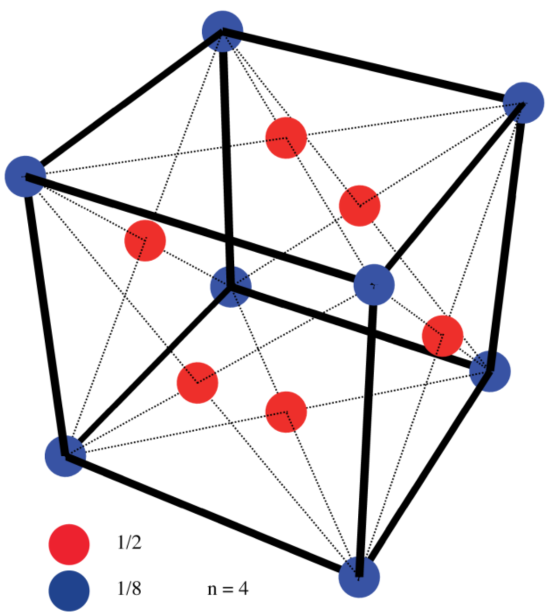



Figure 1
Cubic face-centred crystal lattice (fc)

As first, we assume that the Metric line-elements (MLE), we want to examine here, are arranged in a (regular) cubic face-centred space-lattice (picture 1) [48]. 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 (also rot) 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.

### 3.2. 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 $\omega_0$, 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

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

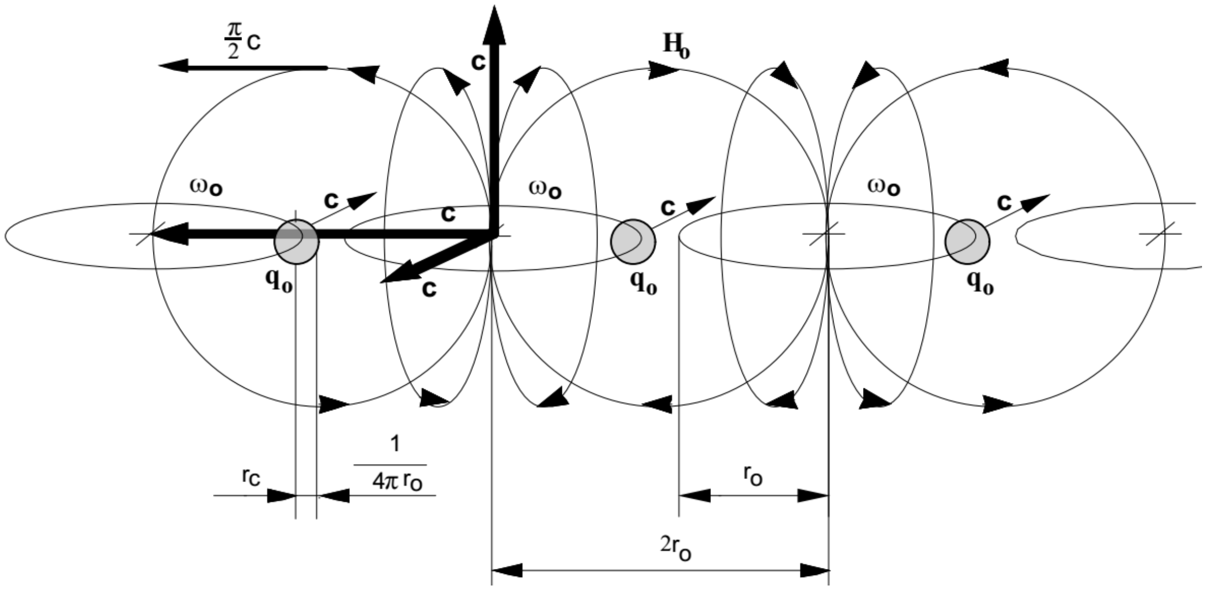



Figure 2
Metric line-elements
Physical dimensions and mutual coupling

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

$$J_0 = m r_0^2 \qquad \text{(point-mass)} \tag{4}$$

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 relation

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

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

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

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

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

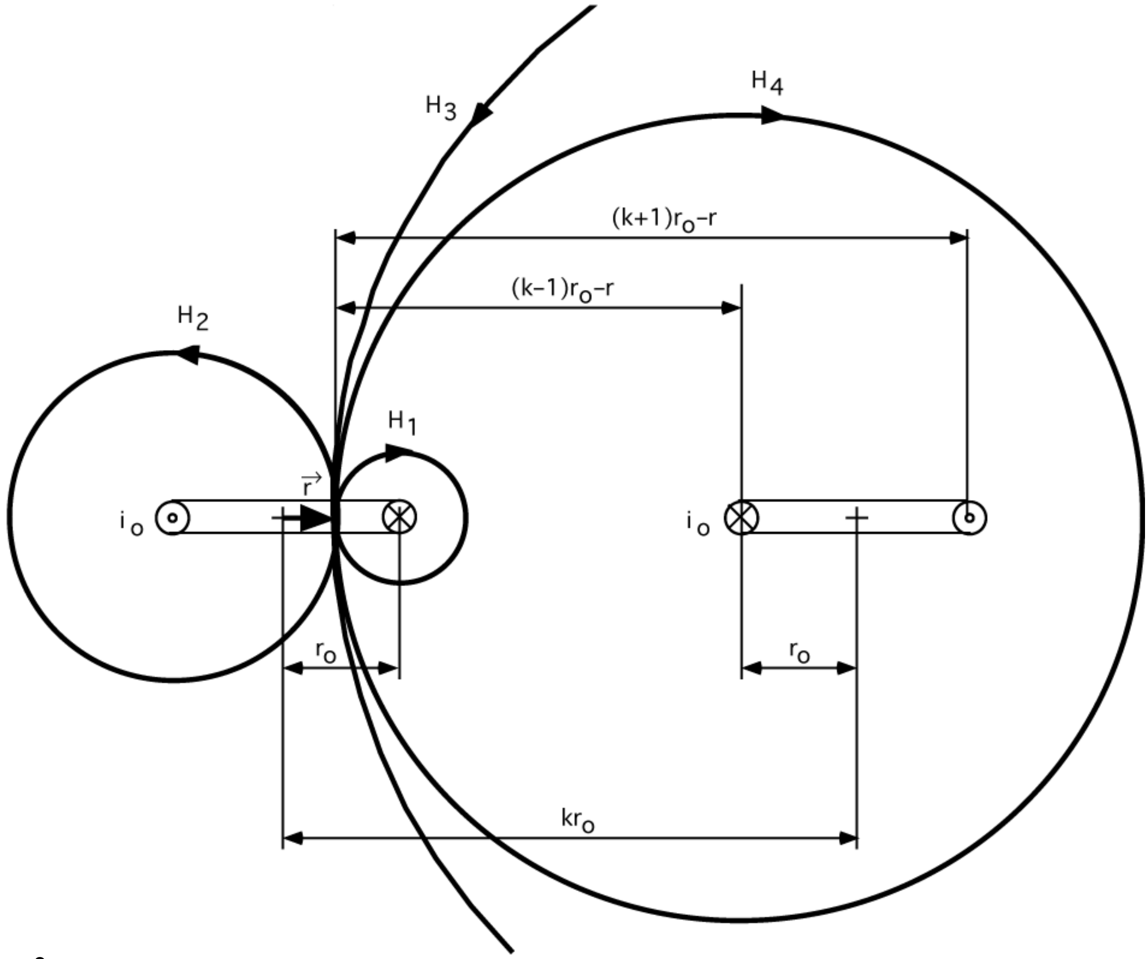



Figure 3
Magnetic field-strength in one and
in several conductor loops

$F_Z$ 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 directed contrarily 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:

$$L = \mu_0 r\left[\ln\frac{8r}{r'}-\frac{7}{4}\right], \qquad (10)$$

in which r represents the inside-radius, r′ the wire-radius of one single short-circuited turn ($\mu_r=1$). 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-parameter) in the centre of the conductor loop (left) amounts to

$$\mathbf{H_0} = -\frac{i_0}{2r_0}\mathbf{e_r} \qquad (11)$$

$\mathbf{e_r}$ is the unit-vector. The negative sign results from the definition of the field-strength as difference between zero-potential ($r=\infty$) and potential in the distance R. The field-strength-share of a current-element $i_0ds$ in the distance r of the centre (Figure 3) calculates according to [20] as follows

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

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

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

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 $\pi$.

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

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:

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

Since the individual line-elements are arranged in a cubic-face-centred space-lattice (Figure 1), in fact altogether four line-elements along a field-line 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.

We must however assume 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 $\mathbf{E_0}$).

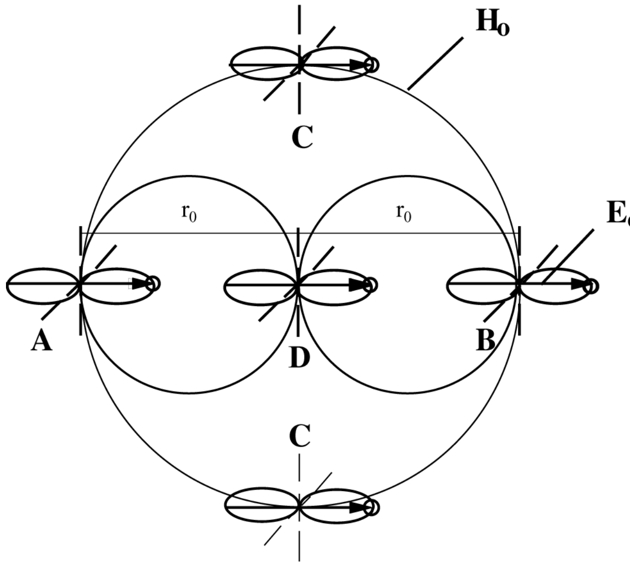



Figure 4
Collocation of the MLE's at a field-line in x-direction at a cubic face-centred lattice

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 $\mathbf{H_0}$:

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

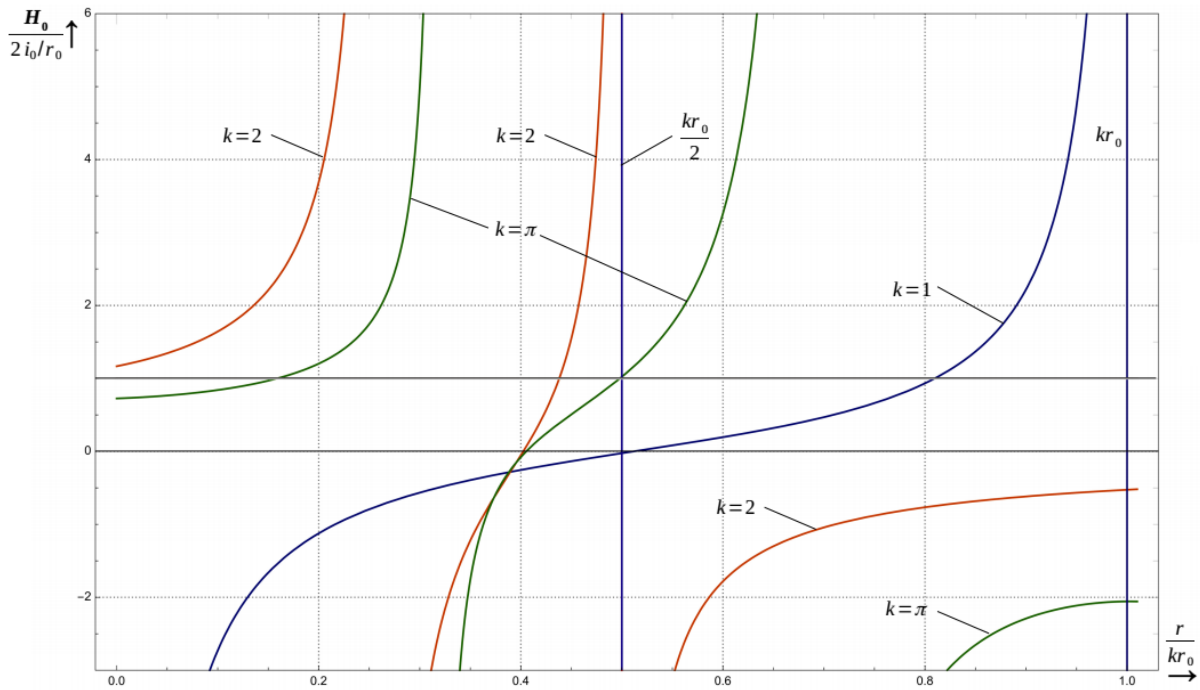



Figure 5
Course of the magnetic field strength depending on the radius r and various lattice constants

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. 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=π. Herewith, the e*ffective lattice constant* has the value $\pi r_0$, 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:

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

and after expansion with $c^2$

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

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

$$r_0 = \sqrt{\frac{G\hbar}{c^3}} \tag{27}$$

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

$$F_g = -\frac{q_0^2}{\varepsilon_0 r_0^2} \tag{28}$$

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:

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

The value for $\omega_0$ 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 $\omega_0$ of the electric dipole and $\omega_0$ 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 $\pi\sqrt{2}$.... $\pi\sqrt{3}$ 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:

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

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 $\varphi_0$, 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.

## 3.3. The Metric line-element as oscillatory circuit

Having considered so far only the case of electric and magnetic mass which are equally large — charge and flux $\varphi_0$ 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:

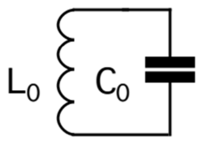



Figure 6
Equivalent circuit
of a static MLE

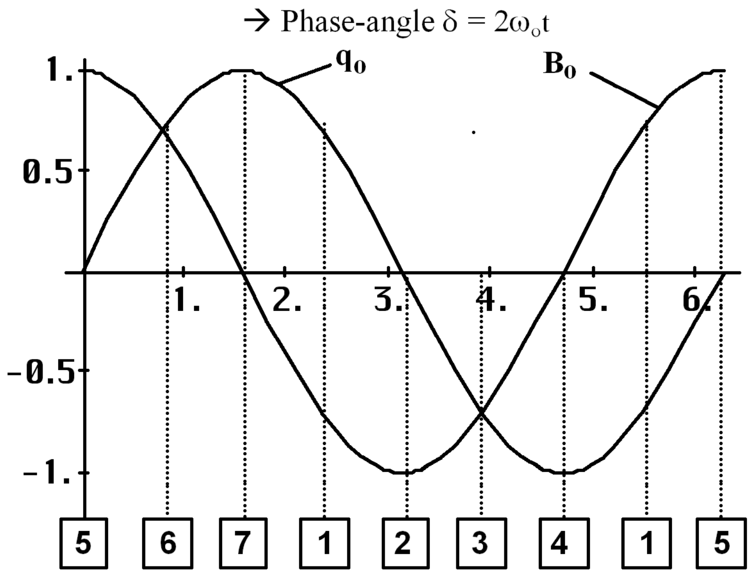



Figure 7
Courses of charge and induction
with labelling of the track-points

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 $q_0$, $\varphi_0$, $H_0$, 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:

$$W_0 \quad = \hbar\omega_0 = \frac{q_0^2}{\varepsilon_0 r_0}\sin^2 2\omega_0 t \tag{38}$$

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

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

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

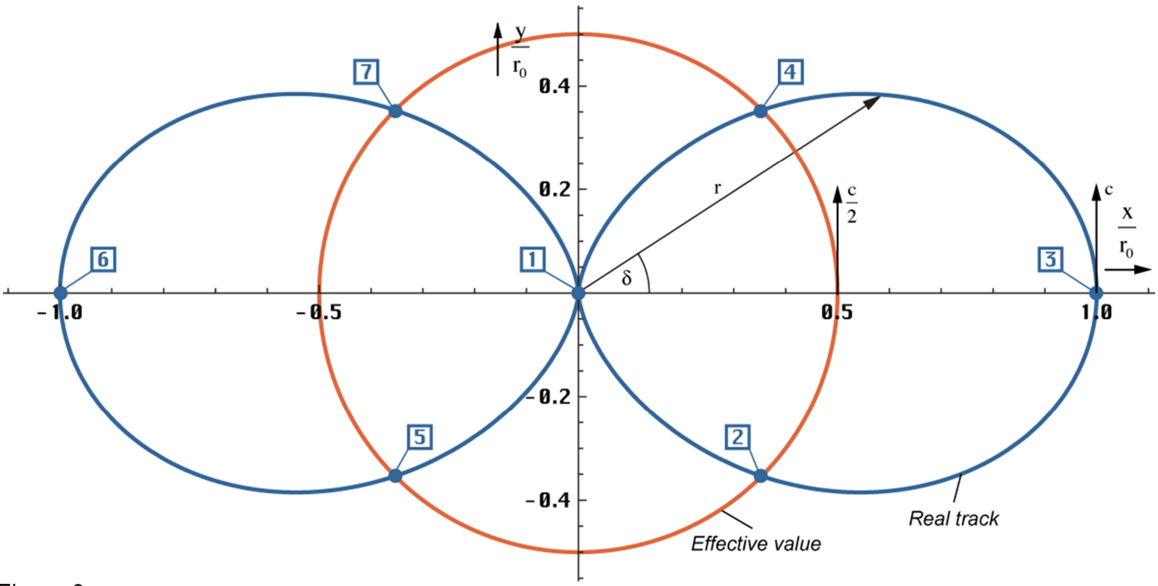



Figure 8
Real track-course in the xy-plane

$$x(\delta) \quad = \frac{r_0}{2}(1+\cos 2\delta)\cos\delta \tag{41}$$

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

The exact course is figured in Figure 8. In the xy-plane it corresponds exactly to the course of the envelope of the POYNTING-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.

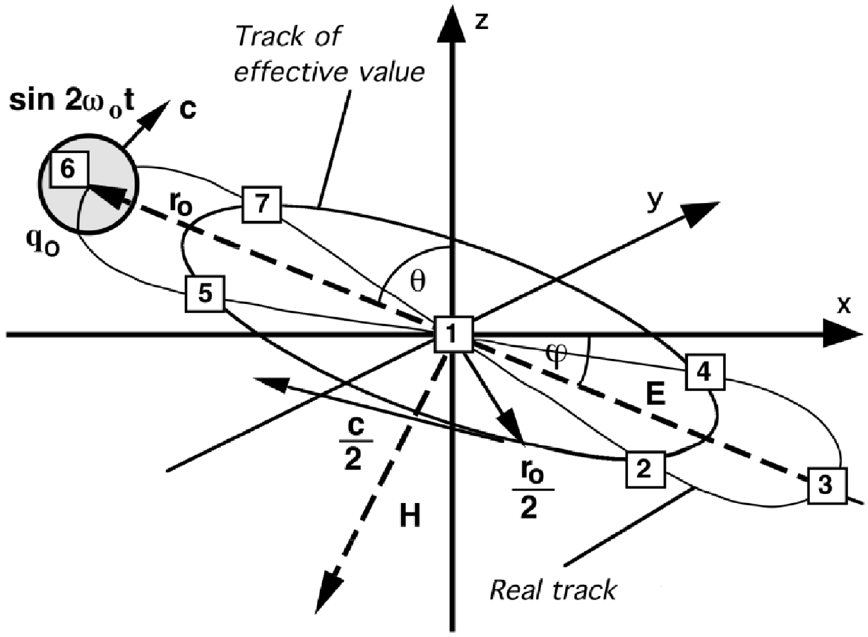



Figure 9
Idealized and real track of
the MLE in three-dimensional presentation

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.

### 3.4. 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 cosmologic 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 $\alpha$ would become unequal to zero and even moreover frequency-dependent with the appearance of an imaginary part of $\underline{c}$. It applies

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

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/$\lambda$). 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 $R_0$.

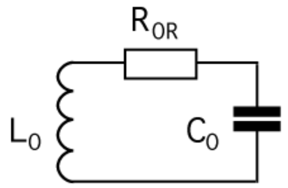



Figure 10
Equivalent circuit with
series-resistor

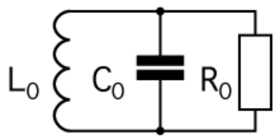



Figure 11
Equivalent circuit with
shunt-resistor

With our further contemplations, now we have to decide in favour 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 favour 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 of $r_0$ 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 $\tau_0$, 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 $\tau_1$ 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 $\tau_1$. We now assume that $\tau_1$ 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 $\tau_1$ 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 $\kappa_0$ 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 $1.710\cdot10^{93}$ $AV^{-1}m^{-1}$. In this connection a value of 55 $kms^{-1}Mpc^{-1}$, has been set up for H, that is $1.7824\cdot10^{-18}s^{-1}$. Possibly, this value is rather not up-to-date anymore. One recognizes the magnitude of $\kappa_0$ 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 $r_0$

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

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

with it we get for the HUBBLE-parameter H

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

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

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

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

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

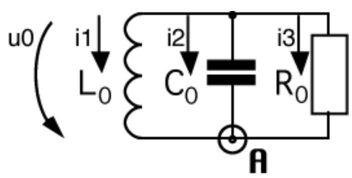



Figure 12
Voltages and currents
in the oscillatory circuit

## 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 $\varphi_0 = i_1 L_0$

$$\boxed{\begin{aligned} u_0 &= \frac{d(i_1 L_0)}{dt} && \text{(I)} \\ u_0 &= \frac{1}{C_0}\int i_2\,dt && \text{(II)} \\ u_0 &= i_3 R_0 && \text{(III)} \end{aligned}}$$

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

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

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

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

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

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

Now, we rearrange equation (II) for $i_2$:

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

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

$$\boxed{\begin{aligned} i_1 &= \frac{1}{L_0}\int u_0 dt && \text{(I)} \\ i_2 &= C_0\frac{du_0}{dt} + u_0\frac{dC_0}{dt} && \text{(II)} \\ i_3 &= \frac{u_0}{R_0} && \text{(III)} \end{aligned}}$$

Put into (61) we obtain

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

Since $u_0 = \dot{\varphi}_0$ equation (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 at all, equation (72) would change into the normal differential equation for a loss-affected oscillatory circuit with shunt-resistor with the well known solution:

$$\omega_0 = \sqrt{\frac{1}{L_0 C_0} - \left(\frac{1}{2R_0 C_0}\right)^2} \quad . \tag{73}$$

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 $\varphi_0$ in equation (72), namely H is $\neq 0$. According to (51) furthermore both augmenters are identically and we can write

$$\ddot{\varphi}_0 + \frac{2}{R_0 C_0}\dot{\varphi}_0 + \frac{1}{L_0 C_0}\varphi_0 = 0 \qquad \text{or} \tag{75}$$

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

Equation (76) is very interesting. If we want to determine the time-function of $\varphi_0$ however, we now have to insert (53, 54):

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

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

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:

$$y''x \quad + \quad A\,y' \quad + \quad B\,y \qquad = \quad 0 \tag{79}$$

We first rearrange this equation to y

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

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:

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

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

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

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

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

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

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

It results in the following coefficients then:

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

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

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

$\ldots$

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

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

Another notation would be

$$a_n = a_0(-1)^n B^n \prod_{k=0}^{\infty}\frac{1}{(A+k)(1+k)} \tag{94}$$

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

$$a_n = a_0(-1)^n B^n \frac{1}{(1)_n(A)_n} = a_0(-1)^n B^n \frac{1}{n!(A)_n} \tag{95}$$

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

This is the general hypergeometric function ${}_0F_1\,(;A;-Bx)$ however [9], [18].

$$\boxed{y = a_0\,{}_0F_1\,[;A;-Bx]} \tag{97}$$

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 behaviour 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 equation (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 $\ddot{\varphi}_0 t + ½\dot{\varphi}_0 + \kappa_0/(2\varepsilon_0)\varphi_0 = 0$ (model without expansion). According to [12] applies:

$${}_0F_1\left[;\frac{1}{2};-\frac{1}{4}z^2\right] = \cos z \tag{99}$$

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

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

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

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

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

Considering the root-expression of eqn. (104) more exactly, so it would have to correspond to the angular frequency $\omega_0$ 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's about 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:

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

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.

$$y = a_0\, {}_0F_1\left[;1;-Bx\right] \tag{109}$$

According to [17] applies

$${}_0F_1(;b;x) = \Gamma(b)(jx)^{b-1} J_{b-1}(j2x^{\frac{1}{2}}) \tag{110}$$

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

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

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

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

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

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)

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

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

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 general solution (115) reads then:

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

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:

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

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 Planck's quantity of action* $\hbar=\varphi_0 q_0$ *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 $\omega_0$, 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

Since the Hankel function is difficult to handle, we want to search for a good approximation. Furthermore we are interested in the course of the function and of $\varphi_0$ and $q_0$. To the approximation we treat the single elements of the Hankel function $J_n(x)$ and $Y_n(x)$. On presence of the following conditions: $t \gg 0$, $\mathrm{Re}(x) \gg 0$, $\mathrm{Re}(n) > -1/2$ according 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:

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

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

For $\omega_0$ we can write

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

For $\varphi_0$ applies then (approximation):

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

Except for one factor and a different phase-angle we get an expression equal to the harmonic solution (107) then. The phase-correction $-\pi/4$ can be omitted with greater arguments. The Hankel function even can be described by an exponential function in the phase (229). Deeper examinations show equation (123) to be very exact (Figure 13 and 14). In [23] an additional approximation is presented:

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

But that one proves to be essentially more inaccurate than (121) and is no longer followed up therefore. Also significant is the effective value. But it is defined across one period minimum. Within the first period ($t<2\tau_1$) and to the calculation of PLANCK's quantum of action it would be opportune to operate with the exact envelope function divided by $\sqrt{2}$ (addition theorem of Bessel functions → modulus of the Hankel function). It applies 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 greater values of t:

$$\varphi_0 = \hat{\varphi}_i \sqrt{J_0^2(2\omega_0 t) + Y_0^2(2\omega_0 t)} \qquad \text{Envelope curve} \tag{127}$$

Indeed, it starts in the infinity. Then, $\hat{\varphi}_i$ is defined to the point of time the envelope curve takes on the value 1. But function (127) does not match correctly with smaller arguments.

The reason is the root in the argument of the Hankel function. Therefore, we make use of the radical expression from (121), which is essentially more correct. Thus, the envelope curve and the effective value are defined as follows:

$$\hat{\varphi}_0 = \sqrt{\frac{2}{\pi}}\,\frac{\hat{\varphi}_i}{\sqrt{2\omega_0 t}} \qquad \text{Envelope curve} \qquad (128)$$

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

The exact course of $\varphi_0$ (125), as well as of the approximate function of the envelope curve (128) and of the effective value (129) is shown in Figure 13. Also depicted are the original Bessel functions, which you can't see however, because they are completely covered by the approximation.

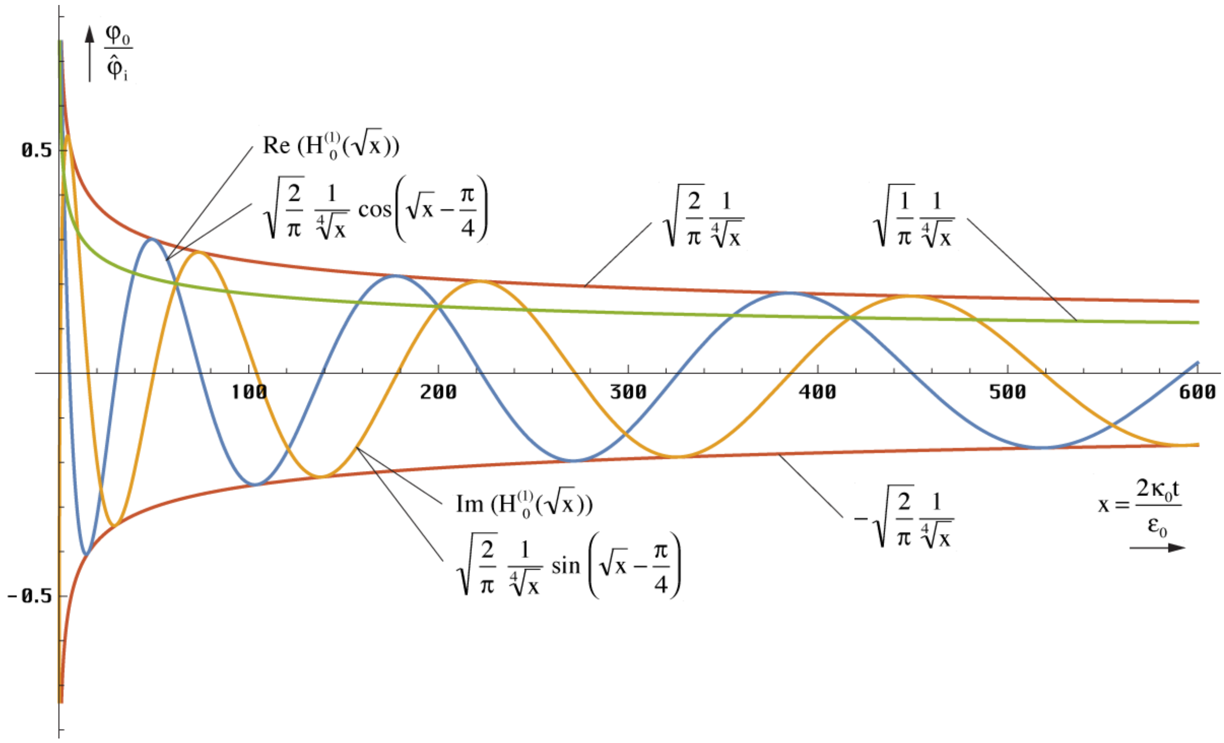



Figure 13
Course of magnetic flux as well as of approximation- and envelope-functions across a greater time period

Thus, with greater arguments, no differences are statable, neither in the amplitude, nor in the phase. Most important for the quality of the approximation is the course in the striking distance of t=0. The exact course of $\varphi_0$ as well as of the envelope functions (128) and (129) for small and very small values of t is shown in Figure 14. The course of $q_0$, the 1st derivative (123), has been omitted. The envelope functions likewise applies to $\varphi_0$ and $q_0$ and they are important to the determination of the effective values and of $\hbar$.

In contrast to the normal Bessel function, which starts similarly to the Cosine function, the temporal function of the magnetic flux within the first part of the first period has rather a course like an RC-circuit of 1st order. The charge $q_0$ starts similar to the function $-\sin x$. With increasing phase-angle/Q-factor $Q_0=2\omega_0 t$ both transition to a nearly harmonic function, at which point the frequency decreases proportional $t^{-1/2}$.

As we can see, the approximation can be used down to $Q_0=1$, that's the particle horizon. The maximum error at that point amounts to +1.44% in the real part and 8.17% with the imaginary part. But you can't get that close to the particle horizon and the beyond remains totally locked. That's the realm of astronomers, physicists, astro-physicists and cosmologists, on paper and in the lab. If you want to know more about the range $Q_0$<1 you are forced to make use of the exact expressions.

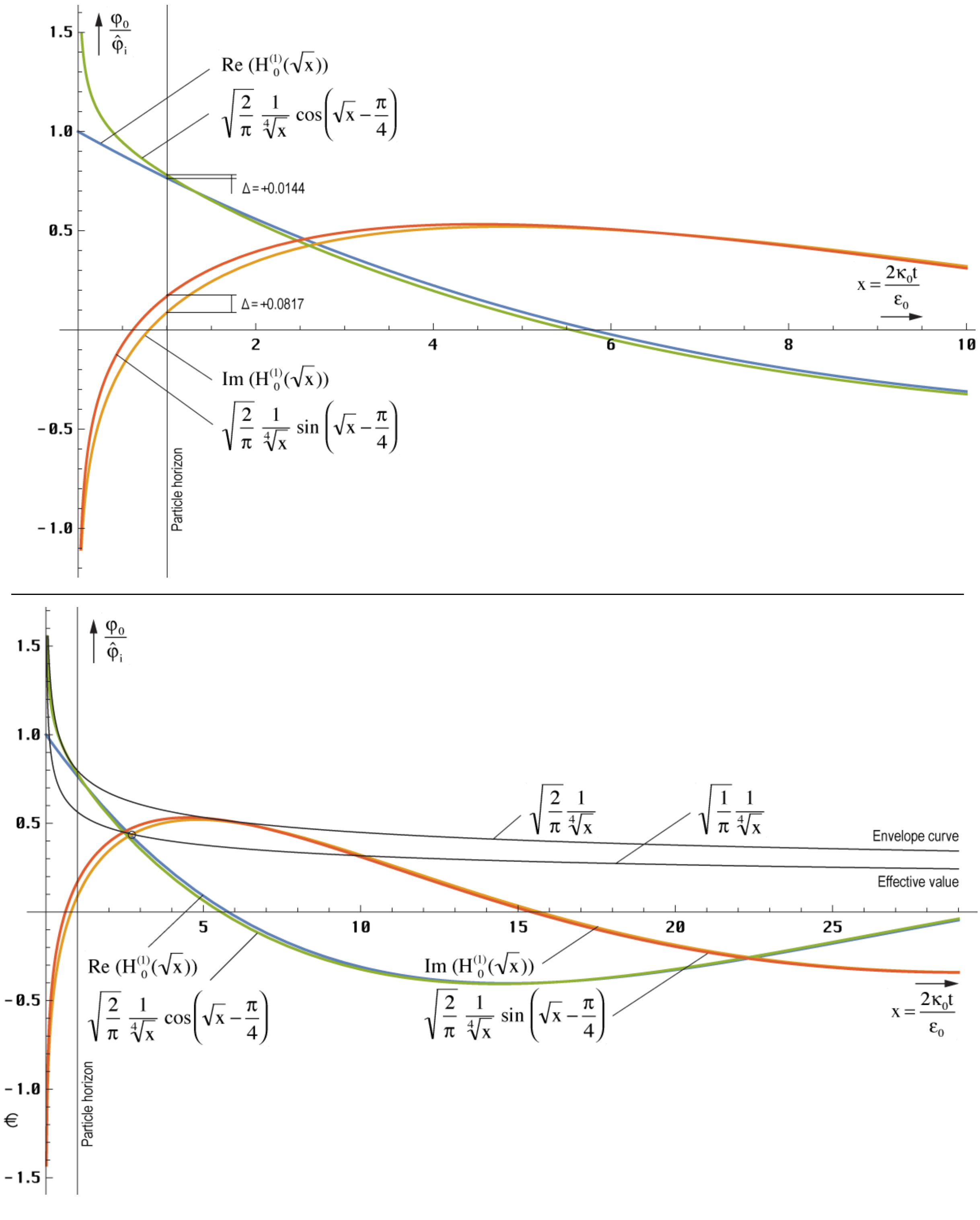



Figure 14
Course of flux as well as of the approximate- and envelope-functions nearby the singularity

## 4.3. Laplace-transform

### 4.3.1. Time domain

How does the solution-behaviour 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):

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

$$y''x + y' + ay = 0 \qquad (131)$$

According to the differentiation-rule [22] applies:

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

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

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

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:

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

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

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

Substitution in (131) results in:

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

$$y(p) = e^{\int\frac{a-p}{p^2}dp} = \frac{C_1}{p}e^{-\frac{a}{p}} = \frac{a}{p}e^{-\frac{a}{p}+C} = \frac{1}{2pt_1}e^{-\frac{1}{2pt_1}+C} \qquad (140)$$

This solution has been specified wrong until now. Unfortunately, I could realize the error but now, since the function is not listed in any correspondence table and the inverse transformation proved to be difficult. The function InverseLaplaceTransform[$\varphi_1$ E^(–(a/p))/p , p, t] really turns out expression (103) now. That also takes effect to the following calculations.

$C_1$ is in the form of a time-constant. The source-function is a differential equation of second order with a time-constant: $\tau_1 = 1/(2a) = \varepsilon_0/\kappa_0 = 1/\omega_1 = 2t_1$. It appears twice and with it, we does not come into the embarrassment, to examine which time-constant to be substitute at which position. The value arising from $H_0$ [49] has a magnitude of $6.46396 \cdot 10^{-105}$ s. In the figure domain with C=−1 applies for the magnetic flux then:

$$\varphi_0(p) = \frac{\hat{\varphi}_i}{p\tau_1} e^{-\frac{1}{p\tau_1}+C} \tag{141}$$

For signals with a duration of $t \gg \tau_1$ it's about an ideal I-gate (Integrating circuit) with a kind of inverse T-gate (Dead time circuit). It would be interesting too in that sense, to find the type of function, the model was activated with at the point of time t=0. 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:

$$\varphi_0 = \hat{\varphi}_i \, \sigma(t) * J_0\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \tag{142}$$

At the beginning, there was the »NOTHING« with the physical qualities $\mu_0$, $\varepsilon_0$ and $\kappa_0$. 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 (overshoot with a mean 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 nature, only in form of an approximation as needle-impulse. This way, another mathematical function would have found its exact correspondence in reality. 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):

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

Btw. the figure-function of the simplest I-gate, the generic RC-low-pass-filter, reads $G(p)=K/(1+p\tau_1)$. The course of the transfer-function for the magnetic flux and of the charge $q_0$ (first derivative) is depicted in Figure 15, at first by setting C=0, since it has only an influence on the scale of the y-axis. Both functions point out a null at p=+0, a pole at p=−0 and a maximum at the point of time $\tau_1$ resp. $\tau_1/2$. For longer impulses, the function changes into the one of an ideal I-gate. The contradiction in the earlier editions (D-gate, high pass) rather should have pointed out the error in (140) to me.

The PN-diagram doesn't need to be figured separately, null at p=+0, pole at p=−0. The number of poles is equal to the number of the nulls (realizability-condition). There are no pole in the left half-plane p<0 (stability-condition). Since the pole is located at the point 0, the system is loss-free anyway but still a „passive component". That state is also named marginally stable.

With pole in the left half-plane, the system could come into an oscillation by itself. With pole 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 oscillation whether hasn't yet faded away even today nor probably in the future. The null in the origin (+0) points to a blocking of higher frequencies.

Physically speaking it's about a low pass. Since the null is in the right half-plane ($p \geq 0$), it's just 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 pole available, even no resonance-effects appear.

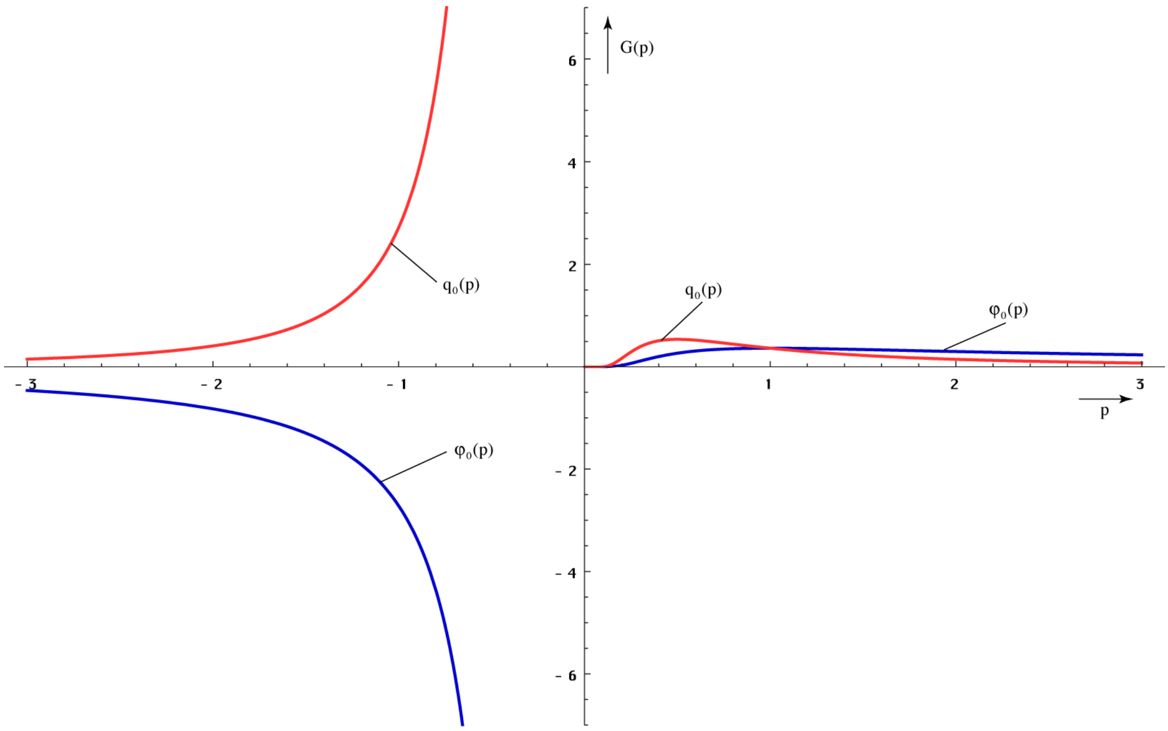



Figure 15
Transfer-functions (figure domain)
for magnetic flux and charge (C=0)

From the figure-function we have read that it deals with a low pass of 2nd order. In general, such a system has a frequency-dependent attenuation. However, this stands in contradiction to the observations, resulting in a constant frequency response across all (technically observable) frequencies.

To the calculation of the complex frequency response of our model we start with equation (143), in that we replace: $p = \sigma + j\omega$. A substitution $p = j\omega$ doesn't emerge any useful result, since the system is still oscillating so that the associated Fourier integral doesn't converge at all. The convergence is forced by the term $\sigma$. The frequency response of the magnetic flux gives also information about the vacuum wave propagation, since the separate dipoles (MLE) are interconnected via the magnetic field (resonant coupling). The value of $\sigma$ arises from the half inverse of the right-hand time constant of (77). The free parameter can be determined to $C = 1$ with the help of the initial condition $G(j0) = 1$.

With $\sigma = \frac{1}{\tau_1} = \frac{1}{2t_1} = \frac{\kappa_0}{\varepsilon_0} = \omega_1$ as well as $\Omega = \frac{\omega}{\omega_1}$ and $\theta = \frac{\Omega}{1+\Omega^2}$ applies:

$$G(\sigma + j\omega) = \frac{1}{(\sigma + j\omega)\tau_1} e^{1 - \frac{1}{(\sigma + j\omega)\tau_1}} \tag{144}$$

$$G(j\omega) = \frac{\omega_1}{\omega_1 + j\omega} e^{1 - \frac{\omega_1}{\omega_1 + j\omega}} = \frac{1}{1 + j\Omega} e^{\frac{j\Omega}{1 + j\Omega}} = \frac{1 - j\Omega}{1 + \Omega^2} e^{\frac{j\Omega(1 - j\Omega)}{1 + \Omega^2}} \tag{145}$$

That yields the following expression (complex frequency response):

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

The locus curve of frequency response in comparison with the one of a generic low pass is shown in Figure 16. Since both don’t cut the y-axis, there is no aperiodic borderline case in this system.

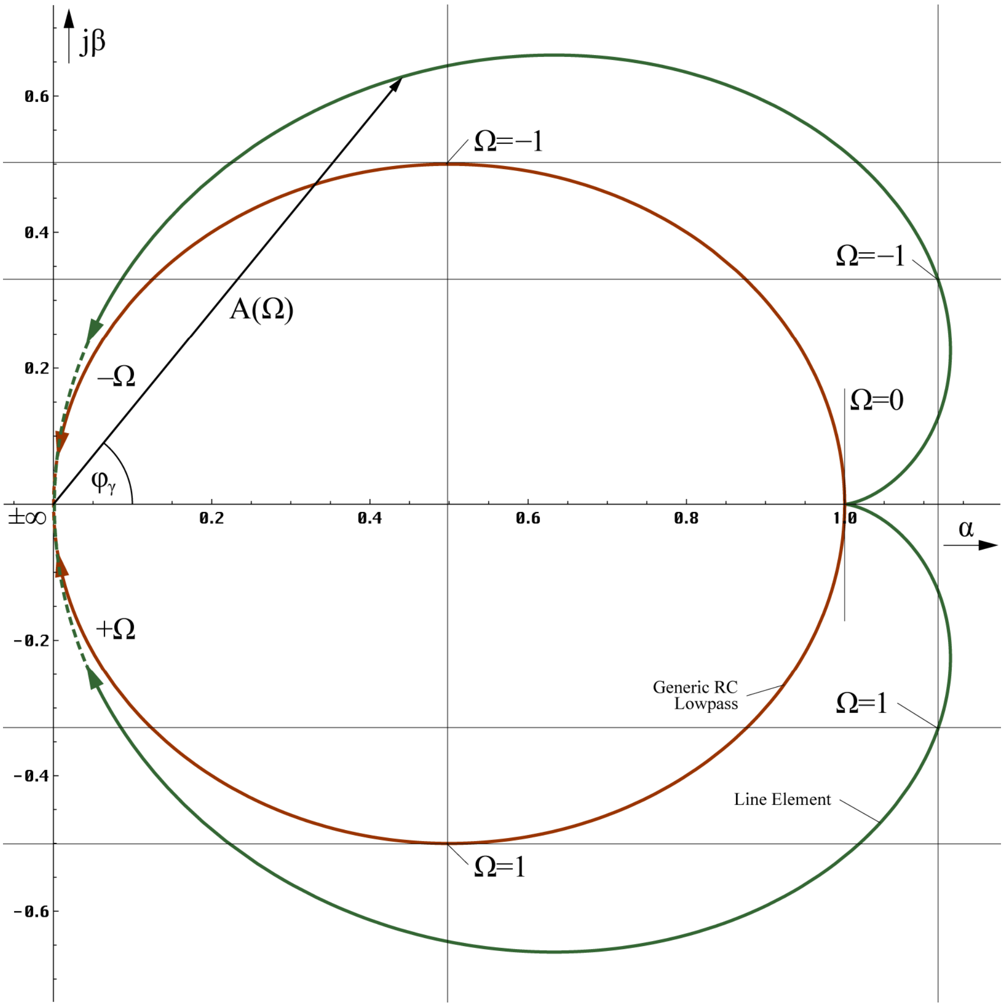



Figure 16
Frequency response locus curve

For frequency and phase response we get further

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

$$B(\omega) \;=\; \arctan\frac{\sin\theta-\Omega\cos\theta}{\cos\theta+\Omega\sin\theta} \;=\; -\arctan\Omega+\frac{\Omega}{1+\Omega^2} \;=\; \varphi_\gamma \tag{148}$$

We have got the right-hand expression of (148) by means of subtle application of the corresponding addition theorems and substitution. In this connection $-\arctan\Omega$ relates to the I-share, $\theta$ to the inverse T-share. Both functions (BODE-diagram) are depicted in Figure 17. The damping course (–6 dB/decade) points to 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 size of the mutual coupling factor of the separate MLE’s. Interestingly enough, because of $\cos\varphi=\cos(-\varphi)$, this value is not affected by the miscalculation.

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

Then equation (146) also can be written in the following manner:

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

Figure 17, the BODE-diagram shows frequency- and phase-response up to $\omega_1/10$, after expansion up to $\omega_0/10$, that's at least $1.855\cdot 10^{42}s^{-1}$ resp. $2.952\cdot 10^{41}$Hz, to be equal to 1 (0dB) constantly, exactly as observed. Technically speaking we are light-years away from the upper limit. There is also a lower cut-off frequency given by the requirement, that the wave length $\lambda_{min}=2cT$ must fit the universe's extension. The value $\omega_{min}$ is equal to the HUBBLE-parameter $H_0$, as can easily be proved.

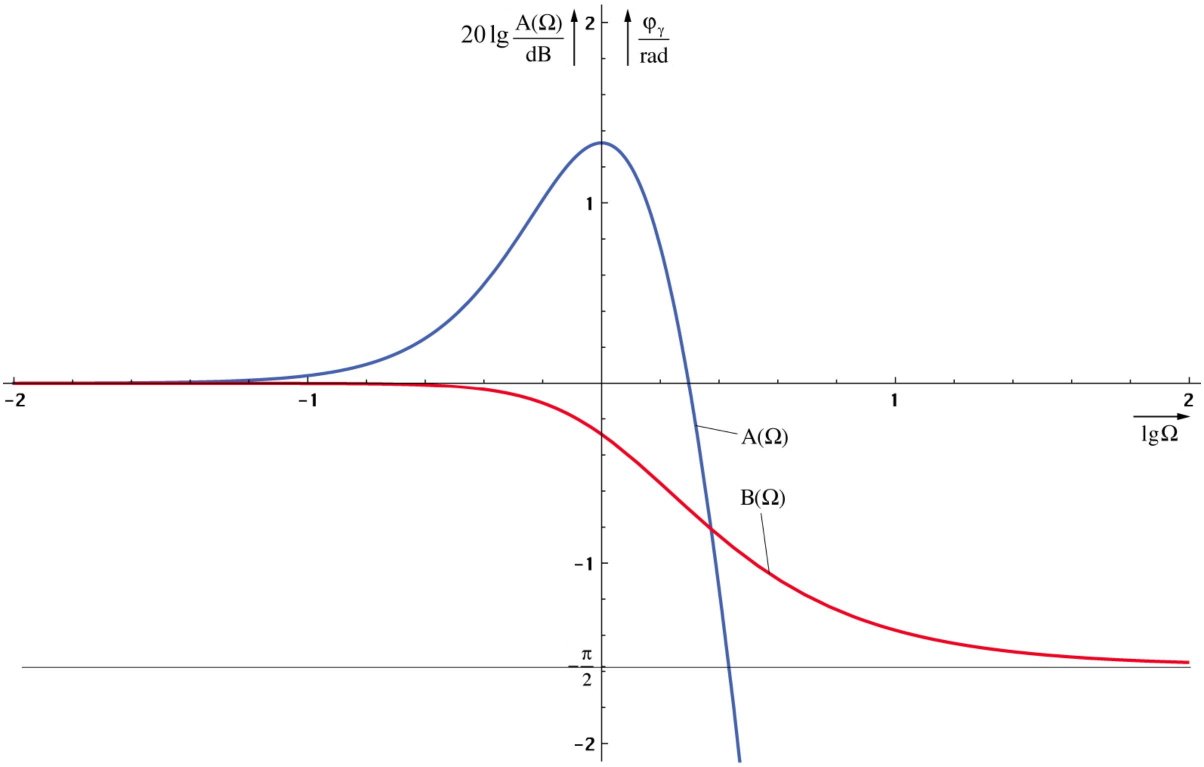



Figure 17
BODE-diagram: Frequency response $A(\omega)$
and phase response $B(\omega)$ of the system

The course of $\cos\varphi_\gamma$ is shown in Figure 18. Furthermore the course of the second term in $\varphi_\gamma$ is depicted. You can see that it only takes effect from frequencies near $\omega_1$ onwards.

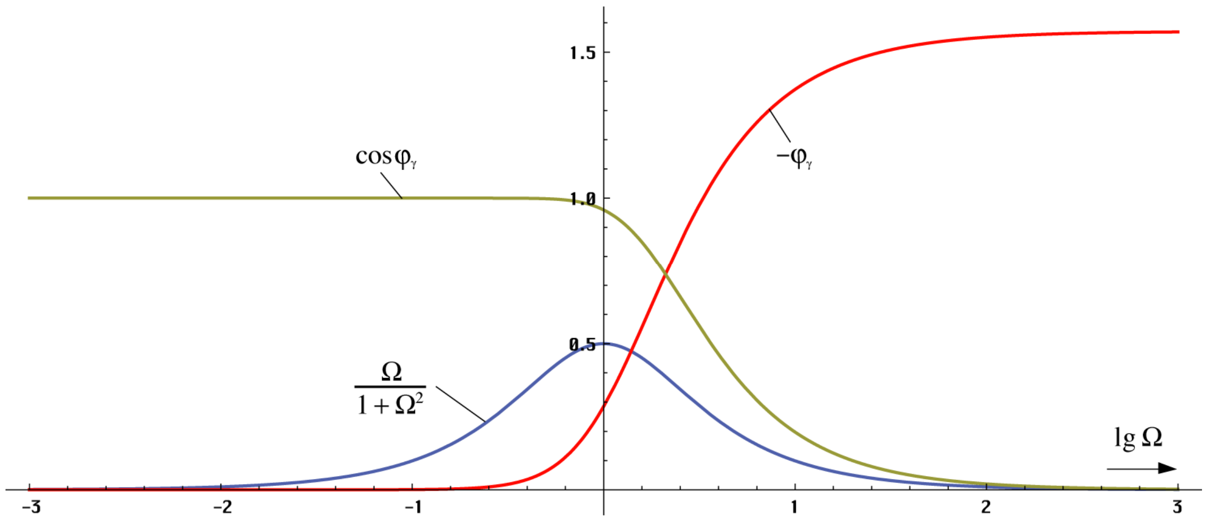



Figure 18
Course of phase angle,
$\cos\varphi$ and of the expression $\theta$

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

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

For the group delay we get:

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

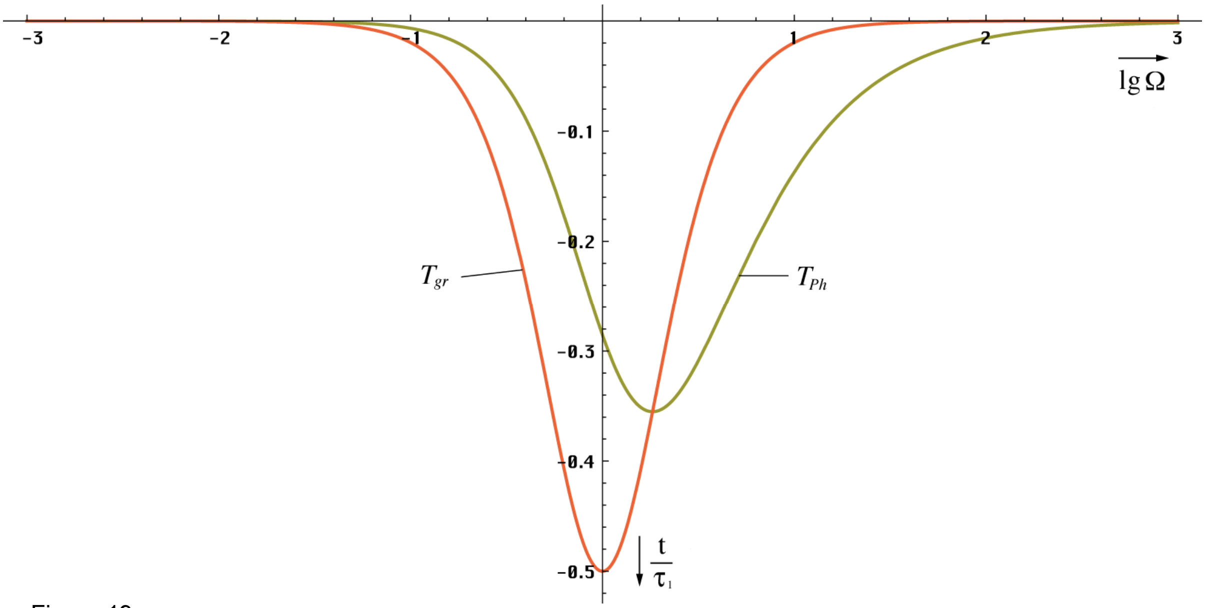



Figure 19
Group- and phase delay

It are the same functions as with the wrong solution, but just negative. Are negative delay times physically possible? The answer is – Yes. That comes about very frequently in technology and is not a breach of causality. See [50] for details.

### 4.3.3. Properties of the model

The following statements are applied to one single MLE only. More exact statements for wave-propagation as such are worked out later. You can see here quite clearly that frequency- and phase-response proceed approximately exact straight-line (0 dB) until one third of the frequency $\omega_1$ and that phase-true. A noticeable attenuation and phase-shift does not occur until approximate one tenth of $\omega_1$. Since the amount of $\omega_1$ is so extremely high (the supreme measured frequency, cosmic radiation is about $10^{42}$Hz), this effect does not have been observed so far however.

The amplitude ascends around $\omega_1$, only to descend again irrevocably (Figure 17). There actually turns out a slight high-pass-behaviour within a low-pass. However, since the value $\cos\varphi_\gamma$ strongly declines above $\omega_1/2$ (Figure 18), and with it the mutual coupling coefficient of the MLEs, both influences cancel each other, a mere hillock remains (Figure 20).

The frequency response across two MLE's with the coupling coefficient $k=\cos\varphi_\gamma$ is shown in Figure 20. The damping course (–12dB/decade) points to the fact, that it's about a group-delay-corrected low pass of 2nd order. 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].

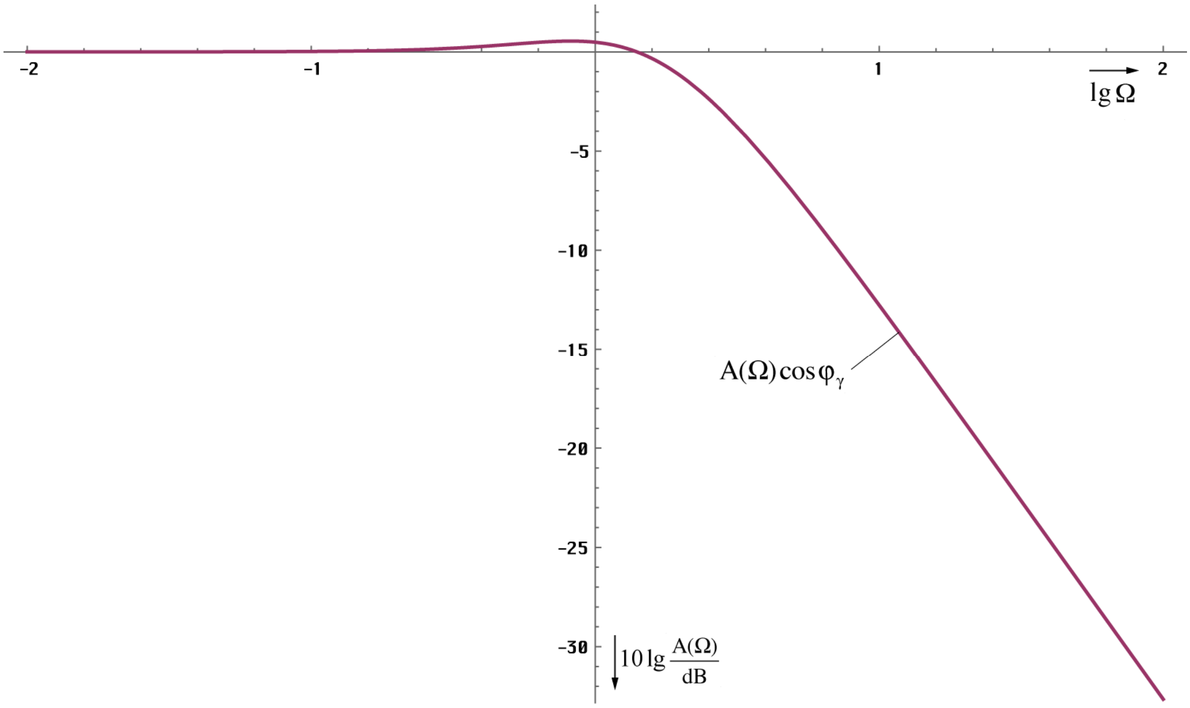



Figure 20
Frequency response for the transfer to the adjacent MLE

In reference to the sampling-theorem we expect, that only frequencies below $\omega_0/2$ are transferred. Strictly speaking, the previous statements apply to the universal wave-field only 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. But only the sum- and difference-frequency $\omega_0 \pm \omega$ are important. With the other frequencies, no power-conversion is achieved (property of a non-linear circuit). But for the cut-off frequency of overlaid signals only the sum frequency is relevant. Since overlaid signals are being more red-shifted than the universal wave-field, the „relative cut-off frequency", i.e. the spacing between the overlaid frequency $\omega$ and the cut-off frequency $\omega_0/2$, ascends continuously with rising age.

The course of group delay shows that the „processing" of changes in 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 $t_V$ we get the following expression then: $t_V=\pi/(2\omega_0)=\pi r_0/(2c)$. For the transfer rate of $\underline{c}$ (the half circumference 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 $\pi r_0/2$), we receive an amount of:

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

With it, the vacuum-wave-propagation-velocity directly arises from the phase-shift $\pi/2$, which comes about with magnetic resonance-coupling of two oscillatory circuits. This effect even can be observed in technology with discrete components, which is figured in [26] extensively. With frequencies near $\omega_1$, the phase delay $T_{Ph}$, multiplied with $2\pi$, has to be added to $t_v$. However, an accurate formula for $\underline{c}$ for this case (critical photons) cannot be stated at this point, because we consider the single MLE only. We will work out an exact expression for the wave-propagation-velocity in section 4.3.4.4.5. being valid near t=0 as well.

Further we can say, that the propagation-velocity c decreases the more approaching to $\omega_1$. However, this value exactly corresponds exactly to that value, at which the track-curve (Figure 8) is no longer defined. A phase-transition occurs, the rotation ends. There is only the straight-line-expansion then.

With it the phase-shift to the adjacent MLE also adds up and achieves a value of $\pi$, a destructive interference appears, a wave-propagation isn't possible at all (coupling-factor $k=\cos(\pi/2)=0$). Furthermore, $\underline{c}$ and even the wave impedance $\underline{Z}$ 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 $\omega_0$, $R_0$ only determines the behaviour of the system then (electric conductor). However this is not applied to the wave-field as such. Reverse behaviour 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 behaviour 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 $\omega_1$ 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 $\rho=0$ (space-charge-density) as well as $\kappa=0$. To the reminiscence here the MAXWELL equations once again:

$$\begin{aligned} &\operatorname{div}\ \mathbf{B} = 0 && \operatorname{div}\ \mathbf{D} = \rho \\ &\operatorname{curl}\ \mathbf{E} = -\dot{\mathbf{B}} && \operatorname{curl}\ \mathbf{H} = \mathbf{i} + \dot{\mathbf{D}} \end{aligned} \tag{154}$$

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):

$$\begin{aligned} &\operatorname{div}\mathbf{H} = 0 && \operatorname{div}\mathbf{E} = 0 \\ &\operatorname{curl}\mathbf{E} = -\mu\dot{\mathbf{H}} && \operatorname{curl}\mathbf{H} = \varepsilon\dot{\mathbf{E}} \\ &\operatorname{curl}\mathbf{E} = -\mu\frac{\partial\mathbf{H}}{\partial t} && \operatorname{curl}\mathbf{H} = \varepsilon\frac{\partial\mathbf{E}}{\partial t} \end{aligned} \tag{156}$$

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

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

Still formal-mathematically applies and due to div $\mathbf{E} = 0$, ($\Delta$ is the LAPLACE-operator):

$$\text{curl curl } \mathbf{E} = \text{grad div } \mathbf{E} - \Delta\mathbf{E} = -\Delta\mathbf{E} \tag{158}$$

Analogously applies for **H:**

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

Just as because of div $\mathbf{H} = 0$:

$$\text{curl curl } \mathbf{H} = \text{grad div } \mathbf{H} - \Delta\mathbf{H} = -\Delta\mathbf{H} \tag{160}$$

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

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

The Laplace-operator $\Delta$ 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:

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

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 $\underline{Z}_F = \mu_0\underline{c}$:

$$\underline{c} = \frac{dx}{dt} = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = c \qquad \underline{Z}_F = \sqrt{\frac{\mu_0}{\varepsilon_0}} = Z_0 \tag{163}$$

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-behaviour 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:

$$\underline{\gamma} = \alpha + j\beta = \pm j\omega/\underline{c} = \pm j\omega\sqrt{\mu_0\varepsilon_0} \tag{164}$$

In this connection is $\alpha$ the attenuation rate ($\alpha$=0) and $\beta$ 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 $\underline{\mathbf{H}}$):

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

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) $\rho$=0 applies as well as $\kappa$>0. **E** and **H** are understood as complex time-functions (underlined). Equation (156) is then:

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

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

$$\underline{\mathbf{E}} = \mathbf{E}\,e^{j\omega_0 t} \qquad \underline{\mathbf{H}} = \mathbf{H}\,e^{j\omega_0 t} \tag{167}$$

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:

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

We apply the rotation-operation to both sides again:

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

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

Furthermore applies:

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

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

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 for the field-wave impedance $\underline{Z}_F$:

$$\underline{c} = \sqrt{\frac{j\omega}{\mu_0(\kappa + j\omega\varepsilon_0)}} \qquad \underline{Z}_F = \sqrt{\frac{j\omega\mu_0}{\kappa + j\omega\varepsilon_0}} \tag{176}$$

Or resolved for real and imaginary part:

$$\underline{c} = \frac{c}{\sqrt{2}}\left(\sqrt{\sqrt{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}+1} + j\sqrt{\sqrt{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}-1}\right)\frac{1}{\sqrt{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}} \tag{177}$$

$$\underline{c} = \frac{c}{\sqrt[4]{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}}\left(\cos\frac{1}{2}\arctan\frac{\kappa}{\omega\varepsilon_0} + j\sin\frac{1}{2}\arctan\frac{\kappa}{\omega\varepsilon_0}\right) \qquad \text{as well as} \tag{178}$$

$$\underline{c} = \frac{c}{\sqrt{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}}\left(\cosh\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0} + j\sinh\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0}\right) \tag{179}$$

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

$$\alpha = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}-1\right)} = \frac{\omega}{c}\sinh\left(\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0}\right) \tag{180}$$

$$\alpha = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\frac{\kappa_0^2}{\omega^2\varepsilon_0^2}}+1\right)} = \frac{\omega}{c}\cosh\left(\frac{1}{2}\operatorname{arsinh}\frac{\kappa}{\omega\varepsilon_0}\right) \tag{181}$$

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 (POYNTING-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 zero space-charge-density. 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

In contrast to MAXWELL, which used the first term of the harmonic solution (108) $e^{j\omega t}$ as ansatz, we now choose the first term of expression (119), obtained as an independent solution of the differential equation (78). It's about the temporal function of the magnetic flux $\varphi_0$ there, relating to one single MLE, from which the charge $q_0$ can be derived. For the propagation function however we need the magnetic and electric field strength **H** and **E**. The relation:

$$\varphi = \int_A \mathbf{B}\,dA \qquad \text{with } \mathbf{B} = \mu_0\mathbf{H} \qquad \text{leads to} \qquad |\mathbf{H}| = \frac{\hat{\varphi}_0}{\mu_0 r_0^2} \tag{182}$$

Because of $r_0$ indeed the right-hand expression depends on the frame of reference. Moreover we are rather looking for the starting value at $T = 0$. The temporal function is just known.

Hence, we must carry out a reference-frame-independent coupling only. The coupling-length $r_k$ is not arbitrary in this case. Because the imaginary part of the Hankel function is coming from infinity, the starting value $\varphi_0$ is defined at the point $2\omega_0 t = Q_0 = 1$. The coupling-length at this point is $r_1$ as already predicted more above. This value is denominated as $\mathbf{H_1}$ resp. $\mathbf{E_1}$. With respect to the fact, that (129) is an effective value, we obtain the following relations:

$$\mathbf{E_1} = \frac{q_1}{\varepsilon_0 r_1^2}\sqrt{2} = \frac{1}{Z_0}\frac{\varphi_0}{\varepsilon_0 r_0^2}\sqrt{2} \qquad \mathbf{H_1} = \frac{\varphi_0}{\mu_0 r_0^2}\sqrt{2} \tag{183}$$

$$\underline{\underline{\mathbf{E}}} = \mathbf{E_1}\, H_0^{(1)}(2\omega_0 t) \qquad \underline{\underline{\mathbf{H}}} = \mathbf{H_1}\, H_0^{(1)}(2\omega_0 t) \tag{184}$$

Here again, the real part of the vector corresponds to an orientation in y-, the imaginary one in z-direction, x is the propagation direction. As already stated, there is an analogy between the exponential function $e^{j2\omega t}$ and the Hankel function. Both are transcendent complex functions and periodic respectively almost periodic. **E** and **H** are understood as complex time-functions again (underlined). We start with the same values as in the previous case: $\rho = 0$ as well as $\kappa_0 > 0$. 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:

$$\operatorname{curl}\underline{\underline{\mathbf{E}}} = -\mu_0 \frac{\partial \underline{\underline{\mathbf{H}}}}{\partial t} \qquad \operatorname{curl}\underline{\underline{\mathbf{H}}} = \left(\kappa_0 + \varepsilon_0 \frac{\partial}{\partial t}\right)\underline{\underline{\mathbf{E}}} \tag{185}$$

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 $\varphi$ is defined at the point $2\omega_0 t = Q_0 = 1$. The coupling-length at this point is $r_1$.

$$\underline{\underline{\mathbf{E}}} = \mathbf{E}\, H_0^{(1)}(2\omega_0 t) \qquad \underline{\underline{\mathbf{H}}} = \mathbf{H}\, H_0^{(1)}(2\omega_0 t) \tag{186}$$

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 $e^{j2\omega_0 t}$ 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 $\omega_0$ is time-dependent in this case. Therefore we will first work with the correct time-functions:

$$\underline{\underline{\mathbf{E}}} = \mathbf{E}\, H_0^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad \underline{\underline{\mathbf{H}}} = \mathbf{H}\, H_0^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{187}$$

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

$$\frac{\partial \underline{\underline{\mathbf{E}}}}{\partial t} = -\frac{2\kappa_0}{2\varepsilon_0}\sqrt{\frac{\varepsilon_0}{2\kappa_0 t}}\,\mathbf{E}\, H_1^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} = -\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\,\mathbf{E}\, H_1^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{188}$$

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

$$\frac{\partial \underline{\underline{\mathbf{E}}}}{\partial t} = -\omega_0\, \mathbf{E}\, H_1^{(1)}(2\omega_0 t) = -\omega_0^2 t\, \mathbf{E}\, (H_0^{(1)}(2\omega_0 t) + H_2^{(1)}(2\omega_0 t)) \tag{189}$$

$$\frac{\partial \underline{\underline{\mathbf{H}}}}{\partial t} = -\omega_0\, \mathbf{H}\, H_1^{(1)}(2\omega_0 t) = -\omega_0^2 t\, \mathbf{H}\, (H_0^{(1)}(2\omega_0 t) + H_2^{(1)}(2\omega_0 t)) \tag{190}$$

As next, we de-parenthesize the expression for the Hankel function of zero order so we can write, because of (186), for the first derivative as expression of the original-function:

$$\frac{\partial \underline{\mathbf{E}}}{\partial t} = -\omega_0^2 t \left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right) \underline{\mathbf{E}} \qquad \frac{\partial \underline{\mathbf{H}}}{\partial t} = -\omega_0^2 t \left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right) \underline{\mathbf{H}} \tag{191}$$

We require the second derivatives as well. These we determine to the best, in that we differentiate the right expression of (188) once again (analogously for $\underline{\mathbf{H}}$):

$$\frac{\partial^2 \underline{\mathbf{E}}}{\partial t^2} = -\frac{\partial}{\partial t}\left(\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\; H_1^{(1)}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right)\mathbf{E} = -(\dot{u}v+u\dot{v})\mathbf{E} \tag{192}$$

For u and v, we get following expressions:

$$u = \omega_0 \qquad \dot{u} = -\frac{\omega_0}{2t} \tag{193}$$

$$v = H_1^{(1)}(2\omega_0 t) = \omega_0 t\left(H_0^{(1)}(2\omega_0 t)+H_2^{(1)}(2\omega_0 t)\right) \tag{194}$$

$$\dot{v} = \omega_0 H_2^{(1)}(2\omega_0 t)-\frac{1}{2t}H_1^{(1)}(2\omega_0 t) = -\frac{\omega_0}{2}\left(H_0^{(1)}(2\omega_0 t)-H_2^{(1)}(2\omega_0 t)\right) \tag{195}$$

Replacement of the second expression of(192) results in:

$$\frac{\partial^2 \underline{\mathbf{E}}}{\partial t^2} = \omega_0^2\, H_0^{(1)}(2\omega_0 t)\,\mathbf{E} = \omega_0^2\,\underline{\mathbf{E}} \tag{196}$$

$$\frac{\partial^2 \underline{\mathbf{H}}}{\partial t^2} = \omega_0^2\, H_0^{(1)}(2\omega_0 t)\,\mathbf{H} = \omega_0^2\,\underline{\mathbf{H}} \tag{197}$$

Now, we put (191) into (185) getting:

$$\operatorname{curl}\underline{\mathbf{H}} = \left(\kappa_0+\varepsilon_0\frac{\partial}{\partial t}\right)\underline{\mathbf{E}} = \left(\kappa_0-\varepsilon_0\omega_0^2 t\left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\right)\underline{\mathbf{E}} \tag{198}$$

Expression (198) even can be written more simple:

$$\operatorname{curl}\underline{\mathbf{H}} = \varepsilon_0\omega_0^2 t\left(\frac{\kappa_0}{\varepsilon_0\omega_0^2 t}-\left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\right)\underline{\mathbf{E}} \tag{199}$$

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

$$\operatorname{curl}\underline{\mathbf{H}} = \varepsilon_0\omega_0^2 t\left(1-\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{E}} \tag{201}$$

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

$$\operatorname{curl}\underline{\mathbf{E}} = \mu_0\omega_0^2 t\left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{H}} \tag{202}$$

We apply the rotation-operation to both sides again:

$$\operatorname{curl}\operatorname{curl}\underline{\mathbf{H}} = \operatorname{curl}\left(\varepsilon_0\omega_0^2 t\left(1-\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{E}}\right) = \varepsilon_0\omega_0^2 t\left(1-\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\operatorname{curl}\underline{\mathbf{E}} \tag{203}$$

$$\operatorname{curl}\operatorname{curl}\underline{\mathbf{H}} = \mu_0\varepsilon_0\omega_0^4 t^2\left(1-\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\left(1+\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)\underline{\mathbf{H}} = -\Delta\underline{\mathbf{H}} \tag{204}$$

$$\operatorname{curl}\operatorname{curl}\underline{\mathbf{H}} = \frac{\omega_0^2}{c^2}\omega_0^2 t^2\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\underline{\mathbf{H}} = -\Delta\underline{\mathbf{H}} \tag{205}$$

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

$$\Delta\underline{\mathbf{E}} = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\left(\omega_0^2\underline{\mathbf{E}}\right) = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\frac{\partial^2\underline{\mathbf{E}}}{\partial t^2} \tag{206}$$

$$\Delta\underline{\mathbf{H}} = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\left(\omega_0^2\underline{\mathbf{H}}\right) = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\frac{\partial^2\underline{\mathbf{H}}}{\partial t^2} \tag{207}$$

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 $\underline{\mathbf{H}}$):

$$\frac{\partial^2\underline{\mathbf{E}}}{\partial x^2} = -\frac{\omega_0^2 t^2}{c^2}\left(1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2\right)\frac{\partial^2\underline{\mathbf{E}}}{\partial t^2} \tag{208}$$

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

$$\underline{c} = \frac{c}{j\omega_0 t}\frac{1}{\sqrt{1-\left(\frac{H_2^{(1)}(2\omega_0 t)}{H_0^{(1)}(2\omega_0 t)}\right)^2}} \quad \text{with} \quad \Theta = \frac{H_2^{(1)}(Q_0)}{H_0^{(1)}(Q_0)} \quad Q_0 = 2\omega_0 t \tag{209}$$

$$\underline{c} = \frac{c}{j\omega_0 t}\frac{1}{\sqrt{1-\Theta^2}} \qquad \underline{Z}_F = \frac{Z_0}{j\omega_0 t}\frac{1}{\sqrt{1-\Theta^2}} \tag{210}$$

We see 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:

$$A = \frac{J_0(Q_0)J_2(Q_0)+Y_0(Q_0)Y_2(Q_0)}{J_0^2(Q_0)+Y_0^2(Q_0)} \qquad \rho_0 = \frac{1}{2}\sqrt[4]{(1-A^2+B^2)^2+(2AB)^2}\ ^{1}$$

$$B = \frac{J_2(Q_0)Y_0(Q_0)-J_0(Q_0)Y_2(Q_0)}{J_0^2(Q_0)+Y_0^2(Q_0)} \qquad \rho_0 = \frac{1}{2}\left|\sqrt{1-\Theta^2}\right| \qquad \theta = \frac{2AB}{1-A^2+B^2} \tag{211}$$

$$\frac{1}{\rho_0 Q_0} = \frac{c_M}{c} = \frac{1}{Q_0}\left|\frac{2}{\sqrt{1-\Theta^2}}\right|$$

```
RhoQ = 2/#/Abs[Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]] &
```

$$\phi_0 = \frac{1}{2}\arctan\theta = \arg\left[\frac{1}{\sqrt{1-\Theta^2}}\right]-\frac{\pi}{2} \tag{212}$$

```
PhiQ = Arg[1/Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]] -π/2 &
```

---

[1] Due to the inaccuracy of the modulus of the Hankel function for derivatives >0, the results of the AB-expressions of (211) slightly differ from the (212) ones which are more exact. Thus, the calculation of all values and graphics is switched over to (212) from this edition on.

The factor ½ arises from the $4^{th}$ root. Expression (209) may be split into a real- and an imaginary part (213). 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 to θ then. The bracketed expression converges to one with it. For $Q_0 \geq 5$ the approximation $\rho_0^2 Q_0^2 \approx Q_0$ applies with $\Delta \leq 1\%$.

$$\underline{c} = \frac{c}{\rho_0 Q_0}\left(\cos\frac{1}{2}\arctan\theta + j\sin\frac{1}{2}\arctan\theta\right) = \frac{c}{\rho_0 Q_0} e^{j\frac{1}{2}\arctan\theta} = \frac{c}{\rho_0 Q_0} e^{j\phi_0} \qquad (213)$$

Unfortunately (213) 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. Thus we should better calculate with the following substitution:

$$\arctan\theta = \arg\left(\left(1 - A^2 + B^2\right) + j2AB\right) \qquad \arg\underline{c} = \frac{1}{2}\operatorname{arccot}\theta - \frac{\pi}{4} \qquad (214)$$

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 (209) 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.

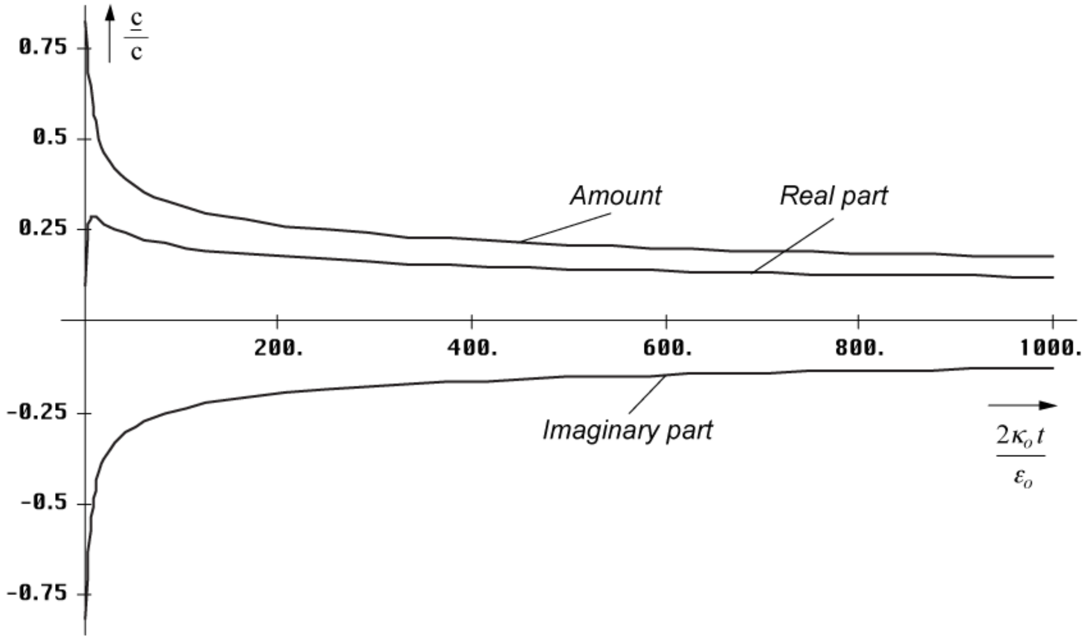



Figure 21
Propagation-velocity
in dependence on time (linear time-scale)

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.

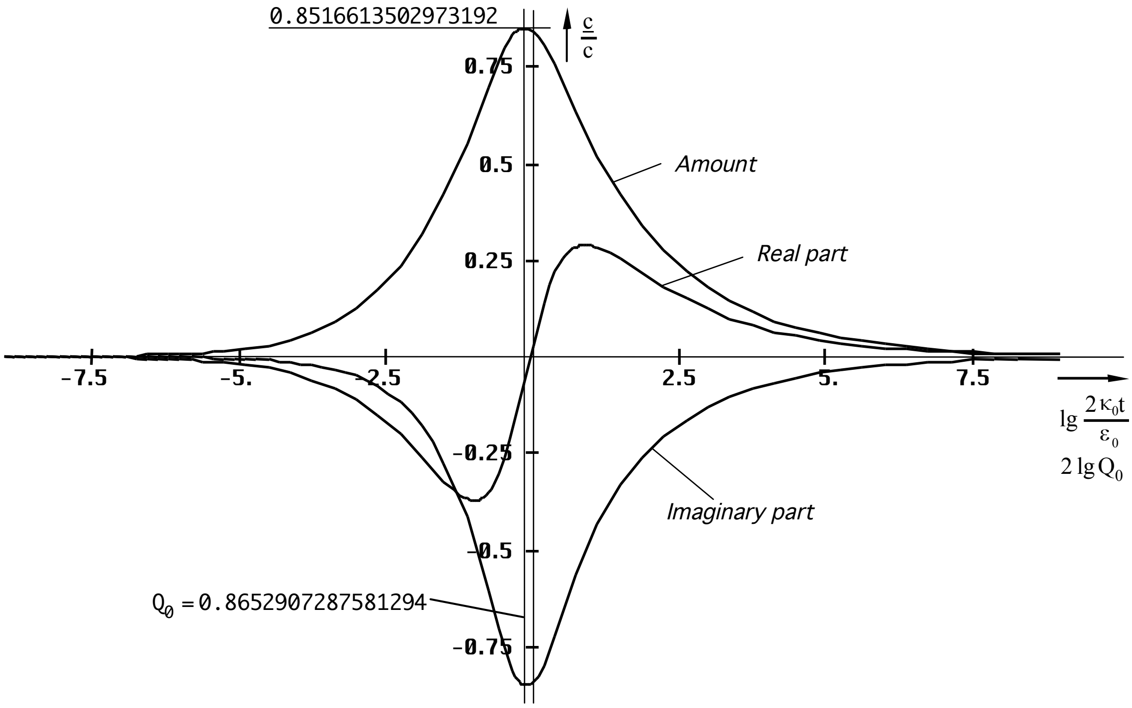



Figure 22
Propagation-velocity
in dependence on time (logarithmic time-scale)

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), (215) once again and at our primary function (186) too.

$$\underline{\mathbf{E}} = \mathbf{E}\,e^{j\omega(t-\frac{x}{\underline{c}})} = \mathbf{E}\,e^{j\omega t-\underline{\gamma}x} = \mathbf{E}\,e^{j(\omega t+j\underline{\gamma}x)} \qquad (215)$$

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 $Z_0^{(2)} = I_0(z) - jK_0(z)$ being the equivalent of the exponential-function. It is valid for $I_0(z)=J_0(jz)$ 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 $\underline{\mathbf{H}}$):

$$\underline{\mathbf{E}} = \mathbf{E}\;H_0^{(1)}\left(2\omega_0\left(t-\frac{x}{\underline{c}}\right)\right) = \mathbf{E}\;H_0^{(1)}(2\omega_0 t - j\underline{\gamma}x) \qquad (216)$$

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 (216) one gets then:

$$\underline{\gamma} = -\frac{2\omega_0}{\underline{c}} \qquad = \qquad j\kappa_0 Z_0 \sqrt{1-\Theta^2} \tag{217}$$

From (213) the reciprocal of $\underline{c}$ can be determined very easily. Due to (164) we get for $\underline{\gamma}$:

$$\frac{1}{\underline{c}} = -\frac{\omega_0 t \rho_0}{c}\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{218}$$

$$\underline{\gamma} = \alpha + j\beta = -\frac{2\omega_0}{\underline{c}} = \frac{2\omega_0^2 t \rho_0}{c}\left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{219}$$

$$\underline{\gamma} = \rho_0 \kappa_0 Z_0 \left(\cos\frac{1}{2}\arctan\theta - j\sin\frac{1}{2}\arctan\theta\right) \tag{220}$$

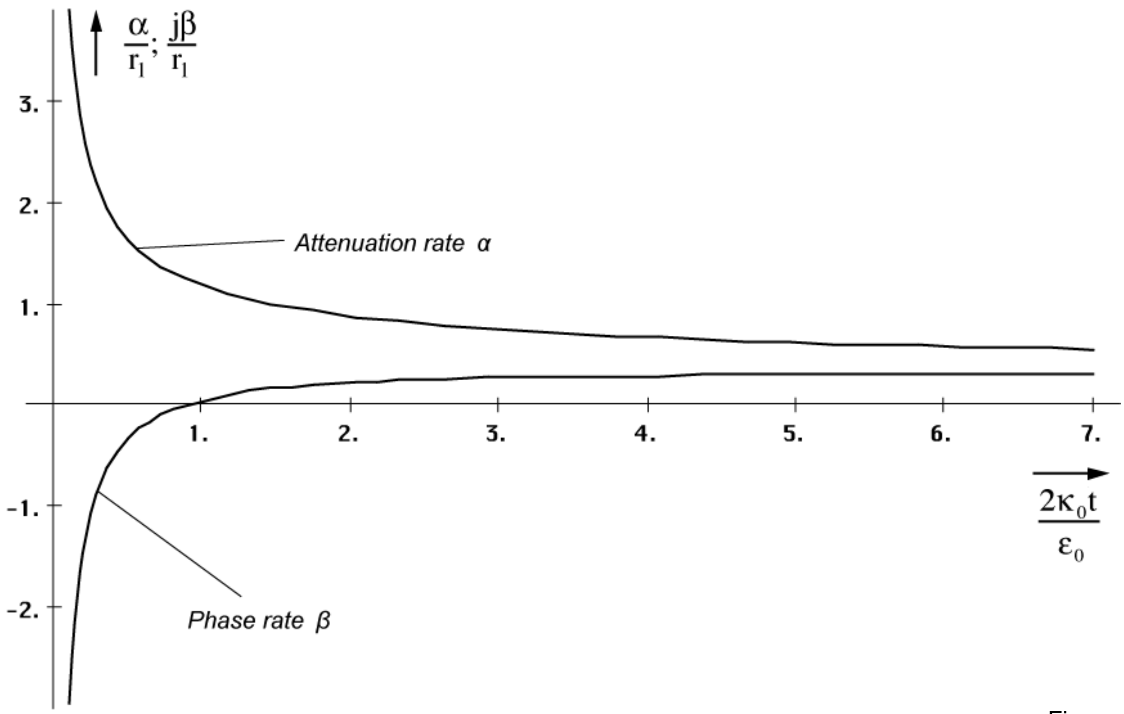



Figure 23
Phase-rate and attenuation rate
in dependence on time (linear scale)

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 $0.897\, t_l$ $(Q = 0.947)$, 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 $100\, t_l$ on we are able to declare, referring to Figure 24, the following approximation:

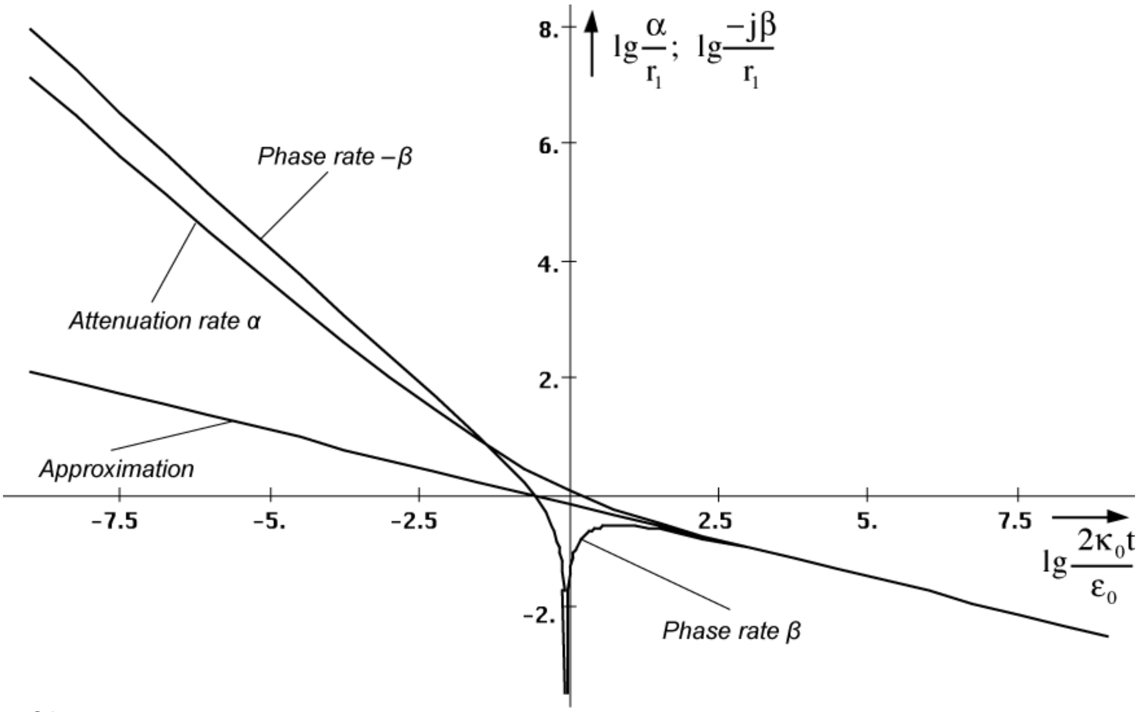



Figure 24
Phase rate and attenuation rate
in dependence on time (logarithmic)

$$\underline{\gamma} \approx (1+j)\kappa_0 Z_0 \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad\qquad \underline{\gamma} \approx (1+j)\frac{\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{221}$$

These relationships can be derived as well graphically from Figure 24, as explicitly using (217) by application of (226). However, it's necessary to multiply (217) with j, in order to take account of the 90° turning (Figure 26). Then, to the approximation $\gamma=2\omega_0/\underline{c}$ 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 behaviour 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 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 would be equipped with the basic physical qualities $\varepsilon_0$, $\mu_0$ and $\kappa_0$, 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 R/2, 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):

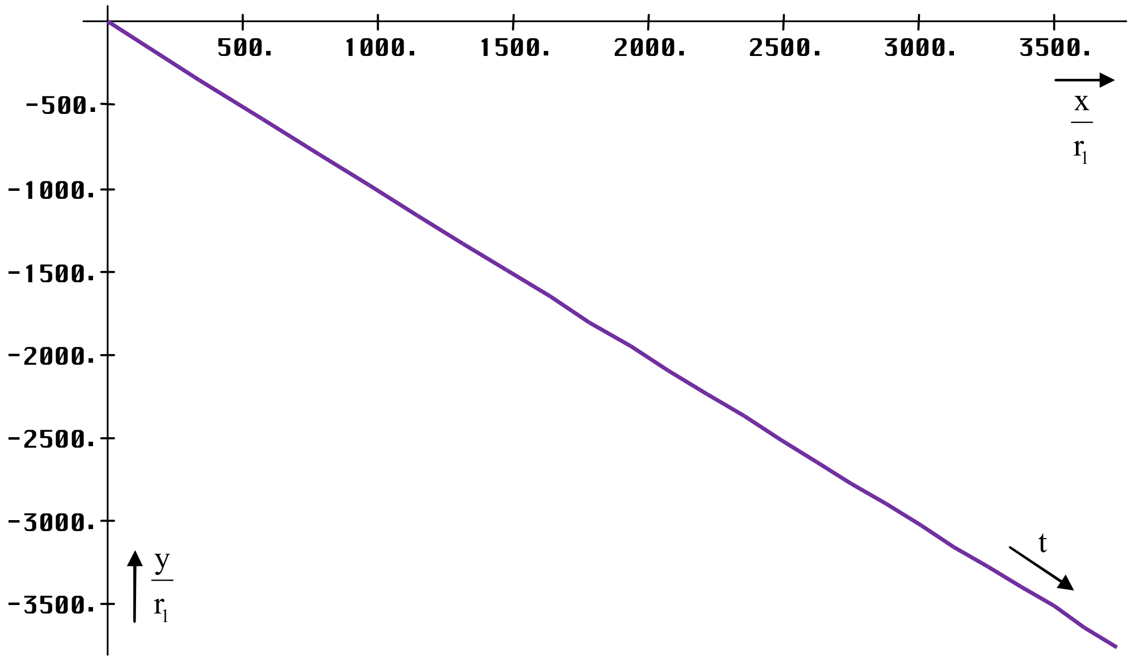



Figure 25
Track-curve for larger values of t
in dependence on time

For larger t, the expansion of the wave-front proceeds approximately rectilinear. The behaviour looks somewhat differently near the singularity. In Figure 26 the course of the track-curve of a discrete section of the wave-front near the singularity is shown. 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.

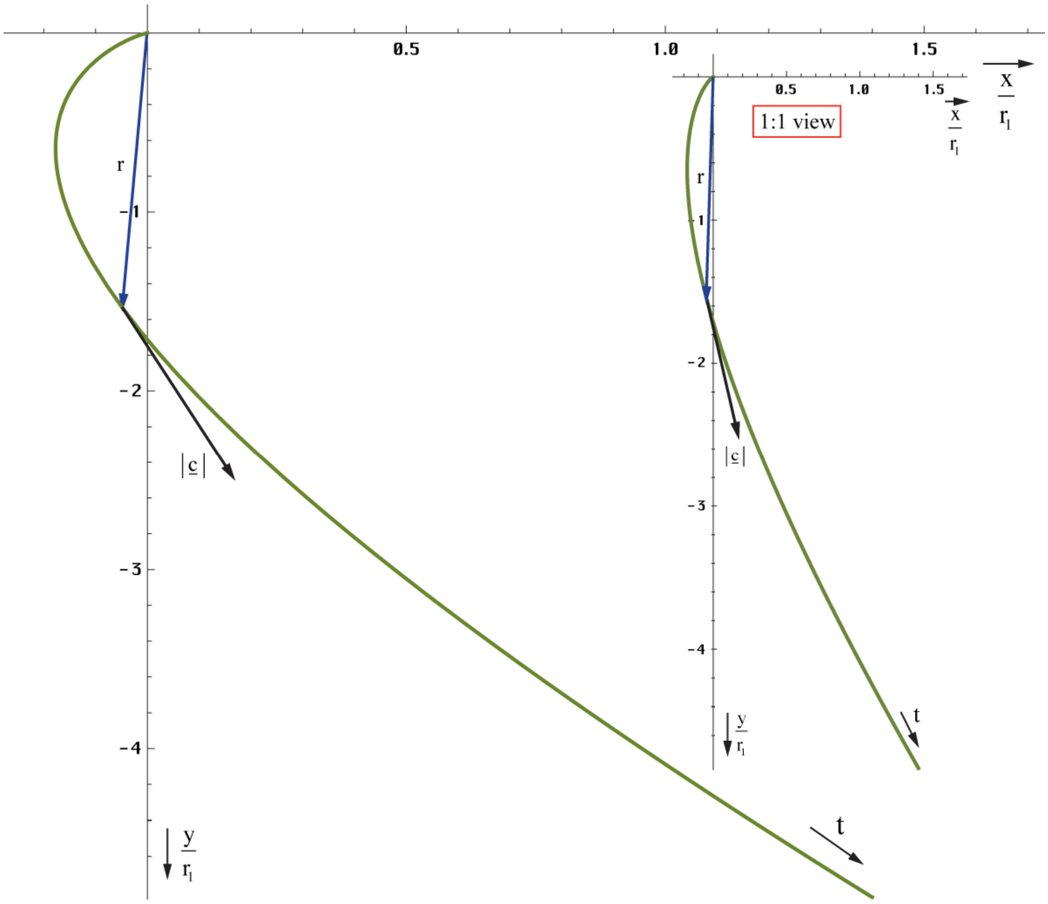



Figure 26
Track-curve near the singularity
in dependence on time

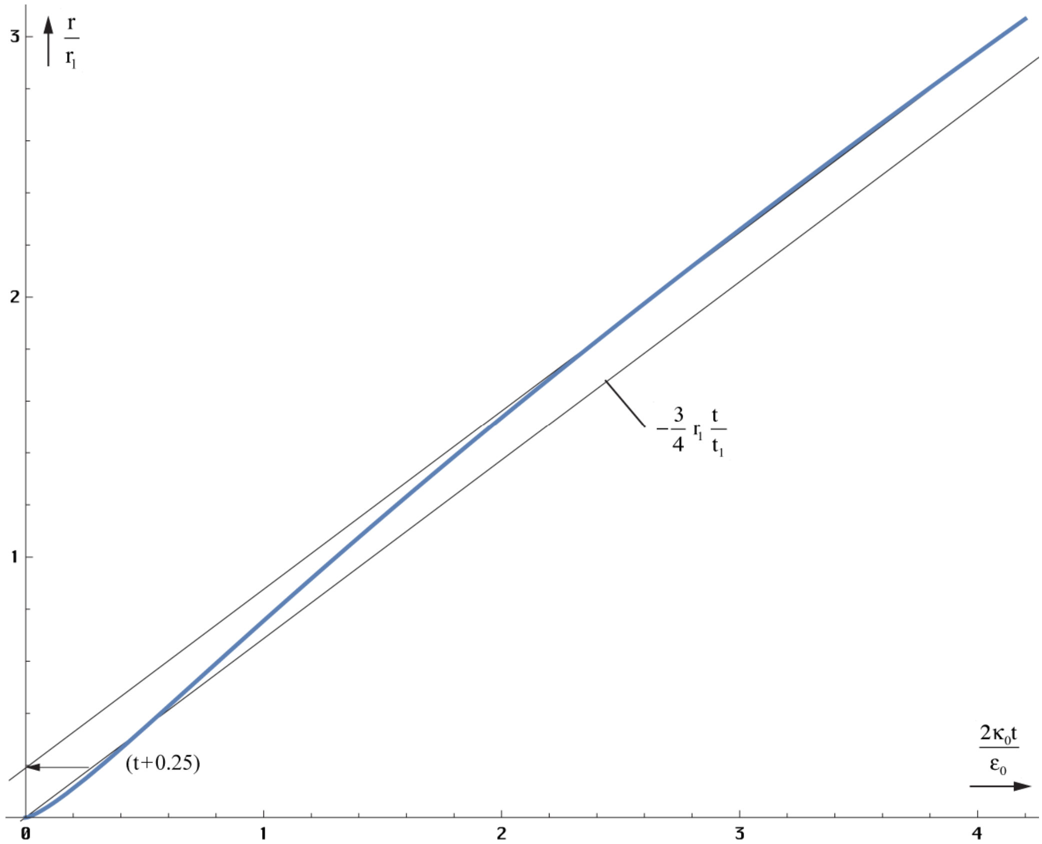



Figure 27
Radius r as the absolute distance to the centre
in dependence on time for smaller values of t

The functions have been calculated and figured with the help of »Mathematica« by numerical integration in the following way:

```
Cd=Function[-2*I/Sqrt[#]/Sqrt[1-(HankelH1[2,Sqrt[#]]/HankelH1[0,Sqrt[#]])^2]];
CdI=Function[NIntegrate[Cd[a],{a,0,#}]];
ParametricPlot[{Re[CdI[t]], Im[CdI[t]]},{t,0,1}, AspectRatio->1]
Plot[Abs[CdI[t]],{t,0,1}, AspectRatio->1]
```
(222)

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.

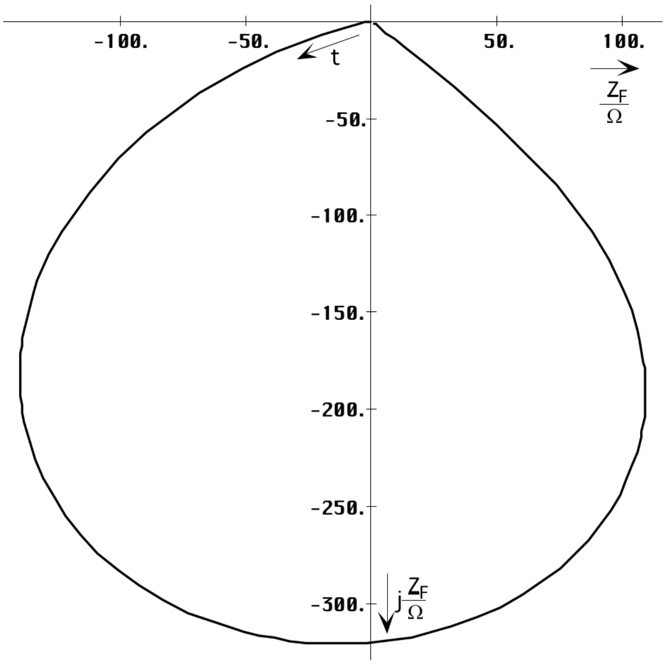



Figure 28
Locus curve of the field-wave impedance

4.3.4.3.2. Approximative solutions

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

$$H_\nu^{(1)}(z)=\sqrt{\frac{2}{\pi z}}\,e^{j\left(z-\frac{\pi}{2}\nu-\frac{\pi}{4}\right)}\left[1+O\left(z^{-1}\right)\right] \qquad \text{for } 0<z<\infty \tag{223}$$

Put into (209), one sees that nearly all expressions can be reduced. The root-expression $R$ converges to a value of:

$$R=\sqrt{1-\left(\frac{\left[1+O_2\left(t^{-1/2}\right)\right]}{\left[1+O_0\left(t^{-1/2}\right)\right]}\right)^2} \qquad \text{or} \tag{224}$$

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

$$R=\sqrt{1-\left[1+O_2(t^{-1/2})-O_0(t^{-1/2})\right]^2} \quad \approx \quad \sqrt{2O_2(t^{-1/2})-2O_0(t^{-1/2})} \tag{225}$$

The root-expression just only depends 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 is the fact, that the imaginary part is actually negative.

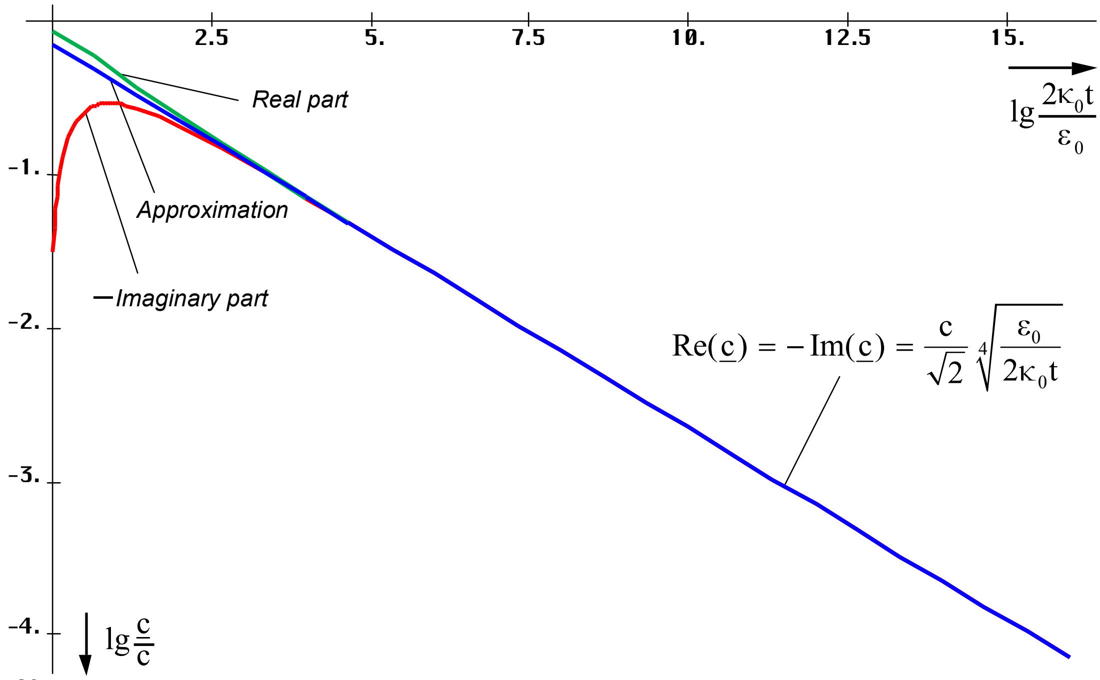



Figure 29
Propagation-velocity
in dependence on time (double logarithmic)

$$\underline{c} = \frac{1-j}{\sqrt{2}}\, c \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad \underline{c} = \frac{1-j}{2} \frac{c}{\sqrt{\omega_0 t}} \qquad (226)$$

$$|\underline{c}| = c \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad |\underline{c}| = \frac{c}{\sqrt{2\omega_0 t}} \qquad (1.03807 \cdot 10^{-22}\ \mathrm{ms}^{-1}) \qquad (227)$$

$$\underline{Z}_F = \frac{1-j}{\sqrt{2}}\, Z_0 \sqrt[4]{\frac{\varepsilon_0}{2\kappa_0 t}} \qquad \underline{c} = \frac{1-j}{2} \frac{Z_0}{\sqrt{\omega_0 t}} \qquad (228)$$

### 4.3.4.3.3. Propagation-function

Now we want to set up a propagation function. The normal form is $\mathbf{E}=\hat{\mathbf{E}}\, e^{j\omega t-\underline{\gamma} x}$ with $\underline{\gamma}=\alpha+j\beta$. But with the exact solution (221) there is a case on hand, at which $\alpha$ and $\beta$ contain both damping- and phase-information and the wave function isn’t harmonic either. That way we aren’t able to form a reasonable propagation function.

In the case $t \gg t_1$ phase- and attenuation rate are of the same size. Thus, the model behaves similar to a metal. There $\alpha$ does not stand for a damping, but for a rotation, namely as long as, with vertical incidence, a value of $\pi$ is reached so that the wave exits the metal in the opposite direction after a minimal intrusion. The depth of penetration depends on the material properties, the wave length and the angle of incidence. In case of this model the material properties aren’t constant either, $\underline{\gamma}$ decreases with t and x. Hence it suffices to a rotation of 90° only and the wave remains in the medium (vacuum). In any case, there is a rotation too.

To cope with it, we do a rotation of the coordinate system about π/4. That corresponds to a multiplication with $\sqrt{j}$ and we get a purely imaginary solution. So becomes α=0 and γ=jβ and the exponentially related attenuation vanishes. Indeed, we still have to multiply the result with $\sqrt{2}$ and to replace x by r. Despite α=0 the amplitudes of **E** and **H** are decreasing continuously. That's caused by the Hankel function alone, resp. by the radical expression in (229). With it amplitude and phase are firmly interlinked (minimum phase system). Now the rotation angle in space is equal to θ+π/4. But a separation of phase- and damping-information isn't possible yet. But we can work with very high precision using the approximation equations in this case. To the general Hankel function $H_0^{(1)}(\omega t-\beta x)$ the following approximation applies (analogously for $\underline{\mathbf{H}}$):

$$\underline{\mathbf{E}} = \hat{\mathbf{E}}\, H_0^{(1)}(\omega t-\beta x) \approx \hat{\mathbf{E}} \sqrt{\frac{2}{\pi(\omega t-\beta x)}}\; e^{j(\omega t-\frac{\pi}{4}-\beta x)} \tag{229}$$

Instead of $\underline{\gamma}x$ only the product βx with the phase rate appears in the exponent, since the amplitude rate is already emulated by the radical expression. With t»0 the angle π/4 can be omitted. After rotation and transition x→r and ω→2ω₀ turns out:

$$\underline{\mathbf{E}} = \hat{\mathbf{E}}\, H_0^{(1)}(2\omega_0 t-2\beta_0 r) \approx \frac{2\mathbf{E}_1}{\sqrt{2\omega_0 t-2\beta_0 r}}\; e^{j(2\omega_0 t-\frac{\pi}{4}-2\beta_0 r)} \qquad H_1=\frac{\varphi_1}{\mu_0 r_1^2} \quad E_1=\frac{q_1}{\varepsilon_0 r_1^2}=\frac{1}{Z_0}\frac{\varphi_1}{\varepsilon_0 r_1^2} \tag{230}$$

$\mathbf{E}_1$ is the peak value of **E** with $Q_0$=1. Indeed are both $\omega=2\omega_0$ and $\beta=2\beta_0$ (with double frequency even the phase rate must be doubled) no constants at all. That means, they depend on t and r at the same time, limiting the manageability of the approximation very much. You can see that also with the phase velocity $v_{ph}$. It is defined in the following manner:

$$v_{ph} = \frac{2\omega_0}{\beta} = \frac{2c}{\sqrt{2\omega_0 t}} = 2|\underline{c}| \qquad \text{for } t \gg 0 \tag{231}$$

Thus, the phase velocity is equal to the double absolute value of propagation velocity. That's caused by the factor 2, since phasing with double frequency propagates with double velocity too. For interest, also the group velocity should be stated here:

$$v_{gr} = \frac{1}{d\beta/d\omega_0} = -2|\underline{c}| \qquad \text{for } t \gg 0 \tag{232}$$

Except for the algebraic sign both results are equal. That means, the propagation takes place free from any bias. Further to the approximation. With (128) in section 4.2.4. we had already found a very good approximation, almost exact, for the same temporal function.

$$\underline{\mathbf{E}} \approx \hat{\mathbf{E}} \sqrt{\frac{2}{\pi}}\, \frac{e^{j(2\omega_0 t+2\beta_0 x)}}{\sqrt{2\omega_0 t+2\beta_0 x}} = 2\mathbf{E}_1 \frac{e^{j2(\omega_0 t+\beta_0 r)}}{\sqrt{2\omega_0 t+2\beta_0 r}} \quad \text{with} \quad \beta_0=\frac{\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{233}$$

Now, expression (233) enables to define an equivalent-$\alpha=\alpha_0$ and, with it, even an equivalent-$\underline{\gamma}_0=\alpha_0+j2\beta_0$, in order to get it up to the normal form for propagation functions.

$$\underline{\mathbf{E}} \approx 2\mathbf{E}_1\, e^{j2\omega_0 t-\underline{\gamma}_0 r} \qquad \text{with} \quad \underline{\gamma}_0 = \frac{1}{2r}\ln\left(2\omega_0 t+\frac{2\kappa_0 Z_0}{\sqrt{2\omega_0 t}}r\right)+j\frac{2\kappa_0 Z_0}{\sqrt{2\omega_0 t}} \tag{234}$$

That's already a big step forward. Unfortunately, both $\omega_0$ and $\underline{\gamma}_0$ depend on time. It's not critical for $2\omega_0 t$, because it's multiplied by t anyway. Else with $\underline{\gamma}_0$, it should depend on r only. To the substitution of t in (229ff) we firstly put (227) left-hand into $t=r/|\underline{c}|$. The real propagation velocity becomes effective here and not $v_{ph}$ or $v_{gr}$. Then we rearrange after t. Putting into (233) right-hand we get:

$$t = \frac{r}{c}\sqrt[4]{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad t^{\cancel{4}3} = \frac{r^4}{c^4}\frac{2\kappa_0 \cancel{t}}{\varepsilon_0} = 2r^4\mu_0^2\varepsilon_0\kappa_0 \tag{235}$$

$$\beta_0^{12} = \frac{1}{8}\kappa_0^{\cancel{12}8} Z_0^{\cancel{12}8}\frac{\cancel{\varepsilon_0^3}}{\cancel{\kappa_0^3}}\cdot\frac{1}{2r^4\cancel{\mu_0^2}\cancel{\varepsilon_0}\cancel{\kappa_0}} = \frac{\kappa_0^8 Z_0^8}{2^4 r^4} \qquad \Bigg| \qquad \beta_0 = \sqrt[3]{\frac{1}{2rr_1^2}} \tag{236}$$

With it, we obtain for $\underline{\gamma}_0$ and the product $\underline{\gamma}_0 r$ the following expressions:

$$\underline{\gamma}_0 = \frac{1}{2r}\ln\left(2\omega_0 t + \left(\frac{2r}{r_1}\right)^{\frac{2}{3}}\right) + j\left(\frac{2}{rr_1^2}\right)^{\frac{1}{3}} \qquad \text{for } t \gg 0 \tag{237}$$

$$\underline{\gamma}_0 r = \frac{1}{2}\ln\left(2\omega_0 t + \left(\frac{2r}{r_1}\right)^{\frac{2}{3}}\right) + j\left(\frac{2r}{r_1}\right)^{\frac{2}{3}} \qquad \text{for } t \gg 0 \tag{238}$$

Last but not least the time t can be completely eliminated. The value $\underline{\gamma}_0$ is proportional to $r^{-1/3}$ and, even more important, the product $\underline{\gamma}_0 r$ is proportional to $r^{2/3}$. Unfortunately, as already said, we can explicitly state $\underline{\gamma}_0(r)$ by approximation only. With the exact function (220) a separation, especially from t is impossible. But generally speaking, an exact solution is not required at all, since the approximation yields very good results until a striking distance to the particle horizon at $Q_0=1$, see Figure 14. Therefore, we won't follow up that matter at this point.

All hitherto stated approximations are based on the 4D-expansion-centre $\{r_1,r_1,r_1,t_1\}$. But it's more practicable to find a function, related to another centre. Most suitable seems to be the point, where we are, the „point being". At first we substitute the time according to $t\rightarrow\tilde{T}+t$. The swung dash stands for the initial value at the point t=0 (nowadays) describing an inertial system. Hence it's about a constant. Because of $\tilde{T}=t_1\tilde{Q}_0^2$ we are able to factor out $\tilde{Q}_0$. The direction of time doesn't change. To the temporal part applies:

$$2\omega_0 t = \tilde{Q}_0\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \tag{239}$$

For the spatial part $\beta_0$ we build up the inertial system once again using the substitution $r_1\rightarrow\tilde{R}$. Because of $\tilde{R}=r_1\tilde{Q}_0^2$, as well as $\tilde{r}\tilde{Q}_0=-r$, now we are measuring from the other end, we can write for $2\beta_0$:

$$2\beta_0 = \tilde{Q}_0\left|\frac{2}{\tilde{r}\tilde{Q}_0\tilde{r}_1^2\tilde{Q}_0^2}\right|^{\frac{1}{3}} = -\tilde{Q}_0\left|\frac{2}{r\tilde{R}^2}\right|^{\frac{1}{3}} \qquad 2\beta_0 r \overset{\text{Exactly}\,\rightarrow}{=} -\tilde{Q}_0\left|\frac{2r-\tilde{r}_0}{\tilde{R}}\right|^{\frac{2}{3}} = -\tilde{Q}_0\left|\frac{2r}{\tilde{R}}-\frac{1}{\tilde{Q}_0}\right|^{\frac{2}{3}} \tag{240}$$

Actually I should have to write $\tilde{r}$ instead of r. But because it's the argument of the function the tilde has been omitted. The right-hand expression considers the fact, that $r_0$ as smallest increment never can be underrun. The value $\alpha_0$ is definitely determined by the envelope curve of the Hankel function, else it would be equal to zero. With it, we obtain for $\underline{\gamma}_0$ and the product $\underline{\gamma}_0 r$:

$$\underline{\gamma}_0 = \frac{1}{2r}\ln\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) + j\tilde{Q}_0\left(\frac{2}{r\tilde{R}^2}\right)^{\frac{1}{3}} \tag{241}$$

$$\underline{\gamma}_0 r = \frac{1}{2}\ln\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) + j\tilde{Q}_0\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \tag{242}$$

With $r_0$ we have already found one elementary length. But LANCZOS speaks about another one [1]. That's the wave length of the metric wave field $\lambda_0=2\pi/\beta$. The approximation of $\lambda_0$ must be divided by 2 once again, due to the double phase velocity. Hence $\lambda_0=2\pi/\beta_0$ applies. To the comparison the expression for $r_0$ once again:

$$\lambda_0 = \frac{2\pi}{\rho_0(2\omega_0 t)\kappa_0 Z_0}\operatorname{cosec}\frac{1}{2}\arctan\theta(2\omega_0 t) \tag{243}$$

$$\lambda_0 = \frac{\pi}{\kappa_0 Z_0}\sqrt[4]{\frac{2\kappa_0 t}{\varepsilon_0}} = \frac{\pi}{\kappa_0 Z_0}\sqrt{2\omega_0 t} \qquad \text{for } \omega_0 t \gg 0 \tag{244}$$

$$r_0 = \frac{1}{\kappa_0 Z_0}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} = \frac{2\omega_0 t}{\kappa_0 Z_0} = \sqrt{\frac{2t}{\kappa_0 \mu_0}} \tag{245}$$

Though $\lambda_0$ is smaller than $r_0$ and not identical to HEISENBERG's elementary length with it. $\lambda_0$ now is in the range of $10^{-68}$m. Thus, LANCZOS was wrong in that point. But it only has been a guess on his part. In fact, it's about the wave length of the wave function forming the metric lattice itself. Expression (243) until (245) only represent the temporal functions. Then, the functions of time and space read as follows.

$$\lambda_0 = \frac{2\pi}{\rho_0(2\omega_0 t - \underline{\gamma}_0 r)\kappa_0 Z_0}\operatorname{cosec}\frac{1}{2}\arctan\theta(2\omega_0 t - \underline{\gamma}_0 r) \tag{246}$$

$$\lambda_0 = \pi r_0 \tilde{Q}_0^{-\frac{1}{2}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^{\frac{1}{2}} = \frac{\pi}{\kappa_0 Z_0}\sqrt{2\omega_0 t - 2\beta_0 r} \tag{247}$$

$$r_0 = dr = \tilde{r}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right) = \frac{2\omega_0 t - 2\beta_0 r}{\kappa_0 Z_0} \tag{248}$$

The temporal course of $\lambda_0(r=0)$, and of $r_0$ $(r=0)$ is shown in Figure 30 and 31. Figure 31 is a little bit deceptive. It looks like $r_0$ is smaller than $\lambda_0$. In fact, the curve of $r_0$ cuts the one of $\lambda_0$ with an argument of 450.592 at 15.0098 $r_1$. The phase jump, barely visible in Figure 31, occurs with an argument of 0.8968.

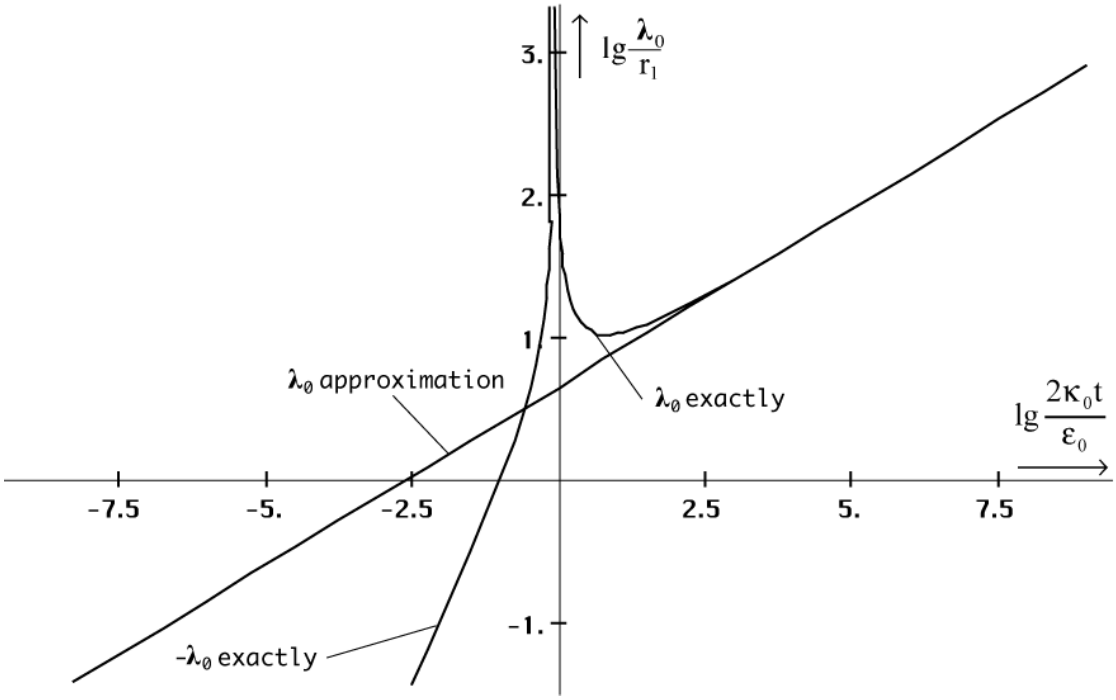



Figure 30
Exact course of $\lambda_0$ logarithmic scale

We only know the local age T, which results from the local HUBBLE-parameter (249). It quasi represents the temporal distance to the expansion centre. But we are able to determine the spatial distance to the world radius R. This forms a spatial singularity (event horizon) with it. The value arises from the ansatz (250):

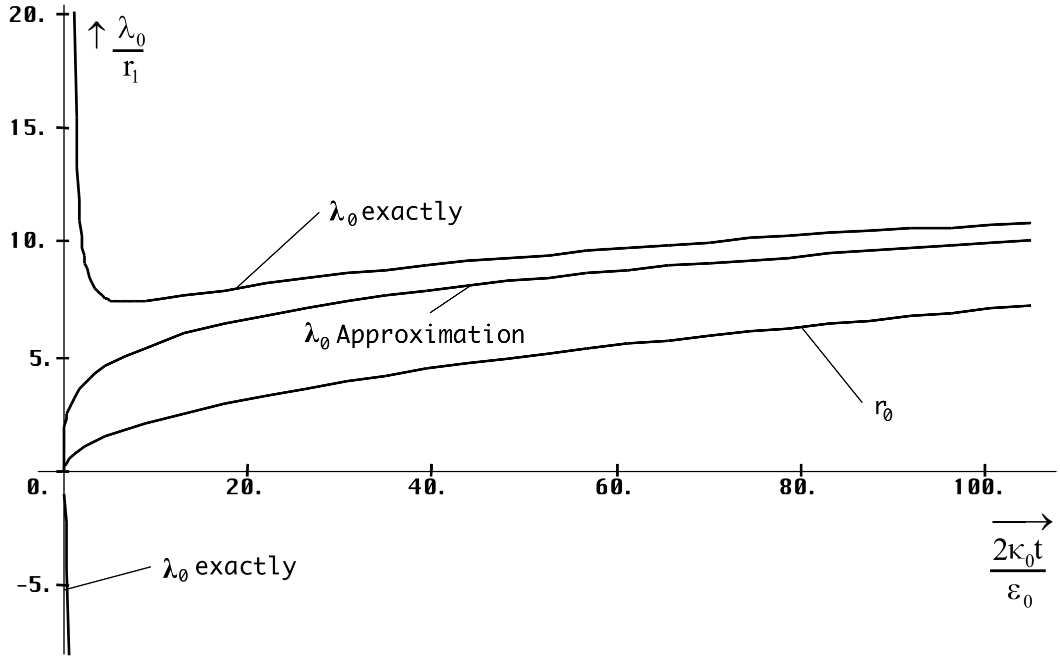



Figure 31
Course of $\lambda_0$ exact and approximated as well as the one of $r_0$ linear scale

$$2\omega_0 t - \beta_0 r = \frac{\omega_0(H)}{H} \qquad \text{with } r = 0 \qquad T = \frac{1}{2H} \tag{249}$$

$$R = -\frac{\omega_0(H)}{\beta_0 H} = -\frac{\omega_0 r_0}{H} = -2ct \qquad \text{with } 2\omega_0 t = 0 \tag{250}$$

$$\beta_0 = \kappa_0 Z_0 \sqrt[4]{\frac{\varepsilon_0 H}{\kappa_0}} = \sqrt{\frac{c^3}{G\hbar}} = \frac{1}{r_0} \tag{251}$$

Hence, the value of $\beta_0 = 1/r_0$ even can be obtained from (221), in that we replace the time with the HUBBLE-parameter. To R applies:

$$R = -\frac{c}{H} = -1.21880 \cdot 10^{26}\,\text{m} = -1.2918 \cdot 10^{10}\,\text{Ly} = -3.950\ \text{Gpc} \tag{252}$$

$$R = -\frac{c}{H} = -1.34803 \cdot 10^{26}\,\text{m} = -1.4249 \cdot 10^{10}\,\text{Ly} = -4.36862\ \text{Gpc} \tag{253}$$

That’s about 12 billion light years according to Table 2. The result (253) has been calculated using (1049) and the $\text{CODATA}_{2018}$ values. The local age has the character of a time-constant and amounts only to the half, namely 6.6/7.1 billion years. The local world radius is equal to cT. Longer time-like vectors up to 2cT are possible because of expansion and wave propagation of the metric wave field. Full particulars in section 4.5.

The wave field examined here, forms the metrics of the universe (empty space), the real (nearly) MINKOVSKIan line element. We can already declare it here. Further contemplations are done in section 7.2.1. We act on (0.23) in it’s differential form in that we replace the otherwise usual light speed c with the propagation velocity $\underline{c}$ of the metric wave field:

$$ds^2 = dx^2 + dy^2 + dz^2 - \underline{c}^2 dt^2 \qquad \text{or} \qquad (254)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta \; d\varphi^2) - \underline{c}^2 dt^2 \qquad (255)$$

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

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) - \frac{c^2 dt^2}{\omega_0^2 t^2 \rho_0^2 (2\omega_0 t - \underline{\gamma} r)} (\sin\frac{1}{2}\arctan\theta(2\omega_0 t - \underline{\gamma} r) - \underline{j}\cos...)^2 \quad (256)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2 dt^2}{\omega_0^2 t^2 \rho_0^2 (2\omega_0 t - \underline{\gamma} r)} (\cos\arctan\theta(2\omega_0 t - \underline{\gamma} r) + j\sin...) \quad (257)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2 dt^2}{\omega_0^2 t^2 \rho_0^2 (2\omega_0 t - \underline{\gamma} r)} \frac{1 + j\theta(2\omega_0 t - \underline{\gamma} r)}{\sqrt{1 + j\theta^2(2\omega_0 t - \underline{\gamma} r)}} \quad (258)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2 dt^2}{\omega_0^2 t^2 (1 - A^2(\phi) + B^2(\phi))\,(1 - j\theta(\phi))} \quad (259)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{4dr_0^2}{1 - (A(\phi) - jB(\phi))^2} \quad \text{because } \dot{r}_0 = \frac{c}{Q_0} \text{ and } \dot{r}_0 dt = dr_0 \quad (260)$$

with $\phi = 2\omega_0 t - \gamma r$. Interesting is the algebraic sign-reversal. The cone turns into a ball. The previous light cone however continues to be applied to overlaid signals always propagating with c. It adds up the local propagation-velocity (not expansion-velocity!). $A(\phi)$ and $B(\phi)$ determine the rotation near the singularity. The reciprocal of the expression in the denominator shows a behaviour like $t^{1/2}$. Now still the approximation:

$$\begin{aligned} ds^2 &\approx dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + (\phi - \tfrac{1}{2})\, dr_0^2 \\ ds^2 &\approx dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + Q_0 dr_0^2 \end{aligned} \quad (261)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \frac{c^2 dt^2}{2\omega_0 t - 2\beta_0 r} \quad (262)$$

$$ds^2 = dr^2 + r^2(d\vartheta^2 + \sin^2\vartheta d\varphi^2) + \underline{\tilde{c}}^2 \left( \left(1 + \frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \right)^{-1} \quad (263)$$

Hereafter, I'll nominate the double-bracketed expression (263) as *navigational gradient*. Moving only in time and not in space, there is no spatial curvature at all. This type of motion is called time-like world-line (e.g. photons). With it, a curvature is synonymous with the motion of a mass. First this must be accelerated for this purpose. That type of motion is called space-like world-line then.

Using the expansion-centre as origin of your coordinate-system, only a temporal dependence exists. Directly at the point r = 0 space-like world-lines aren't possible, but in a striking distance of course. They are directed outside the singularity, the time-like ones inwards. A body would be repelled by the singularity. Thus, it's about a particle-horizon then. Another example for this type of singularity are white holes (if existing) and the local world-radius R/2. Therefore e.g., the latter can be passed by photons.

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, no universal spatial coordinate-system exists anyway. In contrast there are only space-like world-lines at the total-world-radius R. It's about a temporal singularity then (event-horizon) that cannot be passed through by photons. With it, there is even no universal time defined, exactly as the SRT predicates. 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 pass through. 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, that there is just an infinite curvature at both ends and even by the symmetry of the time-function of propagation-velocity (Figure 22). Crossing the point, the phase-jump appears, you will come out at the „other end of the world". Such a model would expand, speaking in behalf of a big bang.

Looking at the second expression of (239) we realize that it describes exactly the just proposed model. For an observer, there is only his local frame of reference. We just found out, that a motion in space also means a motion in time. But expression (240) shows clearly, that it doesn't matter, into which direction we move. The temporal direction is always the same, opposite to the natural time-direction (because of $r^2$).

But it still means something else: Each observer has the impression to be in the centre of the universe at all times. Since the natural time-vector is always larger than that caused by motion, the observer is always moving in the natural time-direction, but even slowed down and (then) delayed. There is just a temporal elongation $t'/t=(1-(\int a\cdot dt+\gamma_0 v_0)^2/c^2)^{1/2}$ during acceleration ($\beta r \neq$const), but only throughout the actual acceleration phase. Once switched-off the engine ($\beta r$=const), time passes normally again.

Because of the relative velocity to the original inertial system, induced by acceleration, only altered scales, like length and velocity, are *observed* from there – and vice versa. The *observation* however plays a greater role, than generally assumed. It is identical to the physical reality on the place of the observer, because impacts are *observed* too.

The behaviour during the acceleration phase is *equivalent* to the behaviour during the stay close to greater masses, only that we cannot just turn off the gravitational field. Hence time dilation is a pure GR-phenomenon, with constant relative velocity only the SRT applies.

With it, a lot of questions relating to the twin-paradox can be answered. The first twin accelerates, and time passes more slowly for him during the four acceleration phases (accelerate, brake, accelerate, brake). The direction of the acceleration does not carry weight. With activated drive he quasi „hangs behind" the normal time vector, the EINSTEIN-train is behind schedule. But after the homeward journey, returned to the starting point, he is not younger than his brother because latter one stayed in the gravitational field in the inhibited free fall with 1g all the time. The first twin would only be younger if it had been accelerated by more than 1g on average or if its brother had been in uninhibited free fall (microgravity) all the time.

### 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 $\kappa_0$. 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 the 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. First we 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 $r_0$, at which point the coupling-factor should be equal to 1. The coupling itself takes place via the magnetic field (Figure 4). And exactly with that 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, assigning 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 ($\mathbf{E}(t,r)$). Nevertheless they have an effect all in all, as we will see later.

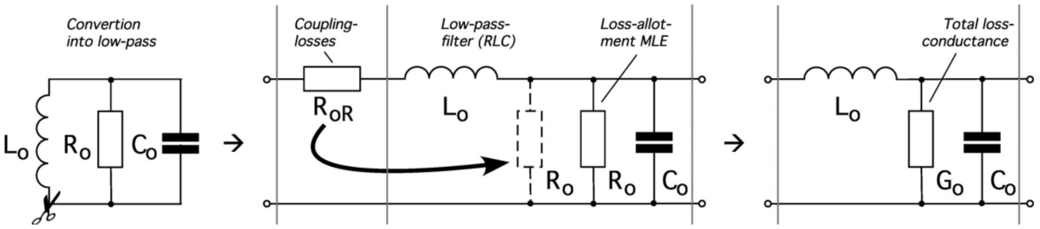



Figure 32
Conversion of the equivalent-circuit of the MLE into a low-pass under consideration of the additional coupling losses

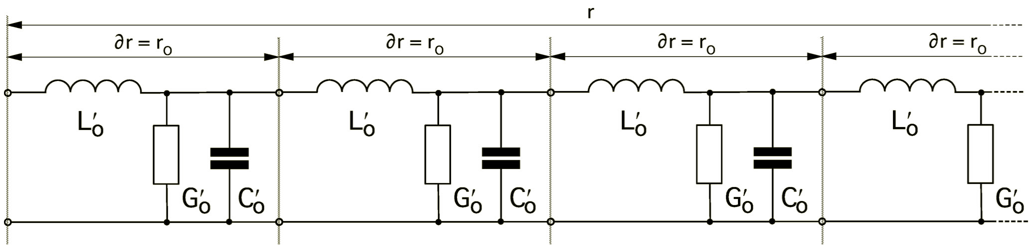



Figure 33
Line-equivalent-circuit with shunt-resistor

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 $\kappa_0$. 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 $\kappa_{0R}$ to it. With the help of (53), (59), (221) and (250) we obtain:

$$R_{0R} = \frac{1}{\kappa_0 r_0} \qquad r_1 = \frac{1}{\kappa_0 Z_0} \qquad r_0 = r_1 Q_0 = \sqrt{\frac{2t}{\kappa_0 \mu_0}} \qquad R_{0R} = \sqrt{\frac{\mu_0}{2\kappa_0 t}} \tag{264}$$

$$R_0 = \frac{Z_0^2}{R_{0R}} = Z_0 Q_0 \qquad G_0 = \frac{2}{R_0} = \frac{2}{Z_0 Q_0} = \kappa_{0R}\frac{r_0^2}{r_0} = \kappa_{0R} r_0 \tag{265}$$

$$\kappa_{0R} = \frac{2}{Z_0 Q_0 r_0} = \frac{2}{Z_0 R} = \frac{2}{Z_0 2ct} = \frac{\varepsilon_0}{t} \qquad \kappa_{0R} = 2\varepsilon_0 H = \frac{2\kappa_0}{Q_0^2} \tag{266}$$

R is the world-radius 2ct. Then, inserting (266) into (176) we obtain for the complex propagation-velocity $\underline{c}$ and the field-wave-impedance $\underline{Z}_F$:

$$\underline{c} = c\sqrt{\frac{j\omega t}{1+j\omega t}} \qquad \underline{Z}_F = Z_0\sqrt{\frac{j\omega t}{1+j\omega t}} \tag{267}$$

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] (268) 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 $\partial r$, i.e. each low pass-gate now represents the properties of a conducting-section of the length $\partial r$. 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 $\partial r \rightarrow r_0$. 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 $\varepsilon_0$, $\mu_0$ and the substitutive value $\kappa_{0R}$ are identical to the capacity, inductivity and conductance covering of our „conduction“, i.e. the vacuum.

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial r^2} + c_1 \frac{\partial u}{\partial r} + c_2 \frac{\partial u}{\partial t} + c_3 u \qquad \text{with} \tag{268}$$

$$c = \frac{1}{\sqrt{L_0' C_0'}} \qquad c_1 = 0 \qquad c_2 = -\frac{R_0'}{L_0'} - \frac{G_0'}{C_0'} \qquad c_3 = -\frac{G_0' R_0'}{L_0' C_0'} \qquad R_0' = 0$$

$$\frac{\partial^2 u}{\partial r^2} - L_0' C_0' \frac{\partial^2 u}{\partial t^2} - (C_0' R_0' + G_0' L_0') \frac{\partial u}{\partial t} - G_0' R_0' u = 0 \qquad \text{analogously for i} \tag{269}$$

$$-\frac{\partial u}{\partial r} = R_0' i + L_0' \frac{\partial i}{\partial t} \qquad\qquad -\frac{\partial i}{\partial r} = G_0' u + C_0' \frac{\partial u}{\partial t} \tag{270}$$

$$-\frac{\partial u}{\partial r} = \mu_0 \frac{\partial i}{\partial t} \qquad\qquad -\frac{\partial i}{\partial r} = \frac{\varepsilon_0}{t} u + \varepsilon_0 \frac{\partial u}{\partial t} \tag{271}$$

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 $r_0$:

$$\frac{\partial \mathbf{E}}{\partial r} = \mu_0 \frac{\partial \mathbf{H}}{\partial t} \quad \hat{=} \quad \text{curl}\,\mathbf{E} \qquad\qquad \frac{\partial \mathbf{H}}{\partial r} = \left( \kappa_{0R} + \varepsilon_0 \frac{\partial}{\partial t} \right) \mathbf{E} \quad \hat{=} \quad \text{curl}\,\mathbf{H} \tag{272}$$

In this way the MAXWELL equations can be derived directly. Unlike 4.3.4.2. the parameter $\kappa_{0R}$ 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 $\kappa_{0R}$ Therefore, it is also named parametric attenuation. Starting with (269), we get for the line-/field-wave-impedance ($\underline{Z}_L = \underline{Z}_F$):

$$\underline{Z}_L = \sqrt{\frac{R_0' + j\omega L_0'}{G_0' + j\omega C_0'}} = \sqrt{\frac{j\omega \mu_0}{\varepsilon_0 / t + j\omega \varepsilon_0}} = Z_0 \sqrt{\frac{j\omega t}{1 + j\omega t}} \tag{273}$$

That’s the same solution as (267). 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 $\kappa_{0R}$ ($2.1779 \cdot 10^{-29}\,\text{Sm}^{-1}$), 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.*

$$\underline{c} = \underline{c}_M + \underline{c}_\lambda \qquad \underline{c} = c\left(\sqrt{\frac{1}{j2\omega_0 t}} + \sqrt{\frac{j\omega t}{1+j\omega t}}\right) \tag{274}$$

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

$$c^2 = c_M^2 + c_\lambda^2 \qquad c^2 = c^2\left(\frac{1}{2\omega_0 t} + \frac{1}{\sqrt{1+\dfrac{1}{\omega^2 t^2}}}\right) \tag{275}$$

This expression is even achieved from the MLE (262) 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 (274) we obtain the following relations:

$$\omega t = \frac{1}{\sqrt{\left(1-\dfrac{1}{2\omega_0 t}\right)^{-2} - 1}} \qquad \omega = \frac{2H}{\sqrt{\left(1-\dfrac{1}{2\omega_0 t}\right)^{-2} - 1}} \tag{276}$$

Since with expression (276) 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 $2\omega_0 t \gg 1$:

$$\omega = \frac{2H}{\sqrt{\dfrac{2y-y^2}{1-2y+y^2}}} \approx 2H\sqrt{\frac{1-2y}{2y}} = 2H\sqrt{\frac{1}{2y}-1} \tag{277}$$

We finally receive after substitution:

$$\omega = 2H\sqrt{\omega_0 t - 1} \approx \sqrt{2}H\sqrt{2\omega_0 t} \tag{278}$$

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 (253) has been neglected. The factor $\sqrt{2}$ stands here instead of 2, as even already with $\lambda_0$, to cancel rotation around $\pi/4$ of the coordinate-system up taken with the definition of the approximative formula of $\gamma(r)$. Then we get the following result:

$$\lambda = \pi\frac{c}{H}\frac{1}{\sqrt{2\omega_0 t}} = \frac{\pi R}{\sqrt{2\omega_0 t}} \qquad \lambda \sim t^{3/4} \tag{279}$$

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/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=∞, t=∞.*

| |
|---|
| *For the* temporal singularity *(wave-front) applies: Each length, measured from this point, always has the quantity $r_1/2$. Each period, measured at this point, always has the amount $t_1$, 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=0.* |

A particle horizon inside is an event horizon outside and vice-versa. The spatial singularity only is suitable as basis of a space-independent temporal, the temporal singularity only 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:′

$$\lambda = \frac{2\pi c C}{\sqrt{\tilde{Q}_0}}\frac{(\tilde{T}+t')}{\sqrt[4]{1+t'/\tilde{T}}} \quad = \quad \frac{\pi\tilde{R}C}{\sqrt{\tilde{Q}_0}}\left(1+\frac{t'}{\tilde{T}}\right)^{\frac{3}{4}} \tag{280}$$

$$\lambda = \tilde{\lambda}\left(1+\frac{t'}{\tilde{T}}\right)^{\frac{3}{4}} \quad = \quad \tilde{\lambda}\left(\sqrt{1+\frac{t'}{\tilde{T}}}\right)^{\frac{3}{2}} \tag{281}$$

C is an arbitrary constant, it disappears on a retransformation. Expression (281) represents the temporal dependence. To the determination of spatial dependence, we must visualize that this case differs from the preceding $\lambda_0$ 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 on 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 (281) with 2c obtaining:

$$\lambda = \tilde{\lambda}\left(1+\frac{2ct'}{2c\tilde{T}}\right)^{\frac{3}{4}} \quad = \quad \tilde{\lambda}\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{3}{4}} \tag{282}$$

With it, the overlaid wave doesn't behave like the metrics $r_0$ as well as $\lambda_0$ concerning wavelength and frequency. But differences exist also between $r_0$ and $\lambda_0$. 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:

$$r_T = -\frac{r_R}{\sqrt{1-\frac{4r_R^2}{R^2}}} \qquad\qquad r_R = -\frac{r_T}{\sqrt{1+\frac{4r_T^2}{R^2}}} \tag{283}$$

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 (282) we can also find a substitution for the expression β, that is applied to signals, which are overlaid the metrics. In contrast to (239) that applies to the metrics itself, we get for the phase rate $\beta$ of the overlaid wave (not equal to the phase rate of the metrics $\beta_0$) because of $\lambda=2\pi c/\omega=2\pi/\beta$:

$$\beta = \frac{\tilde{\omega}}{c}\left(1+\frac{2r}{\tilde{R}}\right)^{-\frac{3}{4}} = \frac{\tilde{\omega}}{c}\Xi(r) \qquad \text{with} \qquad \Xi(r)=\left(1+\frac{2r}{\tilde{R}}\right)^{-\frac{3}{4}} \qquad \Xi(t)=\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{3}{4}} \tag{284}$$

We introduce the two right functions to the better presentation. With the propagation of overlaid waves, $\beta$ is not identical to $\alpha$ obviously. We obtain $\alpha$ and $\beta$ from (180, 181) by replacement of $\kappa_0$ with $\kappa_{0R}$

$$\alpha = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\frac{1}{\omega^2 t^2}}-1\right)} = \frac{\omega}{c}\sinh\left(\frac{1}{2}\operatorname{arsinh}\frac{1}{\omega t}\right) \tag{285}$$

$$\beta = \omega\sqrt{\frac{\mu_0\varepsilon_0}{2}\left(\sqrt{1+\frac{1}{\omega^2 t^2}}+1\right)} = \frac{\omega}{c}\cosh\left(\frac{1}{2}\operatorname{arsinh}\frac{1}{\omega t}\right) \tag{286}$$

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:

$$\alpha = \frac{1}{R} \qquad\qquad \beta = \frac{\omega}{c} = \pm\omega\sqrt{\mu_0\varepsilon_0} \tag{287}$$

Here, we get for the phase rate $\beta$ 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):

$$A = 20\ \lg e^{-\frac{r}{R}} = -8.686\frac{r}{R}\ \text{dB} \tag{288}$$

$$A = 20\ \lg e^{-\frac{t}{2T}} = -4.343\frac{t}{T}\ \text{dB} \tag{289}$$

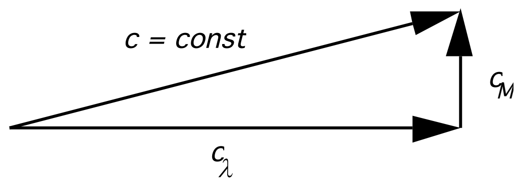



Figure 34
Propagation velocity of the metrics and of an overlaid electromagnetic wave

or $A'=-1$Np/R. Because of c=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 (273). 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 $\beta$ (the attenuation rate $\alpha$ is not affected) by the bracketed expression of (282) obtaining our substitute-$\underline{\gamma}$, $\underline{c}$ and $\underline{Z}_L$, it applies $R=r_0Q_0$:

$$\underline{\gamma} = \frac{\tilde{H}}{c} + j\frac{\tilde{\omega}}{c}\Xi(r) \qquad \underline{c}=c \qquad \underline{Z}_L=Z_0 \tag{290}$$

Expression (290) 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.

$$\begin{aligned} &\underline{u}_2 \cosh\underline{\gamma}r + \underline{i}_2\underline{Z}_L \sinh\underline{\gamma}r = \underline{u}_1 \\ &\frac{\underline{u}_2}{\underline{Z}_L}\sinh\underline{\gamma}r + \underline{i}_2\cosh\underline{\gamma}r = \underline{i}_1 \end{aligned} \tag{291}$$

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

$$\underline{\mathbf{E}}_1 = -\frac{\hat{u}_1}{r_0}\,\mathbf{e}_r\,e^{j\omega t} = \mathbf{E}_1\,e^{j\omega t} \qquad \underline{\mathbf{H}}_1 = -\frac{\hat{i}_1}{r_0}\,\mathbf{e}_r\,e^{j\omega t} = \mathbf{H}_1\,e^{j\omega t} \tag{292}$$

$\mathbf{e_r}$ 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 (291):

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1\,e^{j\omega t-\underline{\gamma}r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1\,e^{j\omega t-\underline{\gamma}r} \qquad \omega = \tilde{\omega}\,\Xi(t) \tag{293}$$

This solution is identical to (165) but it considers the cosmologic red-shift only for $\underline{\gamma}$ (290). 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 (293) 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 (293) shows all-pass behaviour 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 (274), however using the correct expression for the propagation-velocity $\underline{c}_M$ of the metrics (213):

$$\underline{c} = \underline{c}_M + \underline{c}_\lambda = c \qquad \underline{c} = c\left(\frac{e^{j\frac{1}{2}\arctan\theta}}{j\rho_0\omega_0 t} + \sqrt{\frac{j\omega t}{1+j\omega t}}\right) \tag{294}$$

We look at the value-function again, at which point it's however necessary to pay attention to the fact, that the angle $\alpha$, depending also on $\theta$, may be unequal to $\pi/2$ (Figure 104). Therefore, the cosine-rule applies:

$$c^2 = c_M^2 + c_\lambda^2 - 2c_M c_\lambda \cos\alpha \qquad\qquad \frac{1}{2\rho_0\omega_0 t} = \frac{c_M}{c} \tag{295}$$

$$\frac{1}{\sqrt{1+\frac{1}{\omega^2 t^2}}} - \frac{\cos\alpha}{\rho_0\omega_0 t \sqrt[4]{1+\frac{1}{\omega^2 t^2}}} + \left(\frac{1}{4\rho_0^2\omega_0^2 t^2} - 1\right) = 0 \tag{296}$$

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

$$\omega = 2H\sqrt{\frac{y^4}{1-y^4}} \qquad \text{with}^1 \qquad y = \beta_x^{-1} = \frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha} \tag{297}$$

The second solution is applied to space-like photons. Similarities exist obviously with the reciprocal of (277). The value of y tends to 1 for $Q_0 \gg 1$. Since the real transfer-function is independent from the metrics, (287) 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:

$$\omega = \frac{2H}{\sqrt{\frac{1}{y^4}-1}} = \frac{2H}{\sqrt{\left(\frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right)^{-4} - 1}} \tag{298}$$

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:

$$\lambda = \pi R \sqrt{\left(\frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right)^{-4} - 1} \tag{299}$$

$$\lambda = C\,R(Q)\sqrt{\beta_x^4 - 1} \qquad\qquad Q = \tilde{Q}_0\left(1+\frac{r}{c\tilde{T}}\right)^{\frac{1}{2}} = \tilde{Q}_0\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \tag{300}$$

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 (211). 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 $R=r_1 Q_0^2$ exactly applies only for $Q_0 \gg 1$. The spatial and temporary dependence of $\tilde{R}$ for zero-vectors is given by the right expression of (300). Furthermore $Q=\tilde{Q}_0$ and $R(Q)=R$ applies. Finally, we get for the wavelength and frequency:

$$\lambda = \tilde{\lambda}\,\frac{R(Q)}{R(\tilde{Q})}\sqrt{\frac{\beta_x^4-1}{\tilde{\beta}_x^4-1}} \qquad\qquad \omega = \tilde{\omega}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_x^4-1}{\beta_x^4-1}} \tag{301}$$

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 $\Xi_x(t)$:

$$\begin{aligned}
\Xi_\gamma(r) = \Xi_\gamma(t) &= \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_\gamma^4-1}{\beta_\gamma^4-1}} & \Xi_{\bar{\gamma}}(r) = \Xi_{\bar{\gamma}}(t) &= \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\gamma}}^4-1}{\beta_{\bar{\gamma}}^4-1}} \\
\Xi_\nu(r) = \Xi_\nu(t) &= \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_\nu^4-1}{\beta_\nu^4-1}} & \Xi_{\bar{\nu}}(r) = \Xi_{\bar{\nu}}(t) &= \frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\nu}}^4-1}{\beta_{\bar{\nu}}^4-1}}
\end{aligned} \tag{302}$$

---

[1] See (621) relativistic dilatation factor β with $v=c_M$, see also section 5.3.
[2] See section 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. (290) and (293) 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 single 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 $\omega_0$ for $\sigma$ in (144) instead of $\omega_1$, it applies $\Omega=\omega/\omega_0$. First, let's have a look at the part of the total attenuation factor $\alpha$, caused by $\omega_g$, which can be calculated from the amplitude response $A(\omega)$. Only the real part is being transferred. In connection with the phase-angle $\varphi_\gamma$ in reference to the length $r_0=c/\omega_0$ applies:

$$\Psi(\omega) = \ln\left|A(j\omega)\right| = \ln(A(\omega)\cos\varphi_\gamma) \tag{303}$$

$$\Psi(\omega) = \ln\left(\frac{1}{\sqrt{1+\Omega^2}}\,e^{\frac{\Omega^2}{1+\Omega^2}}\cos\left(\arctan\Omega-\frac{\Omega}{1+\Omega^2}\right)\right) \quad \text{with} \quad \Omega=\frac{1}{2}\frac{\tilde{\omega}}{\tilde{\omega}_0}\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{1}{2}}\Xi(r) \tag{304}$$

$$\Psi(\omega) = -\frac{1}{2}\ln(1+\Omega^2)+\frac{\Omega^2}{1+\Omega^2}+\ln\cos\left(\arctan\Omega-\frac{\Omega}{1+\Omega^2}\right) \tag{305}$$

$$\alpha = \frac{\tilde{H}}{c}-\frac{\tilde{\omega}_0}{c}\Psi(\omega) \qquad\qquad \Psi(\omega)=0 \quad \text{for} \quad \omega \ll \omega_0 \tag{306}$$

The part $\Psi(\omega)$ depends on space and time indeed, since it depends on $\Omega$ too, on the ratio of two frequencies, changing according to different functions ($\omega\sim t^{-3/4}$, $\omega_0\sim t^{-1/2}$). The negative sign arises from the re-exchange of the integration limits. With it the change doesn't cancel out. In the approximation $\Omega\sim t^{-1/4}$ applies.

But the cut-off frequency affects the phase rate $\beta$. The more approaching the cut-off frequency, all the more the phase-shift $\varphi_\gamma$ (149) is making noticeable, caused by the ascending phase delay $T_{Ph}$ (151) during the transfer from 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), so that $\omega$ remains unchanged and $\lambda$ declines on the other hand. The smaller value of $|\underline{c}|$ affects $\alpha$ and $\beta$ in the same manner. With the nowadays manageable frequencies however, the phase-defect is practically equal to zero. Before we can calculate on, we already have to convert the phase-shift $\Phi(\omega)$ into units of wavelength however. It applies $\Phi(\omega)=1+T_{Ph}/T_\omega$, at which point $T_\omega$ is the period of $\omega$:

$$\Phi(\omega) = \left(1-\frac{1}{2\pi}\left(\arctan\Omega-\frac{\Omega}{1+\Omega^2}\right)\right) \qquad\qquad \Phi(\omega)=1 \quad \text{for} \quad \omega \ll \omega_0 \tag{307}$$

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

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1\, e^{j\omega t-\gamma r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1\, e^{j\omega t-\gamma r} \qquad \omega=\tilde{\omega}\;\Xi(t) \tag{308}$$

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

The complete solution with frequency response is not required in most cases. With later contemplations we will still work with (309) however. In cases, 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 $\omega_0$, have only a small-scale reach, since with approach to $\omega_0$ 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 $\kappa_0$. If you should be interested, please look up in section 4.6.5.

4.3.4.4.6. The cosmologic red-shift

From (282) an expression for the cosmologic red-shift can be derived directly:

$$\lambda = \tilde{\lambda}\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{3}{4}} \qquad z = \frac{\lambda-\tilde{\lambda}}{\tilde{\lambda}} = \frac{\lambda}{\tilde{\lambda}}-1 \tag{310}$$

$$\left(1+\frac{2r}{\tilde{R}}\right)^{\frac{3}{4}} = z+1 \qquad \frac{2r}{\tilde{R}} = (z+1)^{\frac{4}{3}}-1 \tag{311}$$

$$r = \frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) \qquad v^{\uparrow} = c\left((z+1)^{\frac{4}{3}}-1\right) \tag{312}$$

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 cosmologic 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 (312). The expressions are namely based on the propagation-function (293) 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 (280) . 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:

$$r = \frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) = c(\tilde{T}^{\downarrow}-t)\left((z+1)^{\frac{4}{3}}-1\right) = c\left(\tilde{T}^{\downarrow}-\frac{r}{c}\right)\left((z+1)^{\frac{4}{3}}-1\right) \tag{313}$$

$$r = \left(\frac{\tilde{R}^{\downarrow}}{2}-r\right)\left((z+1)^{\frac{4}{3}}-1\right) = \frac{\tilde{R}^{\downarrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right)-r\left((z+1)^{\frac{4}{3}}-1\right) \tag{314}$$

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

$$r = \frac{\tilde{R}^{\downarrow}}{2}\left(1-(z+1)^{-\frac{4}{3}}\right) \qquad v^{\downarrow} = c\left(1-(z+1)^{-\frac{4}{3}}\right) \tag{315}$$

The expressions (312) and (315) 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 ɣ and ω must be multiplied with a correction-factor. For the world-radius R applies:

$$\tilde{R}^{\uparrow} = 2c(\tilde{T}^{\downarrow}-t) = 2c\left(\tilde{T}^{\downarrow}-\frac{r}{c}\right) = \tilde{R}^{\downarrow}-2r = \tilde{R}^{\downarrow}-\tilde{R}^{\downarrow}(1-(z+1)^{-4/3}) \tag{316}$$

$$\tilde{R}^{\uparrow} = \tilde{R}^{\downarrow}\frac{1}{(z+1)^{4/3}} \quad \tilde{R}^{\downarrow} = \tilde{R}^{\uparrow}(z+1)^{4/3} \quad \tilde{H}^{\uparrow} = \tilde{H}^{\downarrow}(z+1)^{4/3} \quad \tilde{H}^{\downarrow} = \tilde{H}^{\uparrow}\frac{1}{(z+1)^{4/3}} \tag{317}$$

By using of (311) can be shown that the expression (z+1) is corresponding to the relativistic dilatation factor $\beta$. Then further $(z+1)^{2/3} \sim \beta^{2/3} \sim Q_0^{-1}$ applies and on the basis of Table 5:

$$\tilde{r}_0^{\uparrow} = \tilde{r}_0^{\downarrow}\frac{1}{(z+1)^{2/3}} \quad \tilde{r}_0^{\downarrow} = \tilde{r}_0^{\uparrow}(z+1)^{2/3} \quad \tilde{\omega}_0^{\uparrow} = \tilde{\omega}_0^{\downarrow}(z+1)^{2/3} \quad \tilde{\omega}_0^{\downarrow} = \tilde{\omega}_0^{\uparrow}\frac{1}{(z+1)^{2/3}} \tag{318}$$

$$\tilde{r}_1^{\uparrow} = \tilde{r}_1^{\downarrow} = \frac{1}{\kappa_0 Z_0} \sim (z+1)^{-0/3} = \text{const} \qquad \tilde{\omega}_1^{\uparrow} = \tilde{\omega}_1^{\downarrow} = \frac{\kappa_0}{\varepsilon_0} \sim (z+1)^{0/3} = \text{const} \tag{319}$$

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

$$\tilde{\lambda}^{\uparrow} = \tilde{\lambda}^{\downarrow}\frac{1}{(z+1)} \qquad \tilde{\lambda}^{\downarrow} = \tilde{\lambda}^{\uparrow}(z+1) \qquad \tilde{\omega}^{\uparrow} = \tilde{\omega}^{\downarrow}(z+1) \qquad \tilde{\omega}^{\downarrow} = \tilde{\omega}^{\uparrow}\frac{1}{(z+1)} \tag{320}$$

To the correction of ɣ and ω, we next consider the product $\alpha r$:

$$\frac{\tilde{H}}{c}r = \frac{1}{\tilde{R}^{\uparrow}}\frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) = \frac{1}{\tilde{R}^{\downarrow}}\frac{1}{(z+1)^{-\frac{4}{3}}}\frac{\tilde{R}^{\downarrow}}{2}\left(1-(z+1)^{-\frac{4}{3}}\right) = \frac{1}{2}\left((z+1)^{\frac{4}{3}}-1\right) \tag{321}$$

$$\frac{\tilde{\omega}_0}{c}r = \frac{1}{\tilde{r}_0^{\uparrow}}\frac{\tilde{R}^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) = \frac{1}{\tilde{r}_0^{\downarrow}}\frac{1}{(z+1)^{-\frac{2}{3}}}\frac{\tilde{r}_0^{\downarrow}\tilde{Q}_0^{\uparrow}}{2}\frac{\left(1-(z+1)^{-\frac{4}{3}}\right)}{(z+1)^{-\frac{2}{3}}} = \frac{\tilde{Q}_0^{\uparrow}}{2}\left((z+1)^{\frac{4}{3}}-1\right) \tag{322}$$

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:

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1\ e^{j\omega t - \underline{\gamma} r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1\ e^{j\omega t - \underline{\gamma} r} \qquad \omega = \tilde{\omega}^{\uparrow}\,\Xi(t) \tag{323}$$

$$\underline{\gamma} = \left(\left(\frac{\tilde{H}^{\uparrow}}{c} + \frac{\tilde{\omega}_0^{\uparrow}}{c}\Psi(\omega)\right) + j\frac{\tilde{\omega}^{\uparrow}}{c}\Xi(r)\right)\ \Phi(\omega) \qquad |\underline{c}| \le c \qquad |\underline{Z}_L| \le Z_0 \tag{324}$$

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 favourable 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:

$$\underline{\mathbf{E}}_2 = \mathbf{E}_1\ e^{j\omega t - \underline{\gamma} r} \qquad \underline{\mathbf{H}}_2 = \mathbf{H}_1\ e^{j\omega t - \underline{\gamma} r} \qquad \omega = \tilde{\omega}^{\downarrow}(z+1)\ \Xi(t) \tag{325}$$

$$\underline{\gamma} = \left(\left(\frac{\tilde{H}^{\downarrow}}{c}(z+1)^{\frac{4}{3}} + \frac{\tilde{\omega}_0^{\downarrow}}{c}(z+1)^{\frac{2}{3}}\Psi(\omega)\right) + j\frac{\tilde{\omega}^{\downarrow}}{c}(z+1)\ \Xi(r)\right)\ \Phi(\omega) \qquad \ldots \tag{326}$$

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.(312) [H=76]↑ | Distance [Gpc] Eq.(312) [H=55]↑ | * Distance geometric [Gpc]↓ | Distance [Gpc] Eq. (315) [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 | 0.6[illegible]3 | 0.283 | 2.610 | 2.583 | 3.5[illegible]5 | 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 (312) 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 (315) 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.

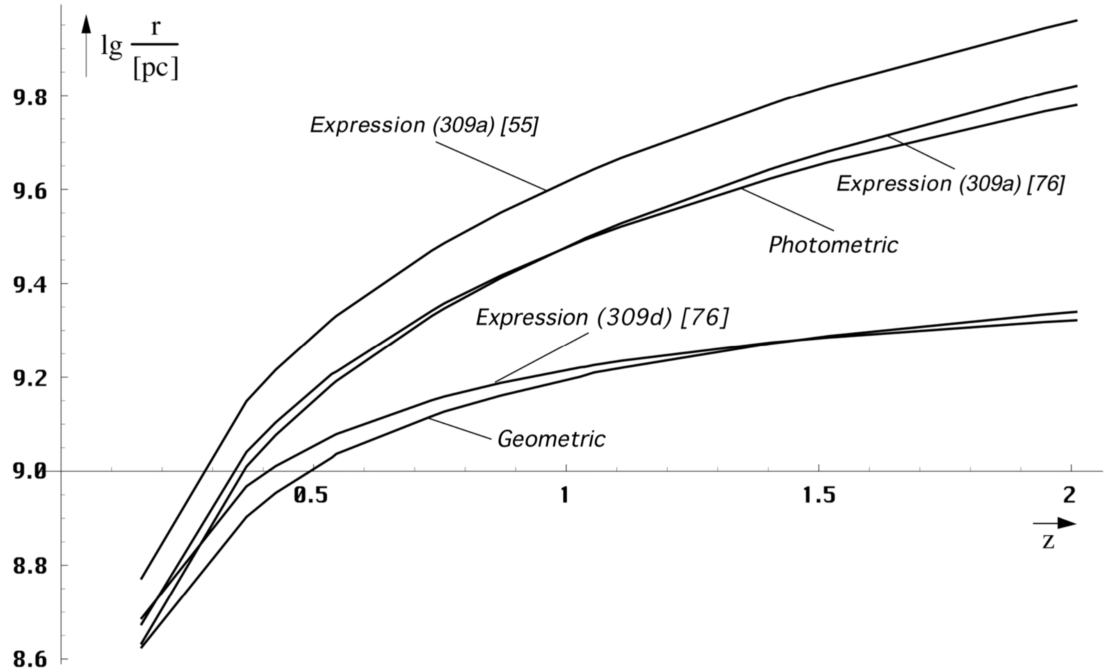



Figure 35
Distance in dependence on the red-shift for elliptical models ($q$=1)

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 (267). 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.

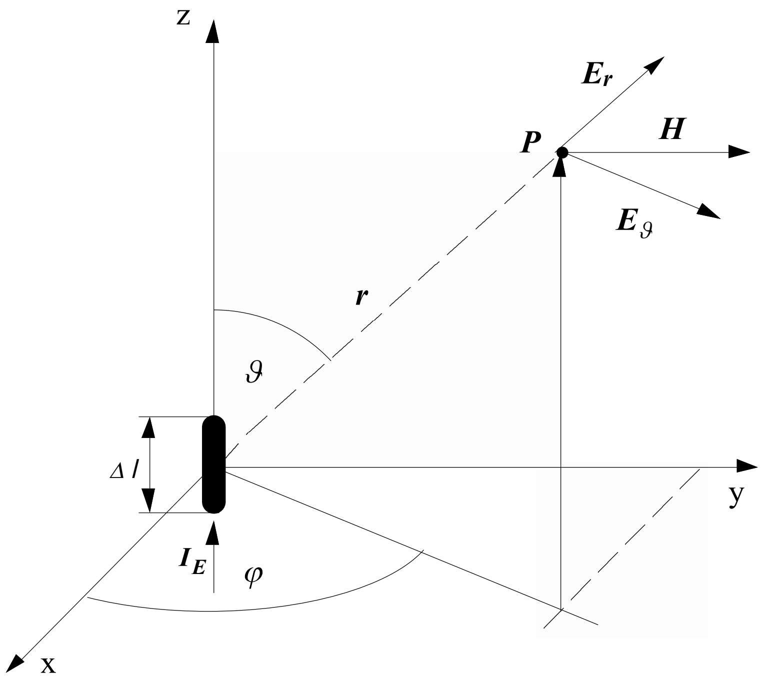
HERTZian field-equations (complex) → radiation-field in the point P:

$$\underline{\mathbf{H}} = \underbrace{\frac{I_E \Delta l}{4\pi}}_{\text{PLANE}} \underbrace{\frac{\sin\vartheta}{r^2}\left(1 + j\frac{\omega r}{c}\right)}_{\text{SPACE}} \underbrace{e^{-j\omega\frac{r}{c}}}_{\text{PROPAGATION DIRECTION}} \underbrace{\mathbf{e}_\varphi}_{\text{UNIT VECTOR}} \qquad (327)$$

For the two electric field-strength-vectors applies:

$$\underline{\mathbf{E}}_\mathbf{r} = \frac{I_E \Delta l}{4\pi} \frac{2\cos\vartheta}{j\omega\varepsilon_0 r^3}\left(1 + j\frac{\omega r}{c}\right) e^{-j\omega\frac{r}{c}}\,\mathbf{e}_\mathbf{r} \qquad (328)$$

$$\underline{\mathbf{E}}_\vartheta = \frac{I_E \Delta l}{4\pi} \frac{2\cos\vartheta}{j\omega\varepsilon_0 r^3}\left(1 + j\frac{\omega r}{c} - \left(\frac{\omega r}{c}\right)^2\right) e^{-j\omega\frac{r}{c}}\,\mathbf{e}_\vartheta \qquad (329)$$




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 (267) 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 $I = U/Z_0$

$$\underline{\mathbf{H}} = \frac{1}{4\pi}\frac{I_E}{r}\frac{\Delta l}{r}\frac{Z_0^2}{Z_0^2 - \underline{Z}_F^2}\sin\vartheta\; e^{-j\omega t}\,\mathbf{e}_\varphi \qquad (330)$$

$$\underline{\mathbf{E}}_\mathbf{r} = \frac{1}{2\pi}\frac{U_E}{r}\frac{\Delta l}{r}\frac{Z_0^2}{\underline{Z}_F^2}\cos\vartheta\; e^{-j\omega t}\,\mathbf{e}_\mathbf{r} \qquad (331)$$

$$\underline{\mathbf{E}}_\vartheta = \frac{1}{4\pi}\frac{U_E}{r}\frac{\Delta l}{r}\left(\frac{Z_0^2}{\underline{Z}_F^2} + \frac{\underline{Z}_F^2}{Z_0^2 - \underline{Z}_F^2}\right)\sin\vartheta\; e^{-j\omega t}\,\mathbf{e}_\vartheta \qquad (332)$$

These are the relationships for a HERTZian dipole of the length $\Delta l$ 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 $\Delta l = R/2$ 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* ($\mu_0$, $\varepsilon_0$, $\kappa_0$, $\hbar_i$ and k).

The speed of light is also a genuine constant admittedly, however not fundamentally at all, since it can be combined from $\mu_0$ and $\varepsilon_0$, just as $r_1$, $\omega_1$ 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 | $\mu_0$ | • | $4\pi \cdot 10^{-7}$ | $Vs\ A^{-1}m^{-1}$ |
| Influence-constant | $\varepsilon_0$ | • | $8.854187817 \cdot 10^{-12}$ | $As\ V^{-1}m^{-1}$ |
| Conductivity-constant | $\kappa_0$ | • | $1.23879 \cdot 10^{93}$ | $A\ V^{-1}m^{-1}$ |
| 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 | $\alpha$ | | $7.2973530 \cdot 10^{-3}$ | 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 | $\omega_0$ | | $1.85501 \cdot 10^{43}$ | $s^{-1}$ |
| Wave impedance vacuum | $Z_0$ | ◦ | $376.73 \approx 2\pi \cdot 60$ | $\Omega$ |
| Cut-off frequency vacuum | $\omega_1$ | ◦ | $1.3991 \cdot 10^{104}$ | $s^{-1}$ |
| 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 | $H$ | | $75.9 \pm 4.4$ | $km\ s^{-1}Mpc^{-1}$ |
| Hubble parameter | $H_0$ ($\omega_{-1}$) | | $2.45972 \cdot 10^{-18}$ | $s^{-1}$ |
| Total age | $2T$ | | $1.291818 \cdot 10^{10}$ | a |
| Local age | $T$ | | $6.45909 \cdot 10^{9}$ | a |
| Local age | $T$ ($t_{-1}$) | | $2.03275 \cdot 10^{17}$ | s |
| Local world-radius | $R$ | | $3.9500$ | Gpc |
| Local world-radius | $R$ ($r_{-1}$) | | $1.21881 \cdot 10^{26}$ | m |

Table 2: Fundamental physical constants standard model

## 4.5. Supplementary contemplations to the metrics

In section 4.3.4.3. we found with (246) an expression for the temporal and spatial dependence of PLANCK's elementary-length $r_0$, figuring at least locally a scale for the proportions (distance). On this occasion I refer once again to the fact that this is *also* applied to the size of material bodies, which is changing in the same measure as $r_0$. Otherwise we could not observe any expansion either.

Just particularly is this a matter of the mutual distances of material bodies. These follow a function, which differ with the considered distance, since quantity and expansion-velocity of the PLANCK elementary-length is changing with ascending distance to the coordinate-origin. But only distances with their starting-point in the origin should will be considered here. Of considerable importance for deeper contemplations is even the number of line elements (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 to the best fits the existing circumstances, since we 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 at free fall. This should be so everywhere then. With it, the expansion of the universe can be traced back to the expansion of the metrics alone. This corresponds to the case of a constant wave count vector.

### 4.5.1. Constant distance

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

$$\mathbf{\Lambda} = \frac{r}{r_0}\mathbf{e_r} \tag{333}$$

$\mathbf{e_r}$ 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 (248) for $r_0$:

$$d\Lambda = \frac{1}{\tilde{r}_0}\frac{dr}{(1+t')^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \qquad \text{with} \quad t' = \frac{t}{\tilde{T}} \tag{334}$$

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

$$d\Lambda = \frac{3}{2}\frac{\tilde{R}}{\tilde{r}_0}\frac{r'^2}{a^2 - r'^2}dr' \qquad \text{with} \quad r' = \left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}} \;\Bigg|\; a^2 = (1+t')^{\frac{1}{2}} \;\Bigg|\; dr = \frac{3}{2}\tilde{R}r'^2 dr' \tag{335}$$

$$\Lambda = \frac{3}{2}\tilde{Q}_0\int\frac{r'^2}{a^2 - r'^2}dr' = \frac{3}{2}\tilde{Q}_0\left(a\ \mathrm{artanh}^{*)}\frac{r'}{a} - r'\right) \qquad \text{*) arcoth for } |r| > ct \text{ (behind the particle horizon)} \tag{336}$$

$$\Lambda = \frac{3}{2}\tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}\mathrm{artanh}\frac{\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right) \qquad \mathrm{def}\ \Lambda_0 = \frac{R}{2r_0} = \frac{Q_0}{2} \tag{337}$$

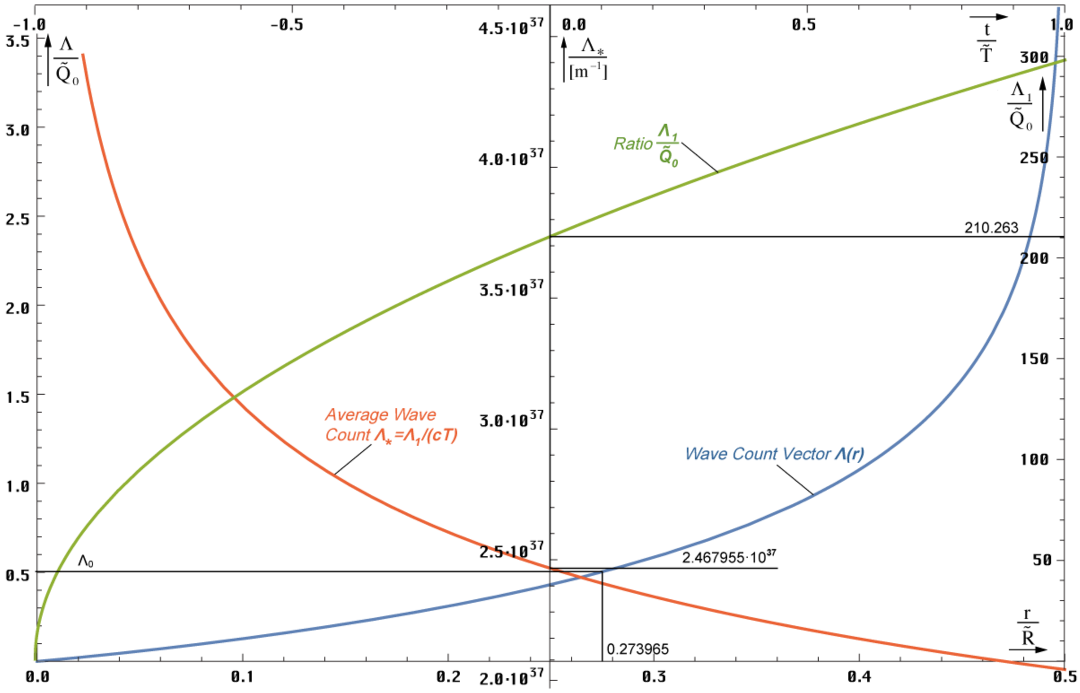



Figure 37
Wave count vector as function
of distance r and t

The wave count $\Lambda$ follows the blue function depicted in Figure 37. Approaching to half the world radius (R/2), it seems to be, that $\Lambda$ strives towards infinity. If we want to define a finite wave count $\Lambda_0$, we take only a certain part of the world radius to calculate the wave count for it. Because of $R/(2r_0) = Q_0/2$ we opt for that value. The value amounts to 0.273965R, that is 54.79% of the distance to the particle horizon (cT). In total however an infinite value will not be reached, since $r_0$ becomes smaller and smaller going to $r_1$. Out there, at Q=1 is the back of beyond, we reached the particle horizon. At first I guessed the value to be $\Lambda_1 = Q_0^2$, 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, turns out $\Lambda_1 = \frac{3}{2}\, Q_0 \ln Q_0 \approx 210\, Q_0 = 1.58461 \cdot 10^{63}$ using the values from Table 2. For $\Lambda_1$ applies $t' \equiv t \equiv 0$ i.e. a constant wave count vector. But by expansion and wave propagation „outwards" the phase angle $2\omega_0 T = Q_0 \sim t^{1/2}$ increases continuously. And because of (53) $\Lambda_1(T) = \frac{3}{2} \sqrt{bT} \ln \sqrt{bT}$ applies with $b = 2\kappa_0/\varepsilon_0$.

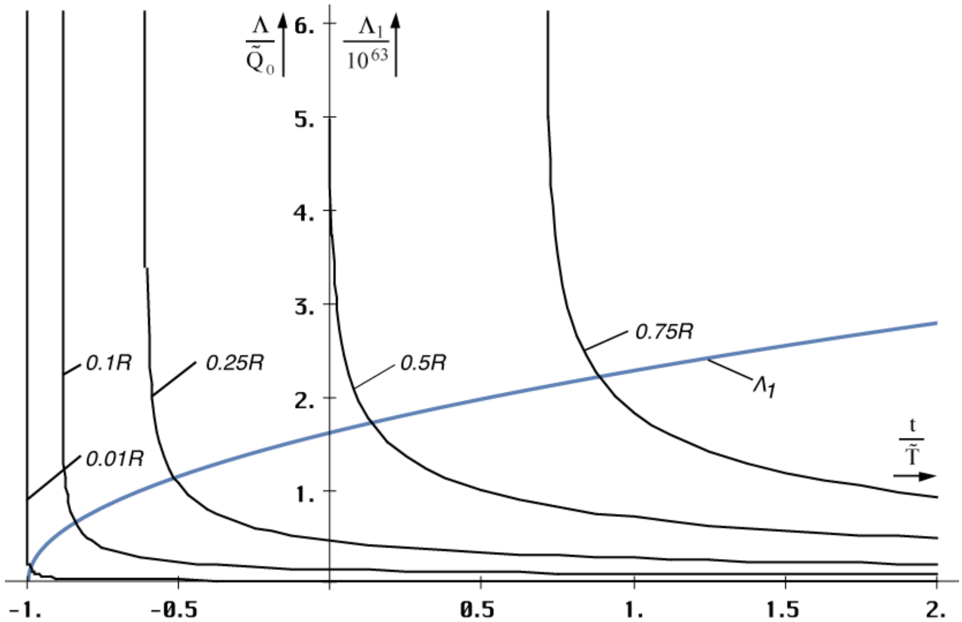



Figure 38
Temporal dependence of the wave count vector
for several distances r

The temporal dependence for several initial distances r is shown in Figure 38. The larger the considered length, the later on the point of time, the wave count vector is defined from. That's easy to understand, we can regard a length as existent only then, when the world-radius is larger or equal to. 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 function (337) does not have a real solution before a value of e.g. t=0.75T is reached (t=0 is the present point of time). Altogether, the wave count decreases. That results from the fact that we are considering a constant length with expanding $r_0$. So it happens, that MLEs are permanently „scrolled out" 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

At first we start with the left expression of (337) for t=0 (a=1). It specifies the quantity of the wave count vector at the present point 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 on a given length $\tilde{r}'$.

$$\Lambda = \frac{3}{2}\tilde{Q}_0\left(\operatorname{artanh}\tilde{r}' - \tilde{r}'\right) = \frac{3}{2}\tilde{Q}_0\left(a\operatorname{artanh}\frac{\tilde{r}'F}{a} - \tilde{r}'F\right) = \text{const} \tag{338}$$

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

$$a\operatorname{artanh}\frac{\tilde{r}'F}{a} - \operatorname{artanh}\tilde{r}' - \tilde{r}'(F-1) = 0 \qquad r(t) = \tilde{r}F^3(t) \tag{339}$$

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];      (340)
F1=Function[Fa1[(1+#1)^.25,(2*#2)^(1/3)]];
```

In this connection we have to be particular about the method (tangent-method) and the initial value. There was a problem using secant method. The temporal course is shown in Figure 39.

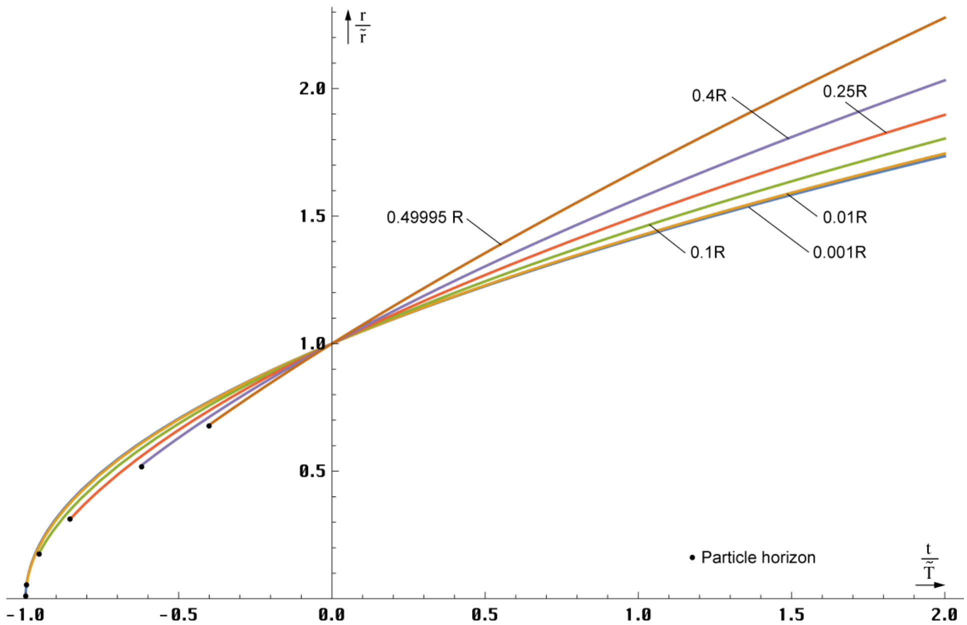



Figure 39
Temporal dependence of a given distance r

There is only a limited definition-range for the solution. It is temporally bounded below by the spatial singularity, the considered length is greater than the world-radius and doesn't exist yet. The greater the considered length, the smaller the definition range. With world-radius the space-like vector R/2 = cT is meant.

### 4.5.2.2. Approximative solutions

A simple solution for small r explicitly arises from (339) under application of the two first terms of the TAYLOR series for the function artanh:

$$r = \tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} \approx \tilde{r}\left(1+\frac{1}{2}\frac{t}{\tilde{T}}\right) \qquad \text{for } \tilde{r} \le 0{,}01\,\tilde{R} \tag{341}$$

This exactly corresponds to the behaviour of PLANCK's elementary-length (MLE) and is valid until 0.01R approximately. For larger distances, the ascend is larger. First we examine the course in the proximity of t=0 (Figure 40) as well as the ascend $\Delta r/\Delta t$ with $\Delta t = 2\cdot 10^{-3}$. With root-functions the ascend (dr/dt) is equal to the exponent m in this point:

$$r = \tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m} \approx \tilde{r}\left(1+m\frac{t}{\tilde{T}}\right) \tag{342}$$

This is shown in Figure 40. It is in the range of 1/2…3/4. Using the function Fit[] approximations of different precision for the exponent m can be found:

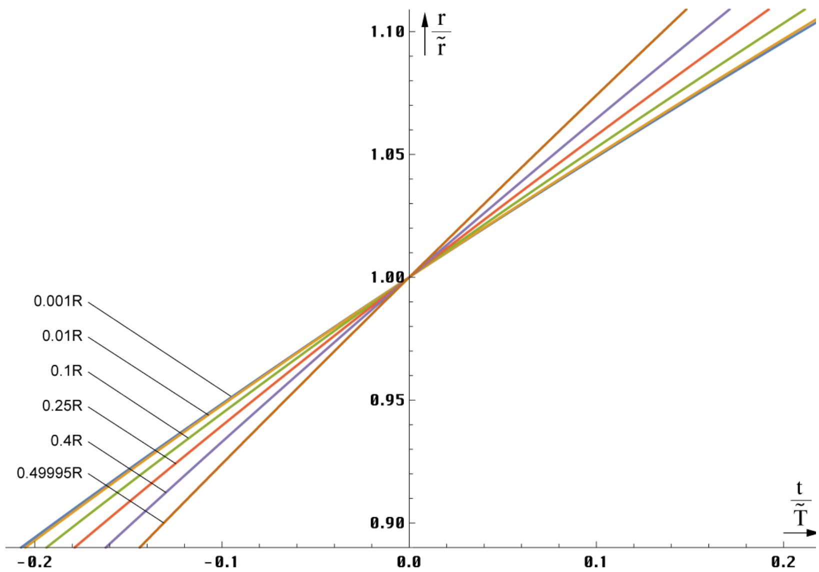



Figure 40
Ascend of several given distances in the proximity of t=0

```
mmm = {{0, .5}};
For[x = 0; i = 0, x < .499, (++i), x += 0.01;
AppendTo[mmm, {x, N[F1[0.0001, x] - F1[0, x]]/0.0001}]]
Fit[mmm, {1, m, m^2, m^3, ... }, m]
```
(343)

$$m \approx 0.513536 + 0.17937r + 0.490927r^2 \qquad \text{with } r = r/\tilde{R}$$
$$m \approx 0.500(980) + 0.50052r - 1.13082r^2 + 2.16233r^3 \tag{344}$$
$$m \approx 0.500(1002) + 0.598206r - 3.45991r^2 + 18.3227r^3 - 42.6995r^4 + 38.0733r^5$$

The third equation of (344) has an accuracy of $\pm 4.83 \cdot 10^{-3}$ and is suitable even for calculations with more extreme demands. It is better to leave out the contents inside brackets at close range. Indeed, there is a need 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) the HUBBLE-parameter $H=\dot{r}/r$ becomes also a function of distance:

$$H = \frac{m}{\tilde{T}+t} \qquad H_0 = \frac{m}{\tilde{T}} \tag{345}$$

The course is shown in Figure 41. The metrics examined by this model is a non-linear metrics. With it, the question has become unnecessary, 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.

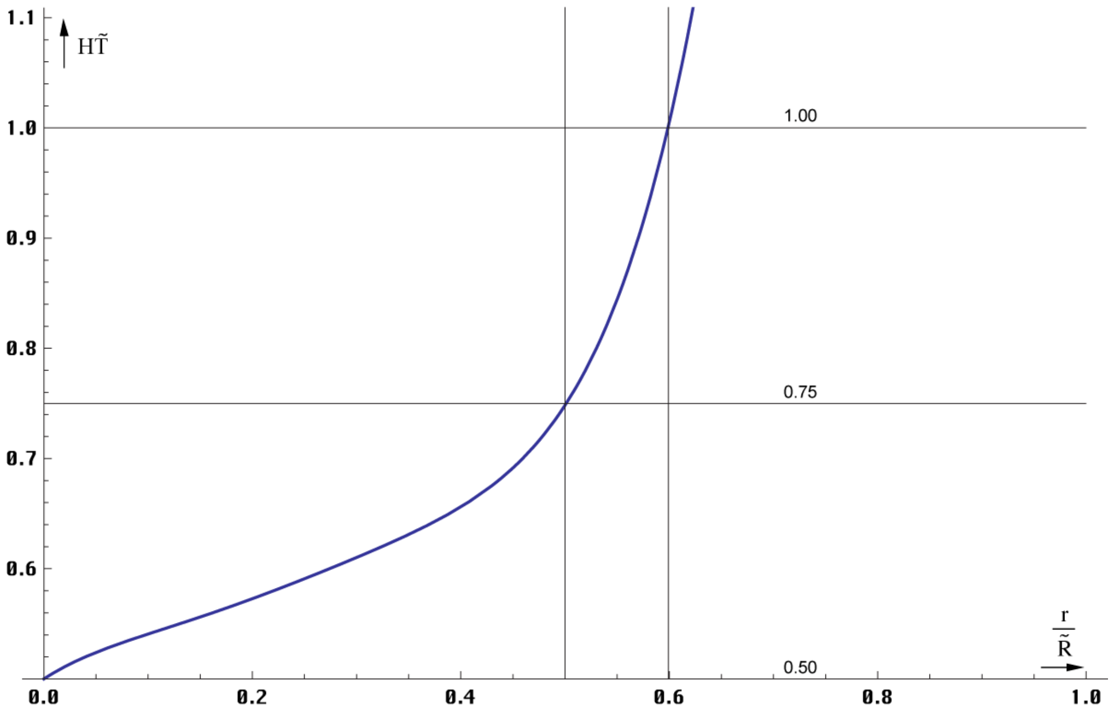



Figure 41
HUBBLE-parameter as a function of the distance for t=0, the values r>0.5R are extrapolated.

However, more latter distance is not an area of infinite red-shift as in other models. It shows with the dilatory-factor $q$ very well The course is depicted in Figure 42.

$$q = -\frac{r\ddot{r}}{\dot{r}^2} = \frac{1}{m} - 1 \tag{346}$$

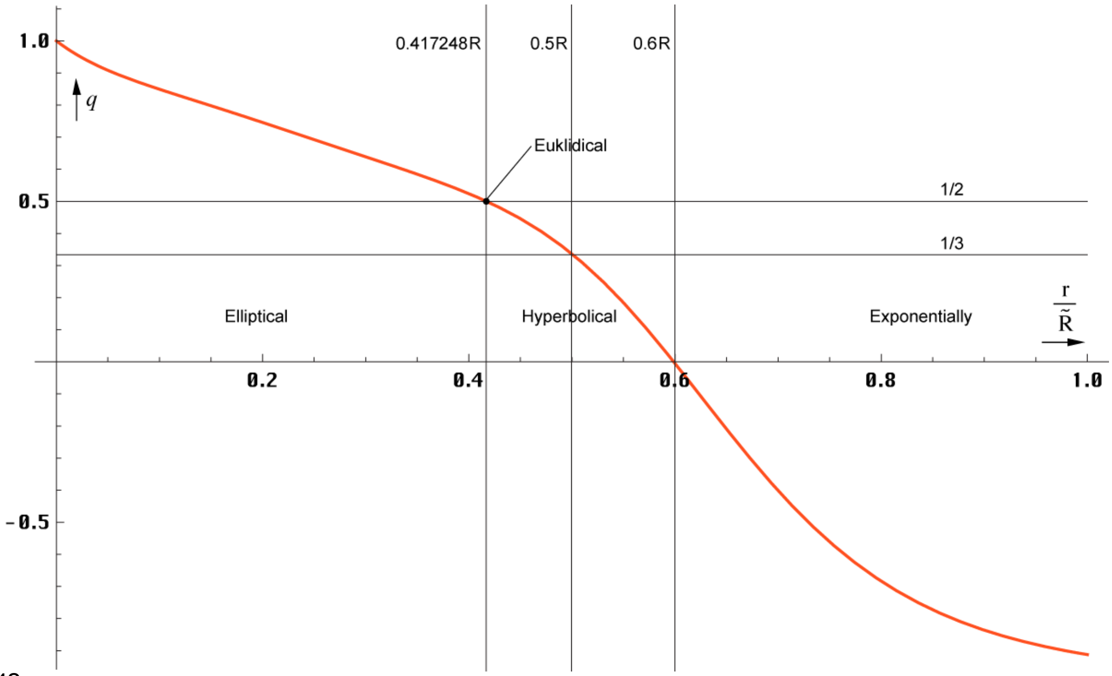



Figure 42
Dilatory-factor as a function of the
distance for t=0, the values r>0.5R are extrapolated

We get the expansion-velocity by differentiation of expression (342) with respect to the time t. At close range m=½ applies, leading to the well-known expression $H_0=1/(2T)$. The approximation is valid for t≪T, that's actually always the case, because we don't get that old.

$$v \;=\; \frac{d}{dt}\tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m} \;=\; m\,\frac{\tilde{r}}{\tilde{T}}\left(1+\frac{t}{\tilde{T}}\right)^{m-1} \;=\; \tilde{H}\,\tilde{r}\left(1+\frac{t}{\tilde{T}}\right)^{m-1} \;\approx\; \tilde{H}\,\tilde{r} \tag{347}$$

The course of Hr as a function of distance is shown in Figure 43. The speed of light is reached in an essentially minor distance as with the standard-models, but only on paper. While the size of $r_0$ at R/2=cT tends to $r_1$, the expansion speed along the time-like world line at this point is not infinite, rather it's smaller than c (0.75c).

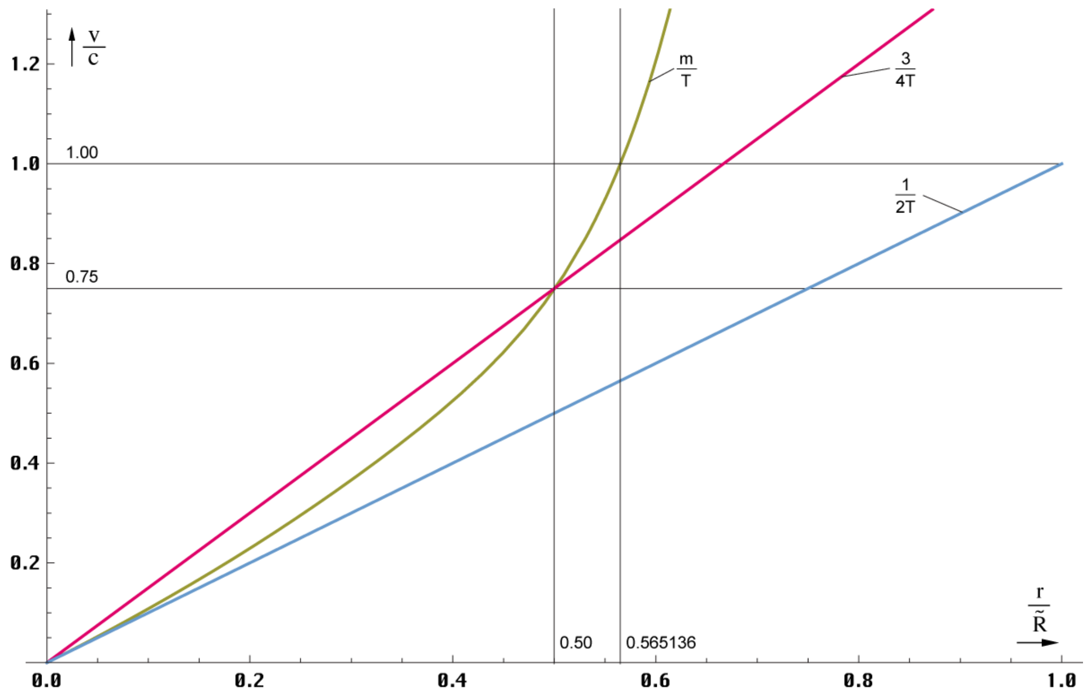



Figure 43
Expansion-velocity as a function of the
distance for t=0, the values r>0.5R are extrapolated

Otherwise we found out, that the maximum propagation speed $|\underline{c}_{max}|$ of the metric wave field amounts to 0.851661c only. But furthermore the world-radius should be cT, whereas time-like vectors with up to 2cT should be possible. So we have to do with four different distances resp. velocities, which all does not seem to fit together anyhow. But using this model it's possible to solve this conflict. Let's have a look on Figure 44, which except for $r_K$, is a true-to-scale representation.

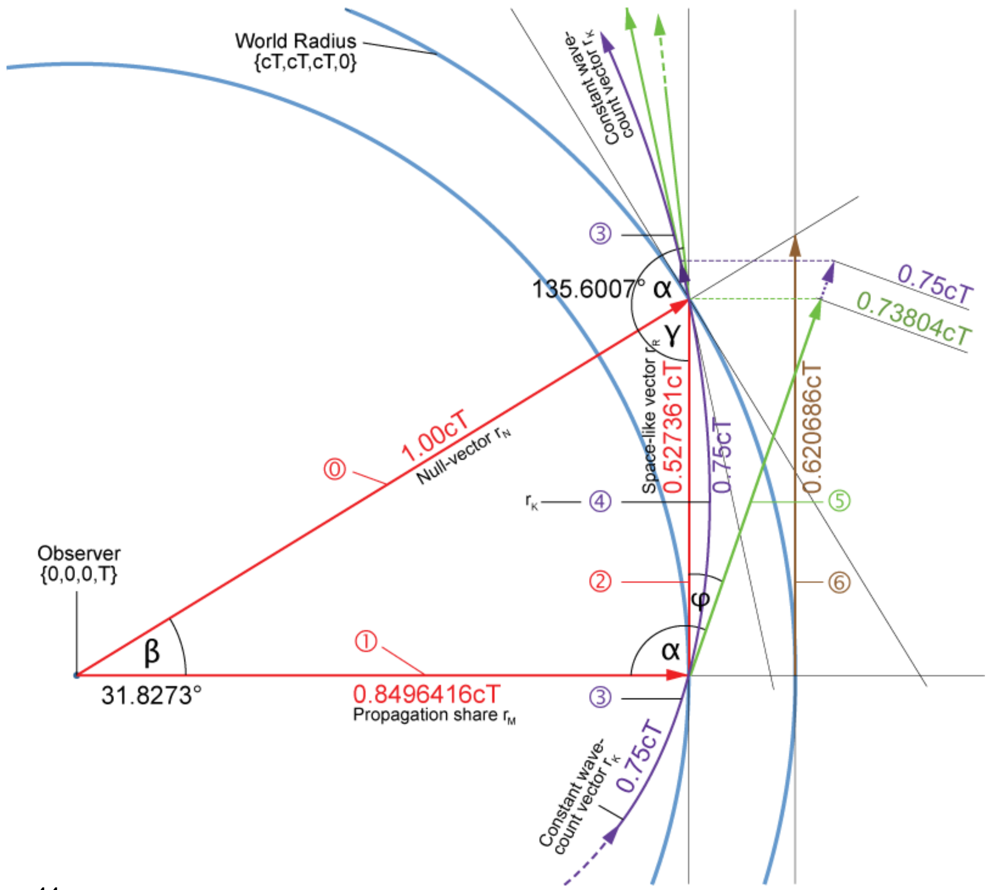



Figure 44a
Expansion-velocity and world-radius in the model

We assume, that the wave front of the metric wave field propagates straight-forward with 0.851661c (propagation share). Then, the share $r_M$ of the world-radius caused by it would amount to 0.851661cT. However, other values are given in the figure, why, we will see later. As noticed furthermore, the constant wave count vector $r_K$ up to the vicinity of R/2 is running on the same track as the incoming time-like vector $r_T$ with 0.75 c (arc length 0.75 cT). But it's tilted about the angle $\alpha_1$, so that we have to sum geometrically. In addition the partial vector ④ is curved. But the object we are looking for is the space-like vector $r_R$ (expansion share ②). Next we flatten the partial vector ④ bending it up to ⑤. Then we project it onto $r_R$, it applies $r_R=-r_K\cos\varphi$ with the angle $\varphi=\arg\underline{c}=\alpha-\pi/2=48.6231°$ of the metric wave function. With a phase angle of Q=0.8652911138 we obtain with the angle $\alpha=2.419430697\triangleq 138.6231678°$ the following solution:

$$c = \sqrt{c_M^2+c_R^2} = \sqrt{c_M^2+c_K^2\cos^2\alpha} = c\sqrt{0.85166^2+0.75^2\cos^2 2.41943} \tag{348}$$

$$c = c\sqrt{0.85166^2+0.562784^2} = 1.02081c \qquad \Delta=+2.08\cdot 10^{-2} \tag{349}$$

This result isn't notably exact and even worse than that in [52], which is barely correct btw. since there values for β, φ and $c_M$ have been used, misfitting Q=1. We will see, if we are able to get a more exact result. If we get granular on Figure 44a, we see, that $r_K$ is curved and, even in this state, protrudes significantly beyond $r_R$. As the case may be, we have to impose it with a correction factor, if we want to get a correct relation. On the one hand there is the ratio $RS = r_K/r_N$, which we can calculate. On the other hand there will be a similar case with the classic electron radius in section 6.2.5. (835), where we defined a correction factor $\zeta = 1.01619033$. Since I wonder about it exactly, I calculated a great many of alternatives, but neither the correction factor $\zeta$ nor $RS = r_K/r_N$ proved to be particularly helpful.

But there is a version, which delivers an acceptable result even without a correction factor. That's *the* case, with which the real part of the wave function $\underline{c}_M$ (209) has a zero-crossing (phase-jump). Since it's the simplest variant, it's probably the right one and I will prioritize it. See [52] for details. Here the exact parameters for this variant:

| | | | |
|---|---|---|---|
| $Q = 0.95013820167858442645$ | $c_M = 0.84854398252300016\,c$ | $c_R = 0.529124852680352\,c$ | $c_K = 0.75\,c$ |
| $\alpha = 134.86993657768931460°$ | $\beta = 31.94634370109298°$ | $\varphi = 44.8699365776893146°$ | $RS = 1.02469672804290424$ |

$$c = \sqrt{c_M^2 + c_K^2 \cos^2\alpha} = c\sqrt{0.848544^2 + 0.529125^2} = 1.0000000c \qquad \Delta = \pm 0.000000 \quad (350)$$

The conclusion is, the universe expands behind the particle horizon at $Q = 0.9501382$. That's between the point with the maximum expansion velocity and $Q = 1$. It is reminiscent of a surfer, who does not run on the crest of waves, but always a little off. With it, we have clarified the contradictions between the various world radii and expansion velocities. It's about a so called LEH-universe (Light speed Expanding Hyper spherical Universe). Please find more information about the time-like vector $r_T$ in section 7.5.2. The knowledge gained here has a significant influence on the calculation of the entropy of the metric wave field.

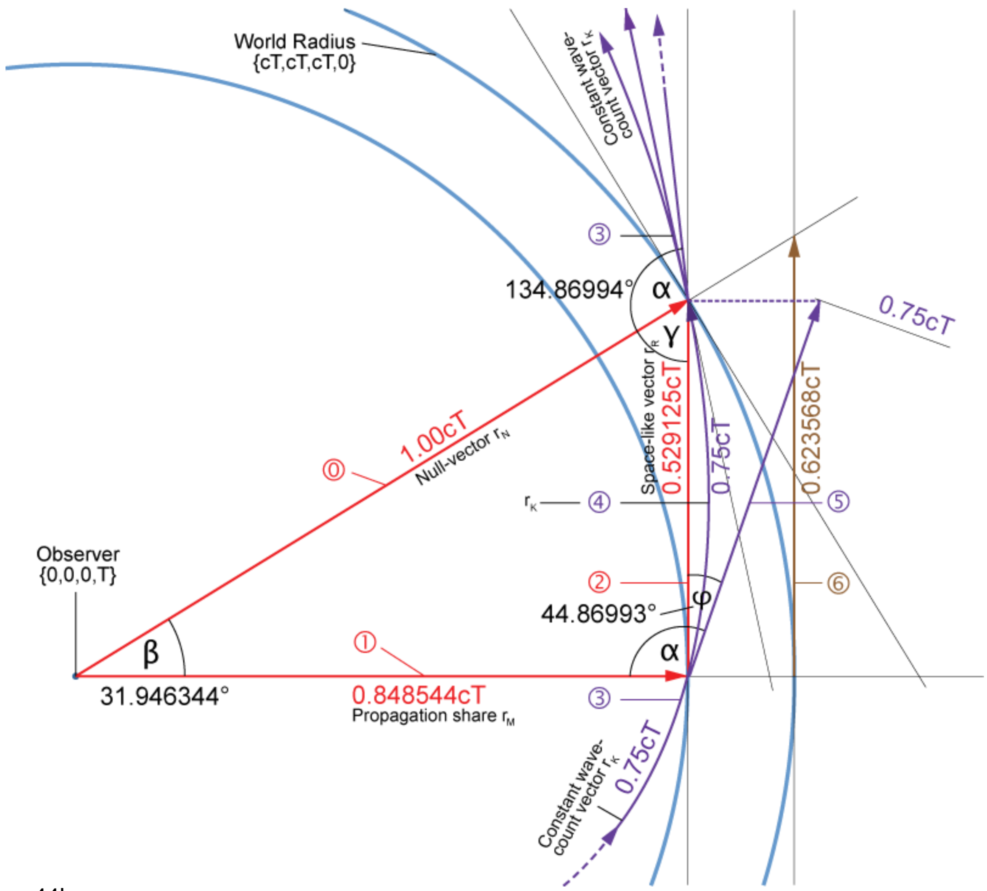



Figure 44b
Expansion-velocity and world-radius
without correction factor

## 4.6. Energy and entropy

### 4.6.1. Entropy

Now we will consider the discrete MLE and our model from the energetic point of view. Since entropy is much more important than energy for the thermodynamician, we will take it into account by examining entropy first. We want to mark entropy with S henceforth. In order to avoid confusions with the POYNTING-vector, we will always figure it bold as vector (**S**). If we write S, we always mean entropy and with **S** always the POYNTING-vector.

From the statistic point of view, the entropy of a system is defined by (351) where k is the BOLTZMANN-constant and N the number of all possible inner configurations.

$$S = k \ln N \tag{351}$$

With a single MLE (N=1) entropy would be equal to zero theoretically, by application of (352). That's wrong of course, since statistics necessitates a minimum number of N to be applied at all. With N=1 the result, mathematically can take on a whatever value without offending the „statistics". Therefore we want to try to find out, if there is another possibility to determine the entropy of this single MLE.

Strictly speaking the MLE is a matter of a ball-capacitor with the mass $m_0$ (29) moving in its inherent magnetic field. We don't know what happens inside the capacitor. Basically it behaves like a (primordial) black hole. According to [5] the SCHWARZSCHILD-radius of such a BH is defined as:

$$r_s = \frac{2mG}{c^2} \tag{352}$$

Now let's substitute m with $m_0$ here (29). We get $r_s=2r_0$, substantiating our foregoing assumption. The surface of this black hole yields with it to $A=4\pi r_0^2$. It's interesting that the expression for the SCHWARZSCHILD-radius can be derived even without aid of the SRT or URT. Because both, SRT and URT according to this model are 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] pp. 211 a method is figured 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 (353) with $R\equiv r^2-2mr+a^2$ and $\rho^2\equiv r^2+a^2\cos^2\vartheta$, $M=mGc^{-2}$ und $a=Lm^{-1}c^{-1}$; m is the mass and L the moment of momentum.

$$ds^2 = -\frac{R}{\rho^2}\left[c\,dt - a\sin^2\vartheta\, d\varphi\right]^2 + \frac{\rho^2}{R}dr^2 + \rho^2 d\vartheta^2 + \frac{\sin^2\vartheta}{\rho^2}\left[(r^2+a^2)\,d\varphi - a\,dt\right]^2 \tag{353}$$

We don't want to engross it here. The author finally comes to the following statements for the radius $r_\pm$ of the black hole and its surface A:

$$r_\pm = M \pm \sqrt{M^2 - a^2} \qquad A = 8\pi\left[M^2 \pm M\sqrt{M^2-a^2}\right] \tag{354}$$

$$r_\pm = \sqrt{\frac{2t}{\mu_0\kappa_0}} \pm \sqrt{\frac{2t}{\mu_0\kappa_0} - \left(\frac{2t}{\mu_0\kappa_0}\right)_{L=\hbar}} \qquad r_\pm = r_0 \pm \sqrt{r_0^2 - (r_0^2)_{L=\hbar}} \tag{355}$$

The result depends thereon, if the MLE disposes of a moment of momentum or not. With $m=m_0$ under application of (29), (53), (59) and (794) we obtain the following values for the SCHWARZSCHILD-radius: Without moment of momentum (L=0) for $r_-=0$, $r_+=r_s=2r_0$ as well as $A=4\pi r_0^2$. With moment of momentum $L=\hbar$, here the brackets apply, we get two identical solutions $r_\pm=r_0$. The surface yields $A=\pi r_0^2$.

Furthermore, the author refers to a work of BEKENSTEIN (1973), according to which 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:

$$S_b = \frac{kc^3}{4G\hbar}A \qquad = \qquad k\frac{A}{4r_0^2} \qquad = \qquad k\frac{A}{(4)r_s^2} \tag{356}$$

k is the BOLTZMANN-constant, the bracketed number applies to $L=\hbar$. Interestingly enough, the expression contains PLANCK's elementary-length and even with $\hbar$ according to our definition instead of h. If we now re-insert the values, we get:

$$S_b = 4\pi k \qquad \text{for } L=0 \qquad \text{as well as} \qquad S_b = \pi k \qquad \text{for } L=\hbar \tag{357}$$

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. For the moment of momentum **L** applies generally:

$$\mathbf{L} \quad = \quad \mathbf{r}\times\mathbf{p} \quad = \quad m\cdot(\mathbf{r}\times\mathbf{v}) \tag{358}$$

With $m=m_0$, $r=r_0$, $v=c$, $c\perp r$ we get after application of (27) and (29) for the amount L:

$$L \quad = \quad m_0 c r_0 \quad = \quad \hbar \qquad \text{and because of} \qquad c=\omega_0 r_0 \tag{359}$$

$$W_0 \quad = \quad m_0 c^2 \quad = \quad \hbar\omega_0 \tag{360}$$

Expression (360) is apparently right. With it, we have explicitly proven, that the MLE owns a moment of momentum. It's 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 Metric 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, almost periodic functions. PLANCK's quantity of action is the sum of track- and inherent moment of momentum then. It's equal to $\hbar$, at which point one time the track-, the other time the inherent moment of momentum becomes 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. $q_0\varphi_0$.

Going back to entropy. We see that the BOLTZMANN-constant figures an elementary quality of our metric fundamental lattice, as elementary as $\varepsilon_0$, $\mu_0$ and $\kappa_0$. Here, someone may say, this cannot be correct, since k is a purely statistical constant. Just we can answer this interjection: »The BOLTZMANN-constant is so elementary because it's statistical«. Even $\pi$ 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 (351). 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-centred crystal-lattice, the number of MLE's within a cube with the edge length d is defined as:

$$N \;=\; 4\left(\frac{d}{\rho}\right)^3 \;=\; 4\left(\frac{d}{r_0}\right)^3 \tag{361}$$

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

$$N = \frac{2}{3}\pi\left(\frac{d}{\rho}\right)^3 = \frac{2}{3}\pi\left(\frac{\Lambda r_0}{r_0}\right)^3 = \frac{2}{3}\pi\Lambda^3 \tag{362}$$

individual MLE's. As long as ρ is not too large, we can insert (333) for Λ, otherwise (337):

$$N = \pi\tilde{Q}_0^3\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{4}}\operatorname{artanh}\left(\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{4}}\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right)-\left(\frac{2r}{\tilde{R}}\right)^{\frac{1}{3}}\right)^3 \quad \text{or} \tag{363}$$

$$N = \pi\tilde{Q}_0^3\left(t^{\frac{1}{4}}\operatorname{artanh}\left(t^{-\frac{1}{4}}(2K_1 r)^{\frac{1}{3}}\right)-(2K_1 r)^{\frac{1}{3}}\right)^3 \quad \text{with } r = \mathrm{r}/\tilde{R} \text{ and } K_1 = 1 \tag{364}$$

That's the number of elements within a sphere with the radius r. The course is shown in Figure 45 curve ①. If we insert the expression $\Lambda_1 = 3/2\, Q_0 \ln Q_0$ into (362), we obtain even a result for $N_1$. Here $t \equiv 0$ reapplies. Then, the whole universe would contain altogether $N_1 = 9/4\,\pi\, Q_0^3 \ln^3 Q_0 = 8.35202 \cdot 10^{189}$ elements. Because of the propagation of the metric wave field this value is increasing continuously too (see Figure 47), and that according to $N_1(T) = 9/4\,\pi\,(\sqrt{bT})^3 \ln^3 \sqrt{bT}$ with $b = 2\,\kappa_0/\varepsilon_0$.

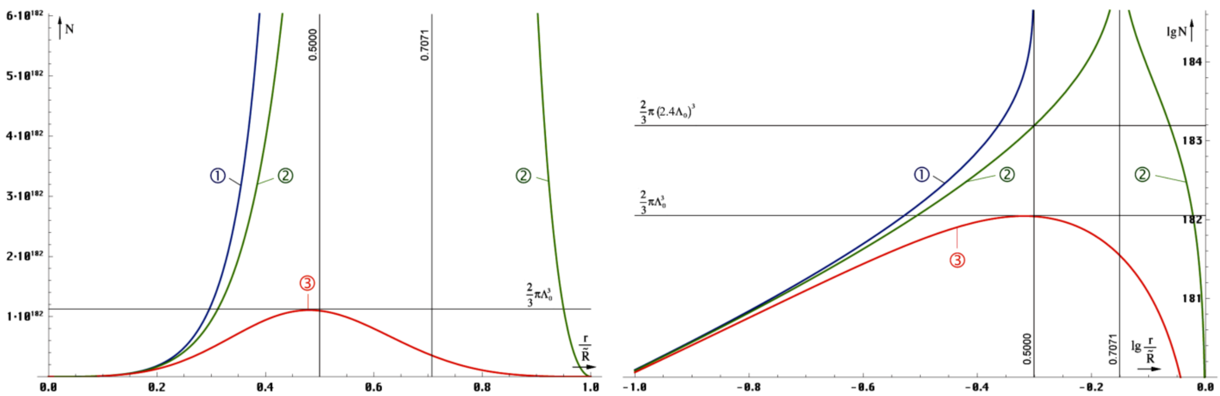



Figure 45
Number of MLE´s in dependence on the radius linear and logarithmic

But for the calculation of the entropy S these values are sparsely helpful. As is known S is about a statistical value and (364) violates a basic rule of the statistics: *A value must not be counted repeatedly.* The relations (341ff) namely apply for a „normal" 3D-sphere only.

But at the universe we have to take into account the particular 4D-topology. An observer in the free fall only imagines to be located in the spatial centre of the universe. In reality he is situated at a temporally singularity, the event horizon {0,0,0,T}. He is unable to overcome it, because beyond there is the future. Indeed, it's not about a point, but about a hyper-surface. All other observers at their own 3D-locations reside widespread at the same surface. Since T proceeds steadily, the temporal radius increases too and the observers are quasi „surfing" on the „time wave". If one observer wants to visit another, he must accelerate. Thus, his temporally course is slowing down. Indeed, he does not travel to the past, but he is only „broken away" from the unbraked time lapse. He suddenly finds himself inside the sphere. With v=c the time stands still for him. Now he is situated at the real spatial centre, but only, because it came up to him.

That means, the spatial 4D-centre is not with the observer, but in the distance cT at the coordinates {cT,cT,cT,0}. More correct would be $t_1$ instead of zero here. With the spatial centre it's also about a hyper-surface, a spatial singularity, the particle horizon. We cannot overcome even that. Like the temporal radius it's expanding steadily. Altogether it's about a closed system.

If two observers could swap their positions, they would find the same conditions on both locations. Since overall in the universe the same physical laws apply. Interesting thereat is, that we *observe* different conditions in a definite distance r. The reason is the finite speed of light. The universe is *not* hot-wired, there is *no* instantaneous interconnection between whatever points (except for quantum entanglement). For all observers the universe consists of the local conditions plus all forces and signals resulting from prior states, delayed by $t \geq r/c$. The farther, the elder the condition, that caused the impact.

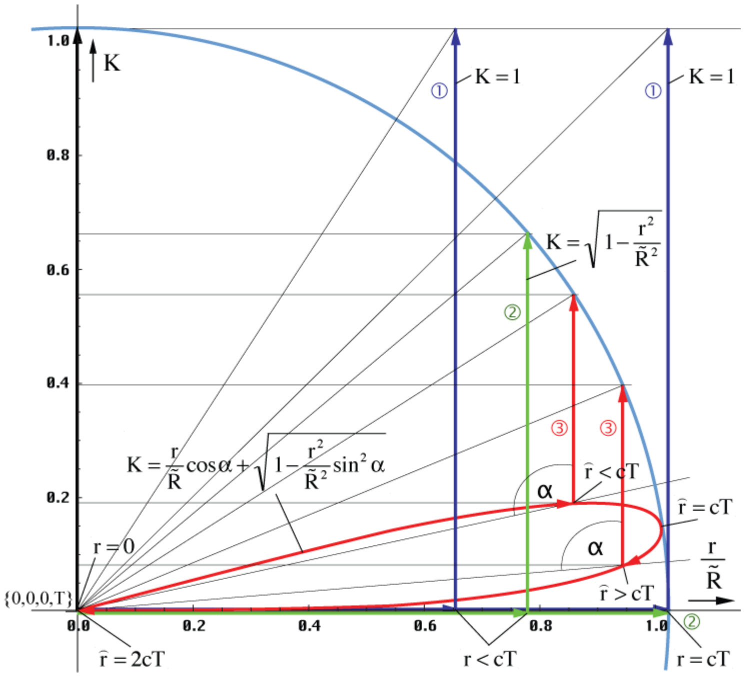



Figure 46
Factor K in dependence on the radius for the 3 solutions (schematic presentation)

And exactly that is the reason, why we cannot use expression (364). Approaching the distance cT, the MLE-density within Λ is increasing enormously indeed. But similarly, the universe in that distance, at that time has had an essentially smaller world radius, a smaller surface. That means, the cross section must be smaller than at solution ①. *The larger* the distance r, *the smaller* the surface A, the opposite way around, as with a „normal" sphere.

Even e.g. the spherical shell in the distance $R/2-r_1$ namely consists of only one single element. If its condition changes, it has a *simultaneous* effect *on all* vectors coming from *all* directions. But we are allowed to count only one element.

In fact that's good for MACH's principle, spatial damping cancels out, the strongest force is coming from the „edge", but not for the statistics. That's why we are forced to find a function, which considers these special conditions. In doing so the reference to the time *t* should not get lost. Because I'm not a topology-expert, I tried to find such a function, at least roughly by introduction of a correction factor K; the whole by trial and error. So it's not about a correct derivation here. With small r a possible solution should run similarly as with a 3D-sphere, likewise as solution ①. In the vicinity of R/2 it should flatten out however. Either the border R/2 should not be passed.

In addition to ① two more possible solutions are depicted in Figure 46 to the correction of one single coordinate. With solution ② (365) I assumed the volume of the inverse sphere to decrease with *r*. Solution ③ (366) additionally considers the curvature in the vicinity of R/2 under consideration of the angle α.

$$N = \pi\tilde{Q}_0^3\left(t^{\frac{1}{4}}\operatorname{artanh}\left(t^{-\frac{1}{4}}(2K_2 r)^{\frac{1}{3}}\right)-(2K_2 r)^{\frac{1}{3}}\right)^3 \quad \text{with} \quad K_2=\sqrt{1-r^2} \qquad (365)$$

$$N = \pi\tilde{Q}_0^3\left(t^{\frac{1}{4}}\operatorname{artanh}\left(t^{-\frac{1}{4}}(2K_3 r)^{\frac{1}{3}}\right)-(2K_3 r)^{\frac{1}{3}}\right)^3 \quad \text{with} \quad K_3=r\cos\alpha+\sqrt{1-r^2\sin^2\alpha} \qquad (366)$$

The angle $\alpha(r)$ calculates as follows (*applies only in connection with (366)!!!*)

$$\alpha = \frac{\pi}{4} - \arg\left(-j4r\left(1-\left(\frac{H_2^{(1)}(r^{-1}/2)}{H_0^{(1)}(r^{-1}/2)}\right)^2\right)^{-\frac{1}{2}}\right) \qquad (367)$$

It's even only a rule of thumb. The course of both functions is depicted in Figure 45. As we can see, function (365) is less suitable, because it exceeds the R/2-border at $N=2/3\pi(1.1955\cdot Q_0)^3=2/3\pi(2.3909\cdot\Lambda_0)^3$ – a crooked value. There isn't a flattening either, but a pole outside R/2.

Function (366) on the contrary fulfils all demands. It proceeds as with a 3D-sphere, like solution ① at small r and there is a flattening in the direct vicinity of R/2. Indeed, the function is defined beyond R/2, but without pole, and the value re-drops to zero at 2cT. That means, it's about a time-like vector remaining inside the world radius. That's easy to understand. When rushing through the 4D-centre {cT,cT,cT,0} or passing it within spitting distance, the vector re-approaches the observer and N has to decline again. The maximum is at the „magic" value $N_0=2/3\pi(Q_0/2)^3=2/3\pi\Lambda_0^3=1.12308\cdot10^{182}$. The reason, why the function hits its maximum already on the verge of R/2, is its curvature. The arc-length becomes effective here.

By the way, all time-like vectors with the length 2cT, regardless of continuous or discontinuous (virtual), are coming from a point with the coordinates $\{r_1/2, r_1/2, r_1/2, t_1/4\}$. That's behind the particle horizon, previous to the phase jump at Q=1, from a time, at which event- and particle-horizon still overlapped each other (Q=1/2). The real world age is T, the length 2cT is the result of curvature, propagation and expansion (see Figure 152).

Thus I'm sure, that (366) fits the actual conditions to the best. Then, $N_0$ would be identical to the total number of possible micro-states of the universe and candidate for the calculation of the entropy $S_0$. The temporal dependence of N according to (366) for several constant distances is depicted in Figure 47. The course of $N_0(T)$ and $N_1(T)$ in the comparison is shown top right. The rule of $N_1$ has been scaled down about $10^8$, because both values gape apart too much.

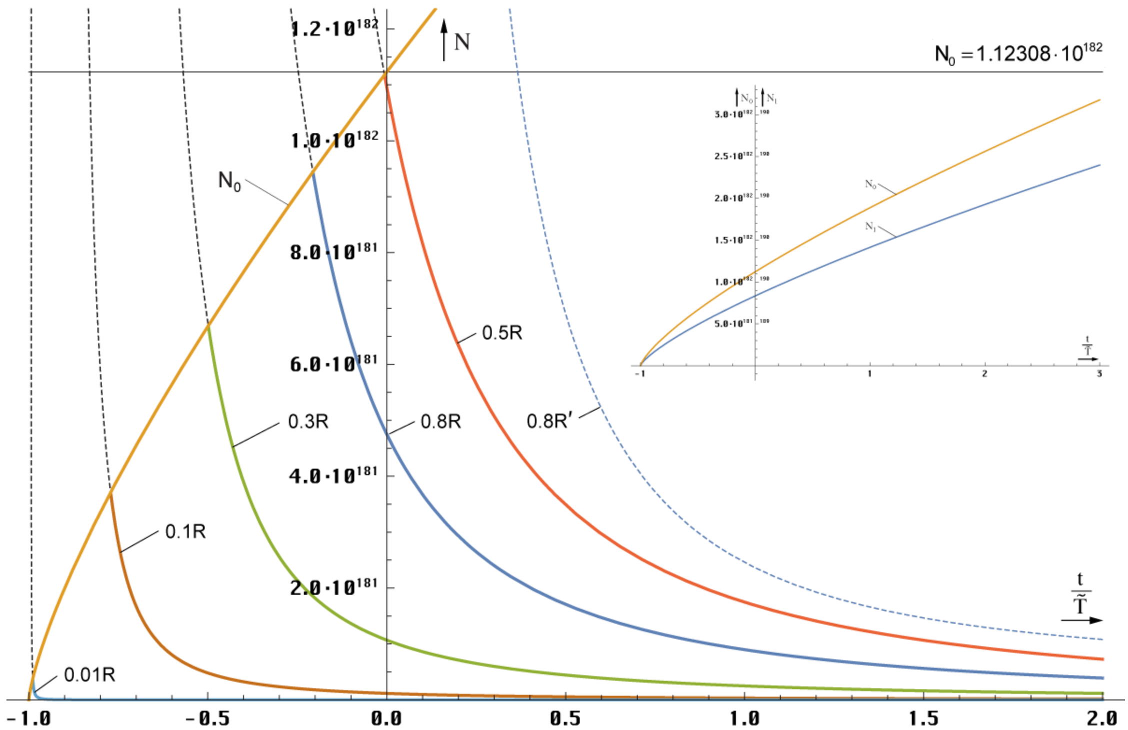



Figure 47
Number of MLEs in dependence on time according to solution ③

Needless to say, the temporal functions are defined from $N_0$ on only, above they are cropped. Solution ① proceeds similarly, but $N_1$ is orders of magnitude greater, so that the crop takes place much higher in a range running nearly vertical up, which can no longer be processed by the plot program. And there is another difference. Distances >R/2 aren't postponed into future with solution ① and ② similar to the dashed blue line (not to scale). That's correct. In contrast, solution ③ shows them, as if it's about a distance <R/2, which is also correct. Of course, there is even such a line with solution ③ (example 0.8R′), but it's

not being emulated by expression (366). That's correct too, since there is a nearly infinite number of solutions already in the example range 0.5…0.8R and beyond, depending on R′.

Now let's get down to the entropy. Generally (351) applies here. As determined more above, the entropy of the MLE calculates similar to that of a black hole according to (357) right ($S_b$). Thus, we have to multiply (351) with π. However, that applies to the metric wave field only and not to the CMBR. All other problems may be calculated with the conventional ansatz and (351). In doubt just divide the results by π.

The course of the entropy S in dependence on the radius is shown in Figure 48. Starting with a value of zero at $r=r_0/2$ the entropy without consideration of curvature ① rises continuously with increasing r, runs through a phase of minor ascend and skyrockets towards infinite with r→cT. But an infinite value will not be achieved, since the number of line elements until the edge is limited to $N_1$.

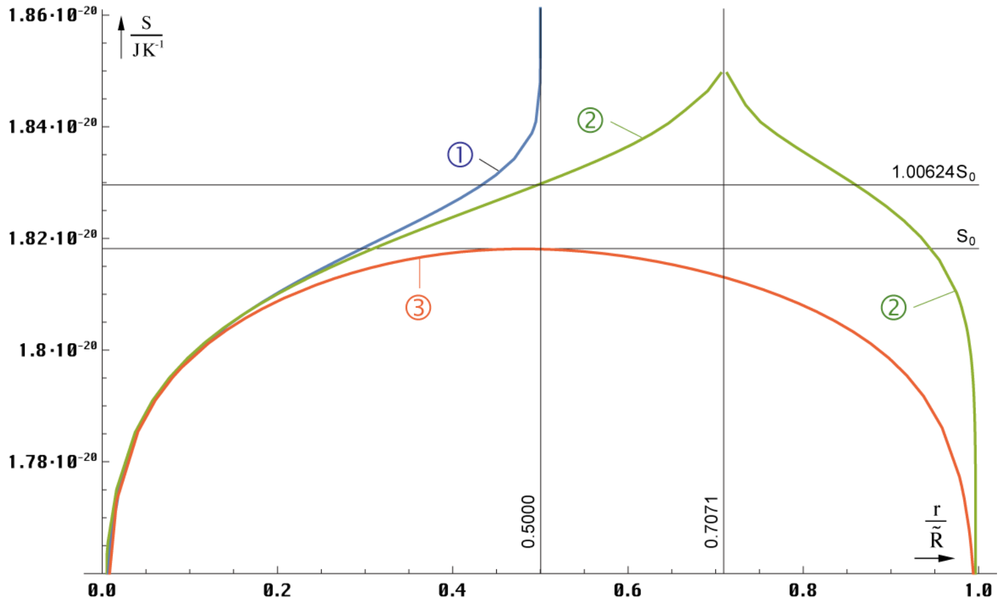



Figure 48
Entropy in dependence on the radius

Because of the pole solution ② is less suitable. For solution ① we obtain the huge value of $S_1 = 3\pi k(⅔ + \ln Q_0 + \ln\ln Q_0) \approx 1312\pi k = 1.89701\cdot 10^{-20}\,\mathrm{JK}^{-1}$. For solution ③ the entropy $S_0$ applies. It's defined as follows:

$$S_0 = \pi k \ln\left(\frac{2}{3}\pi\Lambda_0^3\right) = \pi k \ln\left(\frac{1}{12}\pi\tilde{Q}_0^3\right) = 1.81821\cdot 10^{-20}\,\mathrm{J\,K}^{-1} \qquad (368)$$

The temporal dependence of $S_0$ for the case r=const is depicted in Figure 49. Interestingly enough the values of regions with fixed size decrease steadily. Maybe that's the „motor" of the evolution from the lower to the higher. In the case constant wave count vector the entropy $S(r\neq R/2)$ remains constant across the whole definition range. It calculates according to (369) on the left. For $S_0$ the right expression applies:

$$S = \pi k \ln N \qquad S_0 = \tilde{S}_0 + 6\pi k \ln t = \tilde{S}_0 + 3\pi k \ln\left(1+\frac{t}{\tilde{T}}\right) \qquad (369)$$

To calculate $S_1$ we advantageously substitute $Q_0$ with $\tilde{Q}_0 t^2$ in the expression in the paragraph below Figure 48. The entropy with constant wave count vector isn't defined across all times for all radii either. Certain distances don't exist, until the radius of the expanding universe has reached that length. Then S gets the value $S_0$ resp. $S_1$ exactly on entry. It applies: The later the entry, the higher starting entropy. Curves are being cropped even here in turn. Solution ① looks similar like Figure 49. The curve $S_1$ proceeds far beyond the plot however. Initial distances >R/2 are moved into future too, with solution ③ into the range <R/2, just like with $N_1$ and $N_0$.

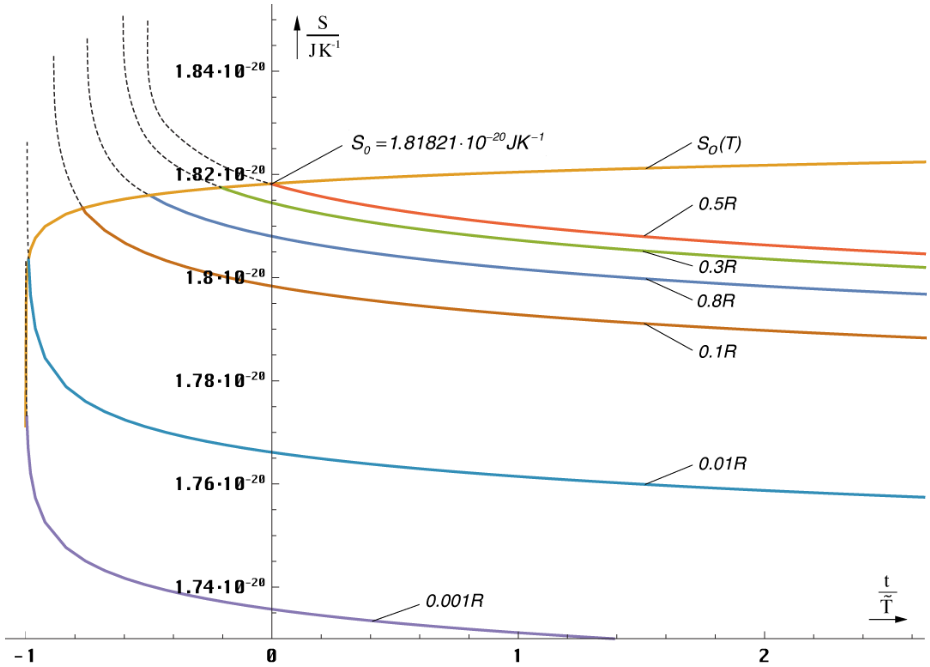



Figure 49
Temporal dependence of the entropy
for r=const (linear scale)

The temporal functions $S_0$ and $S_1$ are tending to $\infty$, as we can easily see by application of the limit theorems. Concerning the future of the universe we can say, that we don't have to fear a heat death. A thermodynamic equilibrium will never occur. The reason is the propagation of the metric wave field, as well as the expansion of the universe. That was a close shave!

## 4.6.2. Particle horizon

As shown in section 4.6.1. the MLE disposes of an inner SCHWARZSCHILD-radius with the value $r_\pm = r_0$. It has the property of a particle horizon. Because of the relations $R = r_0 Q_0$ and $r_1 = r_0/Q_0$ it may be possible, that such a particle horizon also exists on a macroscopic scale, for the cosmos as a whole. The HUBBLE-parameter $H_0 = \omega_0 Q_0^{-1}$ has the character of an angular frequency, just as $\omega_0 = \omega_1 Q_0^{-1}$. Thus, it may be possible, that even the whole universe owns an angular momentum in the amount of $\hbar_1 = \hbar Q_0$. The MLE with its spin 2 lets suppose, that the universe also owns a spin of the size 2. That would explain a lot of phenomena. Therefore, with this information, we want to try, to calculate such a hypothetic SCHWARZSCHILD-radius $R_\pm$ with ($L = \hbar_1 = \hbar Q_0$).

We start, in that we multiply (355) with $Q_0$ resetting the bracketed expression to the definition $a = \hbar m^{-1} c^{-1}$. The value $M_1$ is determined using the right-hand ansatz and (794):

$$R_\pm = Q_0 r_\pm = R \pm \sqrt{R^2 - \left(\frac{Q_0 \hbar_1}{2M_1 c}\right)^2} \quad \text{with} \quad \frac{M_1 G}{c^2} = 2ct \quad \Big| \quad M_1 = m_0 Q_0 = \mu_0 \kappa_0 \hbar \qquad (370)$$

$$R_\pm = R \pm \sqrt{R^2 - Q_0^2 r_0^2} = R \pm \sqrt{R^2 - R^2} = R \qquad (371)$$

As result a double solution with $R_\pm = R$ turns out, exactly as with the MLE but on a larger scale. The universe inside is larger then outside apparently, maybe due to the curvature of the time-like vectors. Notably interesting is the value $M_1 = 1.73068 \cdot 10^{53}$ kg ($Q_0$ as per Table 11). That's the total mass of the metric wave field and identical to MACH's counter mass. Dividing it by the volume $V_1 = \frac{4}{3}\pi R^3$ we obtain a value of $1.94676 \cdot 10^{-29}$ kg dm$^{-3}$ for the density. This one is about 3/2 times greater than the value $G_{11}$(R/2) calculated in section 7.2.7.2. Well, we are living in a black hole actually and we can use nearly 100% thereof. Or is there yet an „outside“ and the universe is nothing other than a huge line element?

### 4.6.3. Temperature

Now we want to assign a temperature to the discrete MLE. According to [4] it arises from GIBBS' fundamental equation as well as from (23) and (32) to:

$$T_b dS_b = d(mc^2) - \omega dL \tag{372}$$

$$T_b dS_b = d(m_0 c^2) - d(\hbar\omega_0) = 0 \qquad T_b \equiv 0\ \mathrm{K} \tag{373}$$

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:

$$T_b = \frac{\hbar c^3}{8\pi m_0 G k} = \frac{W_0}{8\pi k} \qquad T_b = 5.638 \cdot 10^{30}\mathrm{K} \tag{374}$$

The result (374) deviates from the one which we would obtain using WIENs displacement law. The magnitude is correct however. Indeed this is even only applied to black radiation, whereas, 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 $r_0$.*
4. *The inner SCHWARZSCHILD-radius of the local universe is equal to 2cT.*

For this reason PLANCK's quantity of action is also a fundamental quality of the metric wave-field. 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:

$$q_0 = \sqrt{\frac{\hbar}{Z_0}} = 5.29081769 \cdot 10^{-19}\,\mathrm{As} = 3.30226866\mathrm{e} \tag{375}$$

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:

$$\Delta W \Delta t \geq \frac{\hbar}{2} \qquad \text{as well as} \qquad \Delta W_0 \Delta\tau_0 \geq \frac{\hbar}{2} \tag{376}$$

$$\Delta q_0 \geq \sqrt{\frac{\hbar}{2Z_0}} = \frac{q_0}{\sqrt{2}} = 2.335056\mathrm{e} \tag{377}$$

Then the lower limit of the conducting band amounts to 2.134e so that the charge of the COOPER-pair with 2e is only 2% ($q_0$) below the conducting band. By the way, the equality-sign in (377) 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 $1/\kappa_0=7.30045\cdot 10^{-94}\ \Omega m^2/m$ is so extremely small that it is factually equal to zero. At all, an instrumentational determination of $\kappa_0$ 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 $\varphi_0$:

$$\varphi_0 = \frac{\hat{\varphi}_i}{\sqrt{2\pi\omega_0 t}}(\cos 2\omega_0 t + \sin 2\omega_0 t) \tag{378}$$

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 $\omega_0$ is a time-dependent value. One works just useful using equ. (114)

$$\varphi_0 = \hat{\varphi}_i J_0(2\omega_0 t) \qquad \varphi_0 = \hat{\varphi}_i J_0\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{379}$$

$$\dot{\varphi}_0 = -\frac{\hat{\varphi}_i}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_o t}}\, J_1\sqrt{\frac{2\kappa_0 t}{\varepsilon_o}} \tag{380}$$

$$u_0 = -\hat{\varphi}_i \omega_0 J_1(2\omega_0 t) \tag{381}$$

For $q_0$ we obtain because of (123):

$$q_0 = C_0 u_0 = \varepsilon_0 r_0 u_0 \tag{382}$$

$$q_0 = -\varepsilon_0 \omega_0 r_0 \hat{\varphi}_i J_1(2\omega_0 t) = -\varepsilon_0 c \hat{\varphi}_i J_1(2\omega_0 t) \tag{383}$$

$$q_0 = -\hat{q}_i J_1(2\omega_0 t) \tag{384}$$

$$q_0 = \frac{\hat{q}_i}{\sqrt{2\pi\omega_0 t}}(\cos 2\omega_0 t - \sin 2\omega_0 t) \tag{385}$$

Now, we get for PLANCK's quantity of action:

$$\hbar(t) = \frac{\hat{\hbar}_i}{2\pi\omega_0 t}(\cos^2 2\omega_0 t - \sin^2 2\omega_0 t) = \frac{\hat{\hbar}_i}{2\pi\omega_0 t}\cos 4\omega_0 t \tag{386}$$

$\hat{\hbar}_i = \hat{q}_i\hat{\varphi}_i$ 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:

$$QM = \sqrt{\frac{1}{t_{k+1} - t_k}\int_{t_k}^{t_{k+1}} F^2(t)\,dt} \tag{387}$$

For periodic functions, the lower limit is zero in general, the upper limit a multiple of $\pi$, mostly $2\pi$. That e.g. leads to an effective-value of $½\sqrt{2}$ 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 (387) 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 $½\sqrt{2}$ 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:

$$\hbar = \frac{\hat{\hbar}_i}{4\pi\omega_0 t} = \frac{\hat{\hbar}_i}{2\pi}\sqrt{\frac{\varepsilon_0}{2\kappa_0 t}} = \frac{1}{2\pi}\frac{\hat{\hbar}_i}{Q_0} \tag{388}$$

The quantity of $\hbar_i$ (peak- and effective-value) allows to be determined from it easily:

$$\hat{\hbar}_i = 2\pi\tilde{Q}_0\tilde{\hbar} = 5.52645\cdot 10^{27}\ \mathrm{Js} \qquad \hbar_i = \frac{\hat{\hbar}_i}{2} \qquad t_i = \frac{t_1}{4\pi^2} \tag{389}$$

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) according to Table 11:

$$\varphi_0 = \sqrt{\frac{\hbar_1 Z_0}{2\omega_0 t}} = \sqrt{\frac{\hbar_1 Z_0}{Q_0}} \qquad \hbar_i = \frac{\hat{\hbar}_i}{2\pi} = 8.79563\cdot 10^{26}\ \mathrm{Js} \tag{390}$$

$$q_0 = \sqrt{\frac{\hbar_1}{2\omega_0 t Z_0}} = \sqrt{\frac{\hbar_1}{Q_0 Z_0}} \qquad q_1 = \sqrt{\frac{\hbar_1}{Z_0}} = 1.52798\cdot 10^{12}\ \mathrm{As} \tag{391}$$

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 (388) is sufficient for the bulk of all cases.

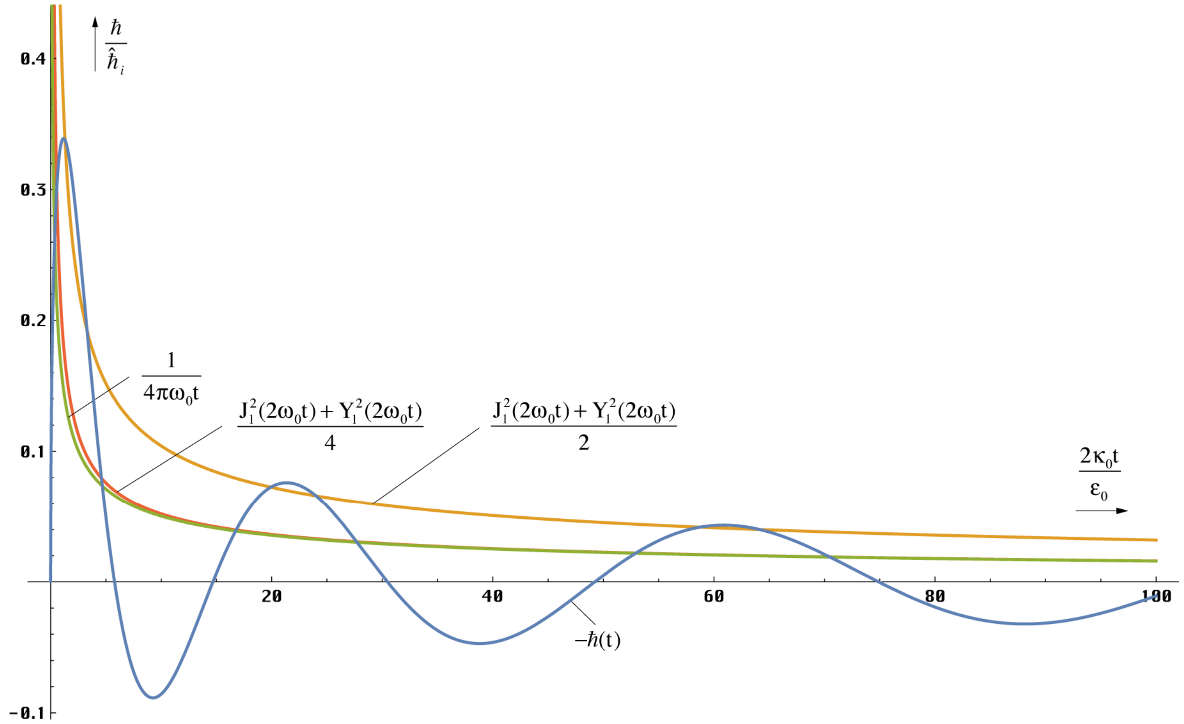



Figure 50
Miscellaneous approximative solutions for
PLANCK's quantity of action, larger scale

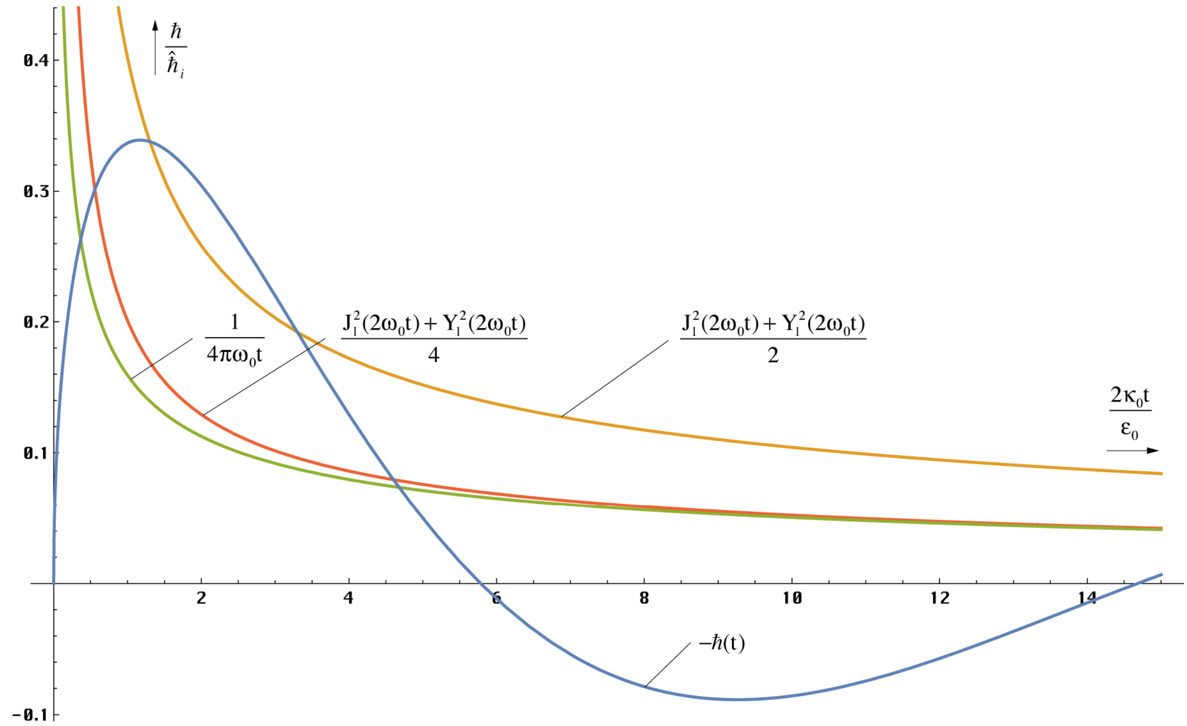



Figure 51
Miscellaneous approximative solutions for
PLANCK's quantity of action, smaller scale

For examinations of the period immediately after big bang it's however opportune to work with the time-function. This is as follows:

$$\hbar = -\hat{\hbar}_i J_0(2\omega_0 t)\, J_1(2\omega_0 t) \tag{392}$$

Another expression for the effective-value h can be found with it. Whether this is better than (389), one can see in Figure 50 and 51 – the approximation (388) 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 (388), 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 (388) that still has the additional advantage, to be better integrable. Also the dependence on the present values is interesting. We take up the known transformation $2\omega_0 t \to t/T$ once again obtaining:

$$\hbar = \frac{\hbar_1}{\tilde{Q}_0}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}} = \tilde{\hbar}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}} \tag{393}$$

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 (393) to:

$$\hbar = \frac{\hbar_1}{\tilde{Q}_0}\frac{1}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} = \frac{\tilde{\hbar}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \tag{394}$$

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.

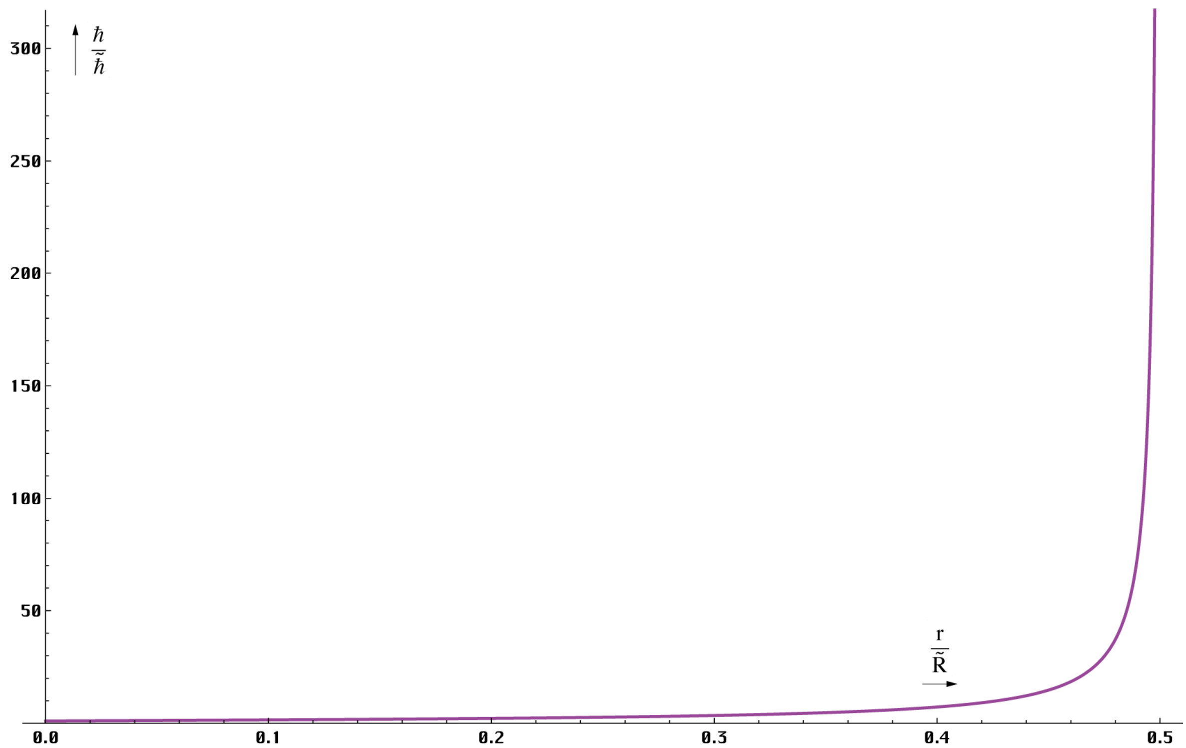



Figure 52
PLANCK's quantity of action
as a function of distance for t=0

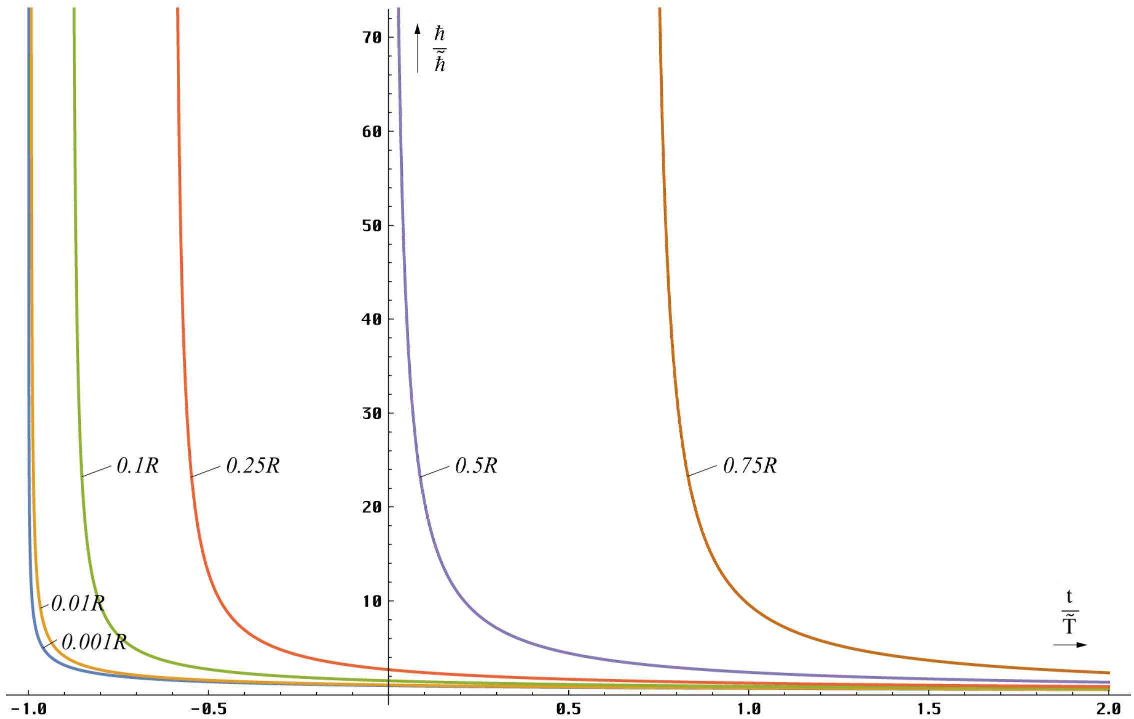



Figure 53
PLANCK's quantity of action
as a function of time for r=const

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.

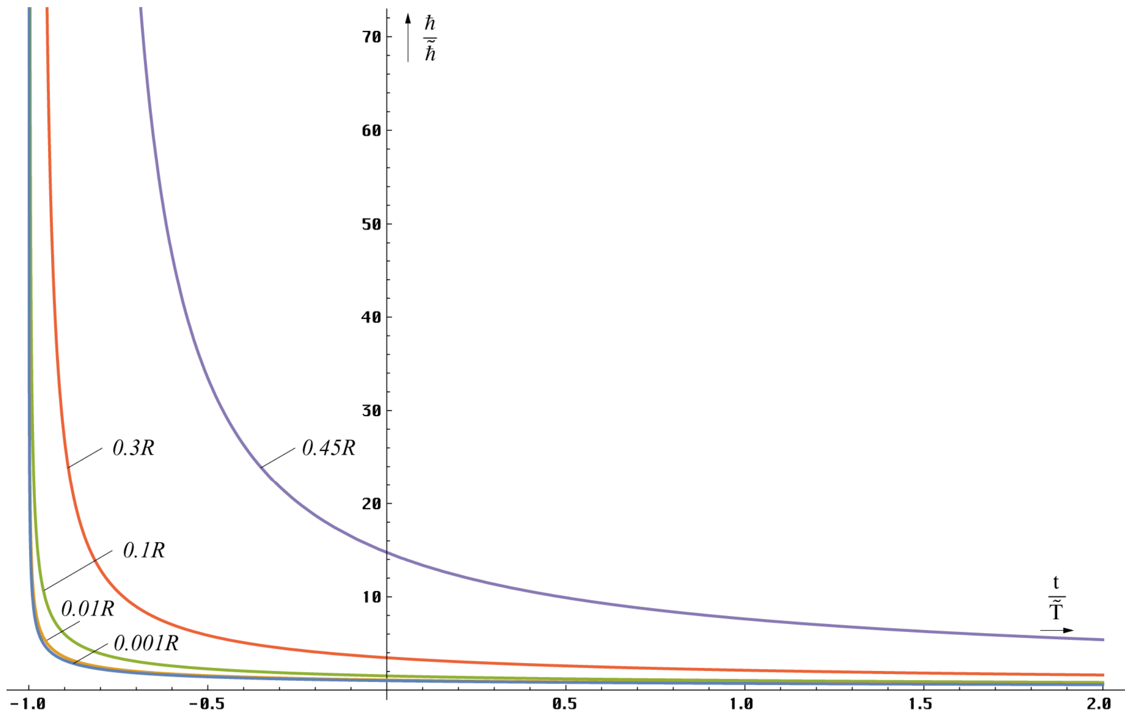



Figure 54
PLANCK's quantity of action as function
of time with constant wave count vector

It will be obtained by application of (343) and (346) without consideration of the restricted definition range by replacement of r (395). However the value of $\hbar$ over a long time period (approximately one age) remains virtually constant (Figure 55). With small distances applies (393) 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.

$$\hbar = \frac{\hbar_1}{\tilde{Q}_0} \frac{1}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \left(1+\frac{t}{\tilde{T}}\right)^{\frac{2m}{3}}} = \frac{\tilde{\hbar}}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \left(1+\frac{t}{\tilde{T}}\right)^{\frac{2m}{3}}} \tag{395}$$

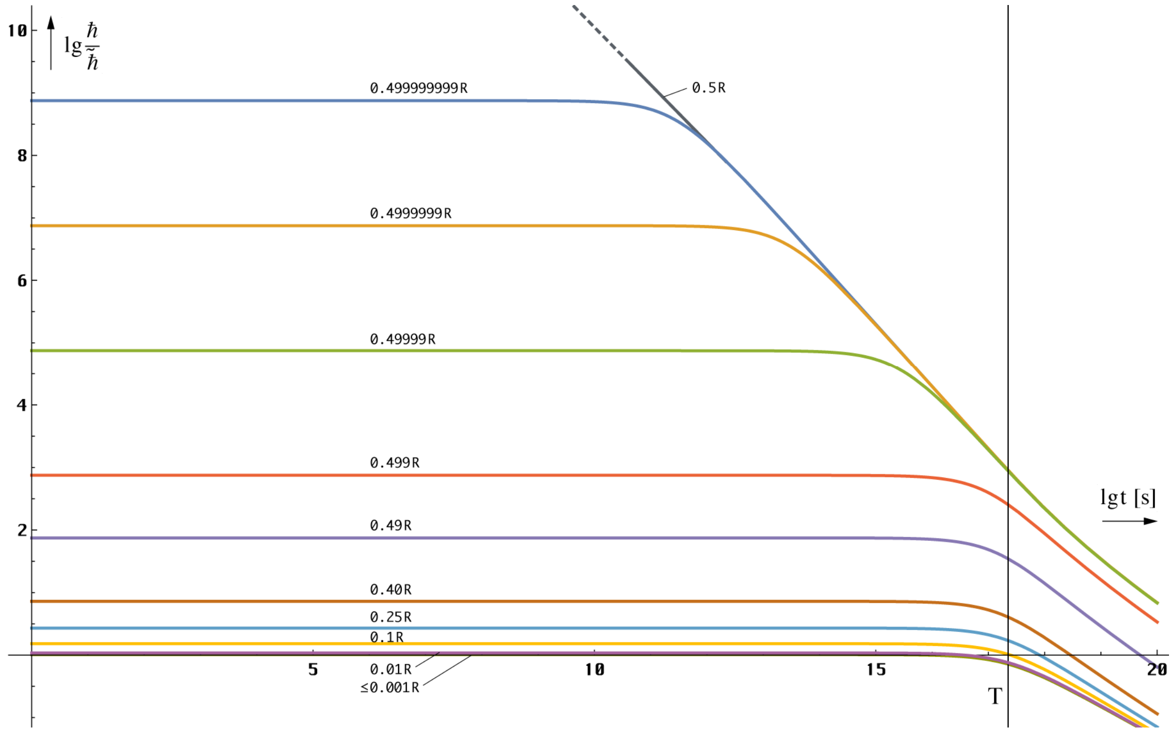



Figure 55
PLANCK's quantity of action with constant wave count vector
for several initially distances (time calculated from nowadays)

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 (368) and (394) 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:

$$\Delta p \cdot \Delta x \geq \frac{\hbar}{2} \qquad\qquad \Delta(mv) \cdot \Delta x \geq \frac{\hbar}{2} \tag{396}$$

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 $\Delta x$:

$$\Delta x = \frac{1}{2}\frac{\hbar}{m_e c} = \frac{1}{4}\frac{\hbar_1}{m_e \omega_0 c t} = \frac{1}{2}\frac{\hbar_1}{m_e c \tilde{Q}_0}\frac{1}{\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \tag{397}$$

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 $\Delta x$. For the electron this amounts to (updated value):

$$\Delta x_i = \frac{1}{2}\frac{\hbar_i}{m_e c} = 1.01183\cdot 10^{49}\,\mathrm{m} \gg \tilde{R}\ (1.34803\cdot 10^{26}\,\mathrm{m}) \tag{398}$$

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 (394) and (397). Also the value of $\hbar$ is essentially lower there. In the distance R/2–1 m 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

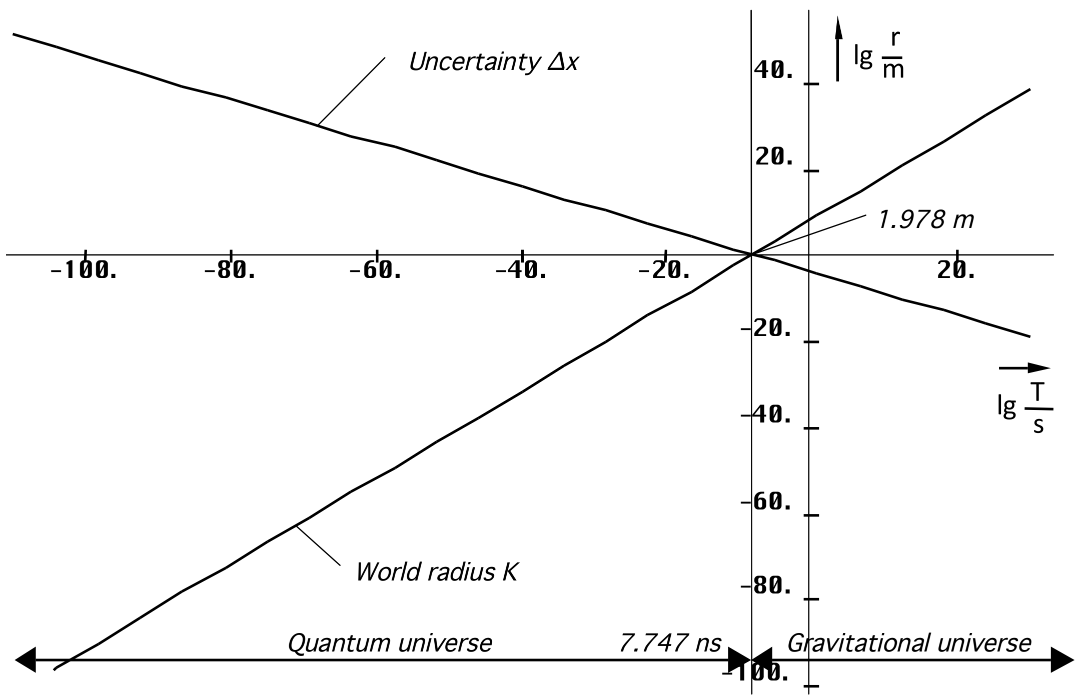



Figure 57
Quantum universe and gravitational universe

### 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 behaviour. 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 cosmologic 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

$$\dot{w}_0 + \operatorname{div}\mathbf{S} = -\mathbf{i}\,\mathbf{E} \tag{399}$$

In this case $\dot{w}_0$ is the shift of the energy-density, $\mathbf{S}$ the POYNTING-Vector, $\mathbf{i}$ the current-density and $\mathbf{E}$ 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 Metric 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 $\omega_0$ are functions of time and place. First, we want to figure the temporal dependence. Under application of (388) we obtain:

$$W_0 = \frac{\hat{\hbar}_i}{4\pi t} = \hbar_1 H = \hbar Q_0 H = \hbar\omega_0 \tag{400}$$

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 expression, the effective lattice constant $\pi$ appears interestingly enough. The course is shown in Figure 58. There is also a maximum-energy (Q=1/2):

$$W_i = \frac{\hat{\hbar}_i}{4\pi t_i} = \frac{\hbar_i\omega_i}{\pi} = 4\,\hbar_1\omega_1 = 4{,}4508\cdot 10^{131}\ \mathrm{Js} \tag{401}$$

No MLE's exist at an earlier point of time. If we want to figure the spatial dependence (Figure 59), we have to rearrange (400) a little bit. We replace $\omega_0=c/r_0$ :

$$W_0 = \frac{\hbar_1\omega_0}{2\omega_0 t} \Rightarrow \frac{\hbar_1 c}{r_0}\,\frac{1}{2\omega_0 t-\beta r} = \frac{\dfrac{\tilde{\hbar}c}{\tilde{r}_0}}{\left(\left(1+\dfrac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\dfrac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^2} = \frac{\tilde{W}_0}{\left(\left(1+\dfrac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\dfrac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^2} \tag{402}$$

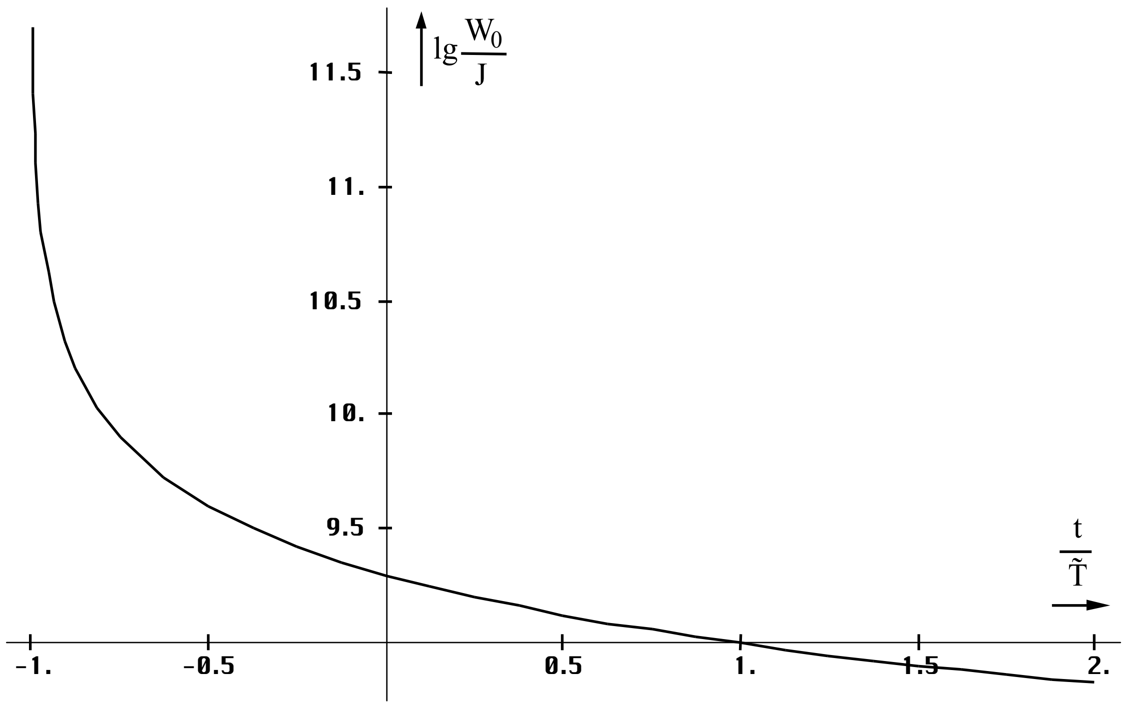



Figure 58
Energy of the Metric line-element
temporal dependence

The third expression in (402) 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.

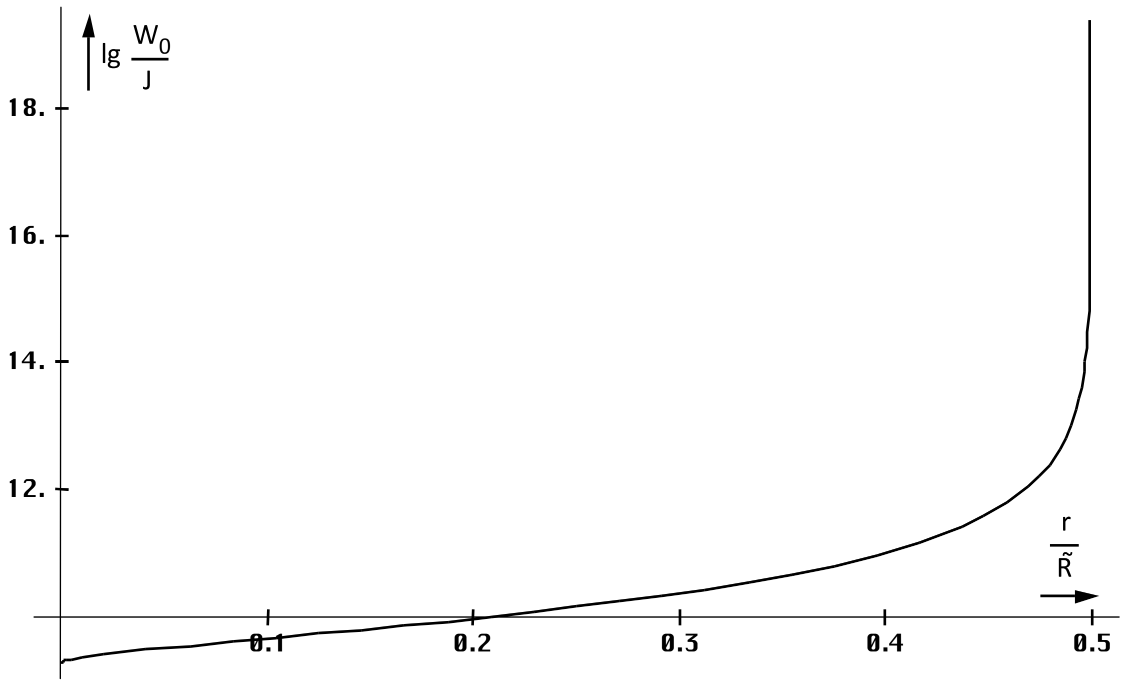



Figure 59
Energy of the Metric line-element
spatial dependence up to the particle-horizon

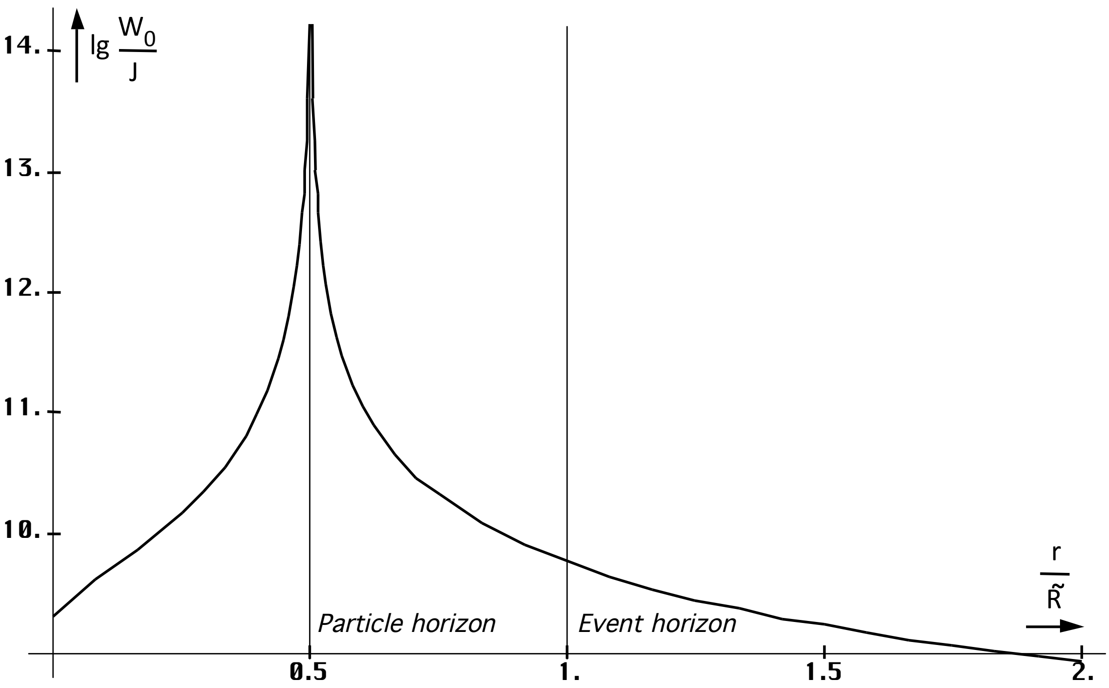



Figure 60
Energy of the Metric line-element
spatial dependence at the particle-horizon

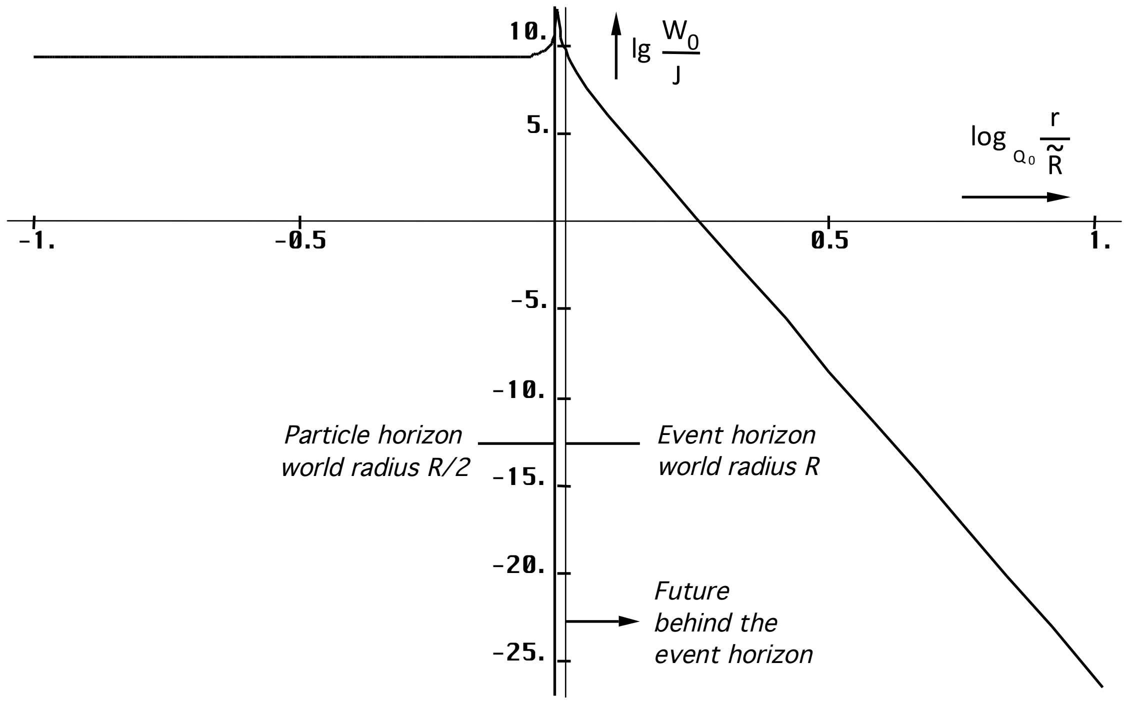



Figure 61
Energy of the Metric line-element
spatial dependence up to the event-horizon

## 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 cosmologic 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:

$$P_v = \frac{u_0^2}{R_0} \qquad u_0 = \frac{q_0}{\varepsilon_0 r_0} = -\frac{c\hat{\varphi}_i}{r_0} J_1(2\omega_0 t) \qquad R_0 = \kappa_0 r_0 Z_0^2 \tag{403}$$

$$P_v = \frac{\hbar_i \omega_0}{t} J_1^2(2\omega_0 t) = \frac{\hbar_i}{t}\sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\, J_1^2\left(\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\right) \tag{404}$$

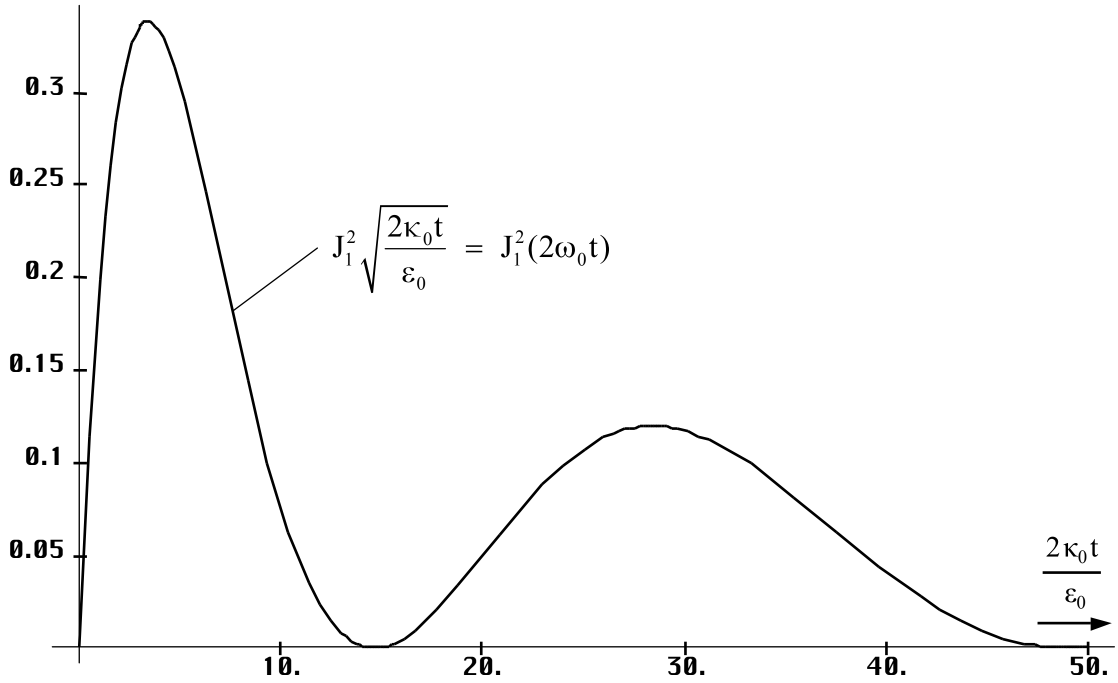



Figure 62
Square of the Bessel function of
1st order during the first period

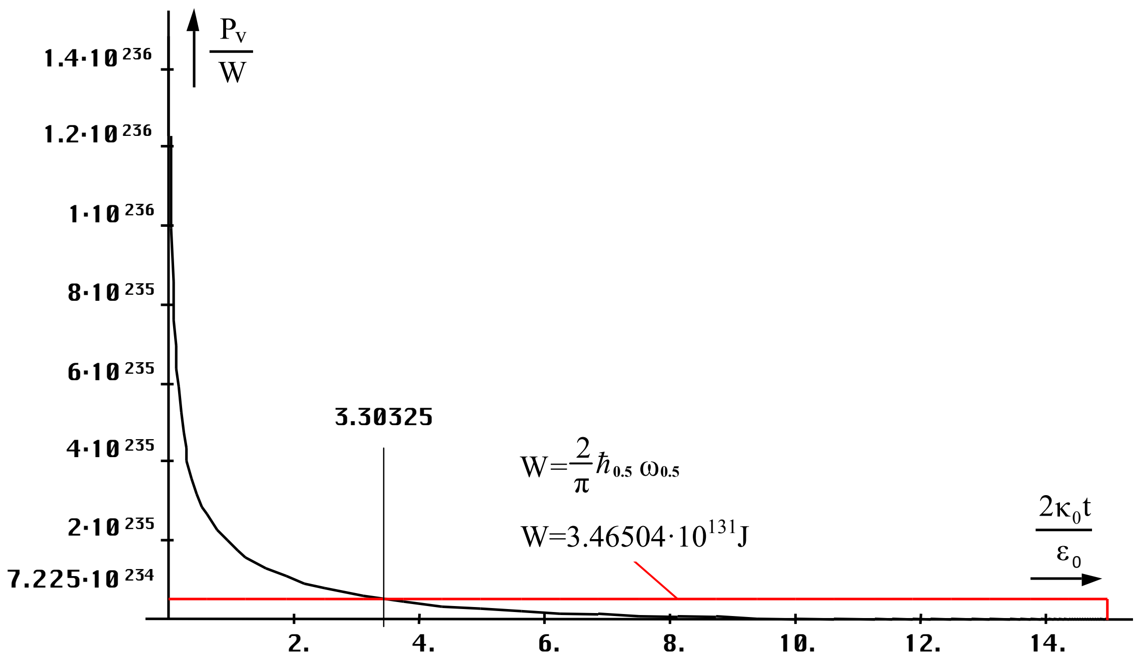



Figure 63
Power dissipation of the Metric
line-element during the first maximum

Minima and maxima are fixed by the Bessel function only. 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 (–21.6 dB=1/143). That means: If the cosmologic 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.

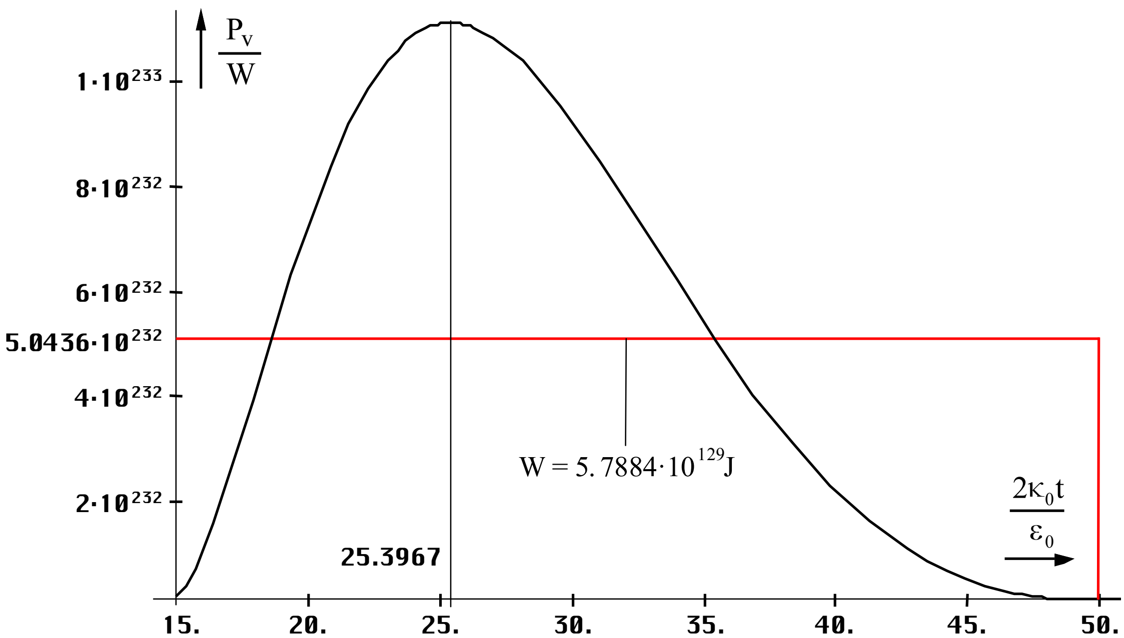



Figure 64
Power dissipation of the Metric
line-element during the second maximum

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 (404) 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 $2\pi$, 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 $\sigma$. We want to take up an estimation of bandwidth and Q-factor. We set $\sigma = 1$ therefore (resetting). First, we calculate the amounts of the figure-functions however. These are figured in Figure 65 and 66 (only positive frequencies $\omega_k=2\pi/T$).

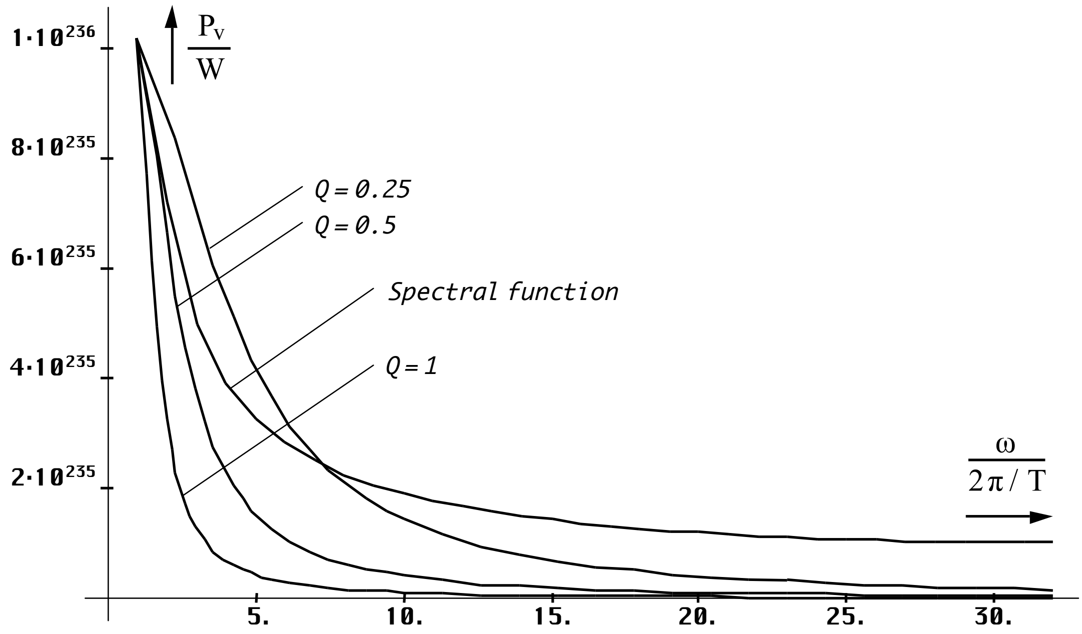



Figure 65
Continuous spectrum (first maximum)

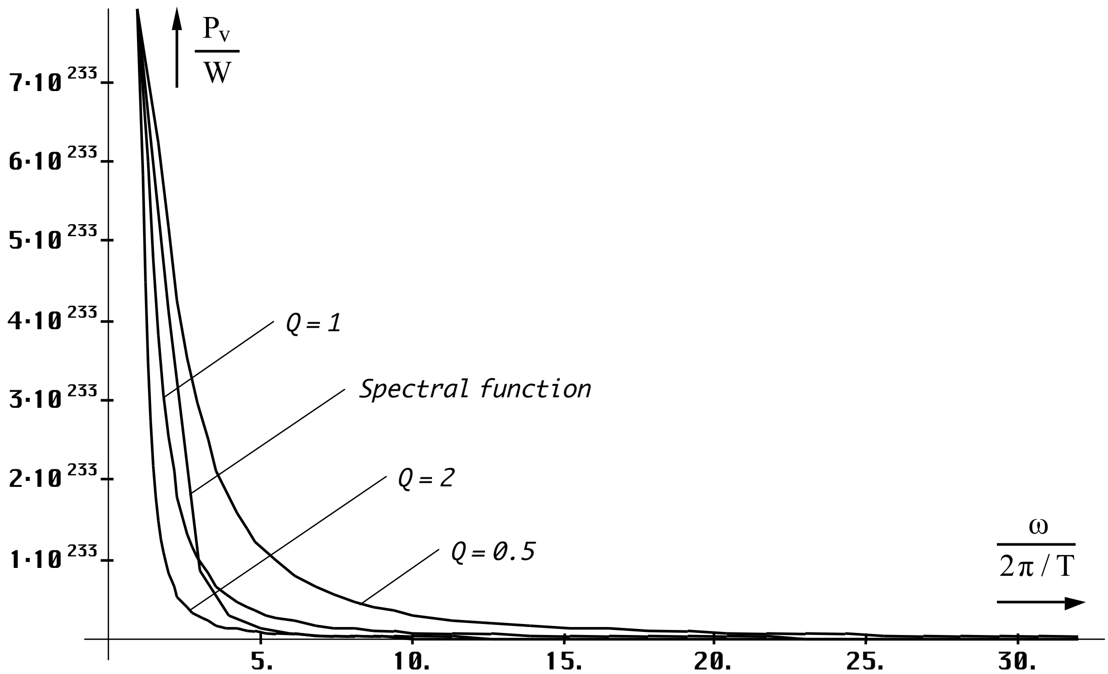



Figure 66
Continuous spectrum (second maximum)

Simultaneously, the transfer-functions of a loss-affected oscillatory circuit of 1st order with various Q-factors are figured. We can take up an estimation of the bandwidth of the cosmologic background-radiation with it. For the transfer-function applies:

$$P_v = \frac{P_s}{1+V^2Q^2} \qquad V = \frac{\omega}{\omega_s} - \frac{\omega_s}{\omega} \qquad \omega_s = 2\omega_1 \qquad \Omega = \frac{\omega}{\omega_s} = \frac{1}{2}\frac{\omega}{\omega_1} \tag{405}$$

For the first maximum, the Q-factor is at ½, 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, it only scratches the mark of being a minimum-phase-system. In fact, it's about a borderline case. This is also named critically stable.

The Q-factor of ½ corresponds exactly to the circumstances at the point of time $t_1/4$ as well as $r_1/2$, just at our coupling-length. With the second maximum, we have to do it with a larger Q-factor. That means, should the emission of the cosmologic 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 cosmologic background-radiation. Unfortunately, many other spectral-lines are in this area at 160 GHz, caused by organic radicals like e.g. $CN^-$, $CH_3^-$, so that a proof is difficult.

Expression (405) comes from electrical engineering and describes the power dissipation $P_v$ of an oscillating circuit of the Q-factor Q at frequency ω, V is the discord. The Q-factor is well known and amounts to Q=½ with $\omega_S=2\omega_1$. The expression on the right follows directly from the sampling theorem. The cutoff-frequency of subspace $\omega_1$ is the value $\omega_0$ with Q=1. We shall continue to consider this point further on. Next, however, we want to deal with the properties and the conditions during in-coupling into the metric transport lattice.

#### 4.6.4.2.3. Qualities of the cosmologic background-radiation

The following calculations are based on the newly determined value of the HUBBLE-parameter of 68.6241 $\mathrm{kms^{-1}Mpc^{-1}}$. The cosmologic 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 cosmologic 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. However, various versions exist, which only differ in the factor in front of the expression [68]. Firstly, there is the half-space, which is a hemisphere with the radius r being applied to emission-issues. The hollow-space is a cube with edge length r being used when the radiation is in equilibrium, e.g. inside the black body. We choose the last form because the CMBR is in equilibrium and the current field strength can only be determined via the energy density $w_k$ in J/m³ in [59]. Using $\hbar$ and ω instead of h and ν we get the following expression:

$$d\mathbf{S_k} = \frac{2}{\pi}\frac{\hbar\omega^3}{c^2}\frac{1}{e^{\frac{\hbar\omega}{kT}}-1}\mathbf{e}_S\, d\omega \qquad \text{PLANCK's radiation-rule} \tag{406}$$

$T$ is the temperature here and $\mathbf{e_s}$ the unit-vector. For very low temperatures ($\hbar\omega \gg kT$) expression (407) changes into the WIEN radiation-rule (approximation). But it's no mistake to calculate always with (407). We want even to do this.

$$d\mathbf{S_k} \approx \frac{2}{\pi}\frac{\hbar\omega^3}{c^2}e^{-\frac{\hbar\omega}{kT}}\mathbf{e}_S\, d\omega \qquad \text{WIEN radiation-rule} \tag{407}$$

The course of intensity for a temperature of 2.725436K is depicted in Figure 67 (curve 6). One can see, that there is a definite maximum. This on the other hand, can be determined with the help of WIEN's displacement law:

$$\hbar\omega_{max} = \tilde{x}\,kT = 2.8214393721\,kT \qquad \text{WIEN's displacement law} \tag{408}$$

The integral of the intensity over the entire frequency range [$Wm^{-2}$], the POYNTING-vector, is also of interest. That's the STEFAN-BOLTZMANN radiation law:

$$\overline{\mathbf{S}}_k = \int W_\omega d\omega = \sigma T^4 \mathbf{e}_s = \frac{\pi^2 k^4 T^4}{60\, c^2 \hbar^3}\mathbf{e}_s \qquad \text{STEFAN-BOLTZMANN radiation law} \tag{409}$$

with $\sigma = 5.67037\cdot 10^{-8} Wm^{-2} K^{-4}$. Because of the constant of integration, (409) applies to both the half- and the hollow-space. In Figure 67 I superimposed the frequency response of an oscillating circuit with the Q-factor 1/2 (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. But Figure 67 shows only an approximation.

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. Such a curve cannot be achieved with a higher-order low-pass either. Thus, that could be the result of the upper cut-off-frequency of the metrics only. 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 $\omega_1$. 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. That means, these functions must have intersected each other at some point in the past having the same value $\omega$.

As is known we have determined the frequency $\omega_0$ very precisely. Therefore we also know $\omega_{0.5}$ exactly so that we can calculate the frequency of the peak of the CMBR and in turn its temperature. Even the band-width of the LAPLACE-transform of the first maximum suggests a Q-factor of ½. This would correspond to the conditions at the point of time $t_l/4$ with $Q_{0.5} = ½$, $\omega_U = \omega_{0.5}$ as well as $r_l/2$, just our coupling-length. The frequency to this point of time amounts to:

$$\omega_{0.5} = \frac{1}{t_1} = \frac{2\kappa_0}{\varepsilon_0} = \frac{\omega_1}{Q_{0.5}} = 2\omega_1 = 3.09408\cdot 10^{104} s^{-1} \tag{410}$$

This does not quite correspond to the value that results from the pulse length of the first maximum, but is in the order of magnitude. 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 (410), so that it is well possible that the in-coupling of the cosmologic background-radiation takes place right at this point of time with exactly this centre frequency.

The following considerations on in-coupling relate specifically to the CMBR. 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 round. Now – up to the moment $t_l/4$ 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°, which we have done in section 4.3.4.3.3. (the metric wave moves in r-direction, the overlaid signals in x-direction).

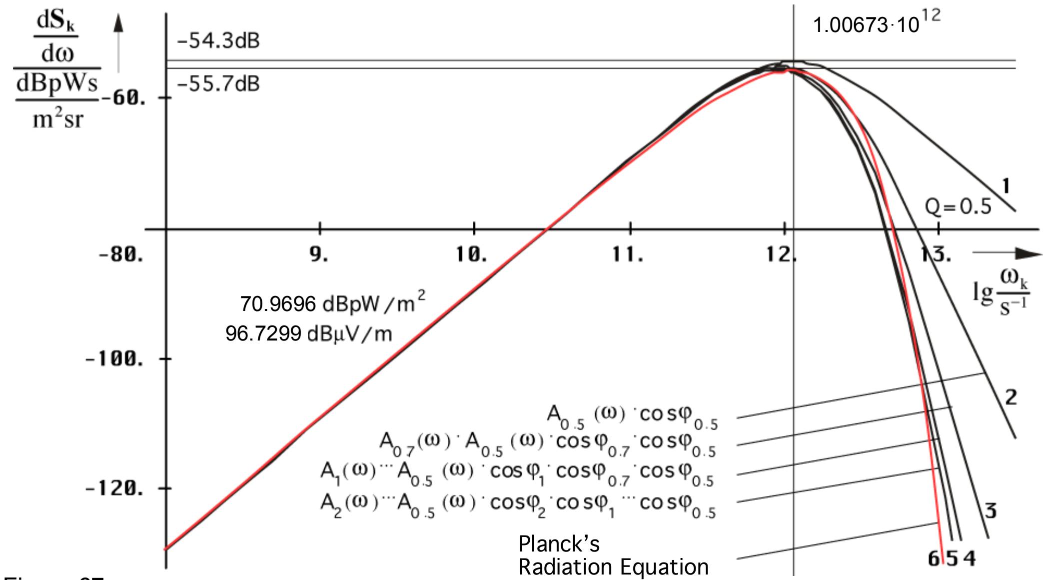



Figure 67
Intensity of the cosmic microwave background radiation with approximation

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 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 $\omega_s$ is smaller than $\omega_1/2$ now. The first two effects are depicted in Figure 68. The split we have to take into account elsewhere.

Altogether, to the frequency at the moment of in-coupling the following factor is applied $\omega_s = \frac{1}{4}\frac{2}{3}\sqrt{2}\,\omega_U = 2\,\frac{1}{4}\frac{2}{3}\sqrt{2}\,\omega_1 = \sqrt{2}/3\,\omega_1 \approx 0.4714\,\omega_1 = 7.29281 \cdot 10^{103} s^{-1}$. 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 $\varepsilon_v = 0.9428 = \frac{2}{3}\sqrt{2}$. Therefore we are dealing with a *grey body* [47]. The *black body* is only a model, which doesn't exist in nature. The reflected share yields a further decrease of $\omega_s$ and with it even of $\omega_k$. So we also have to multiply with $\varepsilon_v$. Interestingly enough the value $\varepsilon_v = 0.9428 = \frac{2}{3}\sqrt{2}$ is close to δ = 0,93786. However, this is a dead end.

Now to the transfer itself. According to (281) the frequency of time-like vectors is proportional to $\omega \sim t^{-3/4}$. That equals $\omega \sim Q^{-3/2}$ for the Q-factor. We do the following ansatz:

$$\omega_s = \frac{2 \cdot 1}{3 \cdot 4}\sqrt{2}\,\varepsilon_v \omega_{0.5}\left(\frac{Q_{0.5}}{Q_{0.5}}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_v \omega_U \left(\frac{1/2}{1/2}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_v \omega_U = \frac{1}{3}\sqrt{2}\,\varepsilon_v \omega_1 \tag{411}$$

$$\omega_k = \frac{2 \cdot 1}{3 \cdot 4}\sqrt{2}\,\varepsilon_v \omega_U \left(\frac{1/2}{Q_0}\right)^{\frac{3}{2}} = \frac{1}{6}\sqrt{2}\,\varepsilon_v \omega_U (2Q_0)^{-\frac{3}{2}} = \frac{1}{3}\sqrt{2}\,\varepsilon_v \omega_1 (2Q_0)^{-\frac{3}{2}} \tag{412}$$

$$z = \frac{\lambda_k - \lambda_s}{\lambda_s} = \frac{\omega_s}{\omega_k} - 1 \qquad z + 1 = 2\sqrt{2}\,Q_0^{\frac{3}{2}}$$

$$\frac{\omega_U}{\omega_s} = \frac{3}{\varepsilon_v}\sqrt{2} = 4.5 \qquad \text{*) Correct } m(Q_0^{3/2} - 1) \text{ resp. } m(Q_0^{3/2} - 1)Q_0$$

$$z_{ab} = \begin{bmatrix} \frac{\omega_1}{\omega_k} & \frac{\hbar_1\omega_1}{\hbar\,\omega_k} \\ \frac{\omega_U}{\omega_k} & \frac{\hbar_U\omega_U}{\hbar\,\omega_k} \end{bmatrix} = \frac{1}{\varepsilon_v}\begin{bmatrix} 6Q_0^{3/2} & 6Q_0^{5/2} \\ 12Q_0^{3/2} & 12Q_0^{5/2} \end{bmatrix}^{*} \tag{413}$$

The factor $2\sqrt{2}$ has nearly the same size as the factor $\tilde{x}$=2.8214' from WIEN's displacement law. In section 4.6.4.2.5. we will notice that using $\tilde{x}$ instead of $2\sqrt{2}$, actually intended as an approximation, leads to the only result (477) that is within the error margins of the COBE measurement. Then (413) should read as follows:

$$z = \frac{\lambda_k - \lambda_s}{\lambda_s} = \frac{\omega_s}{\omega_k} - 1 \quad \Bigg| \quad z+1 = \tilde{x} Q_0^{\frac{3}{2}} \quad \Bigg| \quad \varepsilon_\nu = \frac{\tilde{x}}{3} \quad \Bigg| \quad \frac{\omega_U}{\omega_s} = \frac{9}{\tilde{x}}\sqrt{2} = 4.511145 \qquad (414)$$

This would correspond to a slightly different refractive index and the factor $\tilde{x}$ in (414) does not seem implausible either, as it is closely linked to the radiation laws. Apart from that we can see, that it's better to relate to $\omega_1$ or $\omega_U$. The components $z_{1b}$ are describing the *frequency related*, the $z_{2b}$ however the *energy related redshift*. For $\omega_k$ (414) we obtain a value of $1.00673 \cdot 10^{12} s^{-1}$. Curve 1 in Figure 67 corresponds to the signal $\omega_s$ redshifted by $\tilde{x} Q_0^{3/2}$ with the frequency response of a 1st order filter with the Q-factor Q=½. Except for the decline in the upper-frequent range it is identical with $\omega_k$ (Curve 6). The conditions before, during and after in-coupling are shown in Figure 68.

According to (414), the CMBR redshift has a value of $z = 6.79605 \cdot 10^{91}$, which is orders of magnitude higher than z=1100, as »generally« assumed. On the one hand, this is due to the fact that this model works with variable natural »constants«. Due to the expansion, i.e. the increase of $r_0 \sim Q_0$ (the viewer grows with it) the impression is given, that z is only proportional to $Q_0^{1/2}$. This would correspond to a value of $z = 8.14828 \cdot 10^{30}$ and is still well above 1100. On the other hand, one assumes today that the physical laws shortly after Big Bang did not differ significantly from those of today. So the origin of the CMBR is said to be around 3000 K, the recombination temperature of hydrogen, at a point in time 379000 years after Big Bang. However, the exact results of the calculation of the CMBR temperature in relation to the time $t_1/4$ suggest that we must slowly get used to the idea that it must have been different at that time.

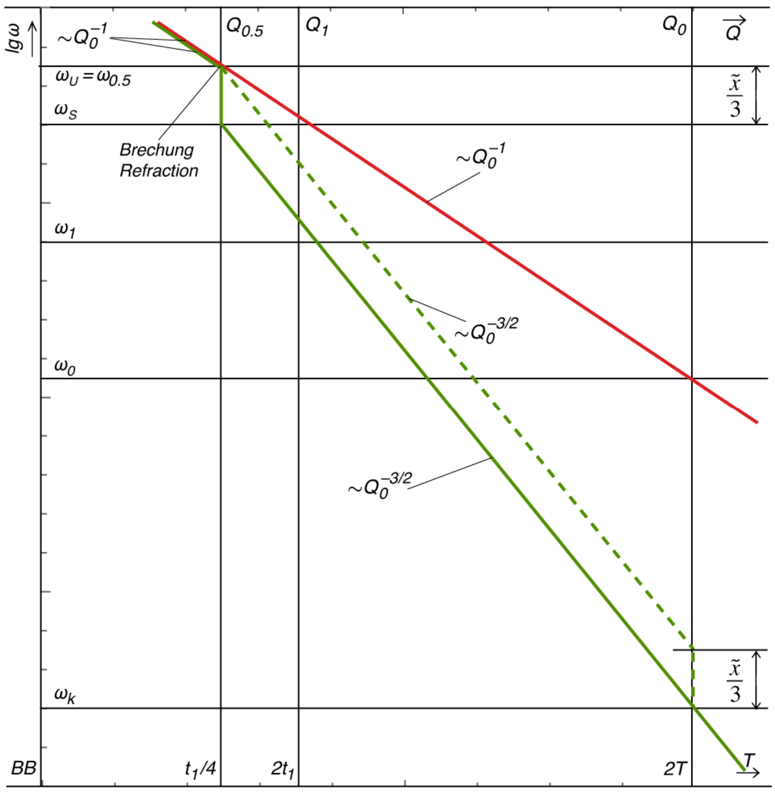



Figure 68
In-coupling process and expansion

Let us now assume that the decline at the higher frequencies is really caused by the existence of a cut-off frequency. In any case, such a specific course cannot be achieved with a normal LC-low-pass filter of any order. Then the intensity of the cosmological background radiation would have to follow exactly PLANCK's radiation formula. We therefore want to see whether PLANCK's curve 6 in Figure 67 can be approximated from the original curve 1, initially only as an estimate.

We have already realized that a single MLE owns a cut-off frequency (147), which changes during expansion. 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 $\omega_s$ (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. 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.

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, being applied to time-like vectors emitted directly after 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.

After we were able to confirm our suspicion with the estimate, we now want to carry out an exact calculation. Please find the complete article in [46]. Let's deal with the source function first. We continue with (405) and rearrange:

$$P_v = \frac{P_s}{1+V^2Q^2} \qquad V = \frac{\omega}{\omega_s} - \frac{\omega_s}{\omega} \qquad \omega_s = 2\omega_1 \qquad \Omega = \frac{\omega}{\omega_s} = \frac{1}{2}\frac{\omega}{\omega_1} \tag{405}$$

$$V = \Omega - \Omega^{-1} \qquad V^2 = \Omega^2 + \Omega^{-2} - 2 \qquad V^2Q^2 = \frac{1}{4}\Omega^2 + \frac{1}{4}\Omega^{-2} - \frac{1}{2} \tag{415}$$

$$P_v = \frac{P_s}{\frac{1}{4}\Omega^2 + \frac{1}{4}\Omega^{-2} + \frac{1}{2}} \cdot \frac{4\Omega^2}{4\Omega^2} = 4P_s \frac{\Omega^2}{\Omega^4 + 2\Omega^2 + 1} = 4P_s \left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{416}$$

You can find that expression more often, among other things even with the group delay $T_{Gr}$ (152) however for a frequency $\omega_1$. For a frequency $2\omega_1$ applies for $T_{Gr}$ and the energy $W_v$:

$$T_{Gr} = \frac{dB(\omega)}{d\omega} = \frac{1}{\omega_1}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \qquad W_v = \frac{1}{6}P_sT_{Gr} = \frac{2}{3}\frac{P_s}{\omega_1}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{417}$$

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 is not surprising. 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. But this only by the by. With the help of (416) we obtain:

$$P_v = 4bP_s\left(\frac{\Omega}{1+\Omega^2}\right)^2 \qquad P_v = 512b\,\hbar_1\omega_1^2\left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{418}$$

b is a factor, we want to determine later on. Let's equate it to one at first. We determined the value $P_s$ with the help of (410) using the values of the point of time Q=½. Interestingly enough, the HUBBLE-parameter $H_0$ at the time $t_{0.5}$ is greater than $\omega_1$ and $\omega_0$. For an individual line-element applies:

$$\omega_{0.5} = \frac{\omega_1}{Q_{0.5}} = \frac{\omega_1}{\frac{1}{2}} = 2\omega_1 \qquad H_{0.5} = \frac{\omega_1}{Q_{0.5}^2} = \frac{\omega_1}{\frac{1}{4}} = 4\omega_1 \tag{419}$$

$$P_s = \frac{\hat{\hbar}_i}{4\pi t_{0.5}^2 Q_{0.5}^4} = \frac{\hat{\hbar}_i}{2\pi}\frac{2^5}{4t_{0.5}^2} = 32\hbar_1 H_{0.5}^2 = 128\hbar_1\omega_1^2 \qquad \frac{\hat{\hbar}_i}{2\pi} = \hbar_1 = \frac{\hbar_{0.5}}{2} \tag{420}$$

Expression (418) 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 (406) 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:

$$d\mathbf{S_k} = 4bA\left(\frac{\Omega}{1+\Omega^2}\right)^2 \mathbf{e_s}\, d\Omega \tag{421}$$

We determine the factor A by a comparison of coefficients. We assume, the WIEN displacement law (408) would apply and substitute as follows:

$$A = \frac{1}{4\pi^2}\frac{k^4 T^4}{\hbar^3 c^2} \qquad c = \omega_1 Q^{-1} r_1 Q \tag{422}$$

We put in $2\sqrt{2}\omega_1$ as initial-frequency into the expression $k^4T^4$. This frequency is not a metric indeed ($\omega_x \sim Q^{-1}$), but an overlaid frequency ($\omega \sim Q^{-3/2}$). During the red-shift of the source-signal, likewise not the factor $\tilde{x}$=2.821439372 but the factor $2\sqrt{2}$ becomes effective. Alternatively, we can calculate with $\tilde{x}\omega_1$ for both values, which makes no difference. Thus applies:

$$k^4 T^4 = \frac{(2\sqrt{2})^4}{(2\sqrt{2})^4}\hbar_1^4 Q^{-4}\omega_1^4 Q^{-6} = \hbar_1^4\omega_1^4 Q^{-10} \qquad Q^{-10} = \frac{Q^{-8}}{Q^2} \tag{423}$$

$$A = \frac{1}{4\pi^2}\frac{\hbar_1^4\omega_1^4 Q^{-8}}{\hbar_1^3 Q^{-3}\omega_1^2 Q^{-2} r_1^2 Q^4} = \frac{1}{4\pi^2}\frac{\hbar^4\omega_0^4}{\hbar^3\omega_0^2 r_1^2 Q^4} = \frac{1}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2} \tag{424}$$

$$4A = \frac{4}{\pi}\frac{\hbar\omega_0^2}{4\pi r_0^2 Q^2} = \frac{4}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2} \qquad R \text{ for } Q \gg 1 \tag{425}$$

$$d\mathbf{S_k} = \frac{4b}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \mathbf{e_s}\, d\Omega \qquad R \text{ for } Q \gg 1 \tag{426}$$

Indeed, that submits only the expression without consideration of red-shift. We determine the real values to the point of time of input coupling, in that we apply the values for Q=½ in turn. It applies:

$$A = \frac{1}{4\pi^2}\frac{\hbar_1^4\omega_1^4 Q^{-8}}{\hbar_1^3 Q^{-3}\omega_1^2 Q^{-2} r_1^2 Q^4} = \frac{2^{8-3-2+4}}{4\pi^2}\frac{\hbar_1^4\omega_1^4}{\hbar_1^3\omega_1^2 r_1^2} = \frac{128}{\pi}\frac{\hbar\omega_1^2}{4\pi r_1^2} \tag{427}$$

$$4A = \frac{512}{\pi}\frac{\hbar_1\omega_1^2}{4\pi r_1^2} \qquad d\mathbf{S_k} = \frac{512b}{\pi}\frac{\hbar_1\omega_1^2}{4\pi r_1^2}Q^{-7}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \mathbf{e_s}\, d\Omega \tag{428}$$

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 1 Np/R (Np=Neper), 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 (406) 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=½ (405). We find the extrema of the source function, in that we equate the first derivative of the bracketed expression (428) to zero. It applies:

$$\frac{d}{d\Omega}\left(\frac{\Omega}{1+\Omega^2}\right)^2 = \frac{2\Omega}{(1+\Omega^2)^2} - \frac{4\Omega^3}{(1+\Omega^2)^3} = \frac{2\Omega\left(1-\Omega^2\right)}{(1+\Omega^2)^3} = 0 \qquad (429)$$

$$2\Omega\left(1-\Omega^2\right) = 0 \qquad \Omega_1 = 0 \quad \text{Minimum} \qquad \Omega_{2,3} = \pm 1 \quad \text{Maximum} \qquad (430)$$

The first solution is trivial, the second and third are identical, if we tolerate negative frequencies (incoming and outgoing vector). Now, we must only find a substitution for Ω, with which (410) and (428) come to congruence in the lower range. This would be the displacement law for the source-signal then (427). 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:

$$\hbar\omega_{max} = a\,kT \qquad \text{Displacement law source-signal} \qquad (431)$$

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 $\tilde{x}$ 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:

$$\frac{\left(a\frac{y}{2}\right)^3}{e^{a\frac{y}{2}}-1} - 4b\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 = 0 \quad y = 10^{-5} \qquad \begin{matrix} b \to 2 & \text{for } a = 2\sqrt{2} \\ b \to 2.009918917 & \text{for } a = 2.821439372 \end{matrix} \qquad (432)$$

The maxima overlap accurately in both cases. The lower value a is equal to the factor in (413). 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 a=$2\sqrt{2}$ are depicted. Now, we can set about to write down the individual relations:

$$\hbar\omega_{max} = 2\sqrt{2}\,kT \qquad \text{Displacement law source-signal} \qquad (433)$$

$$\Omega = \frac{1}{2}\frac{\omega}{\omega_1} = \frac{1}{2\sqrt{2}}\frac{\hbar\omega}{kT_k} = \frac{x}{a} = \frac{y}{2} \qquad y = \frac{\omega}{\omega_1} \qquad b = 2 \qquad (434)$$

Thus, we have found our source-function. In y it reads as follows:

$$dS_k = \frac{16}{\pi}\frac{\hbar\omega_0^2}{4\pi R^2}\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 \mathbf{e}_s\, dy \qquad R \text{ for } \qquad Q \gg 1 \qquad (435)$$

But we aren't interested in the absolute value but in the relative level only:

$$dS_1 = 8\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 dy \qquad (436)$$

We want to mark the approximation with $dS_2$. For the target-function $dS_3$ we obtain:

$$dS_3 = \frac{\left(2,821439\,\frac{y}{2}\right)^3}{e^{2,821439\frac{y}{2}}-1}\, dy \qquad (437)$$

In figure 69 are presented the course of the source-function and the PLANCK's graph.

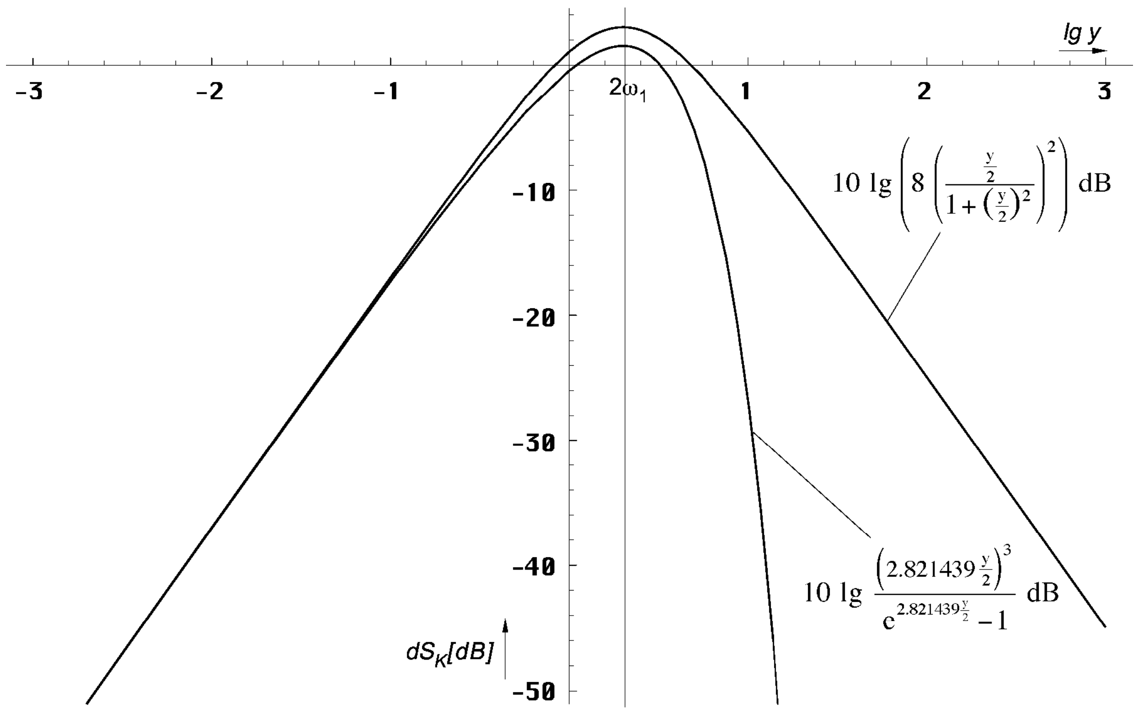



Figure 69
Planck's radiation-rule and source-function
in the superposition (logarithmic, relative level)

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 amplitude response $A(\omega)$.The result is our approximation $dS_2$. It 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. D.h. That means, we have to execute the multiplication with $A(\omega)$ 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. There is another problem with the amplitude response $A(\omega)$ and with the phase-angle $\varphi$. Since the cut-off frequency $\omega_0 = f(Q, \omega_1)$ and the frequency $\omega$ 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. But this corresponds to a *transposition of integration limits*. 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:

$$dS_2 = 8\left(\frac{\frac{y}{2}}{1+(\frac{y}{2})^2}\right)^2 \prod_{Q_0}^{½} A(y)\cos\varphi(y)\, đy\, dy \tag{438}$$

Expression (438) 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 (438) to continue. We use $Q_0=8.34047113224285\cdot 10^{60}$ as the updated value of the Q-factor and the phase-angle of the metric wave-function. It determines the upper limit of the multiplication resp. summation. 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:

$$A(\omega)\cdot\cos\varphi(\omega) = e^{\Psi(\omega)} \qquad \varphi = B(\omega) \qquad \text{Frequency response of a line element} \tag{439}$$

The fact, that only the real component is transferred, is taken into account by the multiplication of $A(\omega)$ with the expression $\cos\varphi$. We use (305) for $\Psi(\omega)$.

$$\Psi(\omega) = -\frac{1}{2}\ln(1+\Omega^2) + \frac{\Omega^2}{1+\Omega^2} + \ln\cos\left(\arctan\Omega - \frac{\Omega}{1+\Omega^2}\right) \tag{305}$$

As next, we substitute $\Omega$ by y with the help of (434):

$$\Psi(\omega) = -\frac{1}{2}\ln\left(1+\left(\frac{y}{2}\right)^2\right) + \frac{(\frac{y}{2})^2}{1+(\frac{y}{2})^2} + \ln\cos\left(\arctan\frac{y}{2} - \frac{\frac{y}{2}}{1+(\frac{y}{2})^2}\right) \tag{440}$$

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. The frequency $\omega_0$ is exactly proportional to $Q^{-1}$.

Instead of the value $\omega_1$ in the denominator actually the PLANCK's frequency $\omega_0$ 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 $\omega_0$ is right equal to $\omega_1$, at which point $\omega_0$ varies with time, $\omega_1$ on the other hand is strictly defined by quantities of subspace having an invariable value therefore. It applies $\omega_0=\omega_1/Q$. That means, that even y depends on time, being proportional to $Q^{-1/2}$.

Now however, we want to freeze the value ω, at least up to the end of the calculation, with the consequence, that we must divide y by a supplementary function ξ, which is proportional to $Q^{1/2}$. It applies $\xi=ccQ^{1/2}$ and

$$\Psi(\omega) = -\frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right) + \frac{(\frac{y}{2}\frac{1}{\xi})^2}{1+(\frac{y}{2}\frac{1}{\xi})^2} + \ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi} - \frac{\frac{y}{2}\frac{1}{\xi}}{1+(\frac{y}{2}\frac{1}{\xi})^2}\right) \tag{441}$$

The factor c arises from the initial conditions at Q=½ (resonance-frequency $2\omega_1$, cut-off frequency $\omega_1$) to c=4 (In the program cc=y/2):

$$y = \frac{\omega}{\omega_0} \sim \frac{2^{-\frac{3}{2}}}{2^{\frac{1}{2}}} = \frac{1}{4} \qquad \xi = 4\sqrt{Q} \qquad \text{Approximation} \tag{442}$$

Thus, together with the 2 of y/2, we acquire exactly the same factor 8 as in the source-function (436). Then, the approximation $dS_2$ calculates as follows:

$$dS_2 \;=\; 8\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 e^{-\int_{1/2}^{Q_0}\left(-\frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right)+\frac{\left(\frac{y}{2}\frac{1}{\xi}\right)^2}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}+\frac{1}{2}\ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi}-\frac{\frac{y}{2}\frac{1}{\xi}}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}\right)\right)dy}\,dy \tag{443}$$

The negative sign before the integral results from the re-exchange of the integration limits. 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 $3\cdot10^3$ in the following representations. The integral only can be determined numerically, namely with the help of the function NIntegrate[$f$(Q), Q, 1/2, $3\times10^3$]. The quotient of y/2 and $\xi$ expression (442) however describes the dependency y(Q) in the approximation only. There is an exact solution as well. According to (208), (299) and (582) applies:

$$\xi=\frac{a}{b}\frac{1}{Q}\frac{R(Q)}{R(\tilde{Q})}\sqrt{\frac{\beta_\gamma^4-1}{\tilde{\beta}_\gamma^4-1}} \qquad \text{with}\;\; \tilde{Q}=\frac{1}{2} \qquad R(Q)\;=\;\frac{3}{2}Q^{\frac{1}{2}}\int_0^Q\frac{dQ}{\rho_0} \tag{444}$$

The factor b arises from the demand, that the exact function $\xi$ and its approximation should be of the same size with larger values of Q. The factor a we will determine later on in turn.

Problematic in (444) rhs and (447) 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 $r_l$ cancels itself because of (444) lhs. We choose sampling points with logarithmic spacing:

```
BRQP=Function[Rk[#] Sqrt[(Sin[AlphaQ[#]]/Sin[GammaPQ[#]])^4-1]];
BGN=Sqrt[2]*BRQP[.5]/3;
brq = {{0, 0}};
For[x = -8; i = 0, x < 50, (++i), x += .05;
 AppendTo[brq, {10^x, N[BRQP[10^x]/BGN/(2.5070314770581117*10^x) ]}]]
BRQ0 = Interpolation[brq];
BRQ1 = Function[If[# < 10^4, BRQ0[#], Sqrt[#]]];
```

The functions Rk, AlphaQ and GammaPQ are defined in the annex. The function BRQP equals the product of Q, root-expression and integral in the denominator of (447). The value BGN is the starting value of the same product at Q=½. For the factor b 2.50703 turns out. According to (211), (492) and (616) further applies:

$$\beta_\gamma \;=\; \frac{\sin\alpha}{\sin\gamma_\gamma} \qquad\qquad \gamma_\gamma \;=\; \arg\underline{c}+\arccos\left(\frac{c_M}{c}\sin\alpha\right)+\frac{\pi}{4} \tag{445}$$

$$\alpha \;=\; \frac{\pi}{4}-\arg\underline{c} \;=\; \frac{3}{4}\pi+\frac{1}{2}\arg\left((1-A^2+B^2)+j2AB\right) \qquad c_M=\left|\underline{c}\right| \tag{446}$$

$$\xi \;=\; \frac{3}{0.56408}\frac{a}{b}Q^{-\frac{1}{2}}\sqrt{\beta_\gamma^4-1}\int_0^Q\frac{dQ}{\rho_0} \;=\; a\frac{3}{2}\sqrt{2}Q^{-\frac{1}{2}}\sqrt{\beta_\gamma^4-1}\int_0^Q\frac{dQ}{\rho_0} \tag{447}$$

$\underline{c}$ 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 70 shows the course of both functions, which describe, multiplied with $Q^{3/2}$, the exact course of the world radius (Figure 147 rhs):

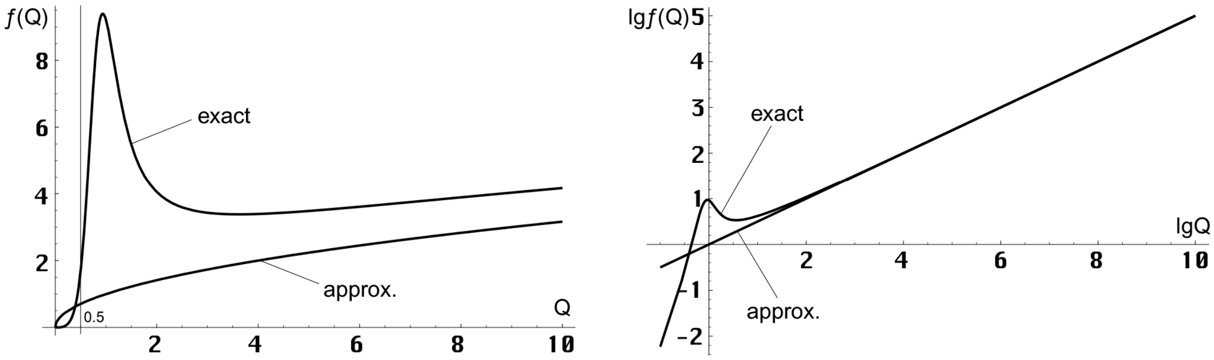



Figure 70
Function BRQ1 exactly and approximation

On the basis of the demand, that the result of both functions must be identical with $Q \gg 1$ we choose the factor a to $\sqrt{\pi}$. As I have found out by trial and error, the value $\sqrt{\pi}$ leads to the result with the smallest difference, so that we obtain the following final relation for ξ:

$$\xi = \frac{3}{2}\sqrt{2\pi}\left(Q^{-\frac{1}{2}}\sqrt{\beta_\gamma^4 - 1}\int_0^Q \frac{dQ}{\rho_0}\right) \qquad cc = \frac{3}{2}\sqrt{2\pi} = 3.756 \qquad (448)$$

The bracketed expression corresponds to the factor $Q^{1/2}$ in the approximation. The course of the dynamic cumulative frequency response $A_{ges}(\omega)=e^{-\int\Psi(\omega)dQ}$ you can see in figure 71. 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 ($\Omega_U = \Omega$). We use a logarithmic scale and the unit decibel [dB], and since we are talking about power per $m^2$, with a factor of 10.

$$X_n(j\omega) = \frac{1}{2}\frac{1}{1+j\Omega}\left(1+\frac{1}{1+j\Omega}\right) \qquad \text{Complex spectral function} \qquad (558)$$

It 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.

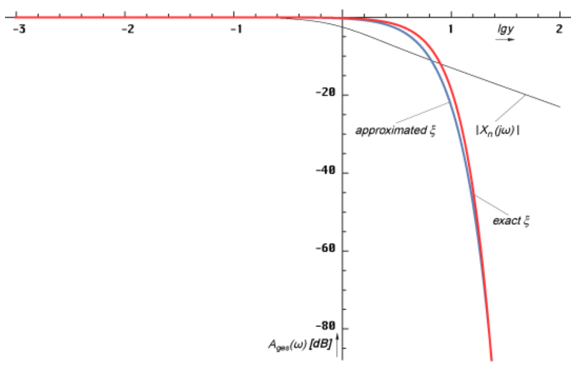



Figure 71
Cumulative frequency response $A_{ges}(\omega)$ and $|X_n(j\omega)|$ of the metric wave field and subspace

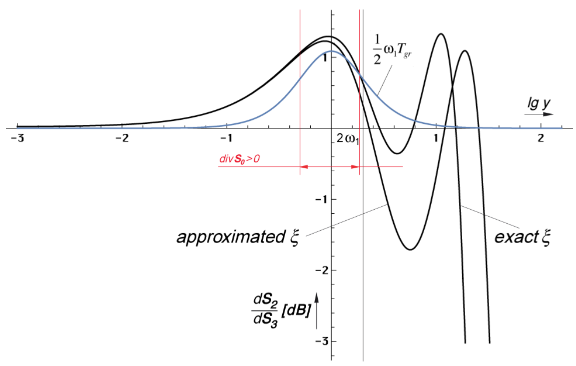



Figure 72
Relative offset between approximation and radiation-rule in dependency of the function ξ used

Thus, all requirements are filled and we are able to demonstrate the course of the approximation (443) in comparison with the target-function (437) and that as well for the approximation as for the exact function ξ. The result is a curve with a correlation factor of 0.99928 for the approximation and 0.999748 for the exact function ξ (both not shown). Figure 72 shows that using the exact function ξ brings an improvement, but there is still a certain residual deviation. If you look at the progression in the second quadrant, you can see a „gap“ here, into which an already known function, multiplied by ½, fits quite exactly. This is the group delay $T_{Gr}$ of the metric wave field (152) from Section 4.3.2. While the phase delay affects the shape of the carrier frequency ($\omega_1$ or $\omega_0$), the group delay affects the shape of the envelope. The expression reads:

$$T_{Gr} \;=\; \frac{d}{d\omega}B(\omega) \qquad = \qquad -\frac{2}{\omega_1}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \quad = \quad -2\frac{\theta^2}{\omega_1} \tag{152}$$

With $\Omega=\omega/\omega_1$. The factor 2 cancels out because it's a Spin2 system in which all time constants are 2T instead of T (double phase/group velocity). While the group delay is constantly equal to zero over almost all decades, this is not the case near $\omega_1$ or today at $\omega_0$. A frequency-dependent group delay always leads to a distortion of the envelope.

As you can see, the group delay is negative. This is also common in engineering and is not a breach of causality. See [50] for details. So far we have considered the frequency response $A(\omega)$ and the phase response $B(\omega)$, only the group delay correction $\Theta(\omega)=½\omega_1 T_{gr}$ is missing, realized by the function gdc[ω]:

$$\frac{1}{2}\omega_1 T_{Gr} \;=\; -\frac{\cancel{2\omega_1}}{\cancel{2\omega_1}}\left(\frac{\Omega}{1+\Omega^2}\right)^2 \;=\; -\left(\frac{\Omega}{1+\Omega^2}\right)^2 \tag{470}$$

$$\Theta(\omega) \;=\; e^{-\omega_1 T_{Gr}} \;=\; e^{-\left(\frac{\Omega}{1+\Omega^2}\right)^2} \;=\; 10^{-\left(\frac{\Omega}{1+\Omega^2}\right)^2 \lg e} \;=\; 10^{-0.434294\left(\frac{\Omega}{1+\Omega^2}\right)^2} \tag{471}$$

The powers of ten are important when calculating in dB. The course is depicted in Figure 72. The group delay correction $\Theta(\omega)$ is applied to $dS_2$ only once:

$$dS_2 \;=\; 8\left(\frac{\frac{y}{2}}{1+\left(\frac{y}{2}\right)^2}\right)^2 e^{\int_{1/2}^{Q_0} \frac{1}{2}\ln\left(1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2\right) - \frac{\left(\frac{y}{2}\frac{1}{\xi}\right)^2}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2} - \frac{1}{2}\ln\cos\left(\arctan\frac{y}{2}\frac{1}{\xi} - \frac{\frac{y}{2}\frac{1}{\xi}}{1+\left(\frac{y}{2}\frac{1}{\xi}\right)^2}\right) dy - \frac{1}{2}\omega_1 T_{Gr}} \, dy \tag{472}$$

```
Plot[{
 10 Log10[S3[10^y]],
 10 (Log10[S1[10^y]] + Log10[E]*Psi2[10^y]) + 10 Log10[gdc[10^y]],
Xline[y, Log10[2]]
}, {y, -3, 3}, PlotRange -> {-51, 4.5}, ImageSize -> Full,
LabelStyle -> {FontFamily -> „Chicago“, 10, GrayLevel[0]}]
```

(473)

The almost perfect result function (472) for an exact $\xi$ with group delay correction can be seen in Figure 73. The maximum frequency $\Omega_{\Uparrow}$ is downshifted about –7.00% (0.93003). That value is far in excess of the –0,0016 % deviation between measured and calculated CMBR-temperature. The maximum amplitude deviation $\Delta A_{\bar{\bar{\wedge}}}$ is at about –0.58954 dB, between both maxima $\Delta A_{\bar{\wedge}}$ is at –0.02762 dB (–0.64%). Of particular interest is the extremely high correlation coefficient of 0.999835 between both curves. Due to the limited calculation accuracy for small values, a phantom branch (vertical line) is displayed at $250\,\omega_1$, which has been removed from the graphic. The missing functions in (473) are defined in the annex in the section »Functions used for calculations in article«.

Thus, we have proved that the PLANCK curve may actually be approximated from the source function, i.e. its course is the result of the existence of an upper cut-off frequency and does not contradict this model. It only remains to determine which way the CMBR has traveled up to the present time. By inserting (414) into (315) we get for the distance r:

$$r \;=\; \frac{\tilde{R}}{2}((z+1)^{\frac{4}{3}}-1) \;\approx\; \frac{\tilde{R}}{2}z^{\frac{4}{3}} \;=\; 2\tilde{R}Q_0^2 \tag{474}$$

$$r \;=\; r_1 Q_0^2 \;=\; R \;=\; 2cT \qquad\qquad \text{with } \tilde{R} \;=\; \frac{r_1}{2} \tag{475}$$

So the cosmological background radiation has covered the maximum possible time-like distance R. Hence it comes from the point where we are and from every other point on the 4D-hypersurface. In terms of time, it comes from the period immediately after the Big Bang ($t_1/4$).

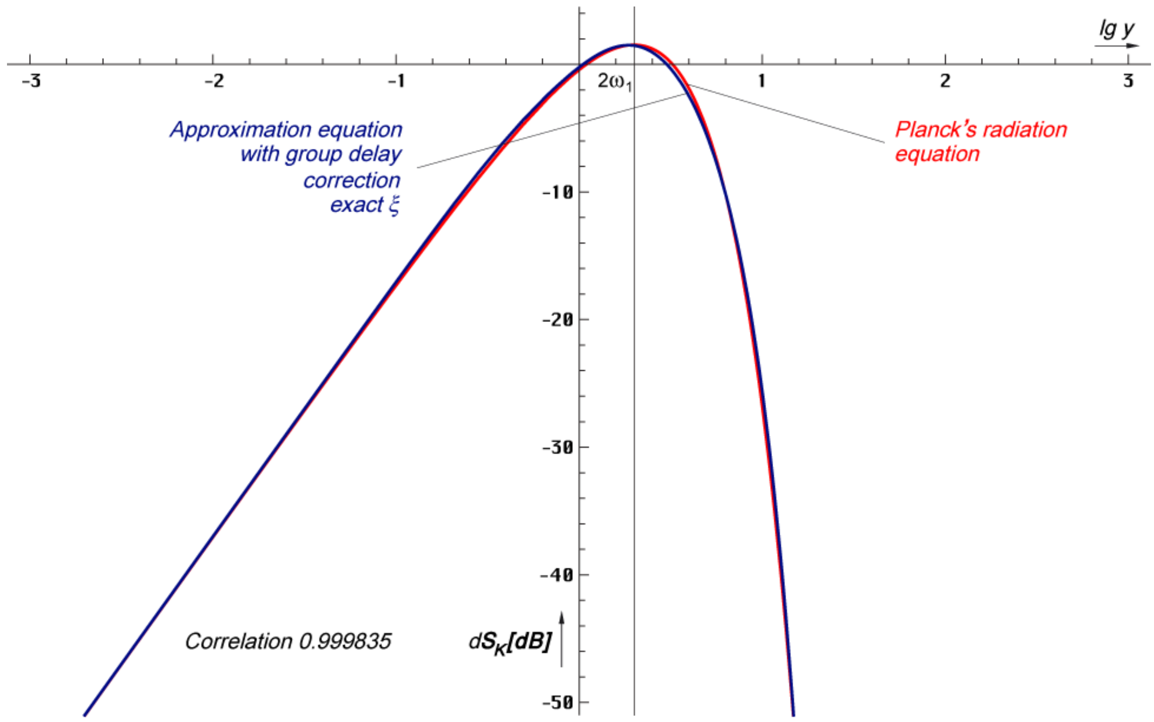



Figure 73
PLANCK's radiation-rule and approximation with group delay correction under application of the exact function ξ (relative level)

### 4.6.4.2.4. The WIEN displacement

Now let's move on to the actual displacement. In doing so, the WIEN displacement law applies. Most publications do not explain why it is called *displacement* law. Usually a graphic of nested curves for the wavelength λ is shown in a linear presentation. It should also be noted that the usual formula $\lambda=c/\nu$ cannot be used for the conversion $\omega_{max}\rightarrow\lambda_{max}$ for thermal spectra. The reason is the different radiation distribution. According to [67] applies $\lambda_{max}=0.6\,c/\nu_{max}$.

The name can only be properly understood in double logarithmic representation, e.g. in dB. Then you can see that the curves are really down-*shifted* along the left slope as temperature/frequency decreases (Figure 74). This can be achieved in a graphics program by moving the top right corner of the curve to the bottom left while holding down the Shift key. This results in a simultaneous reduction in frequency and amplitude. However, the prerequisite is that the aspect ratio is equal to 1. Then the factor $\tilde{x}$ describes exactly the distance between the peak value and the edge.

In principle, an explicit peak value is assigned to each peak frequency, including to the integral of the intensity over the entire frequency range, i.e. to the POYNTING vector $\overline{\mathbf{S}}_\mathbf{k}$. Before calculating the value $\overline{\mathbf{S}}_{\mathbf{k}U}$, we first determine $\overline{\mathbf{S}}_{\mathbf{k1}}$ by extrapolating $\overline{\mathbf{S}}_{\mathbf{k0}}$. The values of $Q_0$, $\omega_1$ and $T_k$ are known or can be calculated exactly. However, one peculiarity of the CMBR should be noted:

> *VI. The cosmological background radiation CMBR is subject to the parametric damping, but not to the geometric damping.*

The reason is that the entire universe is permeated by the radiation affecting the observer from all sides (state of equilibrium). We calculate the value $\overline{\mathbf{S}}_{\mathbf{kU}}$ using the STEFAN-BOLTZMANN radiation law (409).

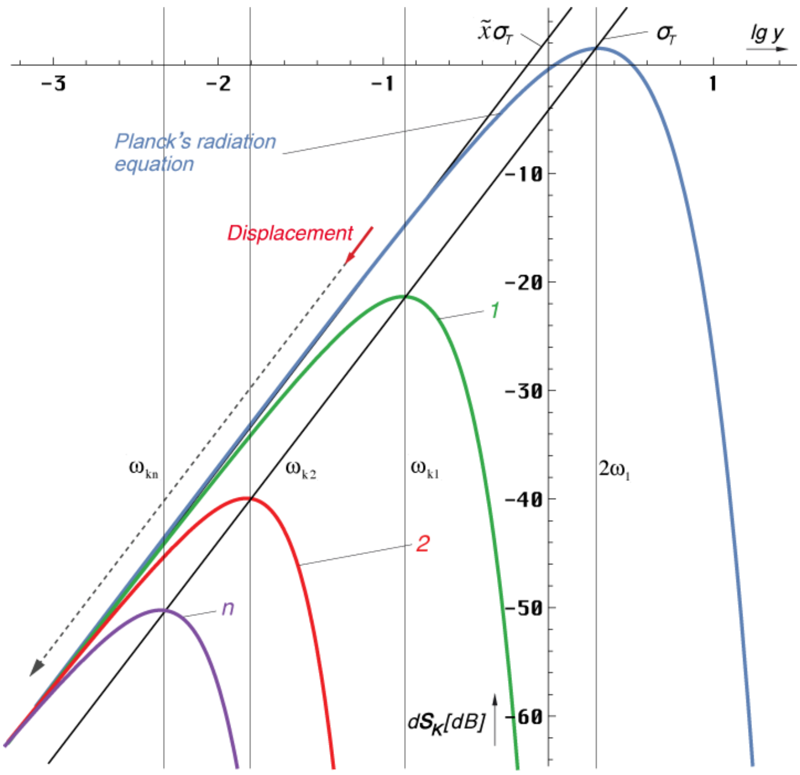



Figure 74
The WIEN displacement law
schematic presentation

However, this requires an exact determination of $T_k$. Of course we could use the COBE value for it, but we want to set up an accurate relation to $Q_0$ indeed. Therefore, at first, we will deal with $T_k$ in the next section. All relevant frequencies are listed in Table 3, the values for $H_0$>70 are for information only.

| | | | | |
|---|---|---|---|---|
| Emission frequency ($H_0$=68.6) | $\omega_U$ | $3.09408 \cdot 10^{104}\,s^{-1}$ | $f_e$ | $4.92438 \cdot 10^{103}$Hz |
| Immission frequency ($H_0$=68.6) | $\omega_S$ | $6.85874 \cdot 10^{103}s^{-1}$ | $f_S$ | $1.09160 \cdot 10^{103}$Hz |
| CMBR-frequency ($H_0$=75.9) | $\omega_k$ | $1.12584 \cdot 10^{12}s^{-1}$ | $f_k$ | 179.18259 GHz |
| CMBR-frequency ($H_0$=72.0) | $\omega_k$ | $1.09639 \cdot 10^{12}s^{-1}$ | $f_k$ | 174.49511 GHz |
| CMBR-frequency (477) ($H_0$=68.6) | $\omega_k$ | $1.00673 \cdot 10^{12}s^{-1}$ | $f_k$ | 160.22630 GHz |
| CMBR-frequency (COBE) | $\omega_k$ | $1.00675 \cdot 10^{12}s^{-1}$ | $f_k$ | 160.23±0.1GHz |

Table 3
Frequencies of the cosmologic
background radiation

### 4.6.4.2.5. Temperature of the cosmologic 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 = $\frac{2}{3}\sqrt{2}$), we are able to calculate the *black temperature* indeed, but we want to keep working with the *gray temperature*. By rearranging of (408) and inserting the energy related redshift $z_{22} = 12\,\varepsilon_v\,Q_0^{5/2}$ from (413) we obtain for $\omega_U = 2\omega_1$:

$$T_k = \frac{\hbar\omega_k}{\tilde{x}k} = \frac{\varepsilon_\nu}{\tilde{x}}\frac{\hbar_1\omega_1}{6k}Q_0^{-\frac{5}{2}} = 0.055693\frac{\hbar_1\omega_1}{k}Q_0^{-\frac{5}{2}} \qquad \tilde{x} = \begin{cases} 2.821439372 & \text{Exactly} \\ 2\sqrt{2} & \text{Approx.} \end{cases} \tag{475}$$

$$T_k = \frac{\hbar\omega_k}{\tilde{x}k} \approx \frac{1}{3}\frac{\hbar_1\omega_1}{6k}Q_0^{-\frac{5}{2}} = \frac{\hbar_1\omega_1}{18k}Q_0^{-\frac{5}{2}} \qquad \varepsilon_\nu = \frac{\tilde{x}}{3} = 0.94048 \quad \text{Exactly} \tag{476}$$

That's the temperature of the CMBR in consideration of the frequency response (see Figure 75). Expression (476) lends itself as approximation, because the value $\tilde{x}=3+\mathrm{lx}(-3e^{-3})$ is only 0.25% below the magic $2\sqrt{2}$. lx is LAMBERT's W-function (ProductLog[#]).

With the updated value from section 6.2.4. in the amount of $Q_0=8.340471132242850\cdot 10^{60}$ expression (476) even gives a correct result. The calculated value is within the accuracy limits of the 2.72548K ±0.00057K, measured by the COBE-satellite. More in [49].

$$T_k = \frac{\hbar\omega_0}{18k}Q_0^{-\frac{1}{2}} = \frac{\hbar_1\omega_1}{18k}Q_0^{-\frac{5}{2}} = 2.725436049\text{K} \qquad \Delta = -1.61258\cdot 10^{-5} \tag{477}$$

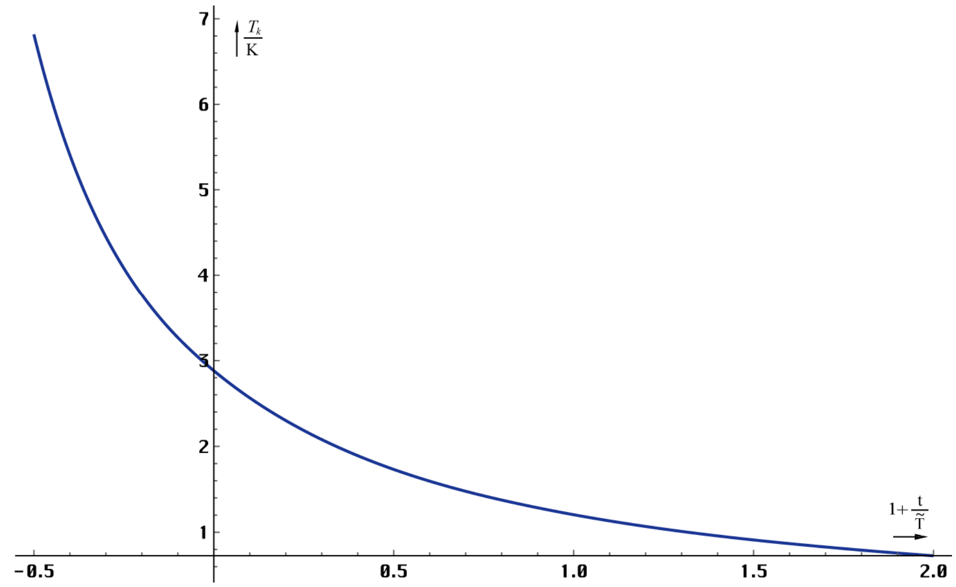



Figure 75
Temporal dependence of the radiation-temperature of the CMBR (linearly)

The temporal course is shown in Figure 76 and 77. There are similarities to the energy density. The presentation of the spatial dependency should be omitted here.

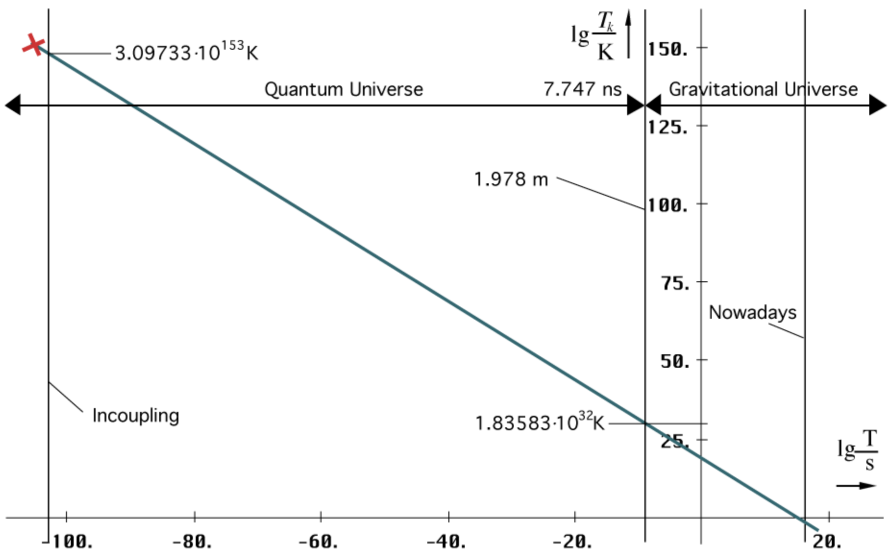



Figure 76
Temporal dependence of the radiation-temperature of the CMBR considered from the point of time of input coupling on

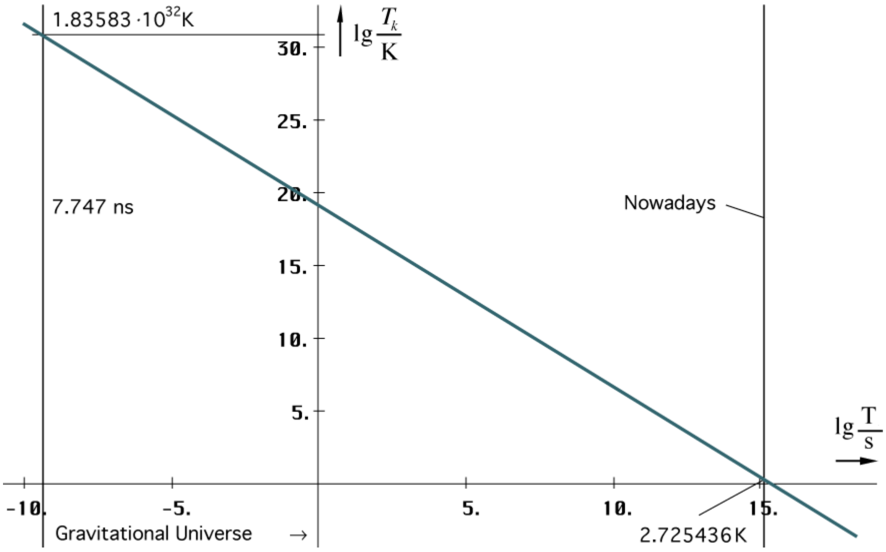



Figure 77
Temporal dependence of the radiation-temperature of the CMBR considered from the beginning of the gravitational-universe on

In [4] also the existence of a background field with neutrinos is postulated, which is said to have a temperature of approx. 1.9 K. Dividing $T_k$ by $\sqrt{2}$ a value of 1.92717 K turns out, which fits well the idea underlying this model that neutrinos propagate rectangularly to photons.

4.6.4.2.6. Energy of the cosmologic background radiation

By this we mean at first the POYNTING vector $\mathbf{\overline{S}_k}$, but also the energy density $w_k$ over the entire frequency range. As said, the calculation is done with the help of the STEFAN-BOLTZMANN radiation law (409). We do not know the values $\overline{S}_{k0.5}$, $\overline{S}_{k1}$, $w_{k0.5}$ and $w_{k1}$ shortly after Big Bang, but we want to calculate them. However, the current value of the energy density is given in [59], amounting to $w_{k0}$=4.17·10$^{-14}$ J/m$^3$. That corresponds to 411 photons/cm$^3$. With it we can first calculate $\overline{S}_{k0}$. We are only interested in the amount:

$$w_{k0} = 4.17\cdot10^{-14}\,\mathrm{Jm^{-3}} \qquad \overline{S}_{k0} = c\,w_{k0} = 12.5013\,\mu\mathrm{Wm^{-2}}\ [71\,\mathrm{dB\,pWm^{-2}}] \tag{478}$$

Now we substitute $T_k$ in (409) with (477) obtaining the following expression:

$$\overline{S}_k = \sigma T_k^4 = \frac{\pi^2 k^4 T_k^4}{60c^2\hbar^3} = \frac{\pi^2 k^4 T_k^4}{60c^2\hbar_1^3}\,Q_0^3 \qquad T_k^4 = \frac{\hbar_1^4\omega_1^4}{18^4 k^4}\,Q_0^{-10} \tag{479}$$

However, the expression on the left is only valid for a single MLE. However, we consider a cube with the edge length $r_0$, which contains a total of 4 pcs. Therefore we need to multiply by 4 obtaining:

$$\overline{S}_k = \frac{4\pi^2}{6298560}\,\frac{\hbar_1\omega_1^4}{c^2}\,Q_0^{-7} = \frac{\pi^2}{1574640}\,\frac{\hbar_1\omega_1^2}{r_1^2}\,Q_0^{-7} \tag{480}$$

It is better to use $/Q_0^4/Q_0^3$ instead of $\times Q_0^{-7}$ in the calculation, otherwise an underflow of values may occur. Interestingly enough, the BOLTZMANN constant k cancels out. That means that it cannot be calculated from other values. Also, it is the only constant which contains the Kelvin. That means, it’s really fundamental and can be fixedly defined as how it happened.

Now in principle, we could calculate the value $\overline{S}_{k1}$ by setting $Q_0$ in (480) equal to one. However, the expression is not yet complete. As already noted, the CMBR is subject to the parametric attenuation. Regardless of the reference frame, the damping factor $\alpha$ is always equal to $-1/R$, at which point R varies. $\alpha$ affects both, E and H, so we need to multiply (480) by $e^{-2r/R}$. Since the CMBR has always covered the maximum time-like distance $r=R=2cT$, the expression simplifies to $e^{-2}$. We expand the fraction by $e^2$:

$$\overline{S}_k = \frac{\pi^2 e^2}{1574640} \frac{\hbar_1\omega_1^2}{r_1^2} e^{-2} Q_0^{-7} \approx \left(\frac{1}{21592} \frac{\hbar_1\omega_1^2}{r_1^2}\right) e^{-2} Q_0^{-7} \qquad [21591.9850214238] \qquad (481)$$

Because of the imprecise value of (478), we can work with the approximation with a clear conscience ($\Delta=-6.94\cdot10^{-7}$). With the bracketed expression $\overline{S}_{k1}$ is actually already defined, but we have to find out whether it is correct.

$$\overline{S}_{k1} = \frac{1}{21592} \frac{\hbar_1\omega_1^2}{r_1^2} = 2.596200\cdot10^{422}\,\mathrm{Wm}^{-2} \qquad [4344.14\mathrm{dB\,pWm}^{-2}] \qquad (482)$$

$$w_{k1} = \frac{1}{21592} \frac{\hbar_1\omega_1}{r_1^3} = \frac{\overline{S}_{k1}}{c} = 8.65999\cdot10^{413}\mathrm{Jm}^{-3} \qquad [8.85872\cdot10^{418}\ w_1 \text{ metrics}] \qquad (483)$$

For comparison, the energy density $w_1$ of the metrics. Here $S_1$ must be divided by $c_M[1]$ and multiplied by 4. The value $w_{k1}$ is orders of magnitude below $w_1$. Attention, both $\overline{S}_{k1}$ and $w_{k1}$ are the values the CMBR would have, if the curve and thus the distribution were the same as today. As can be seen in Figure 67, the dynamic frequency response at $Q_0=1$ is not yet ready with its work. There is no PLANCK-distribution, but curve 4. This is quite similar to the target function curve 6, but not completely. However, $\overline{S}_{k1}$ and $w_{k1}$ are very well suited as fixed reference points.

Now we can use (481) to calculate the actual values and compare them with the measured ones (478):

$$\overline{S}_{k0} = \frac{1}{159544} \frac{\hbar_1\omega_1^2}{r_1^2} Q_0^{-7} = \overline{S}_{k1} e^{-2} Q_0^{-7} = 1.25145\cdot10^{-5}\,\mathrm{Wm}^{-2} \qquad [12.5013\mu\mathrm{Wm}^{-2}] \qquad (482)$$

$$w_{k0} = \frac{1}{159544} \frac{\hbar_1\omega_1}{r_1^3} Q_0^{-7} = w_{k1} e^{-2} Q_0^{-7} = 4.1744\cdot10^{-14}\mathrm{Jm}^{-3} \qquad [4.17\cdot10^{-14}\mathrm{Jm}^{-3}] \qquad (483)$$

That results in the local density of the CMBR background ($r\leq0{,}01R$):

$$\rho_{k0} = \frac{1}{159544} \frac{\hbar_1\omega_1}{c^2 r_1^3} Q_0^{-7} = \frac{w_{k0}}{c^2} = 4.64465\cdot10^{-34}\mathrm{kgdm}^{-3} \qquad [4.64\cdot10^{-34}\mathrm{kgdm}^{-3}] \qquad (484)$$

The values in square brackets are those given in [59]. The deviation of $-1.06\cdot10^{-3}$ is less due to a calculation error than to the fact that the comparative values are only given with two decimal places. Rather, the calculated values are accurate and actually much more accurate: $w_{k0}=4.174403405098\cdot10^{-14}\mathrm{Jm}^{-3}$, but only under the assumption that the CMBR has not interacted with other matter losing energy in the process. Since the deviation is a maximum of 0.1%, it does not appear to be the case. Because the model can be used to calculate back to $Q_0=½$ exactly, we can confidently shelve the idea of the CMBR origin 379,000 years after Big Bang. Then any thermal radiation would only be a narrow spectral line.

However, since in-coupling did not take place at $Q_0=1$ but at $Q_0=½$, there are 4 additional values of interest: $\overline{S}_{k05}$, $w_{k05}$, $\overline{S}_{kU}$ as well as $w_{kU}$. The first two are again the values immediately after in-coupling, assuming a PLANCK distribution.To the calculation we use (482) and (483) by setting $Q_0=½$, $e^2$ is already contained in $\overline{S}_{k1}$.

$$\overline{S}_{k05} = \frac{16}{2699} \frac{\hbar_1\omega_1^2}{r_1^2} = 128\,\overline{S}_{k1} = 3.32313\cdot10^{424}\,\mathrm{Wm}^{-2} \qquad [4365.21\mathrm{dB\,pWm}^{-2}] \qquad (485)$$

$$w_{k05} = \frac{16}{2699}\frac{\hbar_1\omega_1}{r_1^3} = 128\,w_{kl} = 1.10848\cdot 10^{416}\,\mathrm{J\,m^{-3}} \qquad [8.85872\cdot 10^{418}\, w_l \text{ metrics}] \qquad (486)$$

In reality, the values are much larger, since the curve has not yet been clipped at this point of time still matching the shape of a resonant circuit with the Q-factor ½. The later POYNTING vector $S_k$ results from the area ratio of the PLANCK-curve (6) and of the source curve $S_T$ (1). I determined this by numerical integration.

$$\mathbf{S_k} = 0.5503\,\mathbf{S_T} \qquad (487)$$

Thus, if we want to determine the real in-coupling values $\overline{S}_{kU}$ and $w_{kU}$, we have to divide by this value. Then we get:

$$\overline{S}_{kU} = \frac{1}{92.83}\frac{\hbar_1\omega_1^2}{r_1^2} = 232.6\,\overline{S}_{k1} = 6.038\cdot 10^{424}\,\mathrm{Wm^{-2}} \qquad [4367.81\mathrm{dB\,pWm^{-2}}] \qquad (488)$$

$$w_{kU} = \frac{1}{92.83}\frac{\hbar_1\omega_1}{r_1^3} = 232.6\,w_{kl} = 2.014\cdot 10^{416}\,\mathrm{J\,m^{-3}} \qquad [8.85872\cdot 10^{418}\, w_l \text{ metrics}] \qquad (489)$$

I have reduced the accuracy here because the area method does not necessarily reflect the actual conditions. I don't want to go back before the point $t_1/4$ (aperiodic borderline case), since there was no real wave propagation before. However, it is possible to determine the total energy that was used to build the CMBR. For this we need the real world radius at time $t_1/4$ ($Q_0$=½). This means that the volume is known and the total energy $W_U$ can be calculated. We have already determined the exact world radius with the help of (444) including expansion implemented as the function BRQ1[Q] multiplied by $Q^{3/2}$ (Figure 147 right). There all angular and speed ratios are taken into account:

$$R_U = \frac{3}{2} r_1 Q^{\frac{3}{2}} \int_0^Q \frac{dQ}{\rho_0} = Q^{3/2}\,\mathrm{BRQ1}[Q]\,r_1 \qquad (490)$$

$$R_U = Q^{3/2}\,\mathrm{BRQ1}[Q]\,r_1 \qquad \begin{cases} R_U(0.5) = 0.598337\,r_1 = 1.15949\cdot 10^{-96}\,\mathrm{m} \\ R_U(1) \quad = 9.207100\,r_1 = 1.78419\cdot 10^{-95}\,\mathrm{m} \end{cases} \qquad (491)$$

Therefrom, the following volumina arise (spheric):

$$V_U = \frac{4}{3}\pi Q^{9/2}\,\mathrm{BRQ1}[Q]^3\, r_1^3 \qquad \begin{cases} V_U(0.5) = 0.897276\,r_1^3 = 6.52956\cdot 10^{-288}\,\mathrm{m^3} \\ V_U(1) \quad = 3269.310\,r_1^3 = 2.37911\cdot 10^{-284}\,\mathrm{m^3} \end{cases} \qquad (492)$$

Important for the calculation of $W_{k05}$ is the answer to the question: How many line elements fit into the universe in actual fact. Regardless of whether we consider a sphere or a cube, because the factor $4/3\pi$ sowie $r_1^3$ cancel out, we get the following values with $r_0(Q) = Q\,r_1$:

$$N_U = Q^{3/2}\,\mathrm{BRQ1}[Q]^3 \qquad \begin{cases} N_U(0.5) = 1.71367 \approx \sqrt{3} \\ N_U(1) \quad = 780.491 \end{cases} \qquad (493)$$

At the point of time $t_1/4$ ($Q_0$=½), the aperiodic borderline case, just one single line element fits into the universe, that's not a contradiction, while at $Q_0$=1 already 780 of them fit in. However, the number decreases to 180 at $Q_0$=2,295 in order to re-increase later approaching the function $N_U = Q_0^3$. Then, from $10^3$ on the approximation applies, but not for long. Für For $R \gg 10^3 r_1$, $r_0$ decreases towards the edge and (349) from Section 4.6.1 applies. This means that the line elements are arranged in a different packing at the beginning. At $Q_0$=1 there is a phase jump in the propagation function and thus a rearrangement towards fc. The course of $N_U$ exactly and approximation is shown in Figure 78.

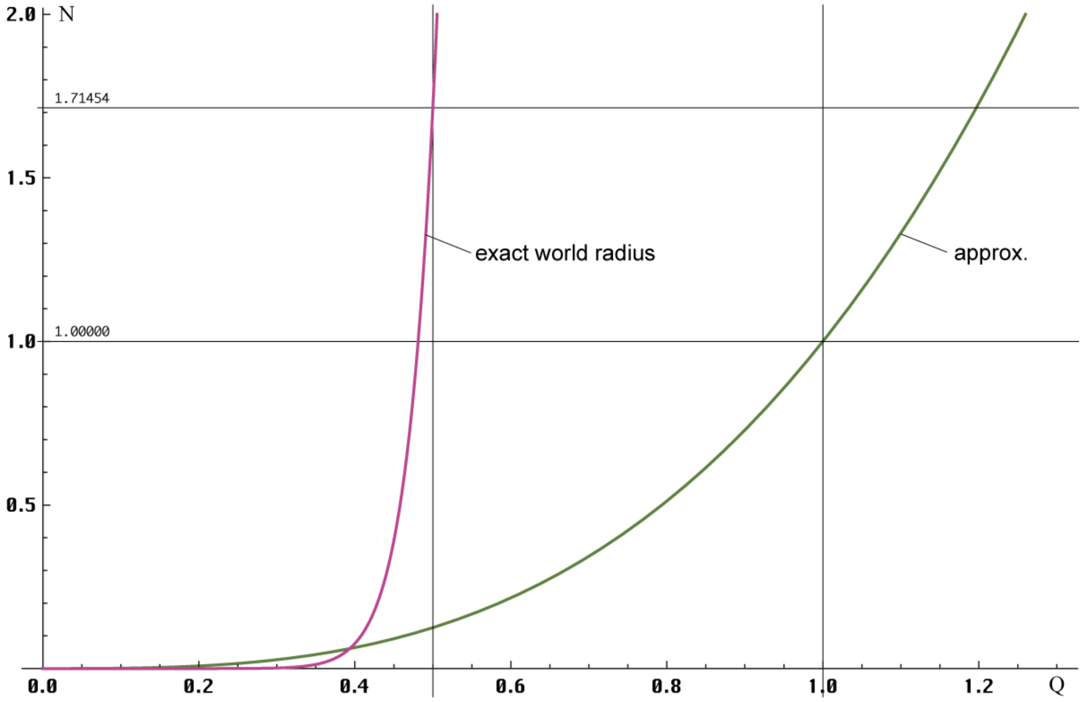



Figure 78
Maximum possible number of line elements N
in the universe at the beginning of expansion

Depending on your point of view, the universe begins with a negative entropy or with zero if we consider the state at $Q<½$ as a feasible degree of freedom. Therefore, when calculating the immission energy $W_{kU}$ we must decide whether we want to multiply the energy density $w_{kU}$ by the volume of an MLE or that of the entire universe (492), and whether we want to choose a sphere or a cube. According to expression (493), a cube with the edge length $r_1$ also fits in, in its interior a line element with the radius $r=r_1/2$.

Since we determined the other values using a cube, we choose the (inner) cube obtaining the volume $V_{\boxdot}=7.2771\cdot 10^{-288}m^3$. The outer sphere has a volume of $V_{\odot}=1.97988\cdot 10^{-287}m^3$. For $W_{k1}$ we choose the approximation because it's used as a fixed reference for larger values of $Q_0$ and also the cube with an edge length of $r_1$. With it, the following values turn out:

$$\begin{aligned} W_{kU} &= 232.6\, w_{kl}\, r_1^3 = \frac{1}{92.83}\hbar_1\omega_1 = 1.46583\cdot 10^{129}\mathrm{J} \\ W_{k1} &\overset{\text{def}}{=} w_{kl}\, r_1^3 = \frac{1}{21592}\hbar_1\omega_1 = 6.30195\cdot 10^{126}\mathrm{J} \end{aligned} \tag{494}$$

This definition of $W_{k1}$ has the advantage, that the value divided by $0.5503\cdot 2^{-7}$ gives exactly the value of $W_{kU}$. With this we can now even calculate the costs of generating the CMBR. After the last price increase from my electricity provider, the kWh costs €0.3434. There is almost parity to the US$. Converted $W_{kU}$ amounts to $4.07177\cdot 10^{122}$kWh, the costs to US$ $1.398\cdot 10^{122}$ including 19% VAT, a bargain compared to the costs of the metric wave field. This as a little fun by the way.

We now want to investigate whether we are able to derive an estimate of the current boson/fermion ratio from these values. It should also be possible to calculate the mean matter density, see Table 4. The photon number density at in-coupling looks very high but it applies per $m^3$. If you multiply by the real volume $r_1^3$, you get 0.01 only. Since in fact only integer n can occur, we should get used to round-up to the next integer (Ceiling[#]), then it'll be fine. Please find the calculation further down.

| Value | Poynting vector | dB | Energy density | Symb. | Definition | Number/m$^3$ |
|---|---|---|---|---|---|---|
| Beginning | $6.0380\cdot10^{424}$Wm$^{-2}$ | 4367.81 | $2.014\cdot10^{416}$ Jm$^{-3}$ | $w_{kU}$ | Immission | $1.30\cdot10^{284}$ |
| Target now | $1.25145\cdot10^{-5}$Wm$^{-2}$ | 70.9742 | $4.1744\cdot10^{-14}$Jm$^{-3}$ | $w_{k0}$ | Bosons target | $4.245\cdot10^{8}$ |
| Actual now | $1.25013\cdot10^{-5}$Wm$^{-2}$ | 70.9696 | 4.17??$\cdot10^{-14}$Jm$^{-3}$ | $n_\gamma$ | Bosons actual | $4.105\cdot10^{8}$ |
| Density | Target now local $\rho_{k0}$ | — | $4.645\cdot10^{-34}$g cm$^{-3}$ | $n_M$ | Fermions | 45.81948 |
| Density | Target now local $\rho_{G0}$ | — | $7.410\cdot10^{-29}$g cm$^{-3}$ | $n_\gamma/n_M$ | Ratio | $8.958\cdot10^{6}$ |

Table 4
Field strength and energy density of the cosmologic background radiation ($H_0$=68,6)

The value $\rho_{k0}$ (484) agrees very well with that given in [59], even if the formula stated there is completely unsuitable for calculation, since essential components have been omitted as »usual«. The same applies to the photon number density. Here the conditions are even more complicated.

The value 411/cm$^3$ specified there is plausible. I've been trying to find a formula that calculates this. With [59] you get a totally wrong result of 5 photons per K$^3$. A unit of length does not appear there. Still best of all one fares with [4]. On p.174 in the continuous text $n_\gamma = 0.37\,\mathrm{b}\,\mathrm{k}^{-1} T_\gamma^3$ is given. Here k is the BOLTZMANN constant and b should be the STEFAN-BOLTZMANN-constant σ, which of course is defined differently again, so that the text formula has to be adapted. Then, with the COBE value we get:

$$n_\gamma = 1.48\,\frac{\sigma}{\mathrm{k}\cdot\mathrm{c}}\,T_{k0}^3 = 410.466\,\mathrm{cm}^{-3} = 4.10466\cdot10^{8}\,\mathrm{m}^{-3} \tag{495}$$

That's actually only 410 photons, but we always wanted to round up in future. So I tried to figure out how to get to 0.37 to increase accuracy and failed miserably. After studying various sources, I do not refer to erroneous publications, it has been shown that the factor amounts to $2\zeta(3)/\pi^2$. It results from the solution of an integral, ζ(x) is Riemann's zeta function. But I don't get a correct result with it. Rather it should be $4\zeta(3)/\pi = 1.53$. There is probably a third, different definition of σ. We use the CODATA$_{2018}$ definition. With it, we obtain the correct expression:

$$n_\gamma = 4\zeta(3)\,\frac{\sigma}{\pi \mathrm{kc}}\,T_{k0}^3 = 424.473\,\mathrm{cm}^{-3} = 4.24473\cdot10^{8}\,\mathrm{m}^{-3} \tag{496}$$

But now, with the COBE value of $T_k$, it are not 411, but 425 photons. What that means I leave open here. It's possible that one solution applies to the frequency, the other to the wavelength. Since both $T_{k0}$ (477) and σ (409) depend on the reference frame, it should be possible to describe the photon number density of the CMBR as a function of $Q_0$ and thus also of t. Expression (477) is already correct, still σ remains. It contains $\hbar^{-3}$. We define:

$$\sigma_1 = \frac{\pi^2 \mathrm{k}^4}{60\hbar_1^3 \mathrm{c}^2} = \mathrm{const} = 9.773258655978905\cdot10^{-191}\,\mathrm{Wm}^{-2}\mathrm{K}^4 \tag{497}$$

$$\sigma = \frac{\pi^2 \mathrm{k}^4}{60\hbar^3 \mathrm{c}^2} = \sigma_1 Q_0^3 = 5.6703666738854964\cdot10^{-8}\,\mathrm{Wm}^{-2}\mathrm{K}^4 \tag{498}$$

This of course eliminates the fixation of σ, which passes over to $\sigma_1$, just like with $\hbar$. Using (409) and (477) we get then for the photon number density:

$$n_\gamma = 1.48\,\frac{\sigma_1 T_{k1}^3}{\mathrm{k}\cdot\mathrm{c}}\,Q_0^{-9/2} = \frac{r_1^{-3}}{23955.6}\,Q_0^{-9/2} \qquad [\mathrm{m}^{-3}] \tag{499}$$

Now we only used the photons of the cosmic background radiation to determine the photon number density. In reality, of course, there are also photons that have nothing to do with it, that originate from interaction processes or were created during the annihilation of matter and antimatter. A large part of the cosmic radiation spectrum comes e.g. from supernova explosions. So we have to correct the photon number slightly upwards. The graphical presentation follows further down together with the nucleon number density $n_M$ in Figure 81. However, before we are able to determine $n_M$, we need to have a look at entropy again.

Since the letter S is already heavily overburden, we must exercise special caution here. We had already used $S_b$, $S_0$ and $S_1$ for the entropy of the metric wave field, and $\mathbf{S_0}$, $\mathbf{S_1}$ and $\overline{S}_{k0/1/U}$ for the POYNTING vectors. Now we still need an expression for the specific entropy per nucleon. In [4] the expression $\overline{S}_\gamma$ is used for this. Since the letters $_U$ and $_M$ can also appear in this context, we use $\underline{S}_\gamma$ instead. According to [4] »the specific entropy $S_\gamma/M$ oder – as a dimensionless quantity – its entropy per nucleon $\underline{S}_\gamma$ measured in natural entropy units, $\underline{S}_\gamma \equiv m_a \times k^{-1} S_\gamma/M$ ... provides us with extraordinarily important information about the early days of the universe« . The cube is used there too, $M = \rho_G R^3$ is the total mass of the fermionic matter, $m_a$ the nucleon mass, i.e. the atomic mass unit. We have to convert the formula given there for the calculation of $\underline{S}_\gamma$ again:

$$\underline{S}_\gamma = \frac{16}{3}\frac{\sigma m_a}{kc\rho_G} T_k^3 = 2.4562 \cdot 10^{-21} \rho_G^{-1} \mathrm{kg\,dm^{-3}} \qquad ([4]\ 4.101)$$

To determine the matter density $\rho_G$ we need the rest mass M of the incoherent matter of the entire universe. For this purpose, counts in the starry sky and estimates were carried out in the past, or one relied on a world model. I would like to expressly refrain from the calculation according to [4], since it uses the standard model, which this model is guaranteed *not* based on. Actually, we only need one mass and which one is the most suitable for this purpose? The MACH-mass $M_1 = \mu_0 \kappa_0 \hbar$ from Section 6.2.4.1. This already represents the average relevant for the observer. It applies $M_1 = \rho_G R^3$. This gives us the current value for $\rho_{G0}$:

$$\rho_{G0} = M_1 R^{-3} = 7.41028 \cdot 10^{-29} \mathrm{kg\,dm^{-3}} \qquad (500)$$

The value of ρG is based on the cube and agrees reasonably with the value $\rho_G \approx 10^{-30}\mathrm{g/cm^3}$ given in [4]. Other publications indicate values of $0.3...1.1 \cdot 10^{-30}\mathrm{kg/dm^3}$ for the density. However, these are only estimates. The entropy per nucleon $\underline{S}_{\gamma 0}$ ($2.4 \cdot 10^{-9}$) differs significantly. The cause is the outdated value of $H_0$ in the amount of $55\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$ and the standard model used there.

For $\underline{S}_{\gamma 0}$ we use (409) and (477) once more and we first replace $m_a$ by $m_e$. Since the ratio $m_p/m_e$ has been proven to be constant [53], the same applies to $m_a/m_e$ and $\underline{S}_{\gamma 0}$ too. By rearranging (112) we can now substitute $m_e$ by $M_1$ and we get for the approximation:

$$\underline{S}_{\gamma 0} = \frac{16}{3}\frac{\sigma m_a}{kc\rho_G} T_k^3 = \frac{16 \cdot 1822.8884862}{3 \cdot 60 \cdot 18^3 \cdot 9 \cdot \sqrt{2}} \delta^{-1} Q_0^{1/6} \approx \frac{1}{429.638496677} Q_0^{1/6} \qquad (501)$$

In fact, all constants can be eliminated and only one constant factor and $Q_0$ remain. Here, the dependency on $Q_0$ is only considered for σ. To *R(Q)* the approximation $R = Q_0^2 r_1$ applies and to $m_a$ the linear approximation 1822.9 $m_e'$ from Figure 15. If we want to use the exact functions, we need the function BRQ1[Q] for the exact world radius, the function deltaF[Q], and expression (112). Then, the exact expression reads:

$$\underline{S}_{\gamma 0} = \frac{1}{458.107543477} \mathrm{BRQ1}[Q_0]^3\, \mathrm{deltaF}[Q_0]^{-1}\, Q_0^{-4/3} = 3.31458 \cdot 10^7 \qquad (502)$$

All non-linearities in the world radius and the nucleon mass shortly after Big Bang are taken into account here. The results of (501) and (502) for $Q_0$ are identical since $Q_0 \gg 1$.

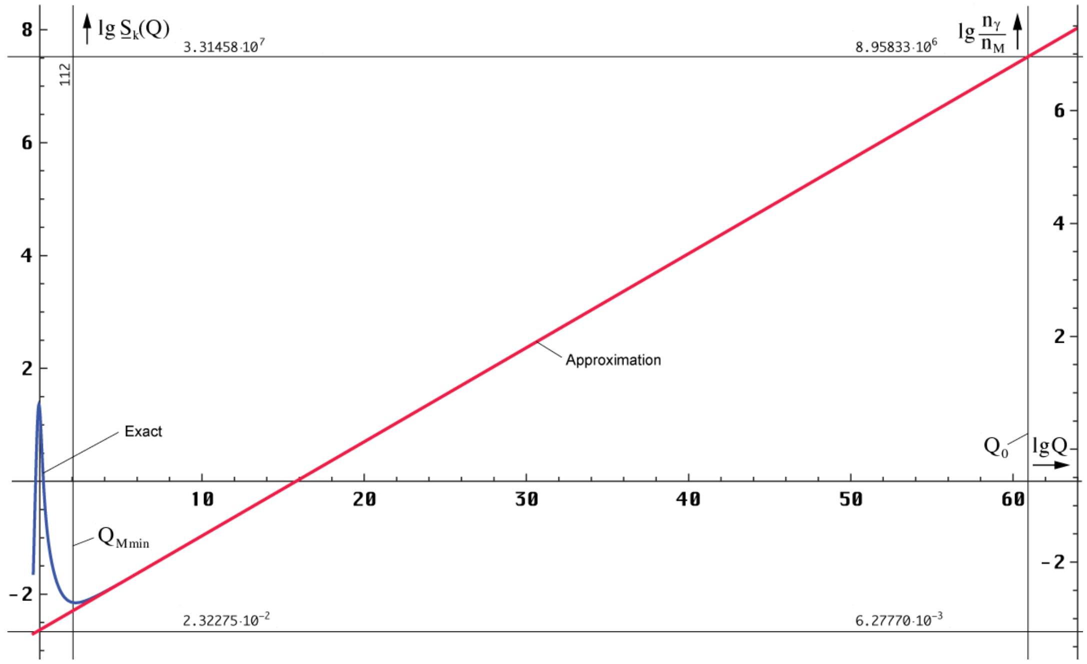



Figure 79
Entropy per nucleon and photon/nucleon-ratio of the CMBR large scale

Now we can also calculate the nucleon number density $n_M$. According to [4] the quotient $n_\gamma/n_M$ is proportional $\underline{S}_\gamma$. It applies:

$$\underline{S}_\gamma = 3.7\frac{n_\gamma}{n_M} \qquad \frac{n_\gamma}{n_M} = 8.95833\cdot 10^6 \qquad n_M = 45.8195\ m^{-3} \qquad ([4]\ 4.102)$$

$$n_M = \frac{r_1^{-3}}{14.133123}\,BRQ1[Q_0]^{-3}\,deltaF[Q_0]\,Q_0^{-19/6} \approx \frac{r_1^{-3}}{15.069623}\,Q_0^{-14/3} \qquad (503)$$

Now we have determined the current values. Thus, we can calculate the course of $\underline{S}_\gamma$ for larger and smaller values as a function of Q. It is shown in Figure 79 and 80.

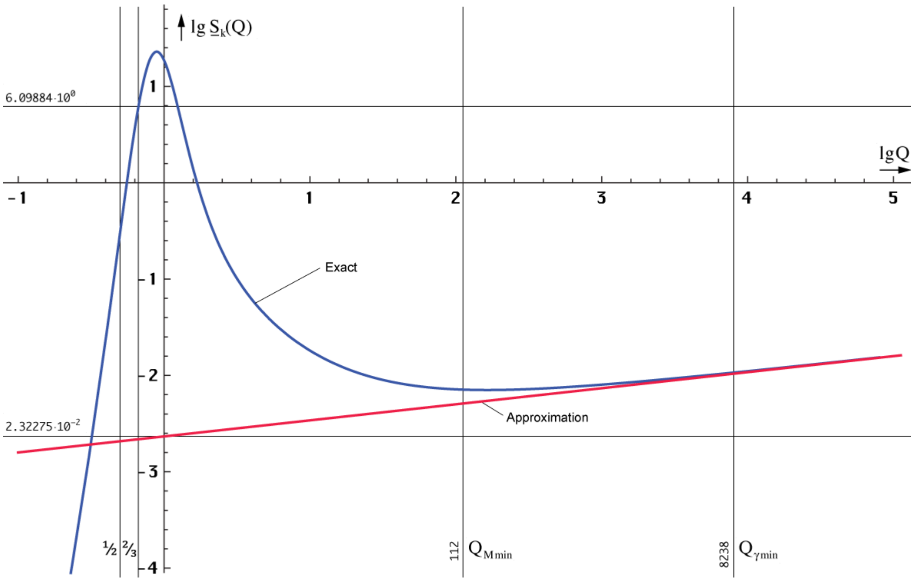



Figure 80
Entropy per nucleon of the CMBR small scale

Now there is the well-known *initial entropy problem* with the standard model, i.e. it is assumed that the universe was in thermodynamic equilibrium at BB, a state of maximum entropy. However then, at the origin of the CMBR at 3000K the entropy must have been lower in order for it to increase over time, since a decrease without energy addition is physically forbidden. After the BB, however, there was no more energy supply. Therefore, most people blame it on the influence of gravity.

Now I had thought that this problem does not exist with my model, since the CMBR here is related to the point Q=½, i.e. much earlier. If you take a closer look at Figure 80, however, you can see that there is also a section where the entropy decreases. The question is now, is there such a problem with my model too? The answer is: No. In reality, it is a statistical problem.

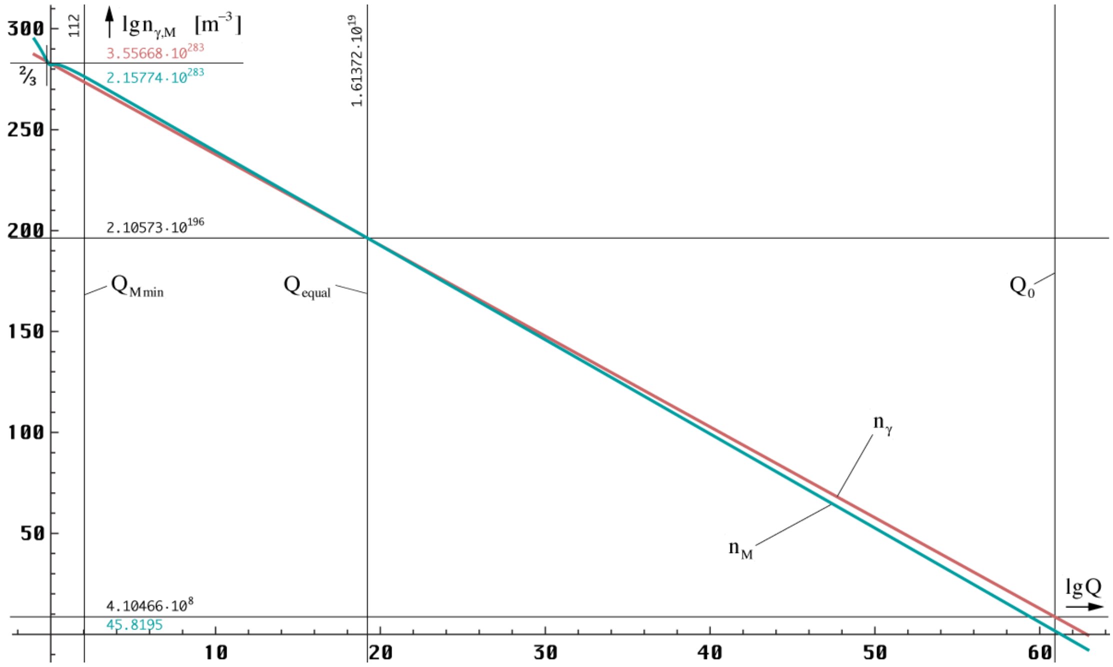



Figure 81
CMBR-photon-number- in comparison to the nucleon-number-density per $m^3$

Even if the mass, photon- and nucleon-number density assumes impressively high values shortly after BB, the number of particles involved is very small, since the world radius is extremely small at this time. Since entropy is a statistical variable, but statistics requires a minimum number of possible degrees of freedom (particles) in order to generate relevant results, the results are not relevant if this number is not reached, nor violations of physical principles. I assumed the minimum value to be 32 and marked it in picture 80. There are two different values, one for nucleons (Q=112), the other for photons (Q=8238), after that, i.e. from $2.13\cdot10^{-97}$s after BB on, there were no more violations and therefore no problem. Before that, quantum effects predominated, which defy any statistics.

Therefrom follows that it is generally sufficient to use the approximation formulas. Figure 81 shows the photon- (499) and the exact nucleon-number density (503) as a function of Q. As you can see, there were initially more nucleons than photons. The parity was reached at the point of time $8.42\cdot10^{-67}$s after BB.

Today there are more photons than nucleons. So we live in a largely radiation-dominated universe. How do we get the time data? Very easy, it applies $t=Q^2t_1$. In the logarithmic presentation the x-axis has to be multiplied by 2 only. In contrast to the impressively high values, Figure 82 shows the actual number of CMBR photons and nucleons in the entire universe.

So today there are $1.19674\cdot10^{80}$ nucleons in the universe. This value corresponds almost exactly to the square of the value C (1038) described by EDDINGTON, which he already assumed to correspond to the total number of nucleons in the universe, see Section 7.5.1. So it seems that the number of photons and nucleons is closely linked to the reference frame and thus to the age of the universe. So the universe *requires* the presence of a certain number of particles at a certain point of time. This is ensured by a certain number of particles decaying into several others, as well as by virtual pairing/annihilation processes.

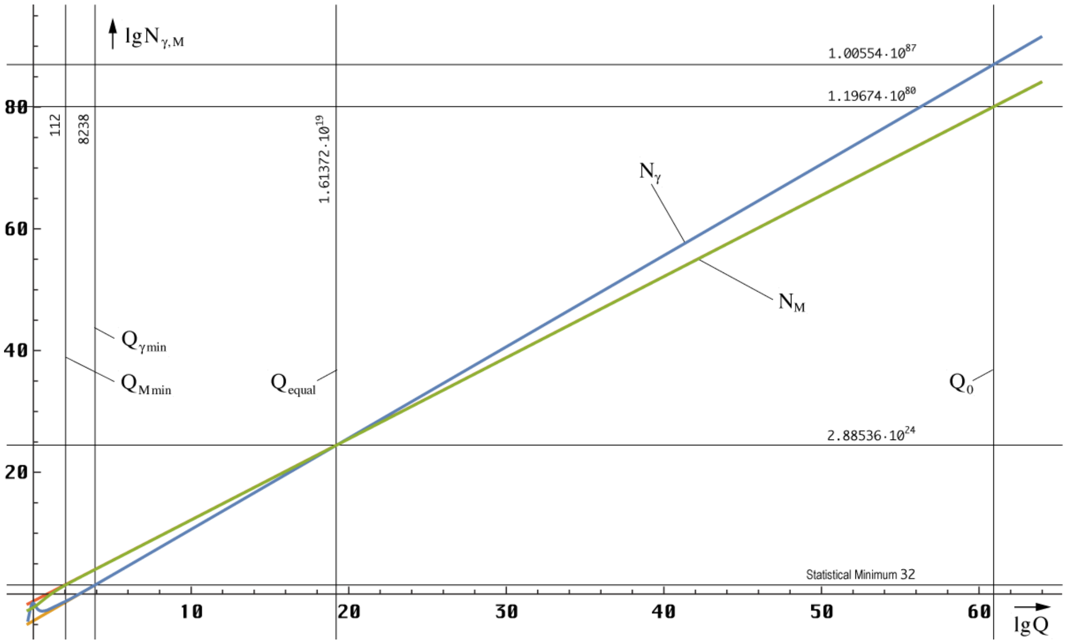



Figure 82
Real number of CMBR-photons
and nucleons in the whole universe

These processes are triggered by entropy. For example, you can assign a certain entropy to an isotope. The larger the value, the shorter the half-life. Because of (708) entropy also depends on the velocity. Thus atoms at high velocities not only decay more slowly because time passes more slowly, but also because the entropy is lower. Both statements describe the same fact and are equivalent.

$$Q_0 = \tilde{Q}_0 \left( \left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \right) \left(1-\frac{v^2}{c^2}\right)^{\frac{1}{3}} \tag{708}$$

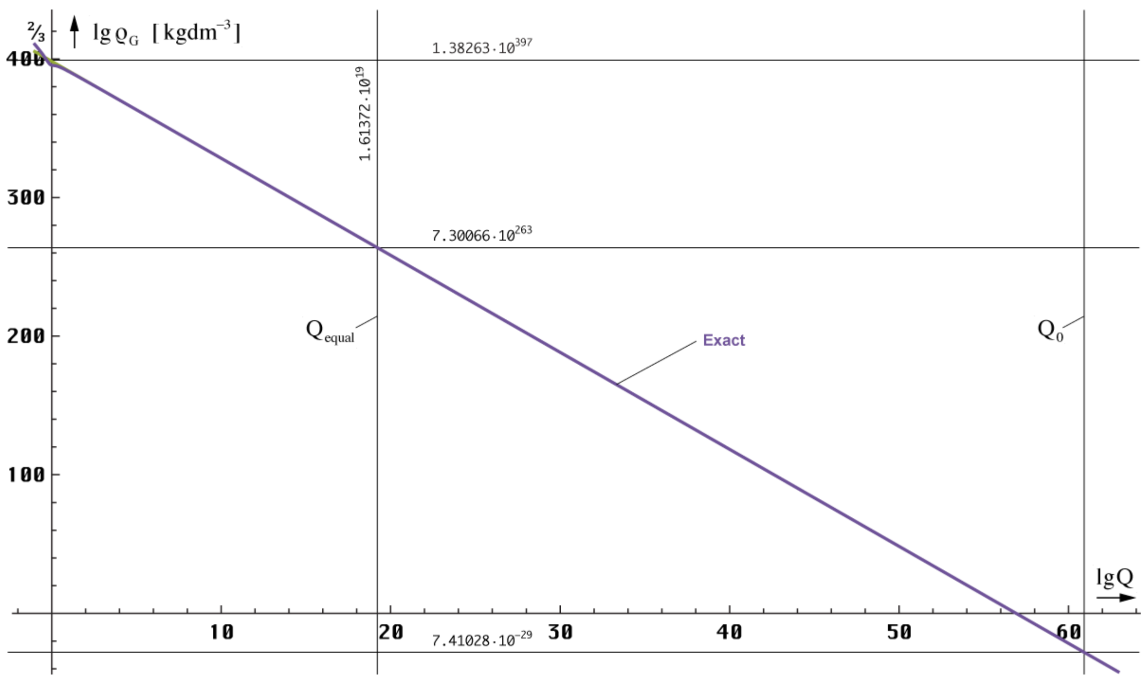



Figure 83
Dependence of the incoherent matter density
considered from the time of in-coupling on

The only thing missing is the density of the incoherent matter $\rho_G$, which is also a function of time and space. The course is shown in Figure 83 and 84. The density is defined as follows:

$$\rho_G \;=\; \frac{M_2}{r_1^3}\,BRQ1[Q_0]^{-3}\,Q_0^{-11/2} \;\approx\; \frac{M_2}{r_1^3}\,Q_0^{-7} \tag{504}$$

In contrast to (500), the value $M_2$ (fixed) is used here instead of $M_1$, since $M_1$ also depends on the reference frame and thus on time. It applies $M_1 = M_2/Q_0$.

Since all previous values are dependent on $Q_0$, one can also show the dependence on other quantities using (708). Figure 84 shows the dependency on the distance r using the example of incoherent matter density. The further away we observe, the older the condition we observe. However, it is relevant for us because even delayed effects are effects.

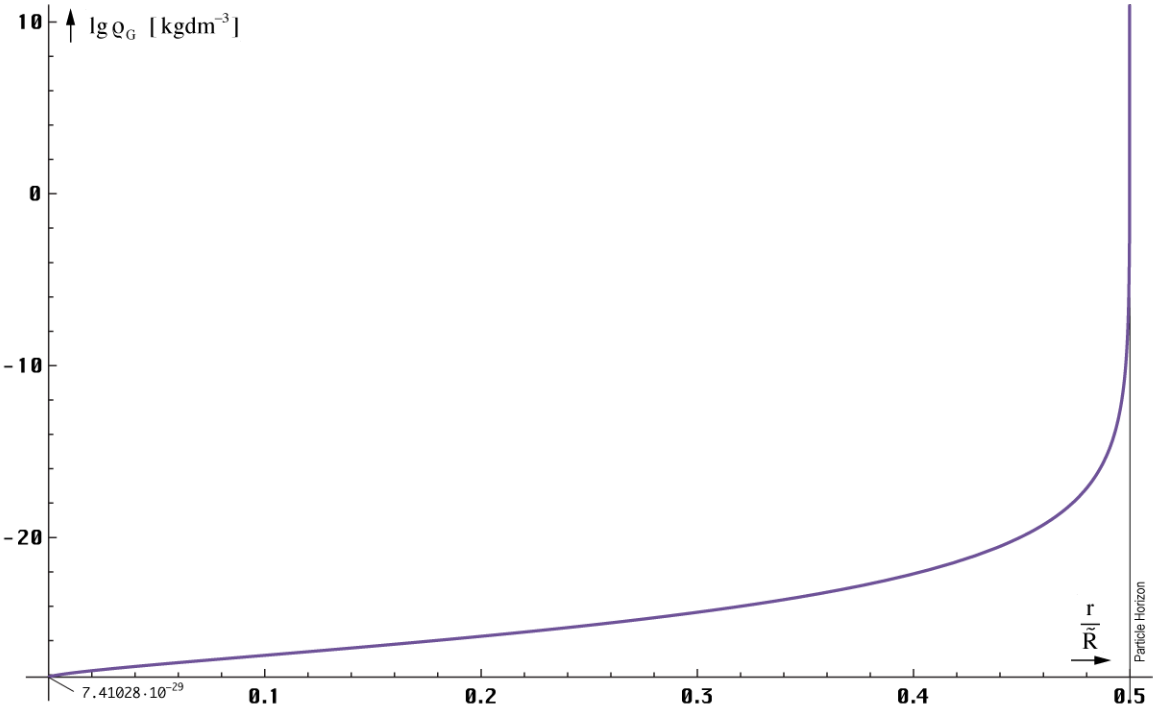



Figure 84
Spatial dependence of the incoherent matter density to the point of time T (nowadays)

Thus, most of the mass is located at the edge for each observer, evenly distributed over the particle horizon (repulsion!), so that the forces cancel each other. However, when accelerating, one leaves the center and must exert a force $F = m \cdot a$. With it, the MACH mass $M_1$ is the cause of the inertial mass, exactly as postulated by MACH. For antimatter a different equivalence principle applies $m_i = -m_g$, so that it is attracted by the particle horizon.

At this point it should be pointed out once again that *particles without a metric* are always in the state as at Q=½ or ⅔, depending on their type. Then, antiparticles have a mass and inherent frequency above, „normal" particles below the upper cut-off frequency of the vacuum. Thus also results in the symmetry breaking, which means that the universe consists predominantly of „normal" matter. All particles remain in this state until some kind of interaction occurs. Any new particles created in this way will also have the properties that prevail at time $t_1/4$ ($2\hbar_1$, $2\omega_1$, $r_0/2$, $\alpha_1/2$ etc.).

The essential point is, that the observer himself is trapped in the metric. Therefore he can only observe the „shadows" of the real conditions, i.e. the red-shifted relative mass such as $m_p$ (PLATO's cave parable). Then, this and not the absolute mass is a function of space and time.

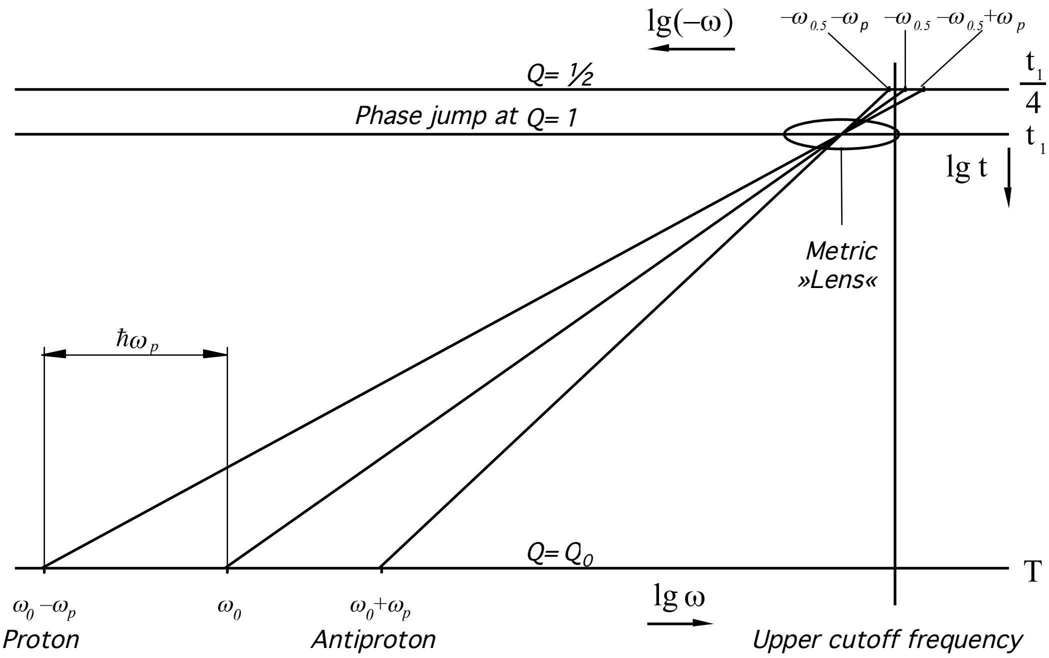



Figure 85
Mass-red-shift using the example of the proton

For this, however, it is necessary that the frequency of the metric wave field has the same red shift as the frequency of the cosmic background radiation (this is guaranteed for $\hbar$ anyway), so that the frequency ratios also remain constant. To the frequency $\omega_0$ applies $\omega_0 \sim Q_0^{-1}$. In addition, there is a difference in the propagation speed, which is approximately $Q_0^{-1/2}$. This makes a total of $Q_0^{-3/2}$, as with superimposed waves. The principle of such a red-shift is shown in Figure 86. The metric acts here like a lens through which we look at the actual conditions. The resolution is exactly $\hbar/2$, i.e. the lens vibrates with the frequency $\omega_0$ and the amplitude $\hbar$. Therefore, e.g. an electron cannot be focused properly. So this is the real reason for PLANCK's uncertainty principle.

The enlargement or better reduction factor changes over time but is also a function of space and the frame of reference. With a Q-factor of 1 at time $t_1$, a phase jump occurs, the phase rate of the metric wave field has a zero crossing (Figure 23). Therefore, the frequency before this point of time is defined negatively, therafter positively. That the nucleons should be much larger than Planck's elementary length is an error resulting from the classical atomic model. Because of the magnification of the wavelength, it only *seems* to be so. To the creation of particle/antiparticle pairs, only the energy difference to $W_0$ is necessary. The metrics do the rest.

### 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 cosmologic 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:

$$\mathbf{S} \;=\; \frac{1}{2}\mathrm{Re}\left[\underline{\mathbf{E}}\times\underline{\mathbf{H}}^*\right] \tag{505}$$

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:

$$\underline{\mathbf{E}} = \hat{\mathbf{E}}_{\mathbf{i}} H_0^{(1)}(2\omega_0 t) \qquad \underline{\mathbf{H}}^* = \hat{\mathbf{H}}_{\mathbf{i}} H_0^{(2)}(2\omega_0 t) \tag{506}$$

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 (240) 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.
First, we replace $\hat{\mathbf{S}}_{\mathbf{i}}$ with $2\pi\mathbf{S_1}$, for better calculation. Then we have to correct (506) as follows:

$$\underline{\mathbf{E}} = \sqrt{2\pi S_1 \underline{Z}_F}\left(J_0(2\omega_0 t) + jY_0(2\omega_0 t)\right)\mathbf{e_E} \tag{507}$$

$$\underline{\mathbf{H}}^* = \sqrt{\frac{2\pi S_1}{\underline{Z}_F}}\left(J_0(2\omega_0 t) - jY_0(2\omega_0 t)\right)\mathbf{e_H} \tag{508}$$

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):

$$Q_0 = 2\omega_0 t \qquad \rho_0\omega_0 t = \frac{c}{|\underline{c}|} = \frac{Z_0}{|\underline{Z}_F|} \sim \frac{1}{2}Q_0^{1/2} \qquad M_0(2\omega_0 t) \sim Q_0^{-3/2} \tag{509}$$

$$\underline{\mathbf{E}} = j\rho_0\omega_0 t\sqrt{2\pi S_1 \underline{Z}_F}\left(J_0(2\omega_0 t) + jY_0(2\omega_0 t)\right)\mathbf{e_E}\, e^{-j\frac{1}{2}\arctan\theta} \tag{510}$$

$$\underline{\mathbf{H}}^* = j\rho_0\omega_0 t\sqrt{\frac{2\pi S_1}{\underline{Z}_F}}\left(J_0(2\omega_0 t) - jY_0(2\omega_0 t)\right)\mathbf{e_H}\, e^{+j\frac{1}{2}\arctan\theta} \tag{511}$$

The definition of $\rho_0$ can be found in (211). 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 (510) and (511) overall (without $S_1$). Under application of (505) we finally get for the amount $S_0$:

$$S_0 \stackrel{?}{=} \frac{\pi^2}{4} S_1 (2\omega_0 t)^4 (J_0^2(2\omega_0 t) + Y_0^2(2\omega_0 t))^2 \rho_0^4 = 4\pi^2 S_1 \rho_0^4 \omega_0^4 t^4 M_0^4(2\omega_0 t) \tag{512}$$

$$S_0 \stackrel{?}{=} S_1(2\omega_0 t - \beta r)^{-4} \qquad \text{Approximation} \tag{513}$$

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 (505). Now we want to determine the absolute value of $\mathbf{S_1}$ using the following approach:

$$\underline{\mathbf{E}} = \frac{q_0 \mathbf{e_E}}{\varepsilon_0 r_0^2} = \frac{q_0 \mathbf{e_E}}{C_0 r_0} = \frac{1}{c}\frac{i_0}{C_0}\mathbf{e_E} \tag{514}$$

$$\underline{\mathbf{H}} = \frac{\varphi_0 \mathbf{e_H}}{\mu_0 r_0^2} = \frac{\varphi_0 \mathbf{e_H}}{L_0 r_0} = \frac{1}{c}\frac{u_0}{L_0}\mathbf{e_H} \tag{515}$$

**e** is the unit-vector, $q_0$, $\varphi_0$, $u_0$ and $i_0$ are time-functions. Finally, we get:

$$\mathbf{S_0} = \frac{1}{2}(\underline{\mathbf{E}} \times \underline{\mathbf{H}}^*) = \frac{\hbar\omega_0^2}{r_0^2}\mathbf{e_r} = \frac{P_0}{r_0^2}\mathbf{e_r} \sim Q_0^{-5} \text{ !!!} \qquad (516)$$

Expression (516) 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 (512) and (513). The value $S_0$ of (516) is proportional to $Q_0^{-5}$ (as with overlaid photons) in contrast to $Q_0^{-4}$ in (513). 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:

$$\hbar = 1.253314\,\hbar_1 \rho_0 2\omega_0 t\, M_0(2\omega_0 t) \approx \hbar_1 Q_0^{-1} \qquad (517)$$

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 (512) and (513) read as follows:

$$S_0 = 10.026512\,\pi^2 S_1 (2\omega_0 t)^5 \rho_0^5 M_0^5(2\omega_0 t) \qquad (518)$$

$$S_0 = S_1\left(2\omega_0 t - \beta r\right)^{-5} \quad \text{Approximation} \qquad (519)$$

With it, the updated initial value $S_1$, being applied as well for the exact function as for the approximation, results to:

$$S_1 = \frac{\hbar_1\omega_1^2}{r_1^2} = \frac{\hbar_1\mu_0\kappa_0^4}{\varepsilon_0^3} = 5.60571 \cdot 10^{426}\,\mathrm{Wm^{-2}} \qquad (520)$$

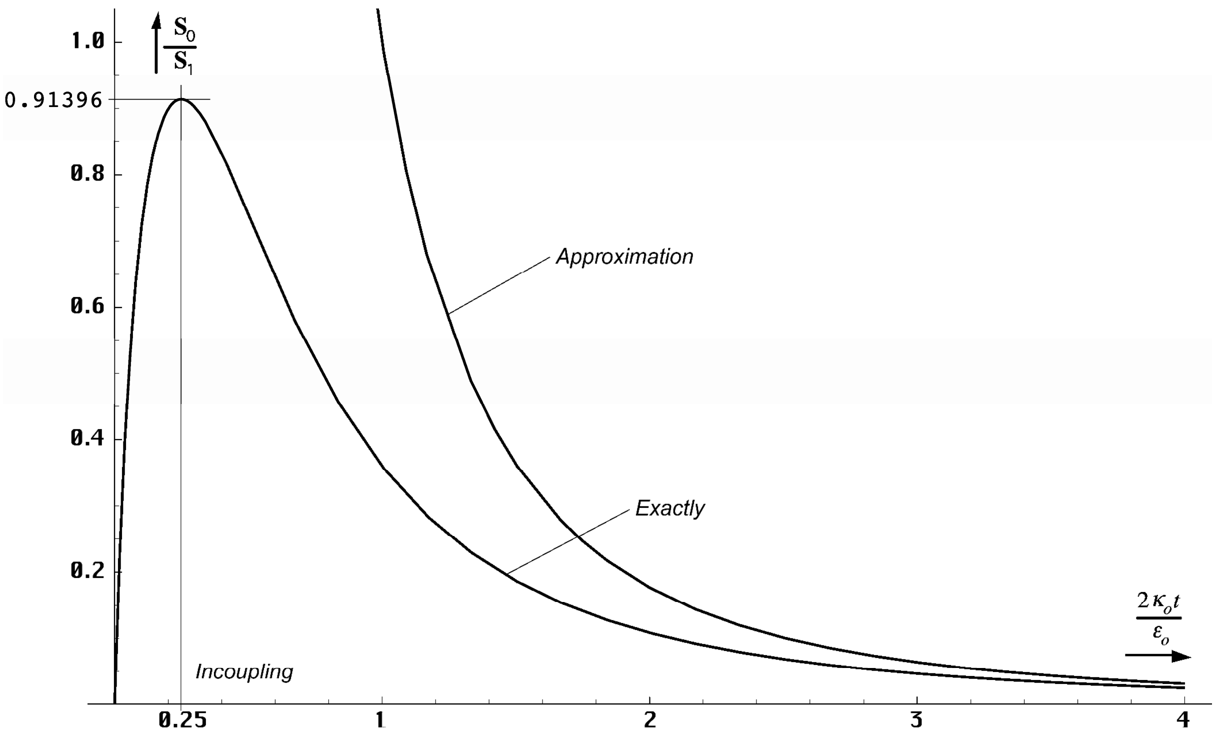



Figure 86
Temporal dependence of the electromagnetic field-strength of the metric wave-field exactly and approximation

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 cosmologic 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 cosmologic 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 86. 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 $w_I$ for both, approximation and exact solution simultaneously again. Additionally to the division by $|\underline{c}|$ (to the definition of $w_I$ we set $|\underline{c}_I|=c$) we must take up the transformation for the meter-rate, namely for the third spatial dimension. That does altogether $\sqrt{2\pi}\, 2\omega_0 t \rho_0 M_0(2\omega_0 t)$. It applies $1.253314\sqrt{2\pi}=\pi$:

$$w_0 = 8\pi^3 w_I (2\omega_0 t)^6 \rho_0^6 M_0^6(2\omega_0 t) \qquad \text{with} \quad w_I = \frac{S_I}{c} \tag{521}$$

$$w_0 = w_I (2\omega_0 t - \beta r)^{-6} \qquad \text{Approximation} \tag{522}$$

The course of the energy-density precisely and the approximation is shown in Figure 87. 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 (399), 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 ($\Delta t=0.0001t_I$). It applies:

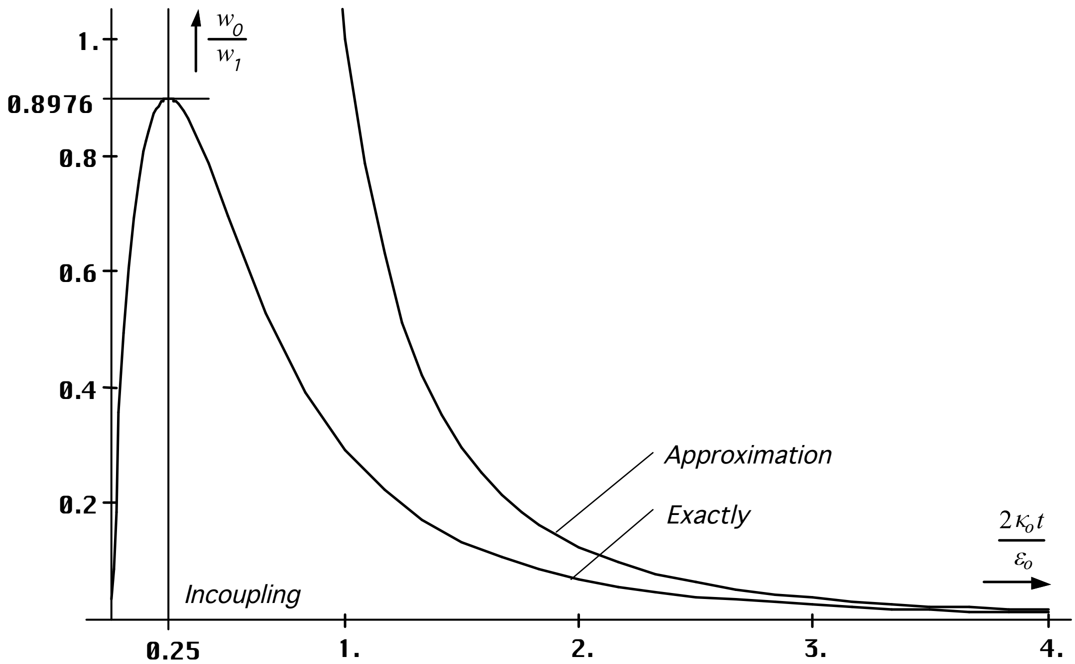



Figure 87
Temporal dependence of the energy-density of the metric wave-field exactly and approximation

$$\dot{w}_0 = 8\pi^3 \dot{w}_I \frac{d}{dt} \rho_0^6 \omega_0^6 t^6 M_0^6(2\omega_0 t) \qquad \text{with} \quad \dot{w}_I = 3\frac{S_I}{r_I} \tag{523}$$

$$\dot{w}_0 = \dot{w}_I (2\omega_0 t - \beta r)^{-8} \qquad \text{Approximation} \tag{524}$$

The value of $\dot{w}_I$ we get by differentiation of the approximative solution (522) after time and subsequent check-up. The factor 3 stems from the exponent of the time of the energy-density (it's proportional $t^{-3}$). Now to the expression $\mathbf{i}\underline{\mathbf{E}}$. For $|\underline{Z}_F| \approx Z_0$ and $\mathbf{i}=\kappa_0\underline{\mathbf{E}}$ applies:

$$\mathbf{i}\underline{\mathbf{E}} = \kappa_0 \underline{\mathbf{E}}^2 = \kappa_0 E^2 = 4\pi^2 \kappa_0 Z_0 S_I \rho_0^4 \omega_0^4 t^4 M_0^4(2\omega_0 t) \tag{525}$$

$$\mathbf{i}\underline{\mathbf{E}} = \frac{4}{3}\pi^2 \dot{w}_I \rho_0^4 \omega_0^4 t^4 M_0^4(2\omega_0 t) \tag{526}$$

$$\mathbf{i}\underline{\mathbf{E}} = \frac{\dot{w}_I}{3}(2\omega_0 t - \beta r)^{-4} \qquad \text{Approximation} \tag{527}$$

Here we insert consciously the square of (510) without additional correction for $\hbar$ as well as $q_0^2$. Since the MAXWELL equations shall be LORENTZ-invariant indeed, the correction in (525) 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 (399) obtaining finally:

$$\mathrm{div}\,\mathbf{S_0} = -\kappa_0 E^2 - \dot{w}_0 \tag{528}$$

$$\mathrm{div}\,\mathbf{S_0} = -4\pi^2 \dot{w}_I \left( \frac{1}{3} \rho_0^4 \omega_0^4 t^4 M_0^4(2\omega_0 t) + 2\pi \frac{d}{dt} \rho_0^6 \omega_0^6 t^6 M_0^6(2\omega_0 t) \right) \tag{529}$$

According to definition, a positive value of the energy-flow-density-vector $\mathrm{div}\,\mathbf{S_0}$ corresponds to an emission of electromagnetic energy. The expression $\dot{w}_0$ (Figure 88) 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.

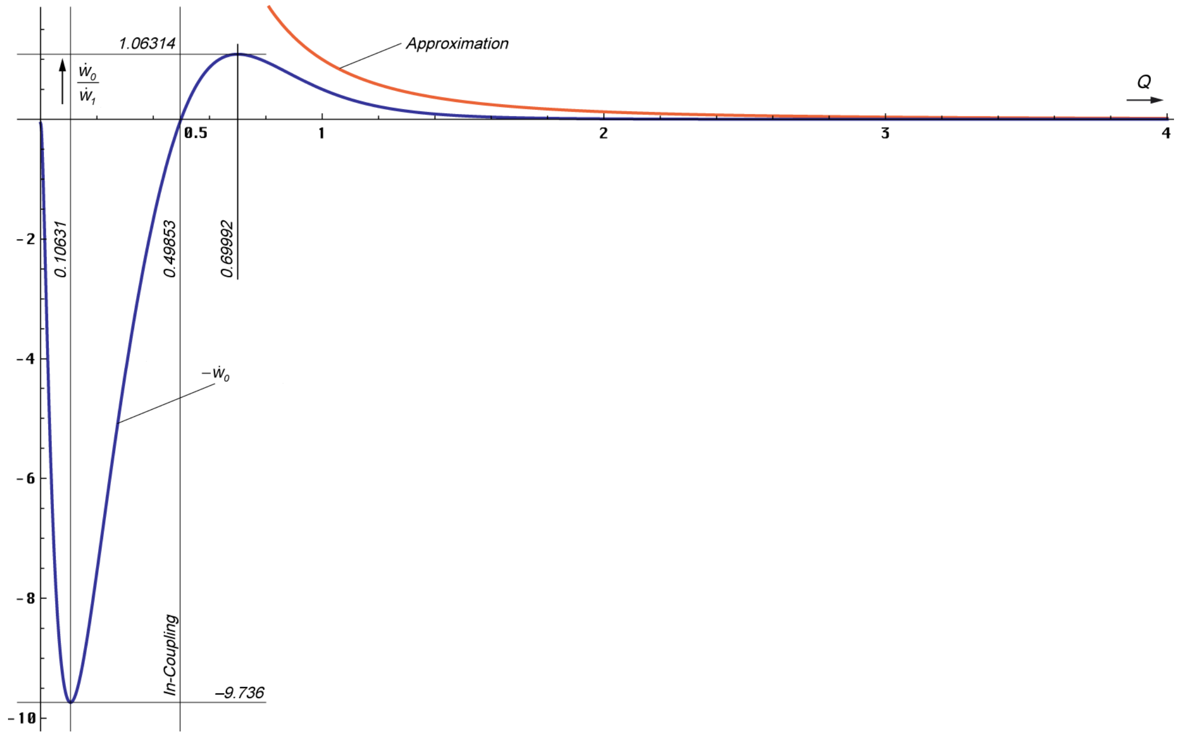



Figure 88
First temporal derivative of the
energy-density of the metric wave-field

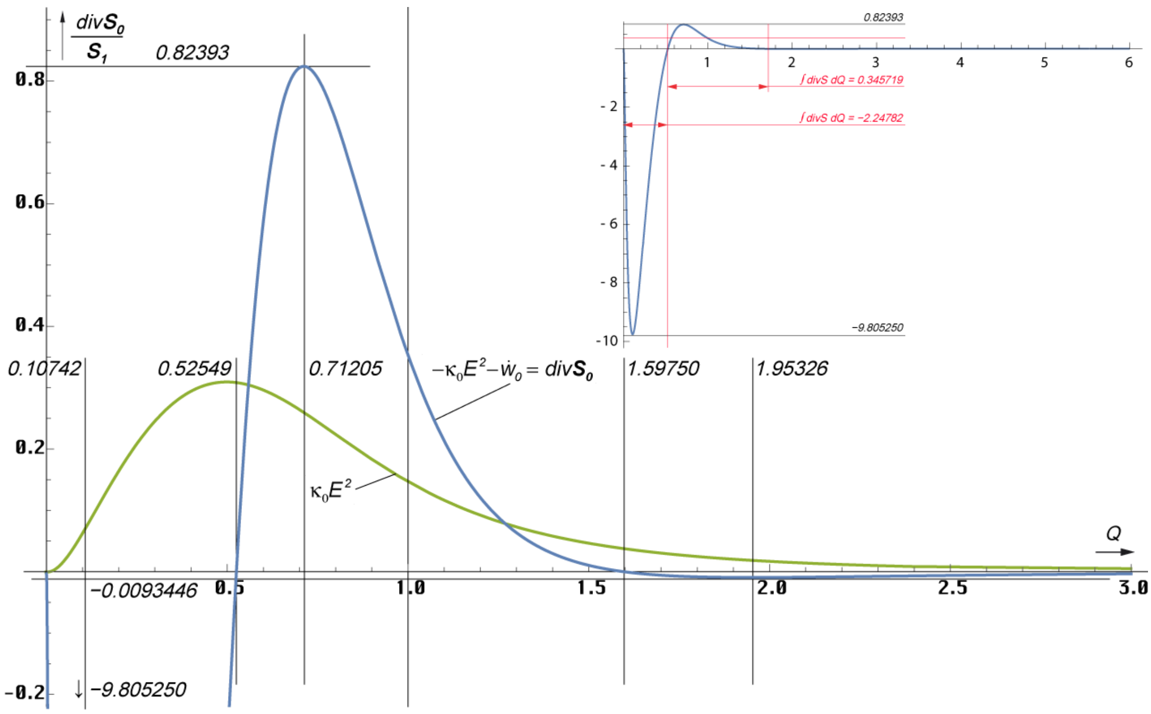



Figure 89
Temporal course of the energy-flow-density-
vector and ohmic losses of the metric wave-field

Especially interesting is the energy-flow-density-vector div$\mathbf{S_0}$. Even this part is negative initially. This corresponds to an influx. Then, energy is emitted again. This is the cosmologic 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 $\kappa_0 E^2$ 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:

$$\mathrm{div}\,\mathbf{S_0} + \kappa_0 E^2 \;=\; 0 \qquad \text{for } t \gg 0 \tag{530}$$

$$\mathrm{div}\,\mathbf{S_0} \;=\; -\frac{\dot{w}_1}{3}(2\omega_0 t - \beta r)^{-4} \qquad \text{Approximation} \tag{531}$$

Now we want to examine, whether the share $\kappa_0 E^2$ for the metrics really corresponds to the in-taken energy of the cosmologic 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 cosmologic background-radiation $\kappa_{0R} E_K^2$ have the same temporal course. It applies:

$$\kappa_{0R} \;=\; 2\kappa_0 Q_0^{-2} \;\sim\; Q_0^{-2} \qquad \mathbf{E_K} \;\sim\; r_0^{-1} \;\sim\; Q_0^{-1} \tag{532}$$

$$\kappa_{0R} E_K^2 \;\sim\; Q_0^{-4} \qquad \text{CMBR} \tag{533}$$

$$\kappa_0 E^2 \;\sim\; Q_0^{-4} \qquad \text{Metrics} \tag{534}$$

The electric field-strength-vector of the cosmologic 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 $\kappa_{0R}$ (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 $\mathrm{div}\,\mathbf{S_0}$ 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 cosmologic background-radiation. That means that the energy $\kappa_0 E^2$ would be fully transformed into „solid“ matter, while the share $\mathrm{div}\,\mathbf{S_0}$ would be joined with the cosmologic 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 (cosmologic 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 cosmologic background-radiation again (dielectric losses). This is changed completely into matter then. Here, we just have answered the question, whether still cosmologic 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 $\mathrm{div}\mathbf{S_0}$ 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:

$$\frac{n_\gamma}{n_M} = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{\int \dot{w}_0\, dt}{\kappa_0 \int E^2 dt} - 1\right) = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{-w_0 + 0.897659\, w_1}{\kappa_0 \int E^2 dt} - 1\right) \tag{535}$$

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 90.

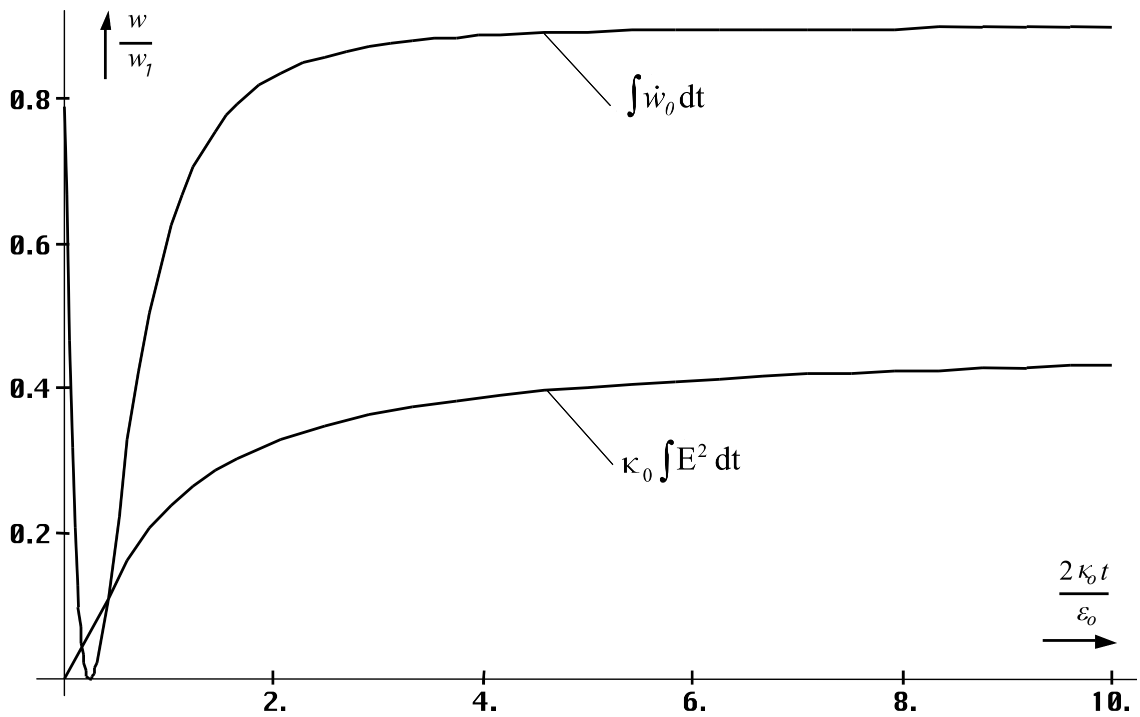



Figure 90
Integrals of energy-density and dielectric losses of the metric wave-field

The calculation of (535) results in a course of the boson-/fermion-ratio, as it is pictured in Figure 91. 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 91 descends much more intensive.

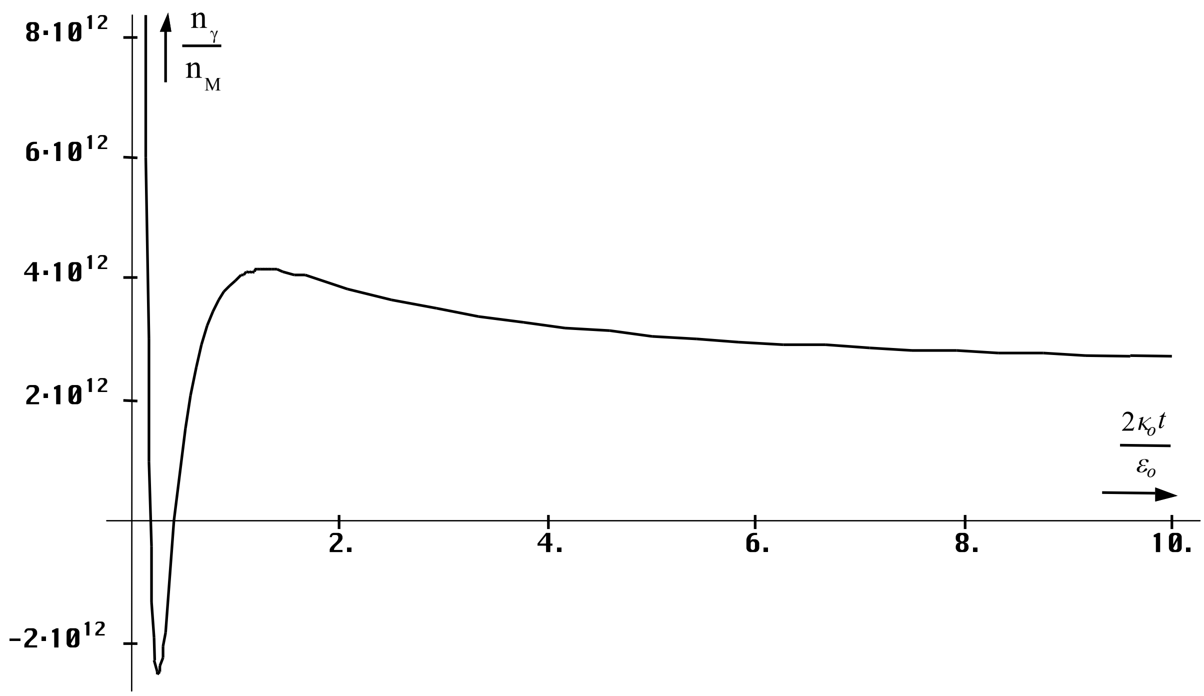



Figure 91
Part of the boson-/fermion-ratio, determined by the metric wave-field
as a function of time without consideration of the fermion-multiplication

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 (535) as follows:

$$\frac{n_\gamma}{n_M} = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{\int_0^T \dot{w}_0\,dt}{\eta\kappa_0\int_0^T E^2 dt} - 1\right) = 6.080\cdot 10^8 \tag{536}$$

$$\frac{n_\gamma}{n_M} = \frac{2m_a c^2}{\hbar\omega_T}\left(\frac{0.897659}{2.5939\cdot 0.34598} - 1\right) = 4.9362769\cdot 10^{-4}\,\frac{m_a c^2}{\hbar\omega_T} \tag{537}$$

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 91 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 $\kappa_0$ 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 $\delta(t)$. This impulse is actually no function but a distribution with the following qualities:

$$\delta(t) = \begin{cases} \infty & \text{für } t = 0 \\ 0 & \text{für } t \neq 0 \end{cases} \qquad \delta(t) = \frac{d}{dt}\sigma(t) \tag{538}$$

$\sigma(t)$ is the jump-function with the amplitude 1. Another essential quality results from the second expression:

$$\int_{-0}^{\infty} \delta(t)dt = \int_{-0}^{\infty} \delta(t)e^{-pt}dt = \{\delta(t)\} = 1 \tag{539}$$

The integral as well as the surface below the DIRAC-impulse is equal to 1. On the basis of expression (538) 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:

$$C_U\ddot{\varphi}_U + \left(\dot{C}_U + \frac{1}{R_U}\right)\dot{\varphi}_U + \frac{1}{L_U}\varphi_U = 0 \qquad \text{with } \dot{C}_U = 0 \tag{540}$$

$$\ddot{\varphi}_U + \frac{1}{R_U C_U}\dot{\varphi}_U + \frac{1}{L_U C_U}\varphi_U = 0 \tag{541}$$

Since we not yet know the quantization-factor, the coupling-length, we want first to assume it as $r_1/n$. Then, the „components“ are defined as follows:

$$L_U = \frac{\mu_0 r_1}{n} = \frac{1}{n}\frac{\mu_0}{\kappa_0 Z_0} = \frac{1}{n}\frac{1}{\kappa_0 c} \tag{542}$$

$$C_U = \frac{\varepsilon_0 r_1}{n} = \frac{1}{n}\frac{\varepsilon_0}{\kappa_0 Z_0} = \frac{1}{n}\frac{\varepsilon_0^2 c}{\kappa_0} \tag{543}$$

$$R_U = \frac{\kappa_0 r_1 Z_0^2}{n} = \frac{1}{n} Z_0 \tag{544}$$

This leads to the following characteristic differential equation:

$$\ddot{\varphi}_U + n\frac{n\kappa_0}{\varepsilon_0}\dot{\varphi}_U + \left(\frac{n\kappa_0}{\varepsilon_0}\right)^2 \varphi_U = 0 \qquad \text{with} \qquad \omega_U = \frac{n\kappa_0}{\varepsilon_0} \tag{545}$$

$$\ddot{\varphi}_U + n\,\omega_U\dot{\varphi}_U + \omega_U^2\varphi_U = 0 \tag{546}$$

$$ar^2e^{rx} + br\,e^{rx} + c\,e^{rx} = 0 \qquad a = 1 \quad b = n\omega_U \quad c = \omega_U^2 \tag{547}$$

$$r^2 + br + c = 0 \qquad \text{Characteristic equation} \tag{548}$$

$$r_{1,2} = -\frac{b}{2} \pm \sqrt{\frac{b^2}{4} - c} = -\frac{n}{2}\omega_U\left(1 \pm \sqrt{\frac{n^2}{4} - c}\right) \tag{549}$$

The solution of the differential equation depends on (549) and with it on n too. 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 (549) has no imaginary-part respectively there is no phase rate $\beta$ 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:

$$\omega_U = \frac{2\kappa_0}{\varepsilon_0} = 2\omega_1 \qquad \omega_U t = \frac{2\kappa_0 t}{\varepsilon_0} = (2\omega_0 t)^2 \qquad r_U = \frac{r_1}{2} \tag{550}$$

Interestingly enough, the same coupling-length $r_1/2$ arises here as with the metric wave-field. Also the frequency $\omega_U$ is the same like the output-frequency of the metrics and of the cosmologic 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 (550) is advantageous in so far as it allows an exact temporal comparison of primordial impulse with the metric wave-field and with the cosmologic 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:

$$\varphi_U = (1+\omega_U t)\, e^{-\omega_U t}\, \varphi_\uparrow \tag{551}$$

$$\mathbf{H} = \frac{4\varphi}{\mu_0 r_1^2}\mathbf{e_r} = \frac{4\kappa_0^2\varphi}{\varepsilon_0}\mathbf{e_r} = 2\kappa_0\varphi\omega_U\,\mathbf{e_r} \tag{552}$$

$$\underline{\mathbf{H}}_U = (1+\omega_U t)\, e^{-\omega_U t}\, \mathbf{H}_\uparrow \qquad \underline{\mathbf{E}}_U = (1+\omega_U t)\, e^{-\omega_U t}\, \mathbf{E}_\uparrow \tag{553}$$

$$\underline{\mathbf{S}}_U = (1+\omega_U t)^2\, e^{-2\omega_U t}\, \mathbf{S}_\uparrow \tag{554}$$

For the transition $\varphi \rightarrow \underline{\mathbf{H}}$ we must insert the coupling-length here again (552). 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 (554) is shown in Figure 92. It corresponds to the requests put in the previous section (energy-storage up to the formation of the metrics).

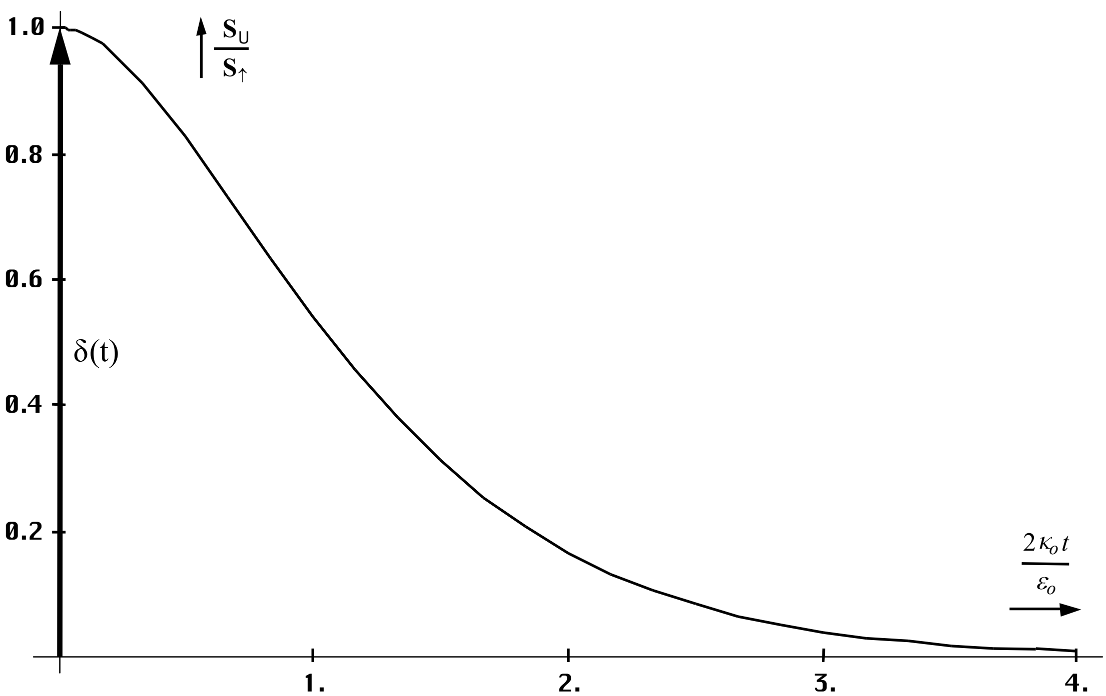



Figure 92
Temporal course of the POYNTING-vector
of the primordial impulse at the point r=0

### 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 (546) 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.

$$\ddot{\varphi}_U + n\omega_U\dot{\varphi}_U + \omega_U^2\varphi_U = 0 \quad \rightarrow \quad p^2\varphi_U - p\varphi_\uparrow + 2p\varphi_U - 2\varphi_\uparrow + \omega_U^2\varphi_U = 0 \tag{555}$$

$$\varphi_U\,(p^2 + 2p\omega_U + \omega_U^2) = \varphi_\uparrow\,(p+2) \tag{556}$$

$$\varphi_U = \varphi_\uparrow \frac{p+2\omega_U}{(p+\omega_U)^2} = \varphi_\uparrow \left( \frac{1}{p+\omega_U} + \frac{\omega_U}{(p+\omega_U)^2} \right) \tag{557}$$

The retransformation leads to expression (551) 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 ($\Omega_U=\omega/\omega_U$):

$$X_n(j\omega) = \frac{1}{2}\,\frac{1}{1+j\Omega_U}\left(1+\frac{1}{1+j\Omega_U}\right) \qquad \text{Complex spectral-function} \tag{558}$$

$$A_n(\omega) = \frac{1}{2}\,\frac{1}{\sqrt{1+j\Omega_U^2}}\left(1+\frac{1}{\sqrt{1+j\Omega_U^2}}\right) \qquad \text{Amplitude response scaled} \tag{559}$$

The real-part of (558), the amplitude response of the magnetic flux and even the electric and magnetic field-strength, is painted in Figure 93 and 86.

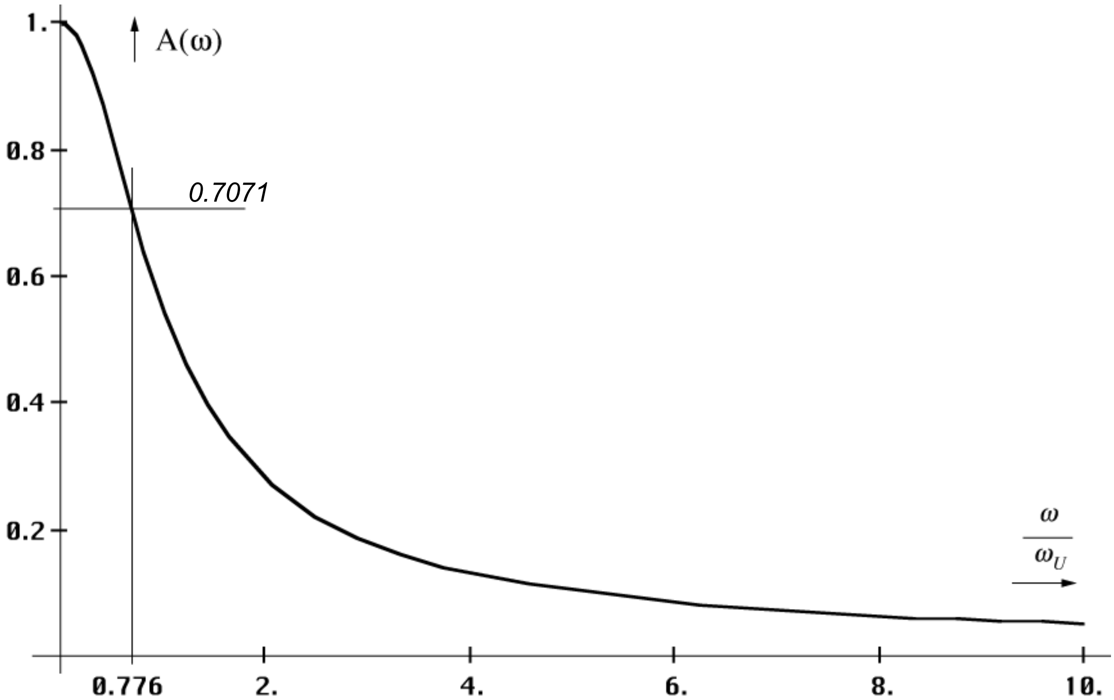



Figure 93
Scaled spectral-function of the electric as well as of the magnetic field-strength of the primordial impulse (linear scale)

For the POYNTING-vector, we must square (558) and (559). The 3dB-cut-off frequency is situated at $0.776\omega_U$ as well as $1.552\omega_1$. 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.

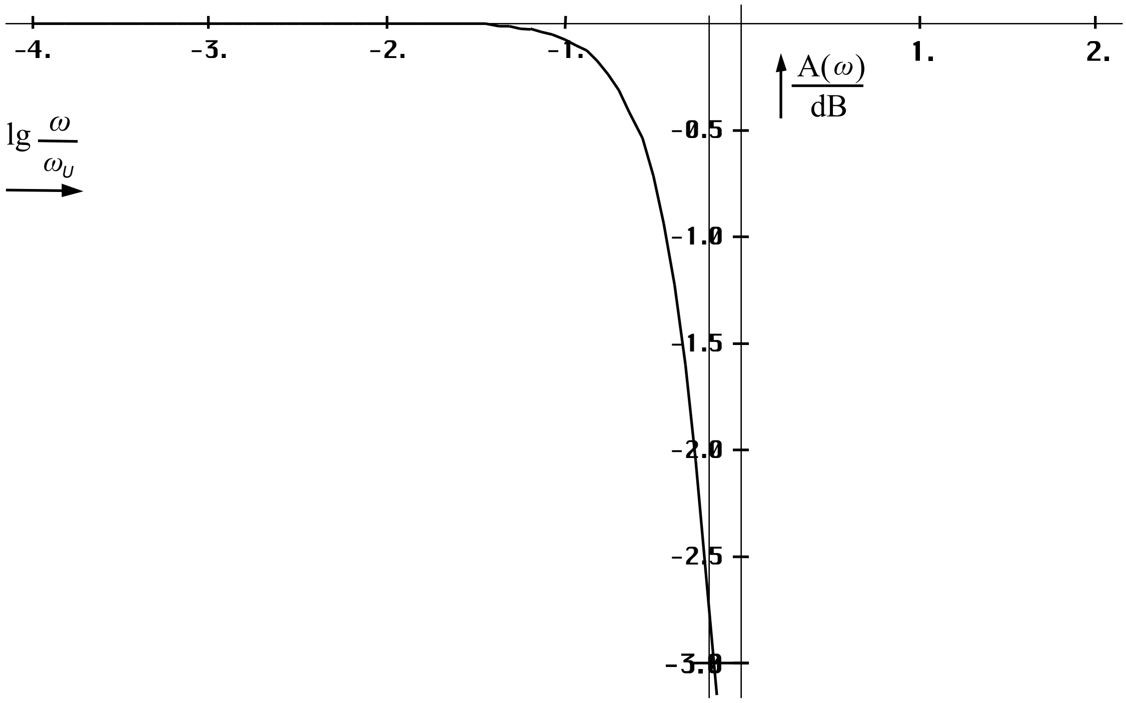



Figure 94
Scaled spectral-function of the electric as well as of the magnetic field-strength of the primordial impulse (logarithmic scale)

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 $\omega_U$ 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 $\omega_U$ 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 (557) with the frequency. The course is shown in Figure 95.

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.

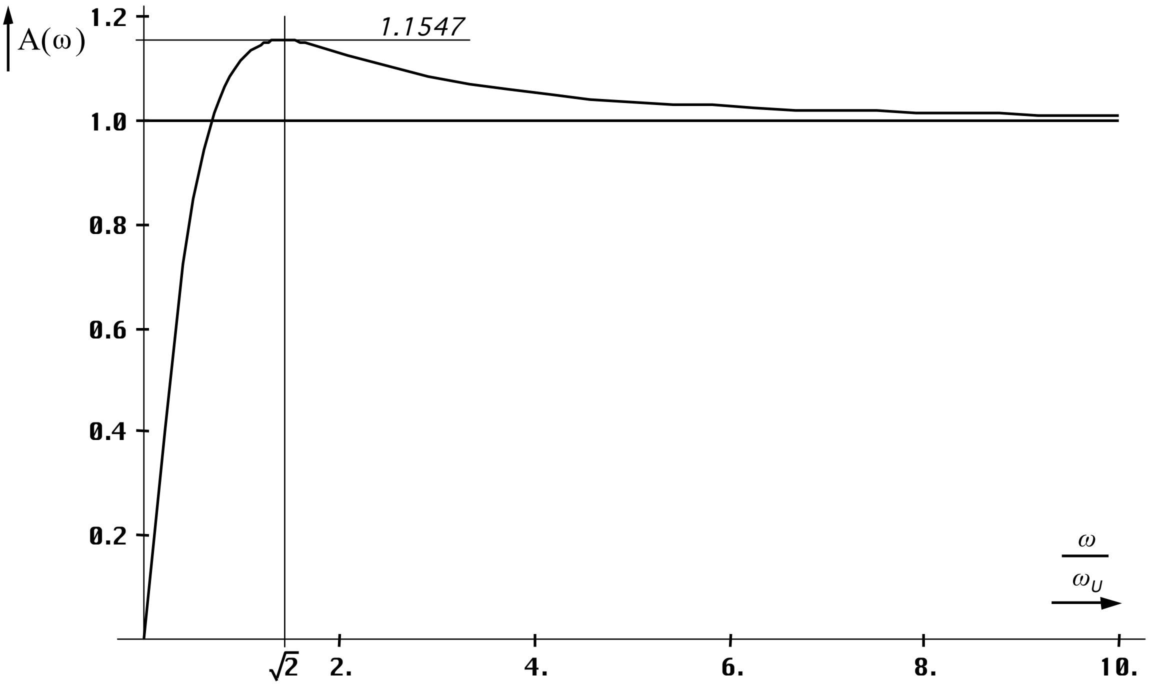



Figure 95
Energetic spectrum of the electric as well as of the magnetic field-strength of the primordial impulse

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 93). If we form the quadratic median value of both, so we get the course painted in Figure 96.

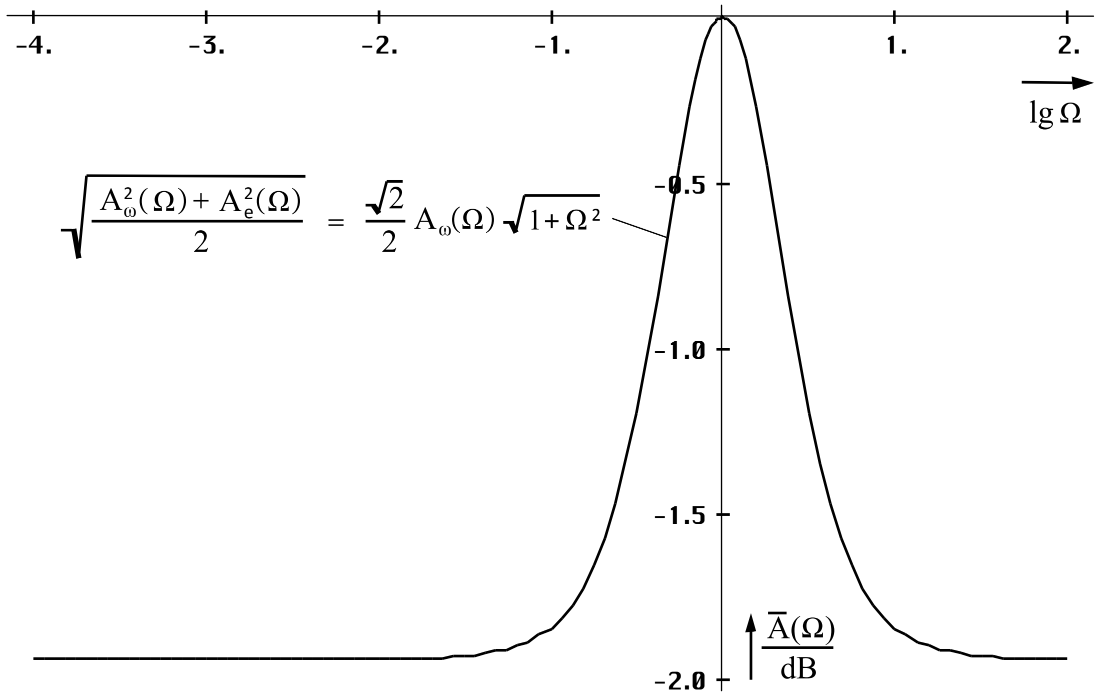



Figure 96
Quadratic median value of energetic and average temporal amplitude-density (E- and H-field) of the primordial impulse

The quadratic median value of energetic and average temporal amplitude-density is situated at $\omega_U$ 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:

$$\operatorname{curl}\underline{\underline{\mathbf{H}}} = \left(\kappa_0 + \varepsilon_0 \frac{\partial}{\partial t}\right)\underline{\underline{\mathbf{E}}} \qquad \operatorname{curl}\underline{\underline{\mathbf{E}}} = -\mu_0 \frac{\partial \underline{\underline{\mathbf{H}}}}{\partial t} \tag{560}$$

$$\underline{\underline{\mathbf{H}}} = (1+\omega_U t)\, e^{-\omega_U t}\, \mathbf{H} \qquad \underline{\underline{\mathbf{E}}} = (1+\omega_U t)\, e^{-\omega_U t}\, \mathbf{E} \tag{561}$$

For the first derivative of the magnetic field-strength applies (always analogously for **E**):

$$\frac{\partial \underline{\underline{\mathbf{H}}}}{\partial t} = -\omega_U^2 t\, e^{-\omega_U t}\, \mathbf{H} = -\omega_U \frac{\omega_U t}{1+\omega_U t}\underline{\underline{\mathbf{H}}} \tag{562}$$

We also require the second derivatives once again:

$$\frac{\partial^2 \underline{\underline{\mathbf{H}}}}{\partial t^2} = -\omega_U^2 (1-\omega_U t)\, e^{-\omega_U t}\, \mathbf{H} = -\omega_U^2 \frac{1-\omega_U t}{1+\omega_U t}\underline{\underline{\mathbf{H}}} \tag{563}$$

Now, we can insert into (560) with $\varepsilon_0\omega_U = 2\kappa_0$:

$$\operatorname{curl}\underline{\underline{\mathbf{H}}} = \left(\kappa_0 - \varepsilon_0\omega_U \frac{\omega_U t}{1+\omega_U t}\right)\underline{\underline{\mathbf{E}}} = \frac{\kappa_0(1+\omega_U t) - 2\kappa_0\omega_U t}{1+\omega_U t}\underline{\underline{\mathbf{E}}} \tag{564}$$

$$\operatorname{curl}\,\underline{\underline{\mathbf{H}}} = \kappa_0 \frac{1-\omega_U t}{1+\omega_U t}\underline{\underline{\mathbf{E}}} \qquad \operatorname{curl}\,\underline{\underline{\mathbf{E}}} = \mu_0\omega_U \frac{\omega_U t}{1+\omega_U t}\underline{\underline{\mathbf{H}}} \tag{565}$$

$$\operatorname{curlcurl}\underline{\underline{\mathbf{H}}} = \operatorname{curl}\left(\kappa_0 \frac{1-\omega_U t}{1+\omega_U t}\right)\underline{\underline{\mathbf{E}}} = \kappa_0 \frac{1-\omega_U t}{1+\omega_U t}\operatorname{curl}\underline{\underline{\mathbf{E}}} = -\Delta\underline{\underline{\mathbf{H}}} \tag{566}$$

$$-\Delta\underline{\underline{\mathbf{H}}} = \mu_0\kappa_0\omega_U^2 t \frac{1-\omega_U t}{(1+\omega_U t)^2}\underline{\underline{\mathbf{H}}} = -\mu_0\varepsilon_0 \frac{\kappa_0}{\varepsilon_0}\frac{1}{1+\omega_U t}\frac{\partial^2 \underline{\underline{\mathbf{H}}}}{\partial t^2} \tag{567}$$

On propagation in x-direction only re-applies:

$$\frac{\partial^2 \underline{\underline{\mathbf{H}}}}{\partial x^2} = \frac{1}{2c^2}\frac{\omega_U t}{1+\omega_U t}\frac{\partial^2 \underline{\underline{\mathbf{H}}}}{\partial t^2} \qquad \frac{\partial^2 \underline{\underline{\mathbf{E}}}}{\partial x^2} = \frac{1}{2c^2}\frac{\omega_U t}{1+\omega_U t}\frac{\partial^2 \underline{\underline{\mathbf{E}}}}{\partial t^2} \tag{568}$$

$$\frac{dx}{dt} = \sqrt{2}\, c\sqrt{1+\frac{1}{\omega_U t}} \qquad \frac{dr}{dt} = c\sqrt{1+\frac{1}{\omega_U t}} \tag{569}$$

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 Metric line-element (57):

$$\dot{r}_U = c\sqrt{1+\frac{1}{\omega_U t}} = c\sqrt{1+\frac{1}{\omega_0^2 t^2}} \qquad \dot{r}_0 = \frac{1}{\sqrt{2\mu_0\kappa_0 t}} = \frac{c}{2\omega_0 t} \tag{570}$$

$$r_U = ct\left(\sqrt{1+\frac{1}{2\omega_0^2 t^2}} + \frac{1}{2\omega_0^2 t^2}\ \mathrm{arcoth}\sqrt{1+\frac{1}{2\omega_0^2 t^2}}\right) \qquad r_0 = 2\omega_0 t\, r_1 \tag{571}$$

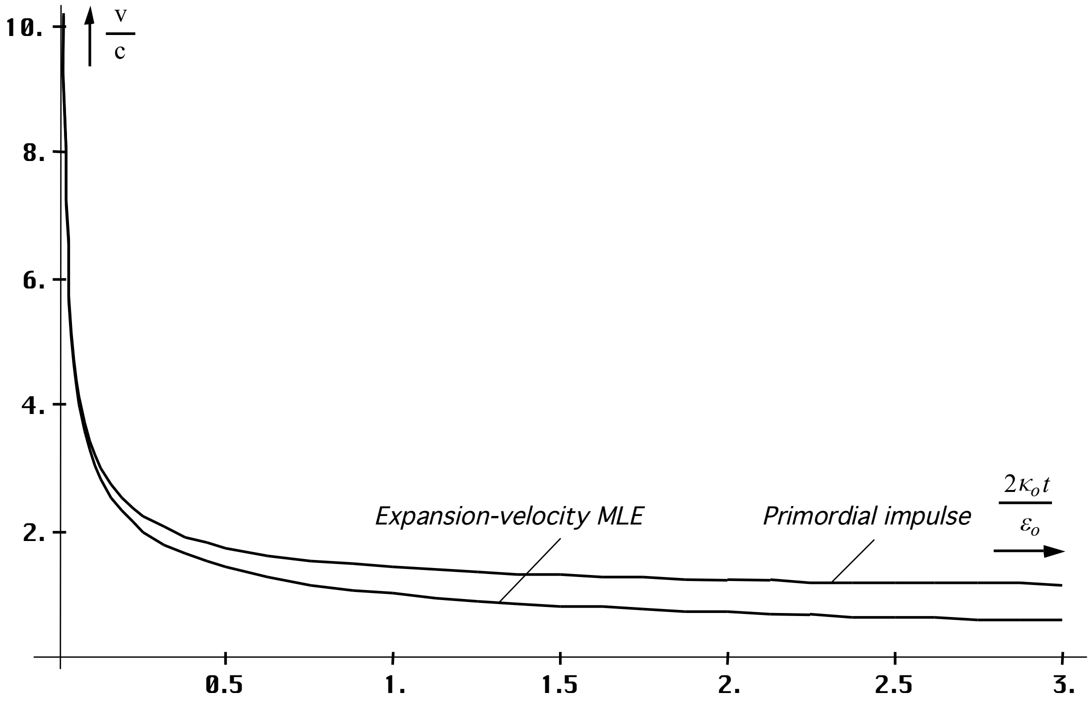



Figure 97
Expansion-velocity of primordial impulse and
of the Metric line-element No. 1

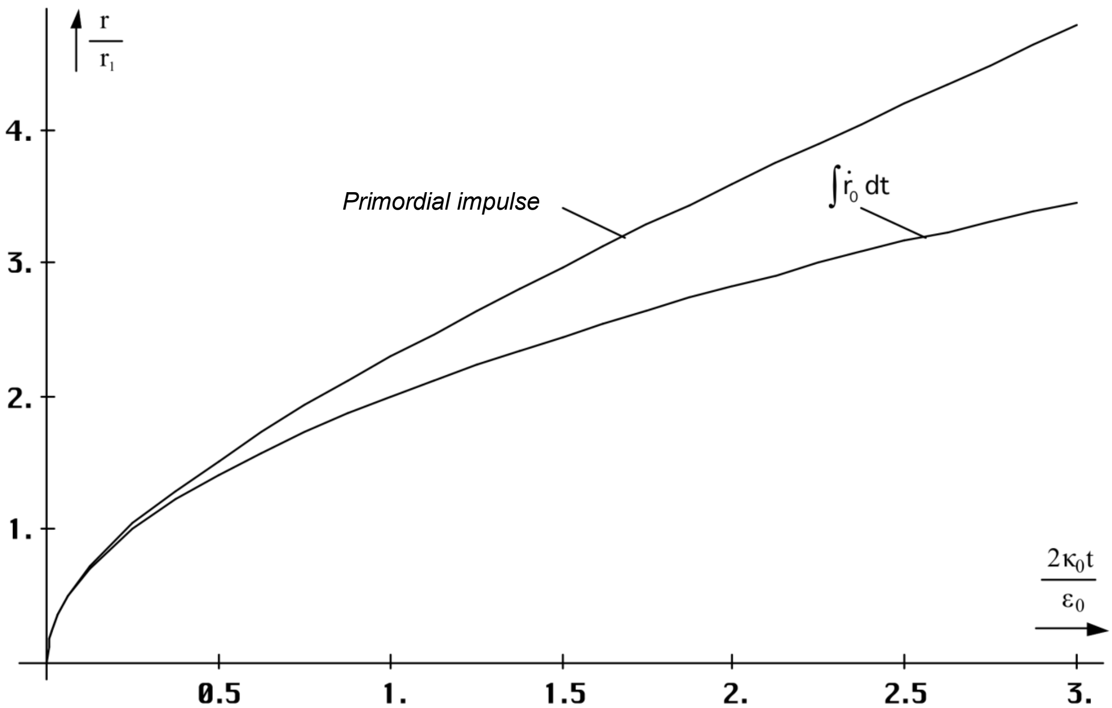



Figure 98
Expansion of primordial impulse and the Metric
line-element No. 1 as a function of time

Also, the temporal validity of the solution is strongly restricted. Let's compare the two expressions stated in (570), so the course should have to be almost identical at $\omega_U \ll 1$ We can well recognize this in Figure 97. It is applied to the expansion of the primordial impulse as well as to the radius of the Metric line-element No. 1 (Figure 98) 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 $t_l$ 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 (570) 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 (213).

### 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 (554) by the value of the *propagation*-velocity (213):

$$w_U = w_\uparrow 2\omega_0 t \rho_0 (1+4\omega_0^2 t^2)^2 e^{-8\omega_0^2 t^2} \qquad \text{with} \quad w_\uparrow = \frac{S_\uparrow}{c} \tag{572}$$

The course is shown in Figure 99. It shows, that the lifetime of the impulse amounts to $3t_l$ 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 $2.55t_l$. With it, the model fulfils 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.

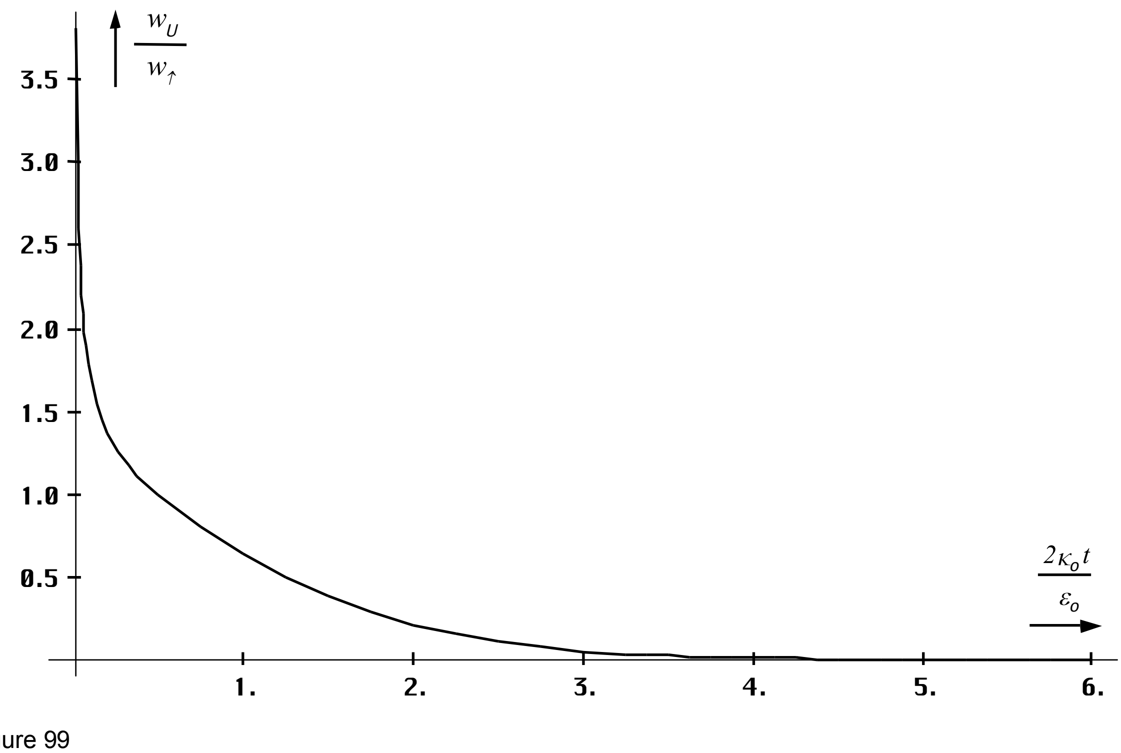



Figure 99
Average energy density of the primordial impulse

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:

$$\dot{w}_f = \mathrm{div}\mathbf{S}_0 - \dot{w}_U \qquad \text{Power density fermion generation} \qquad \dot{w}_f \mathrel{\hat{=}} \kappa_0 E^2 \tag{573}$$

With help of (573) at least the lower limit of $w_\uparrow$ can be determined. It results from the assumption that the value of (573) 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 (573) for several values of $w_\uparrow$ is shown in Figure 100. The first derivative of $w_U$ has been determined with the help of the difference-quotient once again.

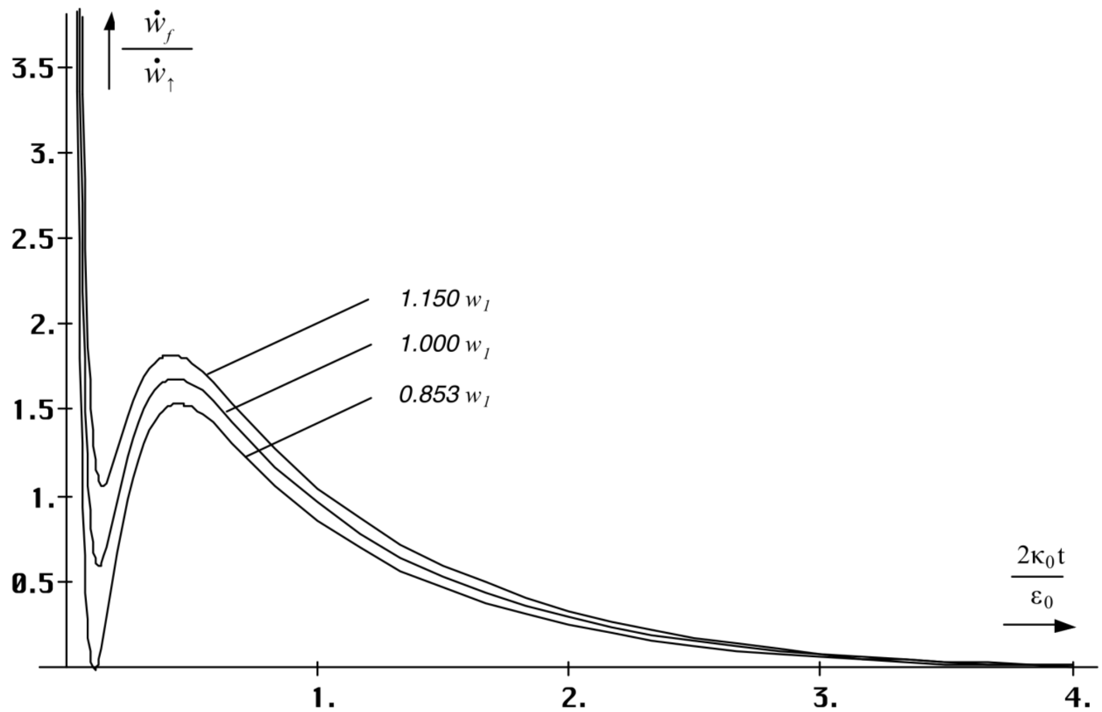



Figure 100
Power-density of the fermion-generation at the primordial impulse

As lower limit for $w_\uparrow$ a value of 0.8533 $w_I$ arises here. The upper limit can be derived from the boson-/fermion-ratio (537) 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 $\int \dot{w}_U \mathrm{dt}$ can't be determined.

The reason is that our average energy-density in Figure 99 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 $w_\uparrow = w_I$. 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 Metric line-element, and the local propagation-velocity of the metrics $c_M$. In the approximation applies:

$$\omega = \tilde{\omega}\frac{\tilde{Q}_0}{Q_0}\frac{c_M}{c} = \tilde{\omega}\frac{\tilde{Q}_0}{Q_0}\sin\delta = \tilde{\omega}\frac{\tilde{Q}_0\tilde{Q}_0^{1/2}}{Q_0 Q_0^{1/2}} = \tilde{\omega}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} = \tilde{\omega}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{3}{4}} \tag{574}$$

with $\tilde{Q}_0 = 1$ and $\tilde{\omega} = \omega_1$ for the cosmologic 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 $\alpha$ 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 $\pm 1$ $(\pm\hbar)$ 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 according to Table 11 arises to $M_H = \hbar H_0/c^2 = 2.60949\cdot 10^{-69}$ kg. This agrees with the statements in literature very well.

Mathematically speaking is there as well a so-called longitudinal 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 101 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

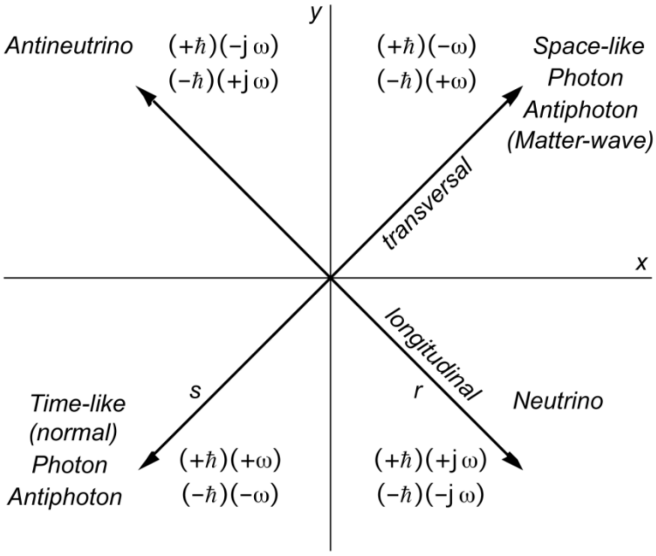



Figure 101
Extended photon model

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 ($\nu_e$, $\nu_\mu$ and $\nu_\tau$). 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 $\nu_e$, $\nu_\mu$ und $\nu_\tau$). 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 102. 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 $\gamma$, 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:

$$c^2 = c_M^2 + c_\gamma^2 - 2c_M c_\gamma \cos\alpha \tag{575}$$

$$c_\gamma^2 - c_\gamma(2c_M \cos\alpha) + c_M^2 - c^2 = 0 \tag{576}$$

$$c_\gamma = c_M \cos\alpha \pm \sqrt{c_M^2 \cos^2\alpha + c^2 - c_M^2} \tag{577}$$

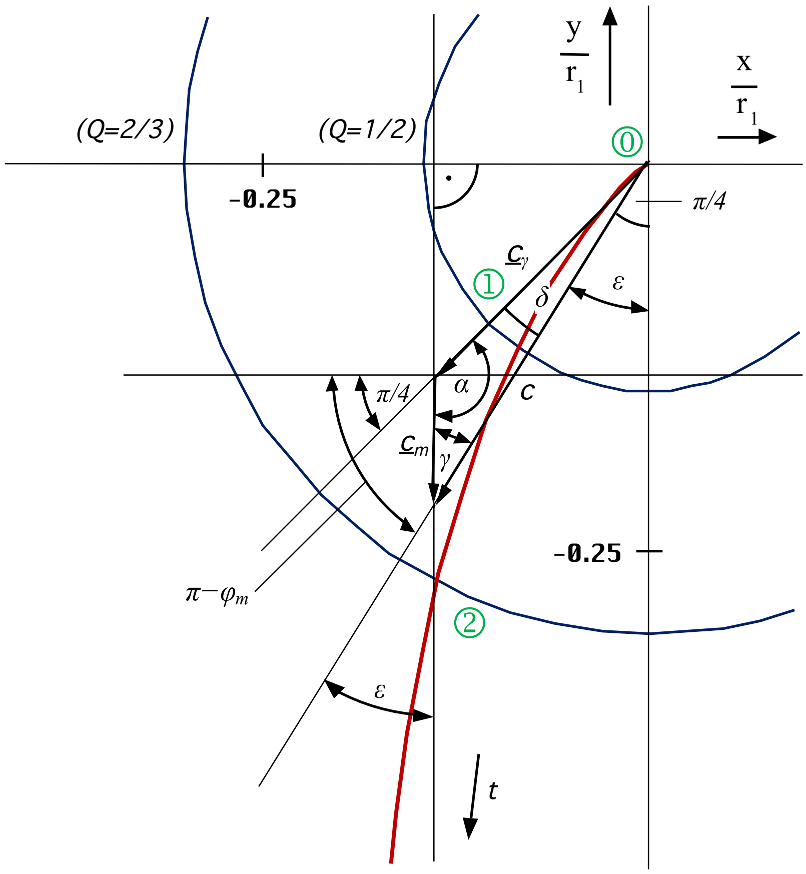



Figure 102
Vectorial speed-addition with photons near the singularity

$$\frac{c_\gamma}{c} = \frac{c_M}{c}\cos\alpha \pm \sqrt{1-\frac{c_M^2}{c^2}(1-\cos^2\alpha)} \tag{578}$$

The positive sign is applied to „generic" photons $\gamma$ (arises from the approximative solution). The negative sign applies to space-like photons $\gamma^*$, which behave differently near the singularity.

$$c_\gamma = c\left(\frac{c_M}{c}\cos\alpha + \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right) \quad \text{Time-like photons} \tag{579}$$

$$c_{\bar\gamma} = c\left(\frac{c_M}{c}\cos\alpha - \sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right) \quad \text{Space-like photons} \tag{580}$$

For the angle $\alpha_\gamma$ applies in both cases (see (211)):

$$\alpha_\gamma = \frac{\pi}{4} - \arg \underline{c} = \frac{\pi}{2} - \frac{1}{2}\operatorname{arccot}\theta = \frac{3}{4}\pi + \frac{1}{2}\arg((1-A^2+B^2)+j2AB) \tag{581}$$

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 103. 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.

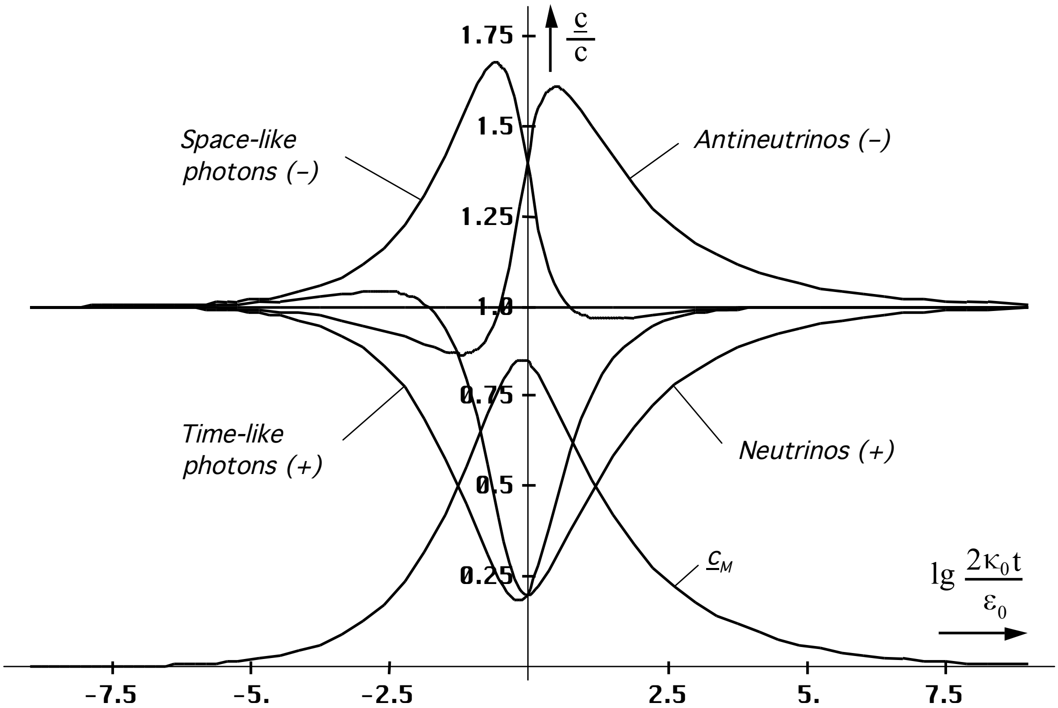



Figure 103
Course of the individual speed-components (absolute value) for photons and neutrinos near the singularity

The intersection angle $\gamma$ with the metrics of the (normal) photons we get by application of the sine-rule ($\alpha = \alpha_\gamma$):

$$\frac{c_M}{c} = \frac{\sin\delta}{\sin\alpha} \qquad \sin\delta = \frac{c_M}{c}\sin\alpha = \frac{\sin\alpha}{2\omega_0 t\rho_0} \tag{582}$$

$$\delta = \arcsin\left(\frac{\sin\alpha}{2\omega_0 t\rho_0}\right) \qquad \gamma = \pi - \alpha - \delta \tag{583}$$

$$\gamma = \arg\underline{c} - \arcsin\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4} - \arg\underline{c}\right)\right) + \frac{3}{4}\pi \qquad \text{Time-like photons} \tag{584}$$

$$\gamma = \frac{1}{2}\arctan\theta + \arccos\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) + \frac{\pi}{4} \tag{585}$$

Figure 105 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 (209).

As for the rest, to the calculation of arctan q we should better work with (214), since one would get a partially wrong result because of the ambiguity of the arctan-function else. For the absolute phase-angle $\varphi$ of the resultant c applies:

$$\varphi = -\arccos\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) - \frac{\pi}{4} \qquad \text{Time-like photons} \tag{586}$$

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 (578) and applies also for antineutrinos.

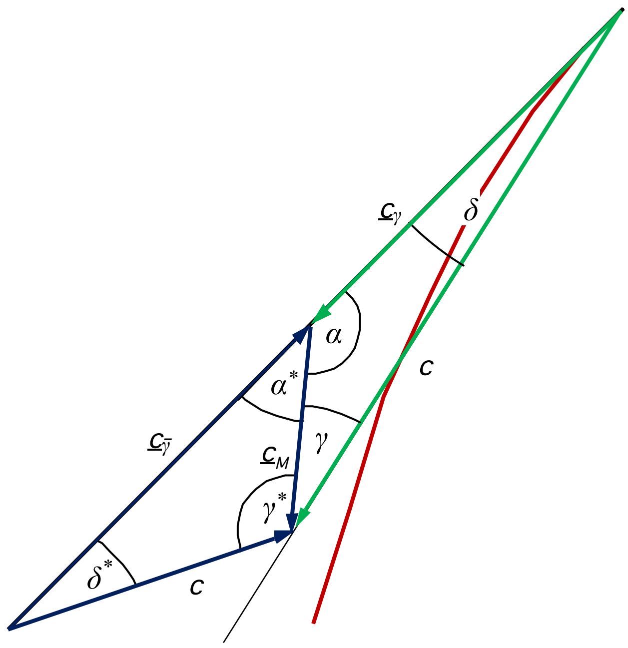



Figure 104
Complementary triangle and angle as second solution of the quadratic equations with reversed speed-vector $\underline{c}_\gamma$

For the complementary angles applies:

$$\alpha^* = \pi - \alpha \qquad \sin\alpha^* = \sin(\pi-\alpha) = \sin\alpha \tag{587}$$

$$\frac{c_M}{c} = \frac{\sin\delta^*}{\sin\alpha} \qquad \sin\delta^* = \frac{c_M}{c}\sin\alpha = \frac{\sin\alpha}{2\omega_0 t\rho_0} \tag{588}$$

$$\delta^* = \arcsin\left(\frac{\sin\alpha}{2\omega_0 t\rho_0}\right) \qquad \gamma^* = \pi - \alpha^* - \delta^* = \alpha - \delta^* \tag{589}$$

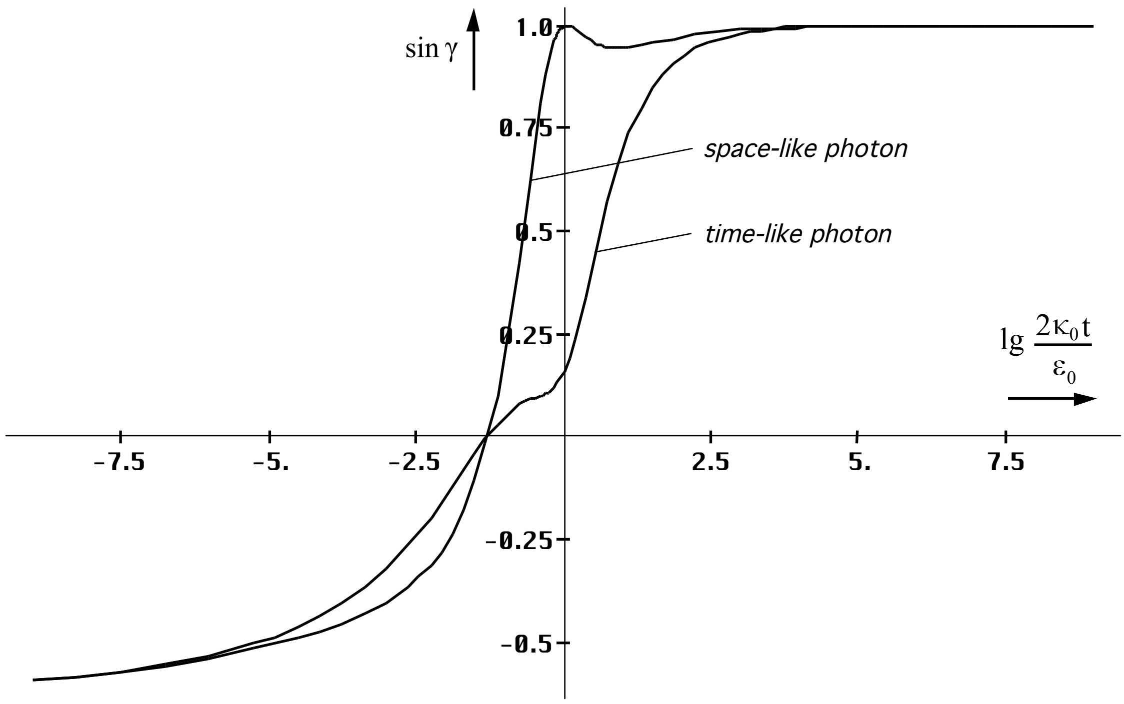



Figure 105
Course of the function sinα of the angle of intersection with the metrics for time-like (normal) and space-like photons near the singularity

$$\gamma^* = -\arg \underline{c} - \arcsin\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4} - \arg \underline{c}\right)\right) + \frac{\pi}{4} \qquad \text{Space-like photons} \qquad (590)$$

$$\gamma^* = -\frac{1}{2}\arctan\theta - \arcsin\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) + \frac{\pi}{4} \qquad (591)$$

The course of $\sin\gamma^*$ is also shown in Figure 105. For the absolute phase-angle $\varphi^*$ of the resultant c applies:

$$\varphi^* = \arcsin\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4} - \frac{1}{2}\arctan\theta\right)\right) - \frac{\pi}{4} \qquad \text{Space-like photons} \qquad (592)$$

## 5.2. Neutrinos

We now look at the model according to Figure 106. Once again, it interests the angle of intersection $\gamma$ with the derivative $\underline{c}_M$ along the metric expansion-graph and even the amount of $|\underline{c}_v| = c_v$.

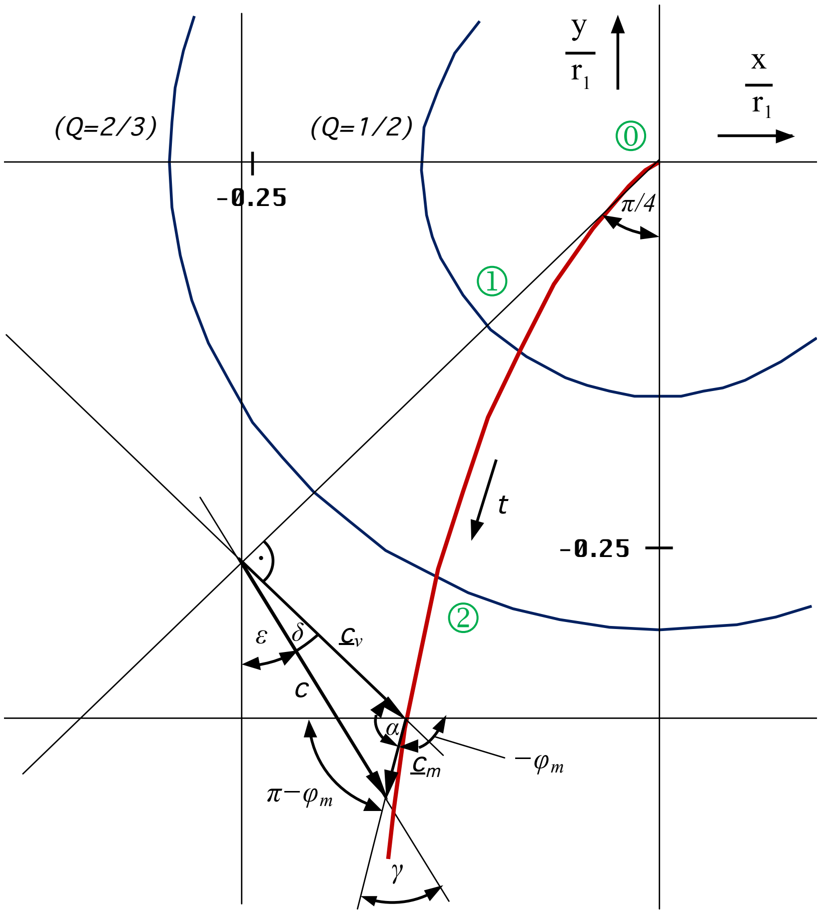



Figure 106
Vectorial speed-addition with neutrinos near the singularity

Since it is not about a rectangular triangle, the sine-rule applies again with the solution:

$$c_v = c\left(\frac{c_M}{c}\cos\alpha + \sqrt{1 - \frac{c_M^2}{c^2}\sin^2\alpha}\right) \qquad \text{Neutrinos} \qquad (593)$$

$$c_{\bar{\nu}} \;=\; c\left(\frac{c_M}{c}\cos\alpha-\sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right) \qquad \text{Antineutrinos} \qquad (594)$$

For the angle $\alpha_\nu$ applies in both cases (see (211)):

$$\alpha_\nu = \frac{5}{4}\pi+\arg\underline{c} \;=\; -\frac{3}{4}\pi+\arg\underline{c} \;=\; -\left(\frac{\pi}{2}+\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right) \;=\; -\left(\frac{\pi}{2}+\alpha_\gamma\right) \qquad (595)$$

The angle $\alpha_\nu$ just figures a sort of complement-angle of $\alpha_\gamma$ i.e. we can dispense with the value $\alpha_\nu$ With $\alpha$, we just always mean $\alpha_\gamma$. 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 (594) and (595) is painted in the Figure 103 (amounts) in turn. The intersection angle $\gamma$ of the neutrinos with the metrics we obtain also directly by application of the sine-rule ($\alpha=\alpha_\gamma$):

$$\frac{c_M}{c} = \frac{\sin\delta}{\sin\alpha_\nu} = -\frac{\sin\delta}{\cos\alpha} \qquad \sin\delta = -\frac{c_M}{c}\cos\alpha = -\frac{\cos\alpha}{2\omega_0 t\rho_0} \qquad (596)$$

$$\delta = -\arcsin\left(\frac{\sin\alpha}{2\omega_0 t\rho_0}\right) \qquad \gamma = \pi-\alpha-\delta = -\frac{\pi}{4}-\arg\underline{c}-\delta \qquad (597)$$

$$\gamma = -\arg\underline{c}+\arcsin\left(\frac{1}{2\omega_0 t\rho_0}\cos\left(\frac{\pi}{4}-\arg\underline{c}\right)\right)-\frac{\pi}{4} \qquad \text{Neutrinos} \qquad (598)$$

$$\gamma = -\frac{1}{2}\arctan\theta+\arcsin\left(\frac{1}{2\omega_0 t\rho_0}\cos\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)-\frac{\pi}{4} \qquad (599)$$

We can see the course of $\sin\gamma$ in Figure 107. 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 $\varphi$ of the neutrinos applies:

$$\varphi = -\arcsin\left(\frac{1}{2\omega_0 t\rho_0}\cos\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)+\frac{\pi}{4} \qquad \text{Neutrinos} \qquad (600)$$

Yet another approach is applied to antineutrinos in turn. The angles in the triangle are defined as follows: $\alpha^*$ (complementary angle to $\alpha$), $\delta^*$ (intersection angle with the metrics beside $\delta$) and $\gamma^*$ (opposite to $\underline{c}_M$). It applies:

$$\alpha_\nu^* = \pi-\alpha_\nu \qquad \begin{aligned}\sin\alpha_\nu^* &= \sin(\pi-\alpha_\nu) = \sin\alpha_\nu\\ \cos\alpha_\nu^* &= \cos(\pi-\alpha_\nu) = -\cos\alpha_\nu\end{aligned} \qquad (601)$$

$$\frac{c_M}{c} = \frac{\sin\delta^*}{\sin\alpha_\nu} \qquad \sin\delta^* = \frac{c_M}{c}\cos\alpha = -\frac{\cos\alpha}{2\omega_0 t\rho_0} \qquad (602)$$

$$\delta^* = -\arcsin\left(\frac{\sin\alpha}{2\omega_0 t\rho_0}\right) \qquad \gamma^* = \pi-\alpha_\nu^*-\delta^* = \alpha_\nu-\delta^* \qquad (603)$$

$$\gamma^* = \arg\underline{c}-\arccos\left(\frac{1}{2\omega_0 t\rho_0}\cos\left(\frac{\pi}{4}-\arg\underline{c}\right)\right)-\frac{\pi}{4} \qquad \text{Antineutrinos} \qquad (604)$$

$$\gamma^* \quad = \frac{1}{2}\arctan\theta - \arccos\left(\frac{1}{2\omega_0 t\rho_0}\cos\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)-\frac{\pi}{4} \tag{605}$$

Figure 107 shows the course of $\sin\gamma^*$. For the absolute phase-angle $\varphi^*$ of the resultant c we finally get:

$$\varphi^* \quad = \arccos\left(\frac{1}{2\omega_0 t\rho_0}\sin\left(\frac{\pi}{4}-\frac{1}{2}\arctan\theta\right)\right)+\frac{\pi}{4} \qquad \text{Antineutrinos} \tag{606}$$

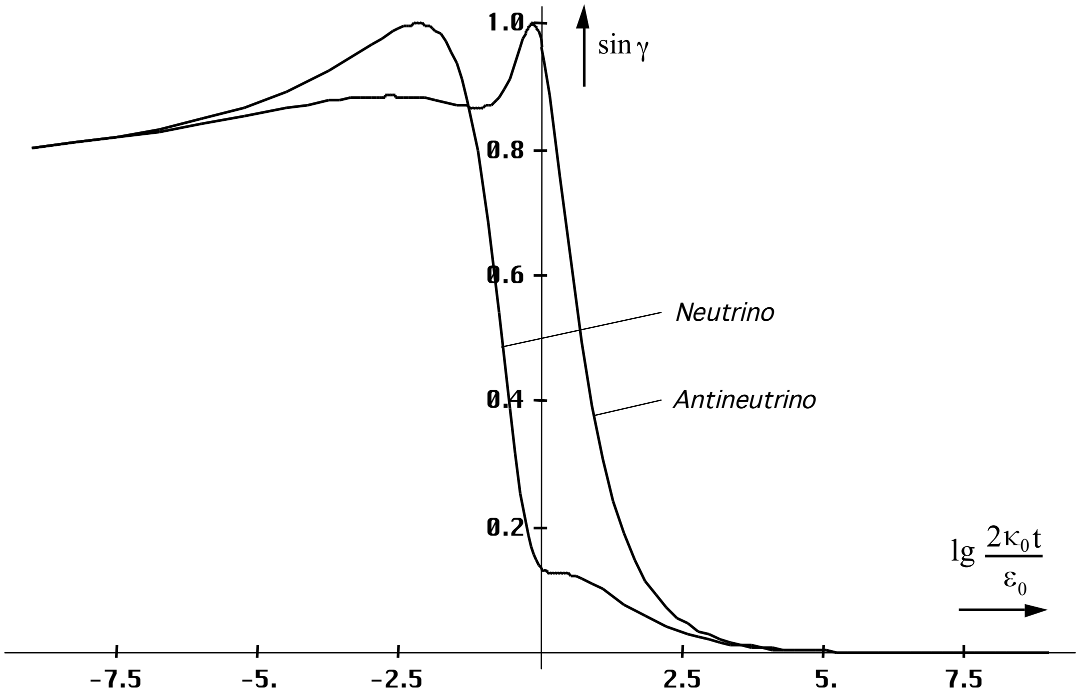



Figure 107
Course of the function $\sin\gamma$ of the angle of intersection with the metrics for neutrinos and antineutrinos near the singularity

With it, at least according to this model, we have proven that photons in the time just after big bang and even 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:

$$\begin{aligned}
\gamma_\gamma &= \arg \underline{c} + \arccos\left(\frac{\sin\alpha}{2\rho_0\omega_0 t}\right)+\frac{\pi}{4} \qquad & \gamma_{\bar{\gamma}} &= -\arg \underline{c} - \arcsin\left(\frac{\sin\alpha}{2\rho_0\omega_0 t}\right)+\frac{\pi}{4} \\
\gamma_\nu &= -\arg \underline{c} + \arcsin\left(\frac{\cos\alpha}{2\rho_0\omega_0 t}\right)-\frac{\pi}{4} \qquad & \gamma_{\bar{\nu}} &= \arg \underline{c} + \arccos\left(\frac{\cos\alpha}{2\rho_0\omega_0 t}\right)-\frac{\pi}{4}
\end{aligned} \tag{607}$$

Intersection angle $\gamma$ with the metrics for the several kinds of photons

## 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 cosmologic 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 cosmologic 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 (300) 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 cosmologic 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 ($\gamma$) as well as 2/3 ($\tilde{\gamma}$) for the associated Q-factor $\tilde{Q}$, we obtain with the help of (722) and (671c):

$$\omega = \tilde{\omega}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_\gamma^4-1}{\beta_\gamma^4-1}} \approx \frac{\sqrt{2}}{3}\omega_1\frac{1}{Q^2}\frac{1.19663}{\sqrt{\beta_\gamma^4-1}} \approx \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{\beta_\gamma^4-1}} \qquad \text{for } Q \gg 1 \tag{608}$$

$$\omega \approx \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(\sqrt{1-\frac{c_M^2}{c^2}\sin^2\alpha}\right)^{-4}-1\right)^{-\frac{1}{2}} = \frac{\omega_1}{2}\frac{1}{Q^2}((1-\sin^2\delta)^{-2}-1)^{-\frac{1}{2}} \tag{609}$$

$$\omega \approx \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{\cos^4\delta}-1\right)^{-\frac{1}{2}} \approx \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(\frac{1}{1-\frac{1}{2}\delta^2}\right)^4-1\right)^{-\frac{1}{2}} \qquad \text{for } \delta \ll 1 \tag{610}$$

$$\omega \approx \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{1-2\delta^2+\cancel{\tfrac{3}{2}\delta^4}-\cancel{\tfrac{1}{2}\delta^6}+\cancel{\tfrac{1}{16}\delta^8}}-1\right)^{-\frac{1}{2}} \approx \frac{\omega_1}{2}\frac{1}{Q^2}\sqrt{\frac{1}{2\delta^2}-1} \tag{611}$$

This result apparently corresponds to expression (277) with $\delta^2=y=Q_0^{-1}$. We employ again:

$$\omega = 2H\sqrt{\omega_0 t-1} \approx \sqrt{2}H\sqrt{2\omega_0 t} \qquad \omega \sim Q_0^{-3/2} \tag{278}$$

This also exactly agrees with expression (278), 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 $\Xi$ 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 (302) during the conversion to the reference point.

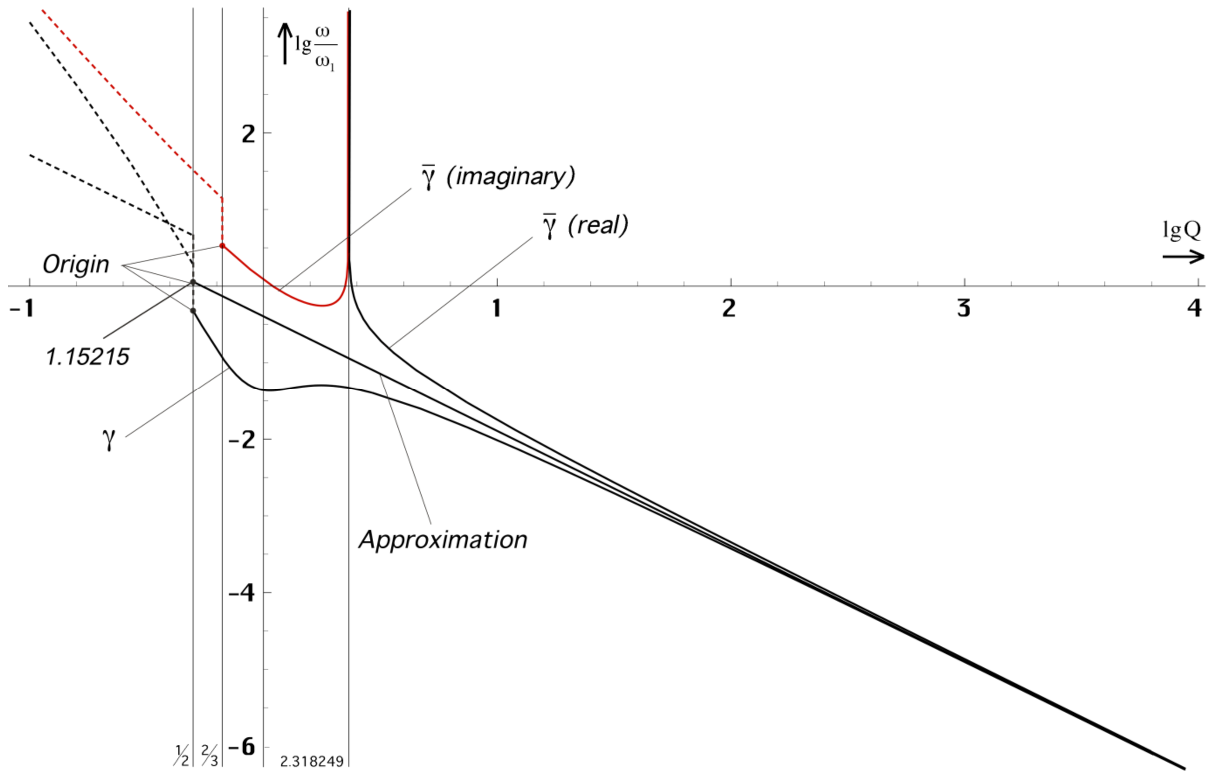



Figure 108
Red-shift of photons exactly and approximation

Only to determine the red-shift of a matter-wave with a start-point greater than Q=2.318249 (phase-jump), (302) 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:

$$\omega \;=\; j\omega_{\bar{1}}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\gamma}}^{4}-1}{\beta_{\bar{\gamma}}^{4}-1}} \;\approx\; 3.27369\omega_1\frac{1}{Q^2}\sqrt{\frac{1-\tilde{\beta}_{\bar{\gamma}}^{4}}{\beta_{\bar{\gamma}}^{4}-1}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{\beta_{\bar{\gamma}}^{4}-1}} \quad \text{for } Q\gg 1 \qquad (612)$$

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:

$$\omega \;\approx\; \tilde{\omega}\left(\frac{\tilde{Q}}{Q}\right)^{\frac{3}{2}} \qquad \text{for Q and } \tilde{Q}\gg 1 \qquad\qquad \omega \;\approx\; 0.4073456\omega_1 Q^{-\frac{3}{2}} \qquad \text{for } Q\gg 1 \qquad (613)$$

The course of the three functions is painted in Figure 108. 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 (302) and (721) for a reference point of 1/2 we obtain:

$$\omega \;=\; \tilde{\omega}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\nu}^{4}-1}{\beta_{\nu}^{4}-1}} \;\approx\; 1.4437\omega_1\frac{1}{Q^2}\frac{0.39073}{\sqrt{\beta_{\nu}^{4}-1}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{\beta_{\nu}^{4}-1}} \qquad \text{for } Q\gg 1 \qquad (614)$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(-\frac{c_M}{c}\sin\alpha+\sqrt{1-\frac{c_M^2}{c^2}\cos^2\alpha}\right)^{-4}-1\right)^{-\frac{1}{2}} \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(-\frac{c_M}{c}+1\right)^{-4}-1\right)^{-\frac{1}{2}} \qquad (615)$$

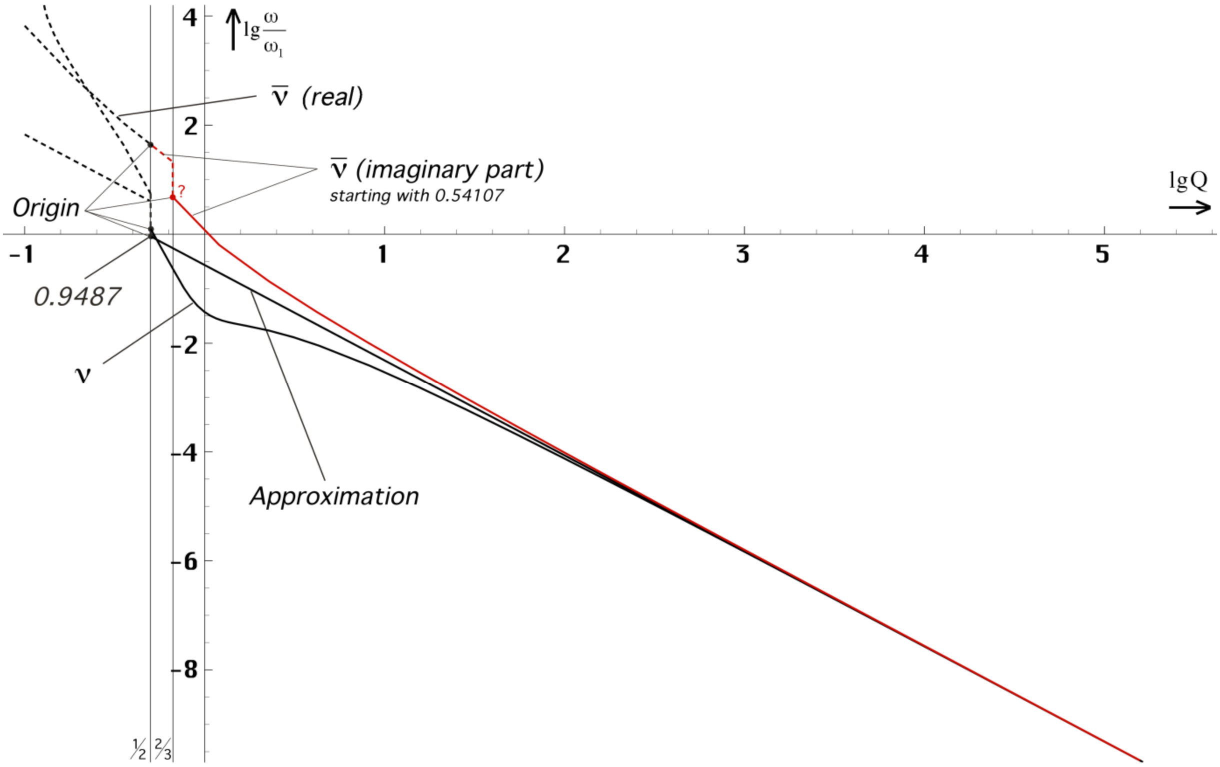



Figure 109
Red-shift of neutrinos exactly and approximation

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\left(-\frac{2}{Q^{1/2}}+1\right)^{-4}-1\right)^{-\frac{1}{2}} \;=\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{(1-2Q^{-1/2})^4}\right)^{-\frac{1}{2}} \qquad \text{for } \frac{c_M}{c}\approx 2Q^{-\frac{1}{2}} \qquad (616)$$

$$\omega \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\left(\frac{1}{1-8Q^{-\frac{1}{2}}+2\cancel{4}Q^{-\frac{2}{2}}-3\cancel{2}Q^{-\frac{3}{2}}+1\cancel{6}Q^{-\frac{4}{2}}}-1\right)^{-\frac{1}{2}} \;\approx\; \frac{\omega_1}{2}\frac{1}{Q^2}\sqrt{\frac{1}{8}Q^{\frac{1}{2}}} \qquad (617)$$

$$\omega \;\approx\; \frac{\omega_1}{8}\sqrt{2}\;Q^{-\frac{8}{4}}Q^{\frac{1}{4}} \;=\; \frac{1}{8}\sqrt{2}H\;Q^{\frac{1}{4}} \qquad \omega\sim Q_0^{-\frac{7}{4}} \qquad (618)$$

$$\omega \;\approx\; \tilde{\omega}\left(\frac{\tilde{Q}}{Q}\right)^{\frac{7}{4}} \quad \text{for } Q \text{ and } \tilde{Q}\gg 1 \qquad \omega \;\approx\; 0.282048\omega_1 Q^{-\frac{7}{4}} \quad \text{for } Q\gg 1 \qquad (619)$$

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 109. 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 (302) 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:

$$\omega \;=\; -j\omega_{\bar{1}}\,\frac{R(\tilde{Q})}{R(Q)}\sqrt{\frac{\tilde{\beta}_{\bar{\nu}}^{4}-1}{\beta_{\bar{\nu}}^{4}-1}} \;\approx\; 18.2787\omega_1\frac{1}{Q^2}\frac{0.03086}{\sqrt{1-\beta_{\bar{\nu}}^{4}}} \;\approx\; \frac{1}{Q^2}\frac{0.56408\omega_1}{\sqrt{1-\beta_{\bar{\nu}}^{4}}} \qquad (620)$$

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 (302) 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 (302) 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 (612) and (620) it shows that the basic frequency $\omega_{\bar{1}}$, even if it's imaginary, is still far above the cut-off frequency $\omega_1$ 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 pole of 1st 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 (308), 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 (309) 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 (308). 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 (268)). It applies:

$$\underline{\mathbf{E}}_{x0} = \hat{\mathbf{E}}_x\, e^{j\omega t} \qquad \underline{\mathbf{E}}_{y0} = \hat{\mathbf{E}}_y\, e^{j\omega t} \qquad \frac{j\underline{\omega}\mu_0}{\underline{\gamma}} = \underline{Z}_F \approx Z_0 \qquad \text{Input values}$$

$$\underline{\mathbf{E}}_x = \underline{\mathbf{E}}_{x0}\, e^{-\underline{\gamma} r} \qquad \underline{\mathbf{H}}_y = \frac{\underline{\gamma}}{j\underline{\omega}\mu_0}\underline{\mathbf{E}}_x \qquad \underline{\mathbf{E}}_y = \underline{\mathbf{E}}_{y0}\, e^{-\underline{\gamma} r} \qquad \underline{\mathbf{H}}_x = -\frac{\underline{\gamma}}{j\underline{\omega}\mu_0}\underline{\mathbf{E}}_y \tag{621}$$

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 $\omega_{HF}$. This depends on the angle $\delta = \omega_{HF} T_\omega$. The expression $T_\omega$ 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:

$$\underline{\omega} = +\tilde{\omega}(\cos\delta \pm j\sin\delta) \quad \text{Time-like photons} \quad (622)$$

$$\underline{\omega} = -\tilde{\omega}(\cos\delta \pm j\sin\delta) \quad \text{Space-like photons} \quad (623)$$

$$\underline{\omega} = +\tilde{\omega}(\sin\delta \pm j\cos\delta) \quad \text{Neutrinos} \quad (624)$$

$$\underline{\omega} = -\tilde{\omega}(\sin\delta \pm j\cos\delta) \quad \text{Antineutrinos} \quad (625)$$

$\tilde{\omega}$ 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 (578), (593) as well as (594), 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 113.

For the line-up 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".

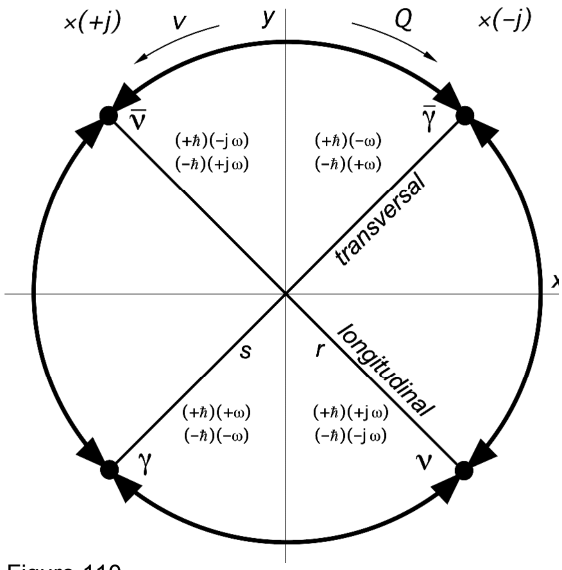


Figure 110
Photon-circle, variance of the properties of the kinds of photon on change of Q and v

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 110 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 $\omega_{HF}$ 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 $\omega_{HF}$ and $\omega$ are of the same size. Then, the direction of polarization of the wave rotates around $2\pi$ exactly one time when it has covered the distance $\lambda$. With a rotation-frequency aberrant there from, naturally the phase-shift is smaller (photons) or even greater (neutrinos). Now, with (621) 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 $\omega_{HF}$ is defined by the angle $\delta_N$. Decisive is the phase-angle, the argument of the complex frequency $\underline{\omega}$. It applies:

$$\delta_\gamma = \arctan\frac{+\sin\delta}{+\cos\delta} = +\arctan\tan\delta = +\delta \qquad \text{Time-like photons} \qquad (626)$$

$$\delta_{\bar{\gamma}} = \arctan\frac{-\sin\delta}{-\cos\delta} = -\arctan\tan\delta = -\delta \qquad \text{Space-like photons} \qquad (627)$$

$$\delta_\nu = \arctan\frac{+\cos\delta}{+\sin\delta} = +\arctan\cot\delta = +\left(\frac{\pi}{2}-\delta\right) \qquad \text{Neutrinos} \qquad (628)$$

$$\delta_{\bar{\nu}} = \arctan\frac{-\cos\delta}{-\sin\delta} = -\arctan\cot\delta = -\left(\frac{\pi}{2}-\delta\right) \qquad \text{Antineutrinos} \qquad (629)$$

The term $\pm j\pi/2$ with the neutrinos corresponds to a rotation of the coordinate-system by ±90°. The transfer-function (621) 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 102 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:

$$\underline{\mathbf{E}}_{x0} = \hat{\mathbf{E}}_x\, e^{j(\underline{\omega}t+\delta_N)} \qquad \underline{\mathbf{E}}_{y0} = \hat{\mathbf{E}}_y\, e^{j(\underline{\omega}t+\delta_N)} \qquad \text{Time-function}$$

$$\underline{\mathbf{E}}_x = \underline{\mathbf{E}}_{x0}\, e^{-\underline{\gamma}r} \qquad \underline{\mathbf{H}}_y = \frac{1}{\underline{Z}_F}\underline{\mathbf{E}}_x \qquad \underline{\mathbf{E}}_y = \underline{\mathbf{E}}_{y0}\, e^{-\underline{\gamma}r} \qquad \underline{\mathbf{H}}_x = -\frac{1}{\underline{Z}_F}\underline{\mathbf{E}}_y \qquad (630)$$

Thereat a positive value $\delta_N$ 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 $\delta_N$. As already mentioned more above, $\delta_N$ 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 $\delta$, 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 (309):

$$\underline{\gamma}_\gamma = \left( \left( \frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j\frac{\tilde{\omega}}{c} \Xi_\gamma(r) \right) \Phi(\omega) \qquad \text{Phase rate} \qquad (631)$$

The phase rate is independent from the respective coordinate. Interestingly enough, the angle $\delta$ 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 $\alpha$ 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:

$$j\underline{\omega}_\gamma t = j(j\tilde{H} + \tilde{\omega}\,\Xi_\gamma(t))\,t = (-\tilde{H} + j\tilde{\omega}\,\Xi_\gamma(t))\,t \qquad \text{Time-function} \qquad (632)$$

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 div**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 (627), a photon rest mass different from zero can be defined, as it is postulated by several modern, local and non-local theories. It's about the so called HUBBLE-mass $M_H=m_0Q_0^{-1}$. The value according to Table 11 agrees very well with the there made projections[1]:

$$\tilde{M}_H = \frac{\hbar\tilde{H}_0}{c^2} = 2.60949\cdot 10^{-69}\,\text{kg} \qquad \text{Rest mass photons} \qquad (633)$$

### 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 (309). Since space-like photons however propagate opposite to the propagation direction (velocity –c), we must take this into account accordingly:

[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.

$$\underline{\gamma}_{\bar{\gamma}} = \left( \left( \frac{\tilde{H}}{-c} + \frac{\tilde{\omega}_0}{-c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{-c} \Xi_{\bar{\gamma}}(r) \right) \Phi(\omega) \tag{634}$$

$$\underline{\gamma}_{\bar{\gamma}} = \left( \left( -\frac{\tilde{H}}{c} - \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) - j \frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(r) \right) \Phi(\omega) \qquad \text{Phase rate} \tag{635}$$

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:

$$j\underline{\omega}_{\bar{\gamma}} t = j((j\tilde{H} + j\tilde{\omega}_0 \Psi(\omega)) + \tilde{\omega}\, \Xi_{\bar{\gamma}}(t))\, t \tag{636}$$

$$j\underline{\omega}_{\bar{\gamma}} t = ((-\tilde{H} - \tilde{\omega}_0 \Psi(\omega)) + j\tilde{\omega}\, \Xi_{\bar{\gamma}}(t))\, t \qquad \text{Time- function} \tag{637}$$

For the difference $j\underline{\omega}t-\underline{\gamma}r$ with $r=(-c+v)t$, $v=\text{const}$ we obtain by expansion:

$$j\underline{\omega}_{\bar{\gamma}} t - \underline{\gamma}_{\bar{\gamma}} r = \left( \left( -\frac{\tilde{H}}{c} - \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(r) \right) ct - \left( \left( -\frac{\tilde{H}}{c} - \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) - j \frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(r) \right) \frac{\cancel{\Phi(\omega)}}{\cancel{\Phi(\omega)}} (-c+v)t \tag{638}$$

$$j\underline{\omega}_{\bar{\gamma}} t - \underline{\gamma}_{\bar{\gamma}} r = -2(\tilde{H} + \tilde{\omega}_0 \Psi(\omega))\, t + \left( \left( \frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\bar{\gamma}}(t) \right) vt \tag{639}$$

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:

$$j\underline{\omega}_{\bar{\gamma}} t - \underline{\gamma}_{\bar{\gamma}} r = -(2\tilde{H}t + 2\tilde{\omega}_0 t \Psi(\omega)) = -\left( \frac{t}{\tilde{\tilde{T}}} + \tilde{Q}_0 \Psi(\omega) \right) \approx -\frac{t}{\tilde{\tilde{T}}} \qquad \underline{\gamma}_{\bar{\gamma}} = 0 \mid v = 0 \tag{640}$$

The approximation is valid for $\omega \ll \omega_0$. Since the angle $\delta$ 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 (309) 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 $\underline{\gamma}$:

$$\underline{\gamma}_{\nu} jr = \left( \left( \frac{\tilde{H}}{jc} + \frac{\tilde{\omega}_0}{jc} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{jc} \Xi_{\nu}(r) \right) \Phi(\omega)\, jr \tag{641}$$

$$\underline{\gamma}_{\nu} jr = \left( \left( \frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\nu}(r) \right) \Phi(\omega)\, r \tag{642}$$

$$\underline{\gamma}_{\nu} = \left( \left( \frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\nu}(r) \right) \Phi(\omega) \qquad \text{Phase rate} \tag{643}$$

With exception of $\Xi$, 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 $\delta_{\nu}$ is positive because of (628), neutrinos are rotating in a mathematical positive manner (counter clockwise/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:

$$j\underline{\omega}_{\nu} t = j(j\tilde{H} + \tilde{\omega}\,\Xi_{\nu}(t))\, t = (-\tilde{H} + j\tilde{\omega}\,\Xi_{\nu}(t))\, t \qquad \text{Time-function} \tag{644}$$

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:

$$\underline{\gamma}_{\bar{\nu}}(-j)\, r = \left( \left( \frac{\tilde{H}}{-jc} + \frac{\tilde{\omega}_0}{-jc} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{-jc} \Xi_{\bar{\nu}}(r) \right) \Phi(\omega)(-j)\, r \tag{645}$$

$$\underline{\gamma}_{\bar{\nu}}(-j)\, r = \left( \left( \frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c} \Psi(\omega) \right) + j \frac{\tilde{\omega}}{c} \Xi_{\bar{\nu}}(r) \right) \Phi(\omega)\, r \tag{646}$$

$$\underline{\gamma}_{\bar{\nu}} = \left(\left(\frac{\tilde{H}}{c} + \frac{\tilde{\omega}_0}{c}\Psi(\omega)\right) + j\frac{\tilde{\omega}}{c}\Xi_{\bar{\nu}}(r)\right)\Phi(\omega) \qquad \text{Phase rate} \qquad (647)$$

Since the antineutrinos are antiparticles, they actually should have also a negative phase rate. According to (644) 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 (629). 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 $j\underline{\omega}t$:

$$j\underline{\omega}_{\bar{\nu}}t = j(j\tilde{H} + \tilde{\omega}\,\Xi_{\bar{\nu}}(t))t = (-\tilde{H} + j\tilde{\omega}\,\Xi_{\bar{\nu}}(t))t \qquad \text{Time-function} \qquad (648)$$

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 (637), 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 $\delta_N$. 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 ($\nu_e$, $\nu_\mu$, $\nu_\tau$) 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 $\delta_N$ 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 $2\pi$. 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), $\omega_0$ and $\kappa_0$. 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!):

$$x' = x\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}} \qquad (649)$$

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 $0 \le v \le c$. 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 (649) 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 Metric 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]:

$$\ddot{x} + 2k\dot{x} + \omega_0^2 x = \frac{F_0}{m}\cos\omega t \tag{650}$$

x is the deflection, $\omega_0$ 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 $k \triangleq H$. For the amplitude A applies then:

$$A = \frac{F_0}{m}((\omega_0^2 - \omega^2)^2 + 4k^2\omega^2)^{-1/2} \tag{651}$$

With k→ 0 we obtain the following expression:

$$A = \frac{F_0}{m}(\omega_0^2 - \omega^2)^{-1} = \frac{F_0\omega_0^2}{m}\left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} = A_0\left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \tag{652}$$

To compare the result with (649), 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, where the amplitude is 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 $\omega_0$ deviates: A phase-jump about $-\pi$ appears while the solution (649) 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 $\omega_0$ is the frequency of the MLE at the place of the observer, the velocity-dependent frequency $\omega$ at the place of the particle arises to $\omega = v/r_0$. Now, we only have to insert into (652) obtaining the classic expression of the SRT for wavelengths, however in the square ($\omega_0 r_0 = c$):

$$A = A_0\left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} = A_0\left(1-\frac{v^2}{\omega_0^2 r_0^2}\right)^{-1} = A_0\left(1-\frac{v^2}{c^2}\right)^{-1} \tag{653}$$

#### 6.1.2.1.1. Approximative solutions

The relativistic dilatation-factor $\beta$ apparently results from the reciprocal of the root of the bracketed expression of (653). In a lot of publications the letter $\gamma$ is used instead. Furthermore, we require an expression, in which the velocity is joined with the Q-factor. But this is not so simple, as it initially appears. Therefore, next we want to try to find one or even more approximative solutions for it. For that purpose, we don't simply want to adopt expression (651) and (652) taken from [5], but rather examine, how to acquire it in general. At first, we start from (650) comparing with equation (76). Then, expression (650) corresponds to the inhomogeneous differential equation (76), when setting $x=\varphi_0$. It applies:

$$\ddot{\varphi}_0 + 2H_0\dot{\varphi}_0 + \omega_0^2\varphi_0 = \dot{u}_a \cos\omega t \tag{654}$$

To the finding of the first approximative solution, we initially want to ignore the HUBBLE-parameter completely, since it's extremely small ($H_0=0$). 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 $\omega_0$ 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 (655). For the solution, we use the LAPLACE-transformation:

$$\ddot{\varphi}_0 + \omega_0^2\varphi_0 = \omega_0^2\varphi_a \cos\omega t \tag{655}$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2\varphi_0 - pf_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = 0 \tag{656}$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2\varphi_0 \qquad \mathscr{L}\{\cos\omega t\} = \frac{p}{p^2+\omega^2} \tag{657}$$

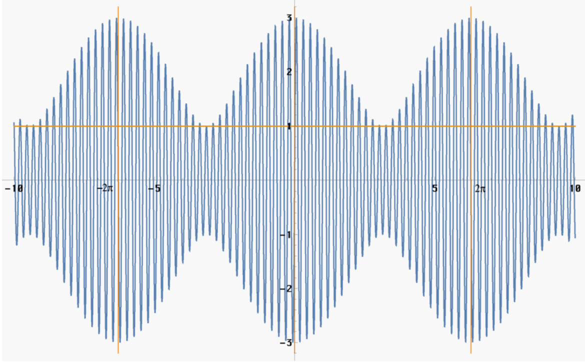
After substitution in (655) we get the following characteristic equation:

$$p^2\varphi_0 + \omega_0^2\varphi_0 = \varphi_a\omega_0^2\frac{p}{p^2+\omega^2} \qquad \varphi_0(p^2+\omega_0^2) = \varphi_a\omega_0^2\frac{p}{p^2+\omega^2} \tag{658}$$

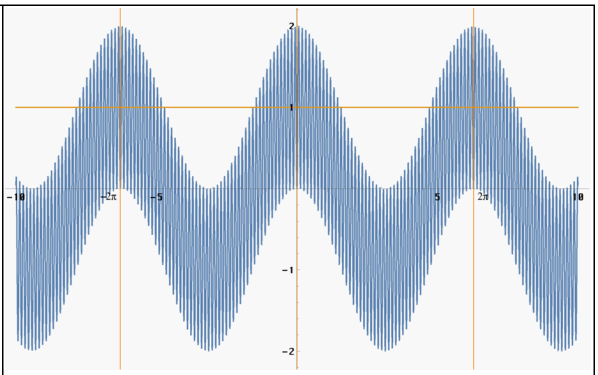
$$\varphi_0(p) = \varphi_a\omega_0^2\frac{p}{(p^2+\omega_0^2)(p^2+\omega^2)} \qquad \varphi_0(t) = \mathscr{L}^{-1}\{\varphi_0(p)\} \tag{659}$$

$$\varphi_0(t) = \varphi_a\omega_0^2\frac{\cos\omega t - \cos\omega_0 t}{\omega_0^2-\omega^2} = 2\varphi_a \sin\frac{\omega_0+\omega}{2}t\,\sin\frac{\omega_0-\omega}{2}t\left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \tag{660}$$

The function (660) looks like a 100% amplitude-modulated signal, at which point the envelope traces the frequency $\omega$ 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). But then, a + and not a × should be located between both sine-functions. With the 2 in front of the first sine the modulation rate reaches only 50%. But with a multiplication the function looks totally different (right figure). Most important is the occurrence of the sum and difference frequency.



Amplitude modulated signal 50% (660)+



Amplitude shifted signal (660)× Figure 111

By addition of 0.46 (constant of integration) to the product of both sine-functions in the enumerator of (660) rhs we get a sine-function in the range {0,2} with the average 1, so that we can disregard the harmonic share (enumerator=1). Only the bracketed expression remains then. By substitution of $\omega \to v/r_0$ and $\omega_0 \to c/r_0$ we obtain expression (661) then. But it's not identical to the relativistic dilatation-factor β:

$$\hat{\varphi}_0 = \varphi_a \left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} = \varphi_a \left(1-\frac{v^2}{c^2}\right)^{-1} \qquad \beta = \left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}} \sim Q_0^{-3/2} \qquad (661)$$

It's even a contradiction. The left-hand expression applies to $\varphi_0$ and that is $\sim Q_0^{1/2}$ as known. Thus, the value $Q_0 = f(v)$ cannot be determined this way. The main reason is, that $Q_0$ is identical to the frame of reference whereat ω and $\omega_0$ depend on $Q_0$ in a different manner.

We have found a result, based on the solution of the inhomogeneous differential equation (655). But now we want to examine, whether there is another possibility to acquire a useful result. 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 the help of the LAPLACE-transformation with subsequent transition $p \to j\omega$, at which point an inverse transformation $\mathscr{L}^{-1}$ is not necessary. We just start from (642). The approach:

$$\ddot{\varphi}_0 + \omega_0^2 \varphi_0 = 0 \qquad \to \qquad p^2 \varphi_0 + \omega_0^2 \varphi_0 = 0 \qquad (662)$$

(662) at first leads to the trivial result $\varphi_0 = 0$ only. We just have to modify the initial-conditions, namely in the following manner:

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2 \varphi_0 - p f_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = \omega_0^2 \varphi_a \qquad (663)$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2 \varphi_0 - \omega_0^2 \varphi_a \qquad (664)$$

$$p^2 \varphi_0 + \omega_0^2 \varphi_0 = \omega_0^2 \varphi_a \qquad \varphi_0 = \varphi_a \frac{\omega_0^2}{p^2 + \omega_0^2} \qquad (665)$$

$$G(p) = \frac{\omega_0^2}{p^2 + \omega_0^2} \qquad G(j\omega) = \frac{\omega_0^2}{\omega_0^2 - \omega^2} = \left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \qquad (666)$$

$$A(\omega) = \left(1-\frac{\omega^2}{\omega_0^2}\right)^{-1} \qquad B(\omega) = \begin{cases} 0 & -\omega_0 < \omega < \omega_0 \\ \pi & \omega < -\omega_0, \omega > \omega_0 \end{cases} \qquad (667)$$

$$\beta(v) = \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \qquad \phi(v) = \begin{cases} 0 & -c < v < c \\ \frac{\pi}{2} & v < -c, v > c \end{cases} \tag{668}$$

Both solutions are just identical and we can declare also an expression for the phase-angle $\phi$. The finally applied procedure has the advantage of a simpler calculation. However, we still cannot declare a function $Q=f(v)$ yet. I tested all possible variants extensively. At most we obtain a function that gives a reasonably accurate result until maximal $\frac{1}{2}\sqrt{2}c$. This is not surprising at first, since we ignored the product $H_0\dot{\varphi}_0$.

Thus, we will 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 $H_0$ 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 $H_0$ 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:

$$\ddot{\varphi}_0 + H_0\dot{\varphi}_0 + \omega_0^2\varphi_0 = \omega_0^2\varphi_a \cos\omega t \tag{669}$$

$$\mathscr{L}\{\dot{\varphi}_0\} = p\varphi_0 - f_0^{(0)} \qquad f_0^{(0)} = 0 \tag{670}$$

$$\mathscr{L}\{\dot{\varphi}_0\} = p\varphi_0 \tag{671}$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2\varphi_0 - pf_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = 0 \tag{672}$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2\varphi_0 \qquad \mathscr{L}\{\cos\omega t\} = \frac{p}{p^2 + \omega^2} \tag{673}$$

After substitution in (669) we get the following characteristic equation:

$$\varphi_0 p^2 + H_0\varphi_0 p + \omega_0^2\varphi_0 = \varphi_a\omega_0^2 \frac{p}{p^2 + \omega^2} \tag{674}$$

$$\varphi_0 (p^2 + H_0 p + \omega_0^2) = \varphi_a\omega_0^2 \frac{p}{p^2 + \omega^2} \tag{675}$$

$$\varphi_0 = \varphi_a\omega_0^2 \frac{p}{(p^2 + H_0 p + \omega_0^2)(p^2 + \omega^2)} \tag{676}$$

Here, our endeavours already finished until now, because this expression was not contained in the correspondence-table and even the BRONSTEIN didn't help. True, with the help of *Mathematica* it is now possible to make the inverse transformation, but the result is extremely complicated. With the introduction of $Q_0$ using $\omega_0=H_0Q_0$ it cannot be rearranged explicitly for $Q_0$. However, we don't want follow up this turning to the second procedure immediately:

$$\ddot{\varphi}_0 + H_0\dot{\varphi}_0 + \omega_0^2\varphi_0 = 0 \tag{677}$$

$$\mathscr{L}\{\dot{\varphi}_0\} = p\varphi_0 - f_0^{(0)} \qquad f_0^{(0)} = 0 \tag{678}$$

$$\mathscr{L}\{\dot{\varphi}_0\} = p\varphi_0 \tag{679}$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2\varphi_0 - pf_0^{(0)} - f_0^{(1)} \qquad f_0^{(0)} = 0 \qquad f_0^{(1)} = \omega_0^2\varphi_a \tag{680}$$

$$\mathscr{L}\{\ddot{\varphi}_0\} = p^2\varphi_0 - \omega_0^2\varphi_a \tag{681}$$

We substitute again in (669) obtaining finally:

$$\varphi_0 p^2 + H_0\varphi_0 p + \omega_0^2\varphi_0 = \varphi_a\omega_0^2 \qquad \varphi_0(p^2 + H_0 p + \omega_0^2) = \varphi_a\omega_0^2 \tag{682}$$

$$G(p) = \frac{\omega_0^2}{p^2 + H_0 p + \omega_0^2} \qquad G(j\omega) = \frac{\omega_0^2}{(\omega_0^2 - \omega^2) + jH_0\omega} \tag{683}$$

$$G(j\omega) = \omega_0^2 \frac{(\omega_0^2 - \omega^2) - jH_0\omega}{(\omega_0^2 - \omega^2)^2 + H_0^2\omega^2} \tag{684}$$

$$A(\omega) = \omega_0^2 \frac{\sqrt{(\omega_0^2 - \omega^2)^2 + H_0^2\omega^2}}{(\omega_0^2 - \omega^2)^2 + H_0^2\omega^2} = \omega_0^2((\omega_0^2 - \omega^2)^2 + H_0^2\omega^2)^{-1/2} \tag{685}$$

With the exception of the factor 4 this exactly equals the expression (651) stated in [5]. We have calculated just right. But expression (685) can be transformed even more ($H_0 Q_0 = \omega_0$):

$$A(\omega) = \frac{\omega_0^2}{\sqrt{(H_0\omega)^2 + (\omega_0^2 - \omega^2)^2}} = \frac{\frac{\omega_0^2}{H_0\omega}}{\sqrt{1 + \left(\frac{\omega_0^2 - \omega^2}{H_0\omega}\right)^2}} \tag{686}$$

$$A(\omega) = \frac{\tilde{Q}_0 \frac{\omega_0^2}{\omega_0\omega}}{\sqrt{1 + \tilde{Q}_0^2\left(\frac{\omega_0^2 - \omega^2}{\omega_0\omega}\right)^2}} = \frac{\tilde{Q}_0 \frac{\omega_0}{\omega}}{\sqrt{1 + \tilde{Q}_0^2\left(\frac{\omega_0}{\omega} - \frac{\omega}{\omega_0}\right)^2}} \tag{687}$$

$$A(v) = \frac{\tilde{Q}_0}{\sqrt{\frac{v^2}{c^2} + \tilde{Q}_0^2\left(1 - \frac{v^2}{c^2}\right)^2}} = \frac{c}{v}\frac{\tilde{Q}_0}{\sqrt{1 + \tilde{Q}_0^2 V^2}} \quad \text{with} \quad V = \frac{v}{c} - \frac{c}{v} \tag{688}$$

Thereat V (capital letter) is the detuning (405), as we know it from the electrotechnics. After substitution of $\omega$ by v, we receive for the dilatation-factor $\beta$:

$$\beta(v) = \frac{\sqrt{\tilde{Q}_0}}{\sqrt[4]{\frac{v^2}{c^2} + \tilde{Q}_0^2\left(1 - \frac{v^2}{c^2}\right)^2}} \approx \left(1 - \frac{v^2}{c^2}\right)^{-\frac{1}{2}} \quad \text{for} \quad Q_0 \gg 1 \tag{689}$$

The approximation (689) is identical to the EINSTEIN expression and to our first approximation. We can specify also a phase angle. Starting from (612) applies:

$$B(\omega) = -\arctan\frac{\omega H_0}{(\omega_0^2 - \omega^2)} = \arctan\frac{1}{Q_0}\frac{\omega\omega_0}{(\omega^2 - \omega_0^2)} = \arctan\frac{1}{Q_0 V} \tag{690}$$

$$B(\omega) = -\pi + \operatorname{arccot}(Q_0 V) = -\frac{\pi}{2} - \arctan(Q_0 V) \tag{691}$$

$$\phi(\omega) = \frac{B(\omega)}{2} = -\frac{\pi}{4} - \frac{1}{2}\arctan(Q_0 V) \overset{?}{=} \alpha - \frac{\pi}{2} \tag{692}$$

The last expression is very interesting. It could give us a relation between Q-factor, velocity and the angle $\alpha$ anyway. Unfortunately this doesn't work, since both functions have a different range of value. So, $\phi$ 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 moving. Really, we still have gotten an expression for the relativistic dilatation-factor $\beta$. 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 (688) 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 (688). We obtain this by inserting the expression $\omega = \omega_0 - v/r_0$ in (611) to:

$$Q_0 = \tilde{Q}_0 \frac{1 - v/c}{\sqrt{1 + \tilde{Q}_0^2 \left( \frac{1}{1 - v/c} - \left( 1 - \frac{v}{c} \right) \right)^2}} \qquad \text{Mirrored function} \qquad (693)$$

Unfortunately, this function doesn't fulfil 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 inverse relation exists at the displaced function (694) with $\omega = \omega_0 + v/r_0$:

$$Q_0 = \tilde{Q}_0 \frac{1 + v/c}{\sqrt{1 + \tilde{Q}_0^2 \left( \frac{1}{1 + v/c} - \left( 1 + \frac{v}{c} \right) \right)^2}} \qquad \text{Displaced function} \qquad (694)$$

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:

$$Q_0 = \tilde{Q}_0 \frac{1 + v/c}{\sqrt{1 + \tilde{Q}_0^2 \left( \frac{1}{1 + v/c} - \left( 1 - \frac{v}{c} \right) \right)^2}} = \frac{\tilde{Q}_0}{\sqrt{\left( 1 - \frac{v}{c} \right)^2 + \tilde{Q}_0^2 \frac{v^4}{c^4}}} \qquad (695)$$

Expanding the left expression the approximative solution turns out:

$$Q_0 \approx \frac{1}{\sqrt{\left( 1 - \left( 1 - \frac{v^2}{c^2} \right) \right)^2}} = \frac{c^2}{v^2} \qquad \text{for} \quad Q_0 \gg 1 \qquad (696)$$

For v=0 expression (696) has an infinite solution, which not quite corresponds to the observations. However if we insert the propagation-velocity of the metrics $c_M$ from (227) as basic-velocity, then we precisely receive the local Q-factor:

$$Q_0 \approx \frac{c^2}{c_M^2} \approx \sqrt{Q_0^2} \qquad \beta_M^{-1} = \sqrt{1 - \frac{1}{Q_0}} \qquad (697)$$

But it only applies to your own frame of reference $Q_0$ for v=0. With acceleration you will leave it building a new one $Q_0'$. The value $\beta_M$ forms the so called basic, as it is used e.g. to the calculation of the inherent time. But you must not simply insert $v = c_M + v_M$ in order to determine $Q_0'$, since $v_M$ is already incorporated in $c_M$ pro rata. The correct solution is obtained by equating (236) with 1. The term $\beta_0$ is the phase rate of the propagation function of the metric wave field at this point. Indeed, with the conversion from one frame of reference to one other we have to subtract (696) from 1, since it's about a LORENTZ-transformation.

$$\beta_0 r = \tilde{Q}_0\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} = 1 \qquad \frac{1}{\tilde{Q}_0} = \left(\frac{\cancel{2}r}{\cancel{2}ct}\right)^{\frac{2}{3}} = \left(\frac{v\cancel{t}}{c\cancel{t}}\right)^{\frac{2}{3}} = \left(\frac{v^2}{c^2}\right)^{\frac{1}{3}} \tag{698}$$

$$\frac{1}{\tilde{Q}_0^3} = \frac{v^2}{c^2} \qquad \Rightarrow \qquad Q_0^3 = \tilde{Q}_0^3\left[1-\frac{v^2}{c^2}\right] \sim \beta^{-2} \tag{699}$$

$$Q_0' = \tilde{Q}_0\left[1-\frac{v^2}{c^2}\right]^{\frac{1}{3}} \qquad \frac{v}{c} = \sqrt{1-\left(\frac{Q_0'}{\tilde{Q}_0}\right)^3} \qquad \beta = \left(\frac{Q_0'}{\tilde{Q}_0}\right)^{-\frac{3}{2}} \tag{700}$$

$$Q^{3/2} \sim t^{3/4} \sim \beta^{-1} \sim (z+1) \qquad Q \sim t^{1/2} \sim \beta^{-2/3} \sim (z+1)^{2/3} \tag{701}$$

This way, we are able to calculate, the diffraction of a light ray in a gravitational field. We choose the ansatz using the refraction law. $\theta$ is angle of diffraction. The factor 2 arises directly from the SRT, since both, the temporal share $g_{00}$, as well as the spatial share $g_{11}$ are affected. Based on (700) we obtain:

$$\theta = 2\arctan\frac{v}{c} \approx 2\frac{v}{c} \qquad \text{for } v \ll c \tag{702}$$

$$\frac{v}{c} = \sqrt{1-\left(\frac{Q_0'}{\tilde{Q}_0}\right)^3} = \sqrt{1-\left(1-\frac{2M_\odot G}{R_\odot c^2}\right)} = \sqrt{\frac{2M_\odot G}{R_\odot c^2}} \tag{703}$$

It should be noted that, except for c, all other values also depend on the frame of reference $Q_0$. With $q=Q_0'/\tilde{Q}_0$ we get under application of (698) and (794):

$$\frac{v}{c} = \sqrt{2\frac{\tilde{M}_\odot q^{-5/2}\,\tilde{r}_0 q^{2/2}}{\tilde{R}_\odot\, q^{2/2}\tilde{m}_0 q^{-2/2}}} = \sqrt{\frac{2\tilde{M}_\odot\tilde{G}}{\tilde{R}_\odot c^2}\left(\frac{Q_0'}{\tilde{Q}_0}\right)^{-3/2}} = \sqrt{\frac{2\tilde{M}_\odot\tilde{G}}{\tilde{R}_\odot c^2}\frac{v}{c}} \tag{704}$$

$$\frac{v}{c} = \frac{2\tilde{M}_\odot\tilde{G}}{\tilde{R}_\odot c^2} \qquad \theta = \arctan\frac{2\,v/c}{1-(v/c)^2} \approx \frac{4\tilde{M}_\odot\tilde{G}}{\tilde{R}_\odot c^2} = 1.75'' \tag{705}$$

Thus, the reciprocal of Q has the character of a refraction index. Values marked with a tilde $\tilde{}$ are measured/calculated from/at earth. The result equals the value predicted by EINSTEIN, which has been confirmed during EDDINGTON's solar eclipse expedition on May 29th, 1919. The diffraction at the sun rim amounted to 1.98″±0.18 at one telescope and 1.60″±0.31 at the other. Because there were always doubts about the correctness of these values, EDDINGTON's photo plates were re-gauged in 1979 at the Royal Greenwich Observatory using modern equipment. Result: 1.90″±0.11 [51]. The aberration is possibly caused by the strong flattening of the sun.

The course of (695) and (700) lhs is shown in Figure 112. We can see, that both curves extremely differ from each other. Only at v=0 and v=c they intersect. Therefore it's very important, to distinguish, whether it's about the Q-factor/phase angle $Q_0$ in its own or in an external frame of reference.

In the further course of this work repeatedly an addition of $c_M$, v and of other expressions is considered. In this connection it should be noted, that the additional speed-components are always added pro rata only, since c cannot be exceeded under any circumstances. The best way to do this is to use the formula for the speed addition (943) for lower resp. (978) for higher velocities and/or in strong gravitational fields, cf. even (704).

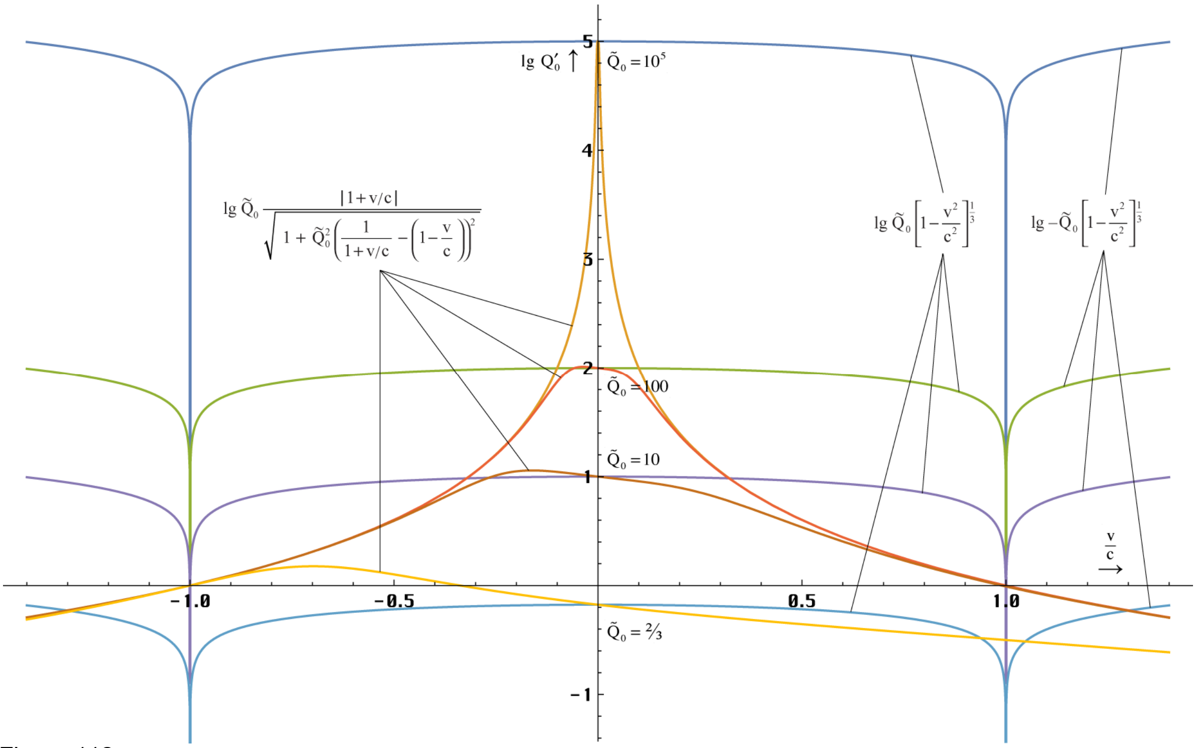



Figure 112
Phase angle $Q_0(v)$ in its own and with respect to another frame of reference

In the latter case we need the value of the angle α both, in its own, as well as in further frames of reference. Since α and $Q_0$ are always tightly connected, this value also can be calculated for other reference systems, if we know $Q_0'$. Using (581) we get for α and $\underline{c}$

$$\alpha = \frac{\pi}{4} - \arg \underline{c} = \frac{\pi}{2} - \frac{1}{2}\operatorname{arccot}\theta = \frac{3}{4}\pi + \frac{1}{2}\arg\left((1 - A^2 + B^2) + j2AB\right) \tag{706}$$

$$\left|\underline{c}\right| = c_M = \frac{c}{\rho_0 Q_0} \approx c\,Q_0^{-1/2} \tag{707}$$

Please find the definition of $\underline{c}$, $\rho_0$, θ, A and B at (211), it applies $2\omega_0 t = Q_0$. Now it seems to be the case that, caused by cM, there is a maximum super elevation, e.g. of the mass during acceleration, of the order of $Q_0$. Thus, it would at least theoretically be possible to surmount the hillock achieving a speed greater than c, for an observer in a strong gravitational field e.g. in the vicinity of a BH. But the hillock is always in the positive velocity range, which typically doesn't exist. No matter in which direction you are moving, you are always moving towards the particle horizon cT, with negative speed against the expansion- and temporal direction. In the case of a BH indeed, there are positive velocities too, towards the event horizon. That would be the SCHWARZSCHILD-radius then. Here you can really reach light speed, namely at the very moment when you pass it. But then you will leave our universe and a whatever velocity is no longer defined (disconnected).

Now, with (429) and (695), we have found two relations, which are independent from each other, describing the dependence of the Q-factor on space and time on the one hand and the dependence from the velocity on the other hand. Now the task consists in that we bring together both relations. This is done by simple multiplication. We get the following expression:

$$Q_0 = \tilde{Q}_0\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{3}} \tag{708}$$

There are just four variables ($Q_0$, T, R und c) included, which are coupled tight together. With it, we are able to calculate $Q_0$ in a whatever reference frame, being at a whatever point in the universe, moving with a whatever speed with respect to our reference frame, at a whatever point of time. Only the effect of a gravitational field is still missing. This can be considered via v indeed. $Q_0$ is of central importance to this model, since it affects nearly all scales in the universe. The most important relations between the values of the empty space (left column, all genuine constants), of the microcosm (middle column, variables) and of the macrocosm (right column, variables) are listed in Table 5 (not complete).

| | | | | | |
|---|---|---|---|---|---|
| $r_1$ | $\text{—}[\times Q_0]\rightarrow$ | $r_0$ | $\text{—}[\times Q_0]\rightarrow$ | $R$ | Spatial increment/World radius |
| $t_1$ | $\text{—}[\times Q_0]\rightarrow$ | $t_0$ | $\text{—}[\times Q_0]\rightarrow$ | $T$ | Temporal increment/The age |
| $G_2$ | $\text{—}[\times Q_0]\rightarrow$ | $G_1$ | $\text{—}[\times Q_0]\rightarrow$ | $G$ | Gravitational constant |
| $\omega_1$ | $\text{—}[:\ Q_0]\rightarrow$ | $\omega_0$ | $\text{—}[:\ Q_0]\rightarrow$ | $H$ | PLANCK-frequency /HUBBLE-param. |
| $M_2 \ldots M_1$ | $\text{—}[:\ Q_0]\rightarrow$ | $m_0$ | $\text{—}[:\ Q_0]\rightarrow$ | $M_H$ | Init-/MACH-/PLANCK-/HUBBLE mass |
| $\boxed{?}$ | $\text{—}[:\ Q_0]\rightarrow$ | $\hbar_1$ | $\text{—}[:\ Q_0]\rightarrow$ | $\hbar$ | PLANCKS quantity of action |
| $2\kappa_0$ | $\text{—}[:\ Q_0]$ ———————— | | $\rightarrow [:\ Q_0]\rightarrow$ | $\kappa_{0R}$ | Specific conductivity vac./Metrics |

Table 5
Relations between the fundamental values of space and of the micro- and macrocosm

There is even an $M_2$, it's the initial mass of the universe [49]. With it, the model disposes of the fundamental property of logarithmic periodicity. It should also be noted, that the $Q_0$-related functions, depicted in this section, are being exact expressions, because there is a fixed assignment $Q_0 \rightarrow \alpha$. Only with the relativistic dilation factor β the angular relations must be considered. A more detailed consideration of this problem follows in the next section.

### 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?

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 $\omega_1$. 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 on 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 $\omega_0$ 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 (605). To the value $Q_0$ still belongs a fixed value $c_M$ and the angle $\theta$ is fixed explicitly too. Furthermore follows that also the angle $\alpha$ has a fixed value (581).

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 (581). While the angle $\alpha$ just has a fixed value, the angles $\gamma$ and $\delta$ 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 $\delta$ applies for all kinds of photons:

$$\delta = \arcsin\left(\left(\frac{1}{\rho_0 Q_0} \oplus \frac{v}{c}\right)\sin\alpha\right) \qquad \oplus \text{ Relativistic speed-addition} \qquad (709)$$

This once again, has effects on frequency and wavelength of photons and neutrinos, which are tightly joined with the angle $\delta$. The angle $\gamma$ is differently defined for photons and neutrinos just as for their antiparticles:

$$\gamma_\gamma = \arg\underline{c} + \arccos\left(\left(\frac{1}{\rho_0 Q_0} \oplus \frac{v}{c}\right)\sin\alpha\right) + \frac{\pi}{4} \qquad \text{Time-like photons} \qquad (710)$$

$$\gamma_{\bar{\gamma}} = -\arg\underline{c} - \arcsin\left(\left(\frac{1}{\rho_0 Q_0} \oplus \frac{v}{c}\right)\sin\alpha\right) + \frac{\pi}{4} \qquad \text{Space-like photons} \qquad (711)$$

$$\gamma_\nu = -\arg\underline{c} + \arcsin\left(\left(\frac{1}{\rho_0 Q_0} \oplus \frac{v}{c}\right)\cos\alpha\right) - \frac{\pi}{4} \qquad \text{Neutrinos} \qquad (712)$$

$$\gamma_{\bar{\nu}} = \arg\underline{c} - \arccos\left(\left(\frac{1}{\rho_0 Q_0} \oplus \frac{v}{c}\right)\cos\alpha\right) - \frac{\pi}{4} \qquad \text{Antineutrinos} \qquad (713)$$

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 $\alpha$ 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 (615), which is correct under acceptance of the validity of the Pythagoras theorem. We reduce this as follows:

$$\beta^{-1} = \sqrt{1-\frac{v^2}{c^2}} \qquad \beta^{-2}c^2 = c^2-v^2 \tag{714}$$

$$c^2 = \beta^{-2}c^2+v^2 \tag{715}$$

Wanted now is a new value β with application of the cosine-rule instead of the PYTHAGORAS. Expression (715) must be expanded then as follows:

$$c^2 = \beta^{-2}c^2+v^2-2\beta^{-1}cv\cos\alpha \tag{716}$$

$$\beta^{-2}c^2-2\beta^{-1}cv\cos\alpha+(v^2-c^2) = 0 \tag{717}$$

$$\beta^{-2}-2\beta^{-1}\frac{v}{c}\cos\alpha-\left(1-\frac{v^2}{c^2}\right) = 0 \tag{718}$$

$$\beta^{-1}_{1,2} = \frac{v}{c}\cos\alpha\pm\sqrt{1-\frac{v^2}{c^2}+\frac{v^2}{c^2}\cos^2\alpha} = \frac{v}{c}\cos\alpha\pm\sqrt{1-\frac{v^2}{c^2}(1-\cos^2\alpha)} \tag{719}$$

We find a congruity with (578). 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 (719) 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 ($\alpha=\alpha_{\gamma,\nu}$):

$$\boxed{\beta^{-1} = \frac{v}{c}\cos\alpha\pm\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}} \quad \text{Exact expression of the relativistic dilatation-factor} \tag{720}$$

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 $\underline{\mathbf{v}}=\underline{\mathbf{v}}_M+\underline{\mathbf{c}}_M$ and $v=v_M+c_M$. With the approach:

$$\frac{v_\gamma}{\sin\gamma_\gamma} = \frac{c}{\sin\alpha_\gamma} \qquad \alpha_\nu = \alpha_\gamma-\frac{\pi}{2} \qquad \sin\alpha_\nu = -\cos\alpha_\gamma \tag{721}$$

we get following expressions for the dilatation-factor β ($\alpha=\alpha_\gamma$):

$$\beta^{-1}_\gamma = \frac{v_\gamma}{c} = \frac{\sin\gamma_\gamma}{\sin\alpha} \ \text{Time-like photons} \qquad \beta^{-1}_{\bar{\gamma}} = \frac{v_{\bar{\gamma}}}{c} = \frac{\sin\gamma_{\bar{\gamma}}}{\sin\alpha} \ \text{Space-like photons} \tag{722}$$

$$\beta^{-1}_\nu = \frac{v_\nu}{c} = \frac{\sin\gamma_\nu}{-\cos\alpha} \ \text{Neutrinos} \qquad \beta^{-1}_{\bar{\nu}} = \frac{v_{\bar{\nu}}}{c} = \frac{\sin\gamma_{\bar{\nu}}}{\cos\alpha} \ \text{Antineutrinos} \tag{723}$$

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 (581) resp. (611-614). The test results in an exact match with (720) in the case $v=v_M+c_M$. The expressions (722) and (723) correspond to the product of the temporal and geometrical part of the total red-shift (610), 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 (720) also in the following form:

$$\beta^{-1}_{\gamma,\bar{\gamma}} = \frac{v}{c}\cos\alpha \pm \cos\delta \approx \pm\cos\delta \tag{724}$$

$$\beta^{-1}_{\nu,\bar{\nu}} = \frac{v}{c}\sin\alpha \pm \cos\delta \approx \frac{v}{c} \pm 1 \tag{725}$$

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 113 very well:

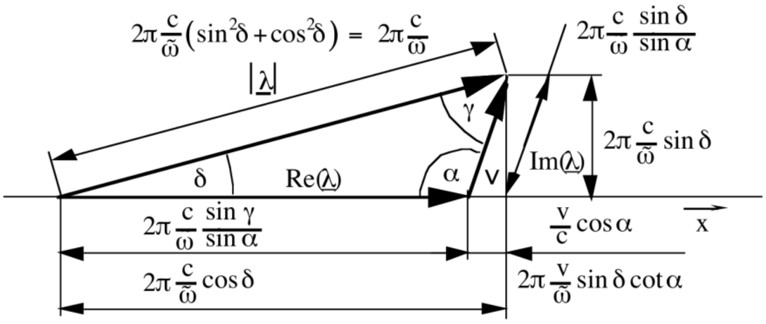



Figure 113
Effect of the relativistic dilatation-factor $\beta$

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 $\beta$ of the propagation-functions in section 5.3.2.

In order to get an exact solution here, we must expand the corresponding $\beta$-values with the expressions $v/c\cos\alpha$ resp. $v/c\sin\alpha$. The course of the function $\beta$ for time- and space-like photons for a Q-factor $Q_0 > 10^5$ is presented in Figure 114.

Here, a contradiction arises with the space-like photons (and fermions) which is based on the observation, that the reciprocal of $\beta$ 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 $\beta$ 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:

$$\underline{\omega} = \omega(\cos\delta + j\sin\delta) \tag{726}$$

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 $\lambda$ and $\nu$. Really, in the theoretical electrotechnics the relation $\lambda=2\pi/\beta$ ($\beta$=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.

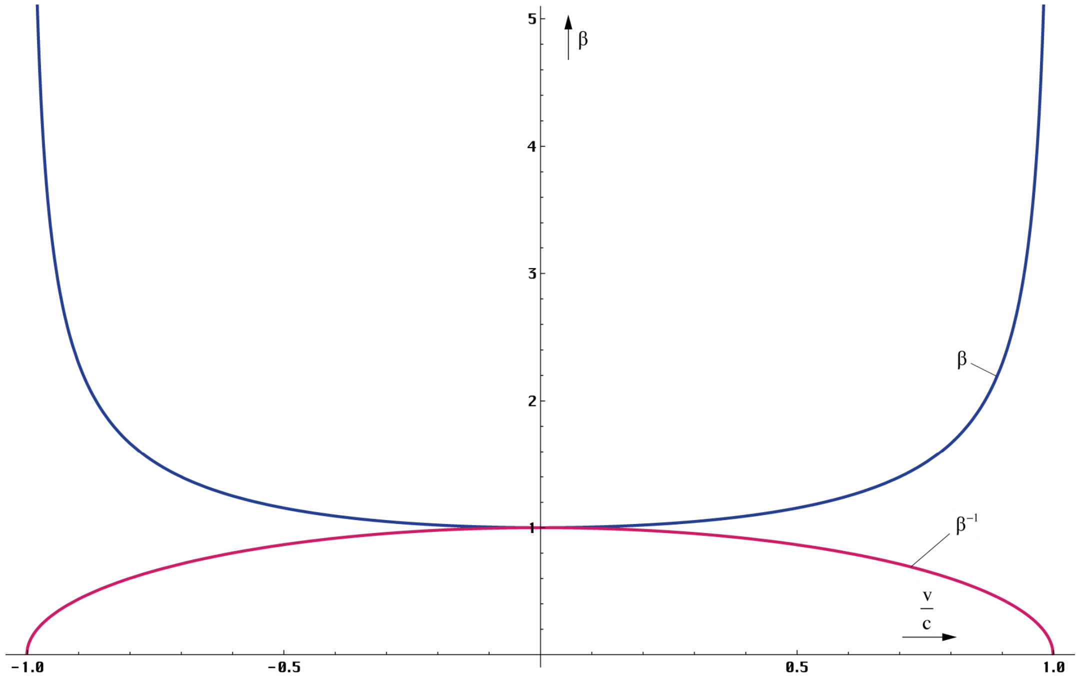



Figure 114
Relativistic dilatation-factor $\beta_\gamma$ for time- and space-like photons in comparison with the classic EINSTEIN solution ($Q_0>10^5$)

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: $\underline{c}=\underline{\lambda}\cdot\underline{v}$ (see Figure 113). Then applies:

$$\underline{\lambda} \;=\; 2\pi\frac{c}{\omega}(\cos\delta - j\sin\delta) \tag{727}$$

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 (727), 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 113, 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 β(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 (631) and the corresponding expressions for neutrinos and antineutrinos would read then as follows:

$$\underline{\gamma}_\gamma = \left(\left(\frac{\tilde{H}}{c}+\frac{\tilde{\omega}_0}{c}\Psi(\omega)+\frac{\tilde{\omega}}{c}\frac{\sin\delta\cos\delta}{\sin\gamma}\,\Xi_\gamma(v,r)\right)+j\frac{\tilde{\omega}}{c}\,\Xi_\gamma(v,r)\right)\Phi(\omega) \tag{728}$$

Both $c_M$ as well as $\sin\alpha$ a are stipulated with the definition of the frame of reference. Here, the part $\omega/c\cdot\sin\delta\cos\delta/\sin\gamma\cdot\Xi_\gamma(v,r)$ 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 $\alpha$ is extremely close to $\pi/2$ 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 115:

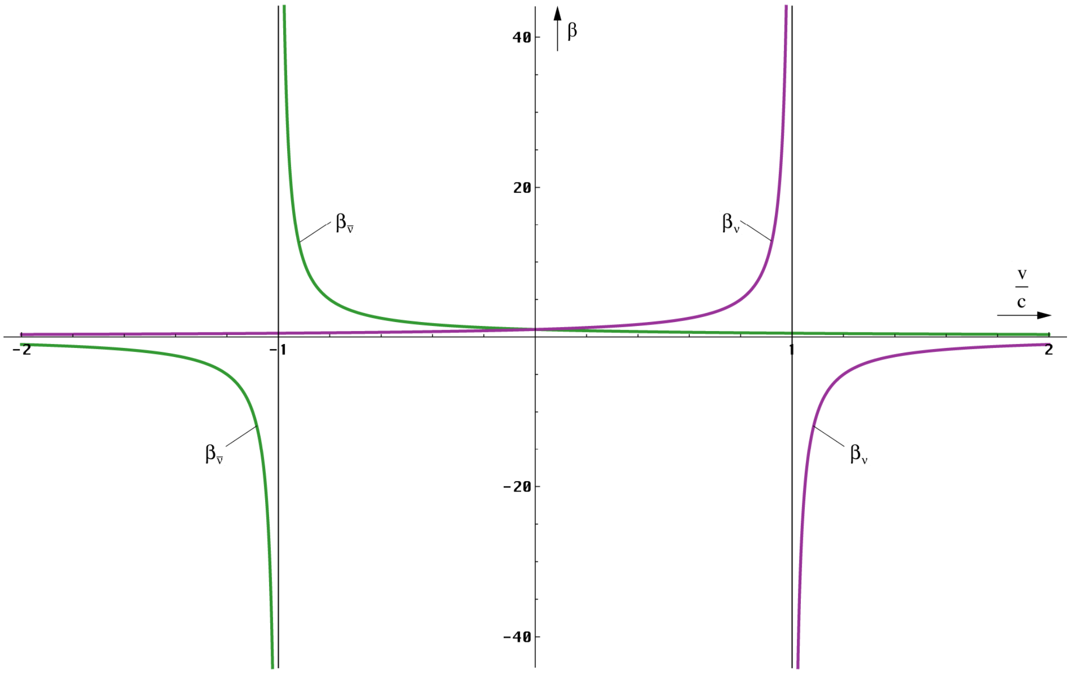



Figure 115
Relativistic dilatation-factor $\beta_\alpha$ for neutrinos and antineutrinos in comparison with the hypothetical classic solution ($Q_0$>$10^5$)

Here, $\beta_\nu$ 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 $\cos\alpha$ is different from (near to) zero and $\sin\alpha \neq 1$. The course of $\beta$ for the four different kinds of photon and for several smaller Q-factors is presented in Figure 116-110. 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 pole 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 pole in the positive range. With extremely small initial-Q-factors there's going to be a rotation around the angle $\pi/2$. The photons behave similarly like neutrinos then.

However, the whole matter is purely theoretical. First of all only a part of v is added to the part cM with the loss of the original frame of reference. Secondly, the addition takes place only when moving in a straight line from or towards a singularity. Thus, in the cosmic vacuum, far away from any mass, there are negative velocities only towards the particle horizon (time direction = expansion direction). Each observer in the free fall is situated on a 4D-hyper surface, the event horizon. Normally, this cannot be exceeded, since what lies behind is in the future. In contrast, in the vicinity of a black hole ($Q_0$ very small) there are positive vicinities too towards event horizon. Here you can actually jump over the „edge", i.e. reach light speed, exactly in the very moment, when you cross the event horizon. But then you're gone.

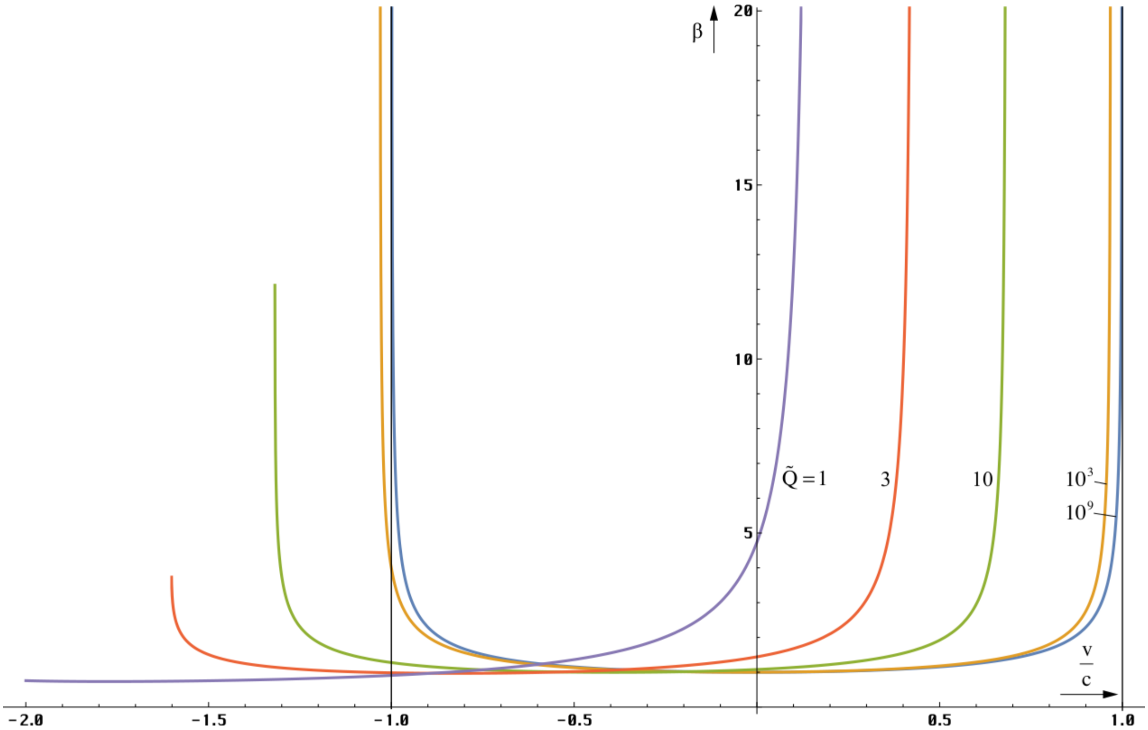



Figure 116
Relativistic dilatation-factor $\beta_\alpha(v)$ for time-like photons for small Q-factors

The course of $\beta$ 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.

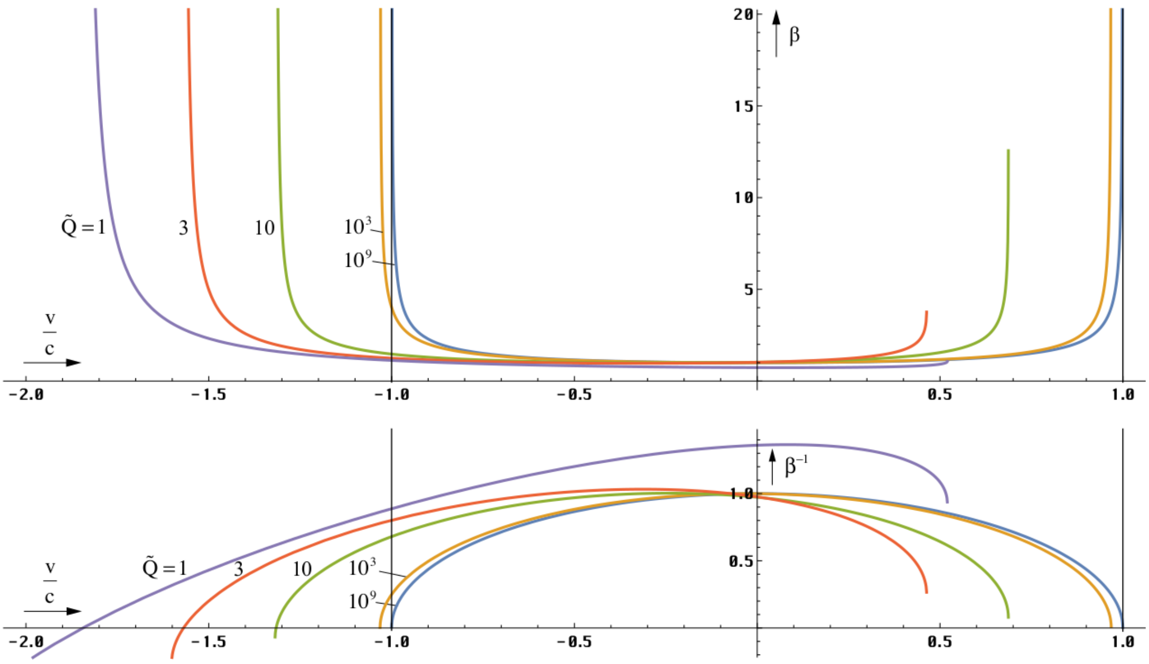



Figure 117
Relativistic dilatation-factor $\beta_\alpha(v)$ for space-like photons

Analogical are the relations for neutrinos and antineutrinos. However, there is no maximal super elevation but only one pole 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 pole using $v = c_M + v_M$ by solving the equation:

$$\mp \frac{v}{c}\cos\alpha + \sqrt{1 - \frac{v^2}{c^2}\sin^2\alpha} \;=\; 0 \qquad \text{to} \quad v \;=\; \pm\left(c - c_M\right) \tag{729}$$

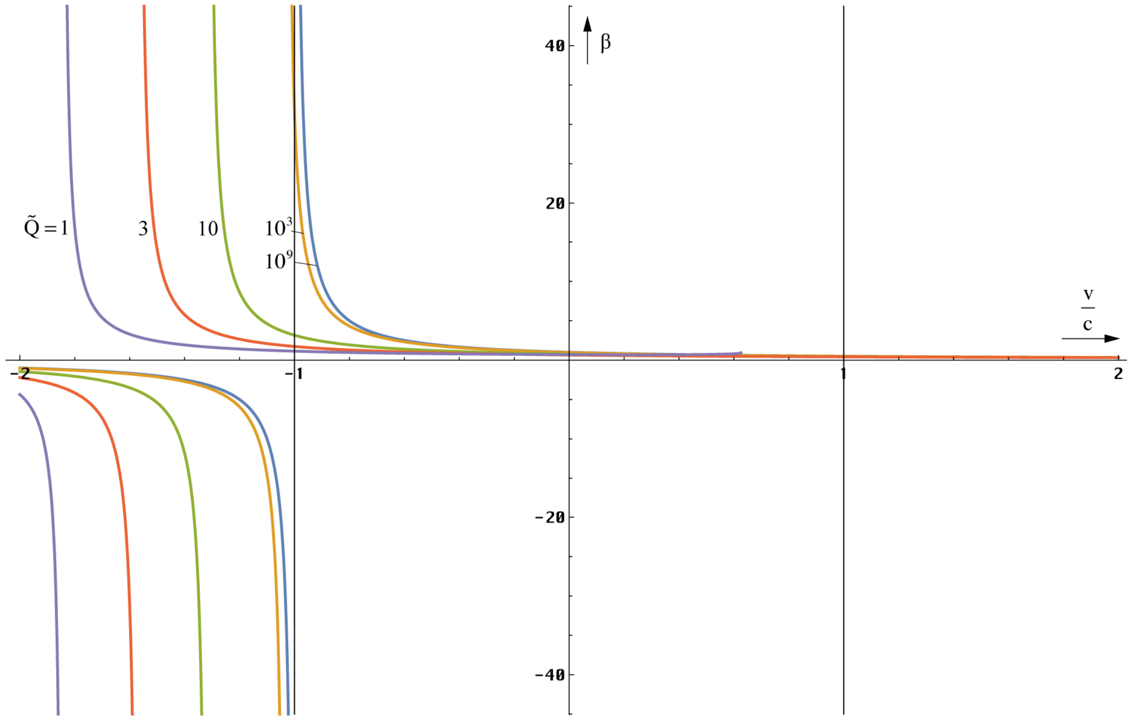



Figure 118
Relativistic dilatation-factor $\beta_\alpha(v)$ for neutrinos

By the way, expression (729) applies even to neutrinos. The maximum super elevation (branching) we find always on the side with opposite sign. The values calculate as follows:

$$\frac{(c_M + v_M)^2}{c^2}\sin^2\alpha \;=\; 1 \qquad\qquad v \;=\; \mp\frac{c}{\sin\alpha} - c_M \tag{730}$$

$$\overset{\frown}{\beta}_\gamma \;=\; -\tan\alpha \mp \frac{c_M}{c}\sin\alpha \quad \text{Photons (Maximum)} \qquad \breve{\beta}_\nu = -\cot\alpha \pm \frac{c_M}{c}\cos\alpha \quad \text{Neutrinos (Branching)} \tag{731}$$

$$\overset{\frown}{\beta}_\gamma \;\approx\; -\tan\alpha \;\approx\; \frac{4}{3}\tilde{Q}_0 \qquad\qquad \breve{\beta}_\nu \approx -\cot \approx \frac{4}{3}\tilde{Q}_0^{-1} \tag{732}$$

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 (731) and of the approximative solution (732) for photons is presented in Figure 120. 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 pole 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.

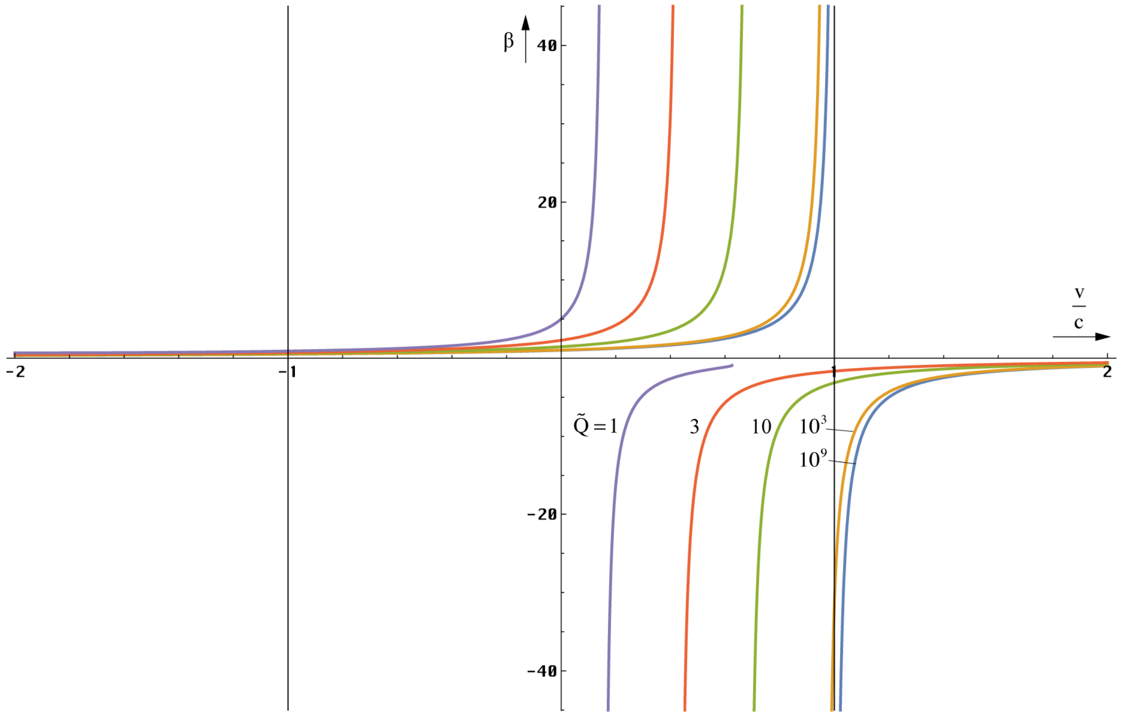



Figure 119
Relativistic dilatation-factor $\beta_\alpha(v)$ for antineutrinos

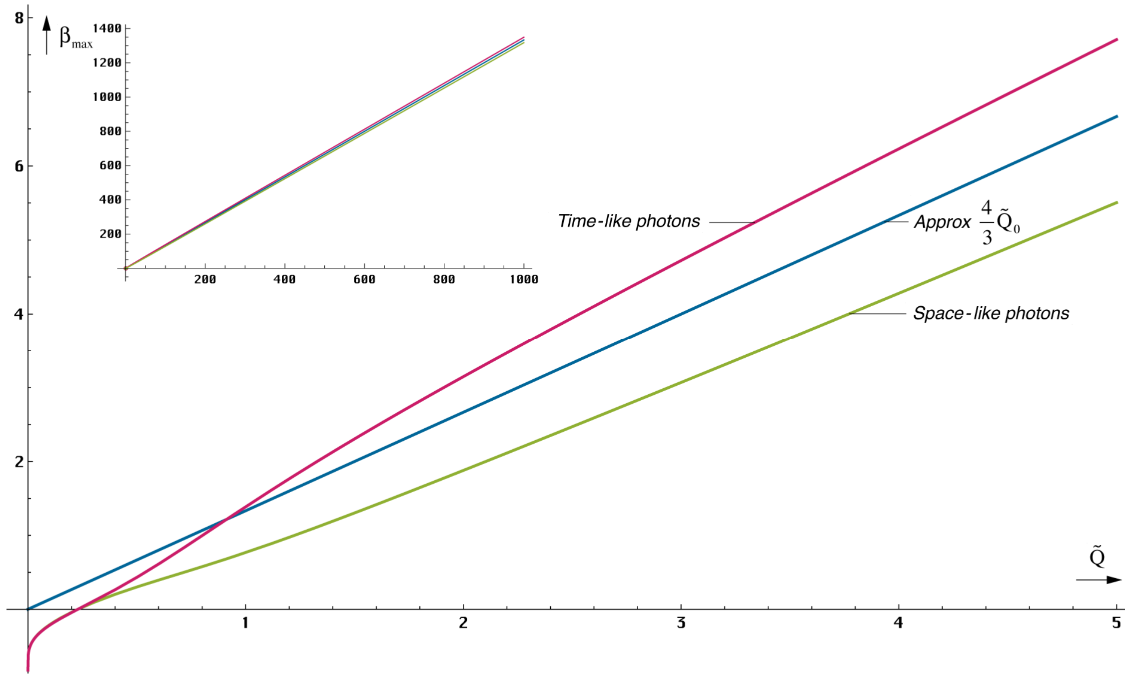



Figure 120
Exact course and approximation for the maximum
super elevation $\beta$ at the time- and space-like photon

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 $\beta$ 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 $\beta = \text{cosec}\gamma = a + jb$ with b>a turns out and it applies:

$$\frac{\lambda}{\sin\gamma} = \tilde{\lambda}(a + jb) \tag{733}$$

While both parts of $\lambda$ 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 $\beta$:

$$\beta^2 = \left(1 - \frac{v^2}{c^2}\right)^{-1} \tag{734}$$

To assume idealized conditions, this expression can be combined in the following manner:

$$\beta^2 = -\left(+\sqrt{1-\frac{v^2}{c^2}}\right)^{-1}\left(-\sqrt{1-\frac{v^2}{c^2}}\right)^{-1} = -\beta_\gamma\beta_{\bar{\gamma}} \qquad \alpha = \frac{\pi}{2} \tag{735}$$

$$\beta^2 = -\left(\frac{v}{c}+1\right)^{-1}\left(\frac{v}{c}-1\right)^{-1} = -\beta_\nu\beta_{\bar{\nu}} \qquad \alpha = 0 \tag{736}$$

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 (721) applies. After all, we have succeeded in finding a new inherent law:

$$\beta^2 = -\beta_x\beta_{\bar{x}} = \left(1-\frac{v^2}{c^2}\right)^{-1} \qquad x=\gamma,\nu \tag{737}$$

The classic value $\beta$ represents the geometric mean of the dilatation-factor of particles and antiparticles with it. We check further:

$$\beta^2 = -\left(\frac{v}{c}\cos\alpha+\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}\right)^{-1}\left(\frac{v}{c}\cos\alpha-\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}\right)^{-1} \tag{738}$$

$$\beta^2 = -\left(\frac{v}{c}\left(\sin^2\alpha+\cos^2\alpha\right)-1\right)^{-1} = \left(1-\frac{v^2}{c^2}\right)^{-1} \tag{739}$$

Expression (737) 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 $\alpha$. An exact examination of (713) immediately leads to the result:

$$\sin\gamma_{\bar{\gamma}}(v) = -\sin\gamma_{\gamma}(-2c_M-v) \qquad \text{and} \qquad \sin\gamma_{\bar{\nu}}(v) = -\sin\gamma_{\nu}(-2c_M-v) \tag{740}$$

The angle $\alpha$ 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:

$$x' = x\sin\gamma_{\bar{\gamma}}\operatorname{cosec}\alpha \qquad \text{Space-like photons (fermions)} \tag{741}$$

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 (739) 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:

$$\lambda' = \lambda\operatorname{cosec}\gamma_{\gamma}\sin\alpha \qquad \text{Time-like photons (generic)} \tag{742}$$

$$\lambda' = -\lambda\operatorname{cosec}\gamma_{\nu}\cos\alpha \qquad \text{Neutrinos} \tag{743}$$

$$\lambda' = \lambda\operatorname{cosec}\gamma_{\bar{\nu}}\cos\alpha \qquad \text{Antineutrinos} \tag{744}$$

The expressions (741) until (744) 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 (742) until (744), 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. In contrast to the relativistic expansion factor β, there are always both negative and positive velocities here. 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:

$$\lambda' = \lambda \frac{1+\frac{v}{c}}{\sqrt{1-\frac{v^2}{c^2}}} = \lambda \left(\frac{1+\frac{v}{c}}{1-\frac{v}{c}}\right)^{\frac{1}{2}} \tag{745}$$

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 (745) by the exact expression (720). This is however not yet the final solution:

$$\lambda' = \lambda \frac{1+\frac{v}{c}}{\frac{v}{c}\cos\alpha_\gamma + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\gamma}} \tag{746}$$

The reason is, that our photon should behave like a neutrino with higher velocities. Furthermore, the expression (746) 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 (745) in the case of smaller velocities. To neutrinos, the following approximation is applied in the case of smaller velocities (cosα is always negative):

$$\frac{v}{c}\cos\alpha_\nu + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\nu} \approx -\frac{v}{c} + \sqrt{1-\frac{v^2}{c^2}0} = 1-\frac{v}{c} \qquad \text{Neutrinos} \tag{747}$$

$$\frac{v}{c}\cos\alpha_{\bar\nu} - \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_{\bar\nu}} \approx -\frac{v}{c} - \sqrt{1-\frac{v^2}{c^2}0} = -\left[1+\frac{v}{c}\right] \qquad \text{Antineutrinos} \tag{748}$$

But the second expression exactly equals the expression in the numerator of (748). We now suspect that it exactly equals the left part of (748). 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:

$$\lambda'_\gamma = -\lambda_\gamma \frac{\frac{v}{c}\cos\alpha_\nu - \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\nu}}{\frac{v}{c}\cos\alpha_\gamma + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha_\gamma}} \qquad \text{Photons} \tag{749}$$

This corresponds to the temporal and perspective share in total. With it, expression (749) is already identical to the exact solution, which can be read also as follows:

$$\lambda' = -\lambda \frac{\beta_\gamma}{\beta_{\bar\nu}} = -\lambda \frac{\sin\gamma_{\bar\nu}\,\sin\alpha}{\sin\gamma_\gamma\,\cos\alpha} = -\lambda \frac{\sin\gamma_{\bar\nu}}{\sin\gamma_\gamma}\tan\alpha \qquad \text{Photons} \tag{750}$$

In this case, λ is the wavelength of the zero-vector and λ′ the real-part of the complex wave-length-vector, i.e. the value, which is measured. For the neutrino and antineutrino similar

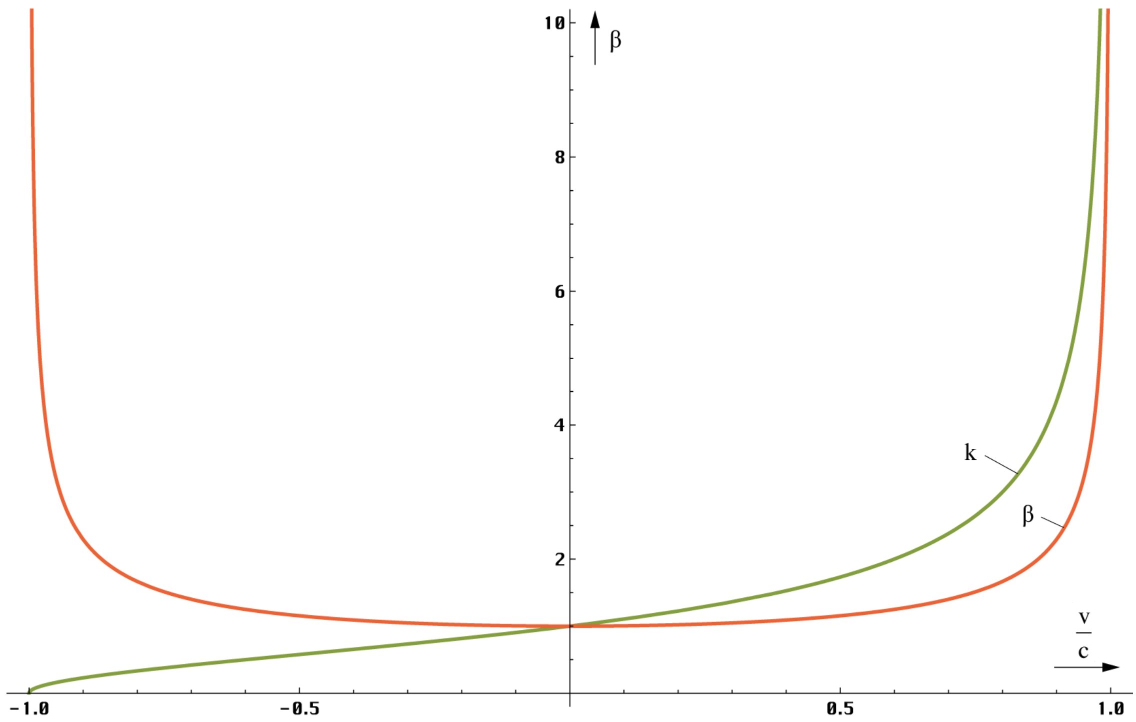



Figure 121
Ratio between k-factor and relativistic
dilatation-factor β classic and model-solution $Q_0>10^9$

similar relations can be found. Here, we however want to figure only the trigonometrical expressions according to (651):

$$\lambda' \;=\; \lambda\frac{\beta_\nu}{\beta_{\bar\gamma}} = -\lambda\frac{\sin\gamma_{\bar\gamma}\cos\alpha}{\sin\gamma_\nu\sin\alpha} \;=\; -\lambda\frac{\sin\gamma_{\bar\gamma}}{\sin\gamma_\nu}\cot\alpha \qquad \text{Neutrinos} \qquad (751)$$

$$\lambda' \;=\; \lambda\frac{\beta_{\bar\nu}}{\beta_\gamma} = -\lambda\frac{\sin\gamma_\gamma\cos\alpha}{\sin\gamma_{\bar\nu}\sin\alpha} \;=\; -\lambda\frac{\sin\gamma_\gamma}{\sin\gamma_{\bar\nu}}\cot\alpha \qquad \text{Antineutrinos} \qquad (752)$$

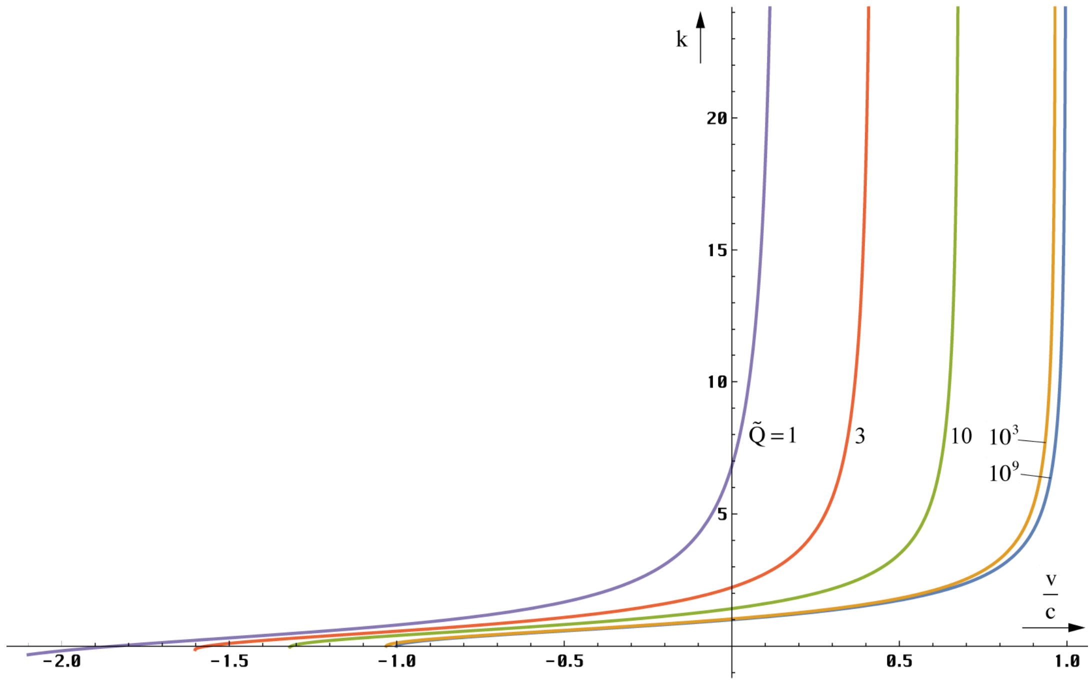



Figure 122
Relativistic doppler shift (wavelength) of the
time-like photons and neutrinos at a Q-factor of $Q<10^9$

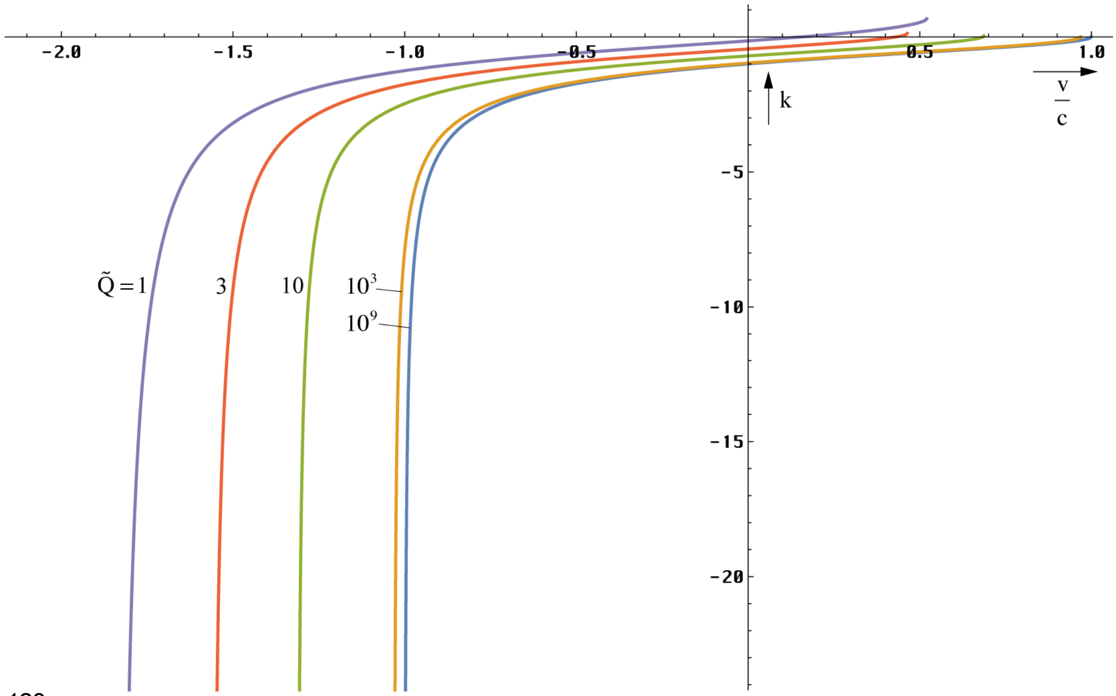



Figure 123
Relativistic doppler shift (wavelength)
of the antineutrinos at a Q-factor of $Q<10^9$

The idealized course for time-like photons and the two kinds of neutrino is presented in Figure 121. It shows the graph for $Q_0>10^9$, which covers the classic k-factor, in comparison with the classic expression $\beta$.

Figure 122 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′):

$$t' \; = \; t \operatorname{cosec} \gamma_\gamma \sin \alpha \qquad \text{Relativistic temporal dilatation} \qquad (753)$$

t′ is essentially longer than T. for him. The occurrence of the expression $\beta_V$ 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 $\beta_\nu$ here obtaining and measuring a duration different from t′.

## 6.1.4. Velocity and mass

The dependence of the mass on 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:

$$m = m_0 \operatorname{cosec} \gamma_{\bar{\gamma}} \sin \alpha \qquad \text{Relativistic mass increase} \qquad (754)$$

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 $\hbar H_0/c^2$). 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 (754) would already be the correct, exact solution. But this statement is not yet unique. So (754) 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 (373), with a temperature T=0 of the metric radiation-field, we acquire the fundamental expression:

$$W = \hbar\omega = mc^2 \qquad \text{resp.} \qquad m = \frac{\hbar\omega}{c^2} \qquad (755)$$

In section 4.6.4.2.3. we had determined that the frequency ω is proportional $Q_0^{-3/2}$ (approximately). A comparison with (620) immediately leads to the solution:

$$m \overset{?}{\approx} \frac{\hbar\tilde{\omega}}{c^2}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} = m_0\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}} \approx m_0\frac{\sin\alpha}{\sin\gamma_{\bar{\gamma}}} = m_0\beta_{\bar{\gamma}} \tag{756}$$

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 cosmologic background-radiation:

$$m \approx \frac{\hbar\tilde{\omega}}{c^2}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}} = m_0\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}} \approx \frac{m_0}{\sqrt[3]{1-\frac{v^2}{c^2}}}\frac{\sin\alpha}{\sin\gamma_{\bar{\gamma}}} = m_0\beta^{2/3}\beta_{\bar{\gamma}} \tag{757}$$

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:

$$m = m_0\frac{\sin\alpha}{\sin\gamma_{\bar{\gamma}}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2}{\tilde{R}}\int\mathbf{v}\,dt\right)^{\frac{2}{3}}\right)^{-1} = m_0\frac{\sin\alpha}{\sin\gamma_{\bar{\gamma}}}\left(1+\frac{t}{\tilde{T}}\right)^{-\frac{1}{2}}_{v=0} \tag{758}$$

Here, a thought Cartesian coordinate-system applies outside the metrics and the angle $\gamma$ is not constant. We have used such a coordinate-system in order to define the qualities of the metrics.

What means however a variable PLANCK's quantity of action for the physical rules? If we assume $\hbar$ to be variable on the basis of the definition of $\hbar$ (37) the charge and the magnetic flux would be variable too. The same is applied even to the electron charge then.

$$\hbar = q_0\varphi_0 \sim Q_0^{-2/2} \quad\rightarrow\quad q_0 \sim Q_0^{-1/2} \quad \varphi_0 \sim Q_0^{-1/2} \tag{759}$$

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 $\lambda$ are subject to a red-shift thereat:

$$\Delta(mv)\cdot\Delta\lambda \geq \frac{\hbar}{2} \tag{760}$$

$$\beta\Delta(mv)\cdot\beta^{-1}\Delta\lambda \geq \frac{\hbar}{2} \tag{761}$$

$$\Delta(mv)\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}}\cdot\Delta\lambda\left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{3}{2}} \geq \frac{\hbar}{2} \qquad \text{Classical} \tag{762}$$

$$\Delta(mv)\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}}\cdot\Delta\lambda\left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{3}{2}} \geq \frac{\hbar}{2}\left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{2}{2}} \qquad \text{Really} \tag{763}$$

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 reference frame. 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 with 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.:

$$q_0 = \tilde{q}_0 \left( \left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}} \right)^{-\frac{1}{2}} = \tilde{q}_0 \left( \left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}} \int \mathbf{v}\, dt\right)^{\frac{2}{3}} \right)^{-\frac{1}{2}} \tag{764}$$

This corresponds to the dependence on $Q_0$ (759) 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 $\varphi_0$ 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 just an additional dependence on the velocity. Let's have a look at this and more 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 α is a 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:

$$\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c} = \frac{1}{137.035999084} = \frac{1}{4\pi}\times 0.0917012 = 0.00729735 \qquad (765)$$

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 hidden an additional, essential, more fundamental legality behind expression (765).

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 had 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 (766).

$$q_0 = \sqrt{\frac{\hbar}{Z_0}} \qquad (766)$$

With a constant in general, it has no influence on the physical content, if we multiply it with another constant. Let's try now, what happens, if we substitute the electron charge in (765) with $q_0$:

$$\alpha_0 = \frac{q_0^2}{4\pi\varepsilon_0\hbar c} = \frac{\hbar}{4\pi\varepsilon_0 c\hbar Z_0} = \frac{1}{4\pi} \qquad \alpha = \frac{1}{4\pi}\frac{e^2}{q_0^2} \qquad (767)$$

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 Metric 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 and 4 crystallize here, that we cannot answer with absolute certainty however. With great probability, we can say that there is no coincidence. That would mean however, that the electron charge is not constant. Before we'll delve into it, we have to deal with a second dimensionless value.

## 6.2.2. The correction factor δ

This value will occur with the comparison of several solutions for the HUBBLE-parameter in section 7.5. and I have already seen it in a publication. Unfortunately, I don't remember, in what. Even the search in the internet run into void. Therefore, I cannot tell you the correct name of it. In any case it's not identical with the quantum defect. But in succession, it plays an important role with the set-up of the Concerted System of Units. It is defined as follows:

$$\delta = \frac{4\pi\hbar}{m_p r_e c} = 0.937855101480256 \qquad \text{with the approximation (769)} \qquad (768)$$

$$\delta \approx \frac{1}{\sqrt{2}}\frac{Q_{2/3}}{Q_{1/2}} = \frac{1}{\sqrt{2}}\frac{2/3}{1/2} = \frac{2}{3}\sqrt{2} = 0.942809 \qquad \Delta = +5\cdot 10^{-3} \qquad (769)$$

Furthermore, following important relation applies: $\frac{m_e}{m_p} \approx \frac{1}{1836} = \text{const}$

$$\alpha\delta = 4\pi\frac{m_e}{m_p} = 6.84386\cdot 10^{-3} \approx \frac{1}{146} \qquad \delta = \frac{4\pi}{\alpha}\frac{m_e}{m_p} \Leftarrow \text{def} \qquad (770)$$

To avoid a circular reference we make use of the right-hand expression (770) to the definition of δ. Obviously, with δ it's about a correction factor which should compensate the eccentricity between proton and electron in the $^1$H-atom of BOHR's classic atom-model, since $m_e$ is not small enough with respect to $m_p$, it wobbles. Well, BOHR's model is not correct in fact. Nevertheless, values thereof, such as $r_e$, do a good service with calculations even this very day. That also applies to δ, as we shall see later. Apparently, because of (770) it's about a kind of complementary fine-structure-constant. As latest, more exact research [53] suggest, the ratio $\mu = m_p/m_e$ turns out to be constant. It varies by max. $-5.0\cdot 10^{-17} a^{-1}$, i.e. with an age of only $1.4\cdot 10^{10}$a it's quasi constant. I agree with this statement, because this model is based on this assumption. With it, the ratio $\mu = m_p/m_e = \text{const}$ forms the 3$^{rd}$ essential constant.

## 6.2.3. The electron charge

### 6.2.3.1. 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 Metric line-element. Let's consider the model according to Figure 124 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 101. 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.

Just like the universe the electron is a four-dimensional object. Because the charge $q_0$ is evenly distributed over the surface, it is quite possible, that we may even be able to *see* only a part of the surface, and with it, only a part of charge, due to the curvature-ratio. The (shifted) r-axis is the asymptote of the track-curve of expansion (Figure 25). It behaves like a parabola near the origin, farther, like a hyperbola (Figure 7). We are primarily interested in the angle ε, which results from the argument of the integral of the complex propagation velocity $\underline{c}$ of the metrics (209). It applies:

$$\varepsilon = \arg \int_0^T \underline{c}\,dt = -\arg j2\int_0^T \frac{1}{2\omega_0 t}\frac{dt}{\sqrt{1-\Theta^2(2\omega_0 t)}} \tag{771}$$

At this point the integral of $\underline{c}$ and not the value itself comes into effect, since not the velocity $\underline{c}$ of the electron but his location is of interest for the further calculations. With the help of (211) we are able to transform (771) in the following manner:

$$\underline{c} = -\arg c\int_0^T \frac{1}{2\rho_0\omega_0 t}\left(\sin\frac{1}{2}\arg\theta + j\sin\frac{1}{2}\arg\theta\right)dt = \arg c\int_0^T \frac{1}{2\rho_0\omega_0 t}e^{-j\frac{1}{2}(\arctan\theta+\pi)}dt \tag{772}$$

The integral by the time is not particularly well-suited however, since the frequency $\omega_0$ 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 $r_N$:

$$Q=\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \qquad dQ=\frac{1}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_0}}\; t^{-\frac{1}{2}}dt \qquad dt=\frac{\varepsilon_0}{\kappa_0}Q\,dQ \tag{773}$$

$$\varepsilon \;=\; \arg r_1 \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \;=\; \arg \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \tag{774}$$

$$r_N \;=\; \left| Z r_1 \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| \qquad Z=\frac{R(Q)}{r_0(Q)} \;=\; \frac{H_1 R}{H_0 r_0} \;=\; \frac{3}{2}Q^{\frac{1}{2}} \tag{775}$$

With $r_1=1/(\kappa_0 Z_0)$. Although, the left expression of (775) 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 (346). 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:

$$r_N \;=\; \left| \frac{3}{2} r_1 Q^{\frac{1}{2}} \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| \qquad -j\frac{1}{2}(\arg\theta+\pi) \;=\; j\frac{1}{2}\arctan\theta \;=\; j\phi_0 \tag{776}$$

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 (774) RnB[Q] and (776) Rn[Q] can be calculated as follows (without $r_1$):

```
cMc = Function[-2 I/#/Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]];
PhiQ = Function[If[# > 10^4, - Pi/4 - 3/4/#,
Arg[1/Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]] - Pi/2]];
RhoQ = Function[If[# < 10^4,
N[2/#/Abs[Sqrt[1 - (HankelH1[2, #]/HankelH1[0, #])^2]]], 1/Sqrt[#]]];
rq = {{0, 0}};
For[x = -8; i = 0, x < 4, ++i, x += .01;                                    (777)
AppendTo[rq, {10^x, N[10^x*RhoQ[10^x]]}]];
RhoQ1 = Interpolation[rq];
RhoQQ1 = Function[If[# < 10^4, RhoQ1[#], Sqrt[#]]];
Rk = Function[If[# < 10^4, 3/2*Sqrt[#]*NIntegrate[RhoQQ1[x], {x, 0, #}], 6 #]];
Rn = Function[Abs[3/2*Sqrt[#]*NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])], {x, 0, #}]]];
RnB = Function[Arg[NIntegrate[RhoQQ1T[x]*Exp[I*(PhiQ[x])], {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 124:

$$\sin\gamma \;=\; \cos\beta \;=\; \sin\left(\frac{\pi}{4}-\varepsilon\right) \;=\; \frac{e}{q_0} \qquad e=q_0\sin\gamma \qquad \alpha \;=\; \frac{1}{4\pi}\sin^2\gamma \tag{778}$$

The exact calculation with the help of the function FindRoot using the $\text{CODATA}_{2018}$-values for the basic condition of the electron turns out the value $\varepsilon=-2.0485420678463937$ resp. $\varepsilon=-0.6520711924588928\pi$ with $Q=0.6567290175491683$. Because the observer, to the point of time $T \gg t_1$, is located (approx.) directly on the r-axis, the electron charge calculates from the real charge of the electron $q_0$ multiplied with the sine of the angle-difference between the phase-angle of the electron in base state and the phase-angle of the observer ($-\pi/4$) as $e=0.3028221208819746q_0$).

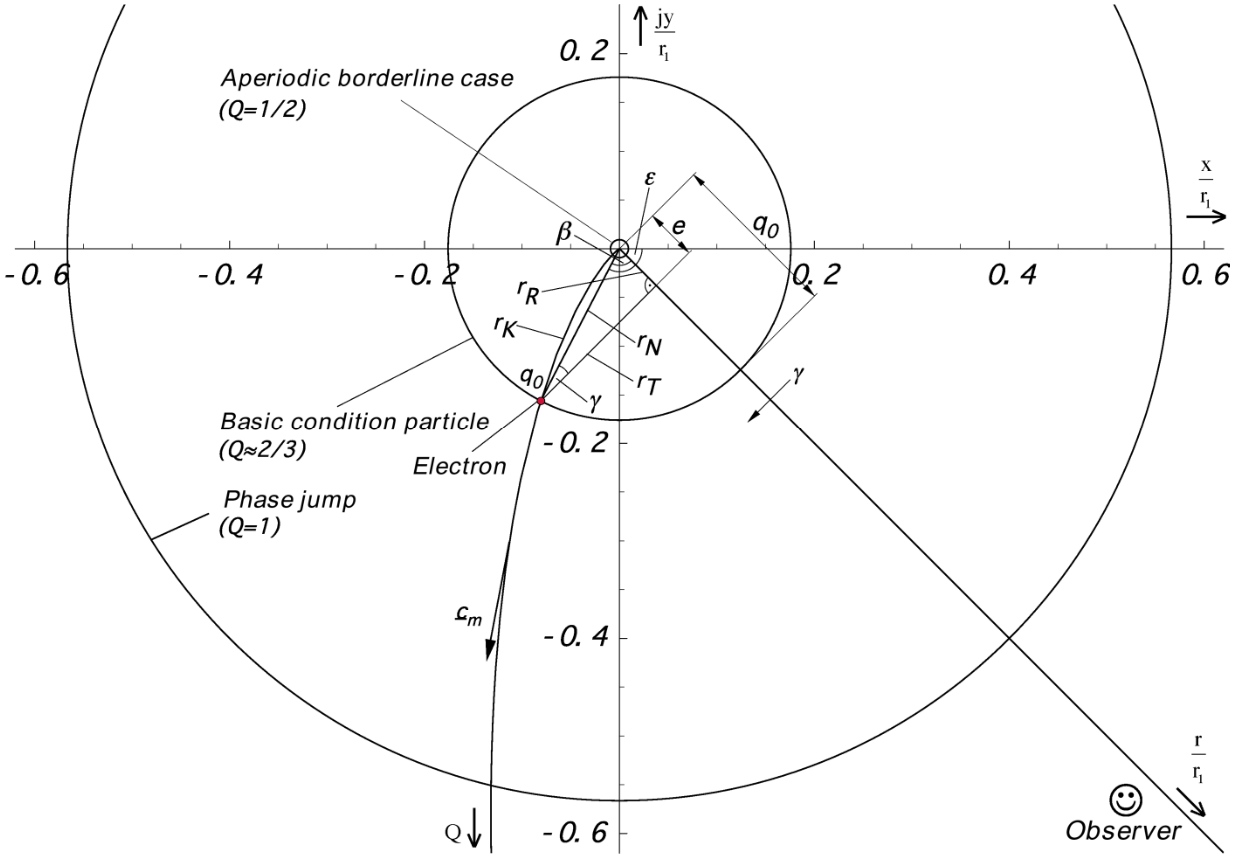



Figure 124
Ratio of electron charge and charge of the MLE in the phase space of the electron

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. Thereby, the very small variation of α by approximately $-2.0 \cdot 10^{-17} a^{-1}$, stated in [53], is no contradiction. Only on extremely relativistic conditions, the ratio between $q_0$ and e varies according to Figure 104.

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 124).

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 $\sin\gamma_\gamma$ 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 $Q \gg 1$. 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 $Q \gg 1$ the angle $\alpha$ 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 $Q \gg 1$ 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 (776), we can say yet, that the determination of the arc length is not impossible. With the help of (772) we obtain:

$$r_K = \int_{t_1}^{t_2} \sqrt{\dot{x}^2 + \dot{y}^2}\, dt = \frac{\varepsilon_0}{\kappa_0} \int_0^Q Q \sqrt{x'^2 + y'^2}\, dQ \tag{779}$$

$$r_K = r_1 \int_0^Q \frac{Q}{Q} \frac{1}{\rho_0} \sqrt{\cos^2 \frac{1}{2} \arg\theta + \sin^2 \frac{1}{2} \arg\theta}\, dQ = r_1 \int_0^Q \frac{dQ}{\rho_0} \tag{780}$$

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:

$$r_K = \frac{3}{2} r_1 Q^{1/2} \int_0^Q \frac{dQ}{\rho_0} = \frac{3}{2} r_1 Q^{1/2} \int_0^Q \frac{dQ}{\sqrt[4]{(1 - A^2 + B^2)^2 + (2AB)^2}} \overset{\text{def}}{=} R(Q) \tag{781}$$

Also for the expression (781) 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:

$$r_K = \frac{3}{2} r_1 Q^{1/2} \int_0^Q \frac{1}{\rho_0} dQ \approx \frac{3}{2} r_1 Q^{1/2} \int_0^Q Q^{1/2} dQ = r_1 Q^2 \qquad Q \gg 1 \tag{782}$$

This is a known relation, which we have derived with it. It is applied however only to values $Q \gg 1$. For the numerical determination of the integral we apply usefully the following expression in »Mathematica«:

```
Rk = Function[If[# < 10^4, 3/2*Sqrt[#]*NIntegrate[RhoQQ1[x], {x, 0, #}], 6 #]];
```
(783)

Now, we are particularly interested in the ratio between $r_K$ and $r_N$. The course is presented in Figure 9 with and without expansion-share. Namely, the expansion-share cancels out in this case. To the calculation we use the function rs. For a faster calculation we generate the interpolation function RS[Q] (see annex). 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 $Q_0$=0.6567290, so the associated constant wave count vector $r_K$ is exactly about 1.0151827890 longer. If we however multiply the latter value with the phase-angle $Q_0=2\omega_0 t$=0.6567290 a value of 0.666699995 turns out. This is a deviation to 2/3 of only $4.99935 \cdot 10^{-5}$.

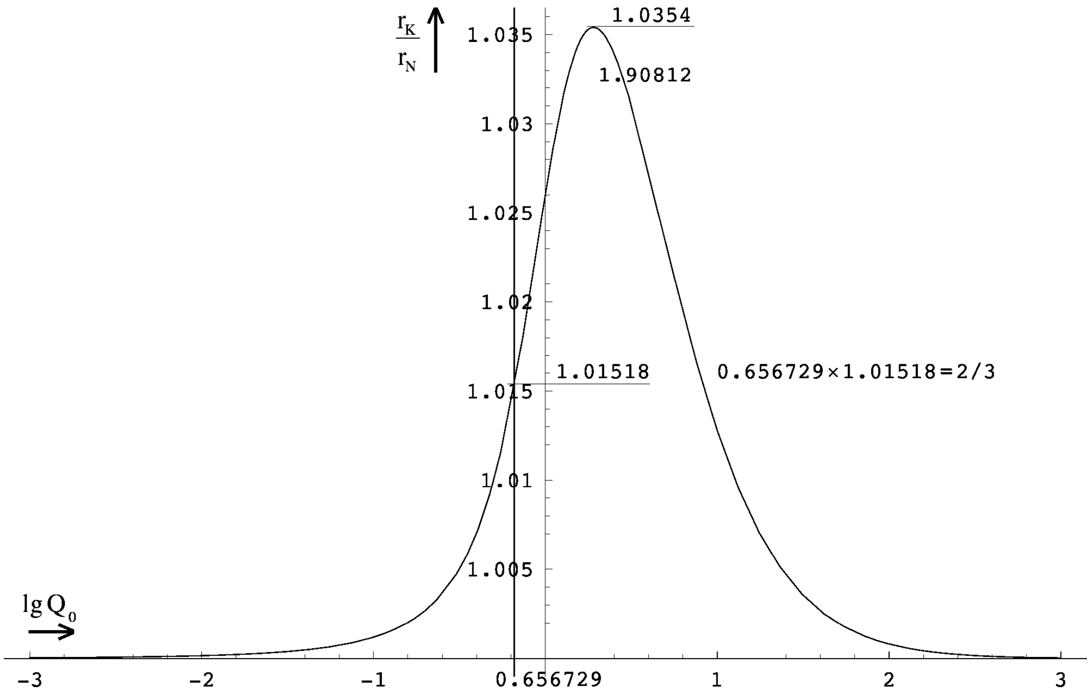



Figure 125
Ratio between the length of the constant wave-count vector
$r_K$ and the length of the zero vector $r_N$ as a function of $Q_0$

The 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 even be about a systematic error then or about others, not considered influences during the determination of electron charge in the experiment or about a misinterpretation. Also possible is, that the value in fact is not exactly at 2/3 but at 0.6567290.

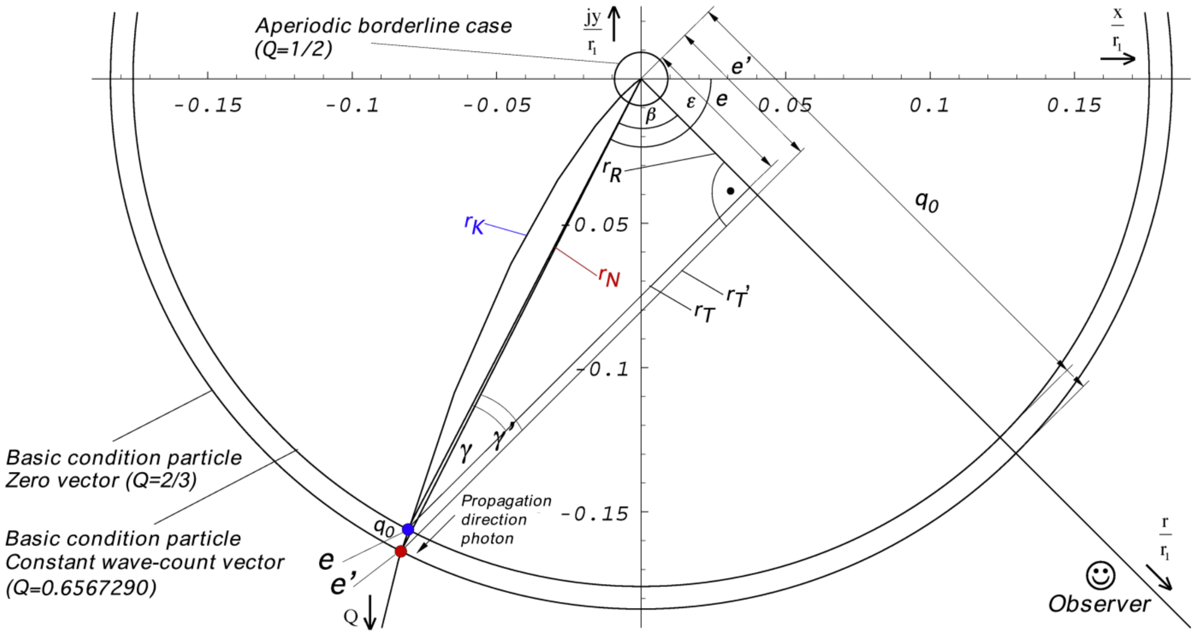



Figure 126
Ratio of electron charge and charge of the MLE
in the phase space of the electron (larger scale)

In Figure 126 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:

$$r_K(0.656729017) = \frac{3}{2} r_1 \sqrt{0.656729017} \int_0^{0.656729017} \frac{dQ}{\rho_0} = 0.178514 r_1 \qquad (784)$$

$$r_N(\frac{2}{3}) = \left| \frac{3}{2} r_1 \sqrt{\frac{2}{3}} \int_0^{2/3} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| = 0.183660 r_1 \qquad (785)$$

$$r_N(0.666699995) = \left| \frac{3}{2} r_1 \sqrt{0.666699995} \int_0^{0.666699995} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right| = 0.183687 r_1 \qquad (786)$$

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 only nearby Q=2/3 i.e. with 0.656729017. That doesn't conflict with other findings here and plays a subordinated role with it. The exact value of 2/3 was just a guess of mine anyway. The only thing, that matters, is the angle $\varepsilon=-2.0485420678463937$. Now, we already want to calculate the corresponding charges:

$$q_0 \sin\left( \frac{\pi}{4} - \arg \int_0^{0.656729017} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right) = e \qquad (787)$$

$$q_0 \sin\left( \frac{\pi}{4} - \arg \int_0^{2/3} \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ \right) = 1.0253956 e = e' \qquad (788)$$

I would denominate condition e′ as excited state of the electron. With it, we have proven, that it is possible, to find a relation between the charge e of the electron and the PLANCK-charge $q_0$. Maybe, these two charge-bearing particles are actually identical, on the one hand as free particle (electron), on the other hand bound in the metrics…?

### 6.2.3.2. 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 point. 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 that depends on the value $\tilde{Q}$ (frame of reference), on time, distance, speed and/or the gravity potential. In order to determine the dependence, let's have a look at the model according to Figure 8. At first, we will determine the dependence with respect to the phase-angle Q.

If the observer is located far away on the r-axis, so the phase-angle ε–β of the metrics, that's the vector from origin to the observer staying on the expansion-graph, amounts to (approx.) –π/4 (r-axis). The r-axis forms the asymptote of the expansion-graph. If we now approach the origin, the value of the angle becomes greater (the r-axis turns to the left). Now, the charge arises to $e'=q_0\sin\gamma'$ (not identical to e′ and γ′ of Figure 126). On this occasion the right angle (α) survives, because with the turnover also the propagation direction of the photons changes. Then, under application of (781) and (782) in the triangle $e'r_T'q_0$, we obtain the following relations:

$$\gamma \quad = \pi - \frac{\pi}{2} - \beta \; = \; \frac{\pi}{2} - \left[-\varepsilon + \arg \int \underline{c}\, dt\right] \tag{789}$$

$$\sin\gamma = \sin\left(\frac{\pi}{2} + \varepsilon - \frac{3}{2} Q^{\frac{1}{2}} \int_0^Q \frac{1}{\rho_0} e^{j\frac{1}{2}\arctan\theta} dQ\right) \tag{790}$$

```
RnB = Function[Arg[NIntegrate[RhoQQ1T[x]*Exp[I*(PhiQ[x])], {x, 0, #}]]];
Plot[{Sin[(Pi/2 - RnB[10^t7] + ε}, {t7, -8, 8}]
```
(791)

For a faster calculation I defined the interpolation function RNBP[Q], for sin γ the function QQ[Q] (see annex). The course of the corresponding function in dependence on Q is shown in Figure 127. We see clearly, that the ratio electron charge and PLANCK charge is nearly constant over a wide reach. With the fine-structure-constant it's really about a genuine constant, at least for the these days technically accessible range. But, approaching the origin, e.g. with very fast speed near c, the ratio changes. The maximum is at Q=0.656795 behind the particle horizon.

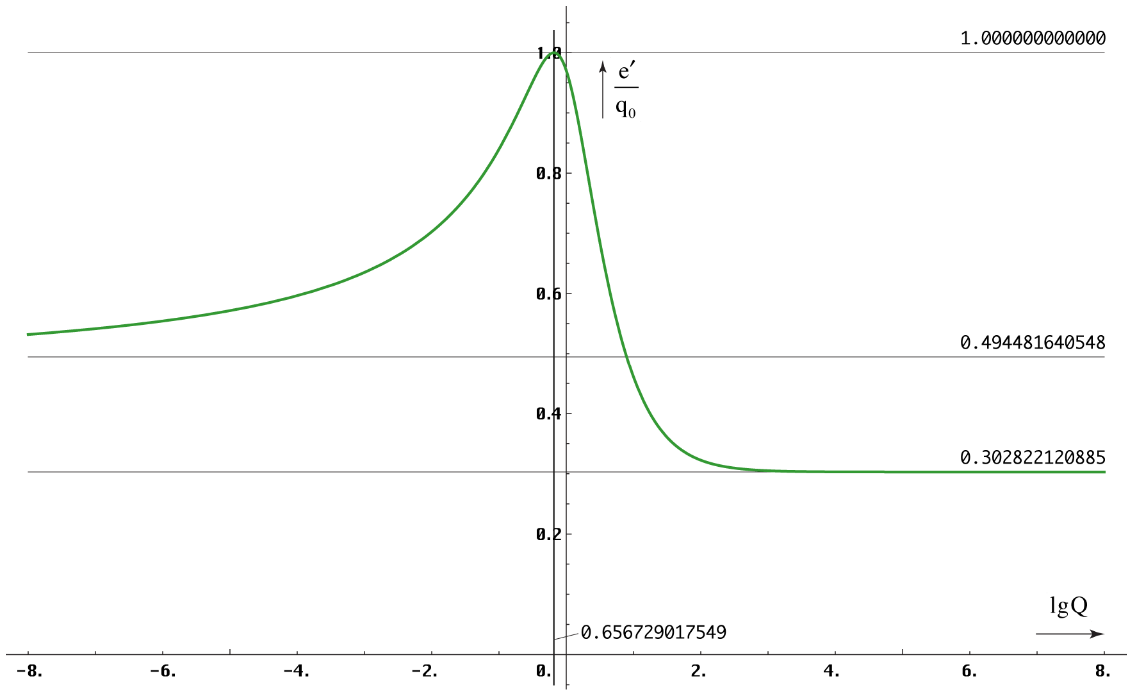



Figure 127
Ratio of electron charge and of the PLANCK charge
as function of the phase angle Q according to (791)

In the approximation $|\underline{c}|\sim Q_0^{-1/2}\sim t^{-1/4}$ applies. With it, we determined the dependence e′(Q). But we are rather looking for the function e′(v). Most simply it would be, if we could determine Q(v). In section 6.1.2.1. we already found with (696) the expression $Q=c^2/v^2$. But we cannot use it here, because it only applies to a non-accelerated frame of reference. The item v is the speed $|\underline{c}|$ with respect to the $r_l$-lattice of subspace in this connection. If we accelerate, our frame of reference gets lost and we get a new one, in which most of the base values, even v, have taken on another value. Indeed, expression (696) applies-on, however with another value of v. Thus, we cannot simply add the speed after acceleration to the value $|\underline{c}|$, at least *not linearly*, but *geometrically*. Therefore, we have to find another, better expression here.

We are moving on the constant wave count vector $r_K$. If we look at expression $r=\int \underline{c}\, dt$ more exactly, so $\underline{c}$ depends on the time dt. Thus, we have to replace dQ with dt at first. Based on (782) without expansion applies:

$$r = \int \underline{c} dt = \frac{3}{2} r_1 \int_0^Q \frac{1}{\rho_0} dQ \approx \frac{3}{2} r_1 \int_0^Q Q^{\frac{1}{2}} dQ \qquad Q = \sqrt{\frac{2\kappa_0 t}{\varepsilon_0}} \tag{792}$$

Reference point is the expansion centre $\{r_1,r_1,r_1,t_1\}$ in this connection. Now let's substitute dQ by dt with the ansatz:

$$dQ = \frac{1}{2}\sqrt{\frac{2\kappa_0}{\varepsilon_0}}\, t^{-\frac{1}{2}} dt = \sqrt{\frac{\kappa_0}{2\varepsilon_0 t}}\, dt \tag{793}$$

$$dt = \sqrt{\frac{2\varepsilon_0 t}{\kappa_0}}\, dQ = \frac{\varepsilon_0}{\kappa_0}\sqrt{\frac{2\kappa_0 t}{\varepsilon_0}}\, dQ = \frac{Q}{\omega_1} dQ \tag{794}$$

Plugged into the integral we obtain then:

$$\int \underline{c} dt \approx \frac{3}{2} c \int Q_0^{-\frac{1}{2}} dt = \frac{3}{2}\frac{c}{\omega_1} \int Q^{\frac{1}{2}} dQ = r_1 Q^{\frac{3}{2}} \tag{795}$$

$$\int \underline{c} dt \approx r_1 Q^{\frac{3}{2}} = r_1 \left(\frac{2\kappa_0 t}{\varepsilon_0}\right)^{\frac{3}{4}} = \left(\frac{2\kappa_0^{-1/3} t}{\varepsilon_0^{1/3}\mu_0^{2/3}}\right)^{\frac{3}{4}} = \left(\frac{2c^2}{\mu_0 \kappa_0}\right)^{\frac{1}{4}} t^{\frac{3}{4}} = c\sqrt[4]{4 t_1 t^3} \tag{796}$$

We can't do much with that either, as we've only proven, that the world radius $R/2=ct$ is, without consideration of expansion, proportional $Q^{3/2}$ resp. $t^{3/4}$ in the approximation.

If speed comes into play, we always have to do with more than one reference system and with measurements of physical quantities we have to perform a LORENTZ-transformation. We have stated in [1], that wave-lengths are stretched according to $\lambda \sim Q^{3/2}$. The same applies to the size of material bodies, whereas the PLANCK-length $r_0$ is $\sim Q$ only. Otherwise no redshift would be detectable. With the LORENTZ-transformation the wave-length $\lambda$ depends on the inverse LORENTZ-factor $\beta=(1-v^2/c^2)^{-1/2}$, it applies $\lambda'=\beta^{-1}\lambda$. However, this must not be confused with the formula for the relativistic DOPPLER-shift. Thus, we have been able to formulate expressions for the dependence $Q=f(v)$:

$$Q_0' = \tilde{Q}_0\left[1-\frac{v^2}{c^2}\right]^{\frac{1}{3}} \qquad \frac{v}{c} = \sqrt{1-\left(\frac{Q_0'}{\tilde{Q}_0}\right)^3} \qquad \beta = \left(\frac{Q_0'}{\tilde{Q}_0}\right)^{-\frac{3}{2}} \tag{700}$$

$\tilde{Q}$ is the value in the observer's frame of reference. In order to ensure an exact calculation even for velocities extremely close to c, it's a good idea, to increase working precision. In Mathematica/Alpha it happens with the help of the function SetPrecision with an allocation to an auxiliary variable inside the definition of the function:

```
Qυ = Function[a4712 = SetPrecision[#2, 309]; #1*(1 - a4712^2)^(1/3)];   (*Q(υ/c, all Q~)*);
Qυ0 = Function[a4713 = SetPrecision[#, 309]; Q0*(1 - a4713^2)^(1/3)];   (*Q(υ/c, Q0)*);
υQ = Function[a4714 = SetPrecision[(#2/#1)^3, 309];                      (797)
  Sqrt[SetPrecision[1 - a4714, 309]]];                                   (*υ/c(Q, all Q~)*);
υQ0 = Function[a4715 = SetPrecision[(#/Q0)^3, 309];
  Sqrt[SetPrecision[1 - a4715, 309]]];                                   (*υ/c(Q, Q0)*);
```

With it, it's possible, to specify the ratio $e/q_0$ as a function of velocity v exactly. Unfortunately, the graphic resulting from, is underwhelming, unless we work with the logarithm of the difference $(1-v^2/c^2)$. But the function $\alpha$ at first. Because of (790) and (700), both are no constants in fact, but reference-system-dependent.

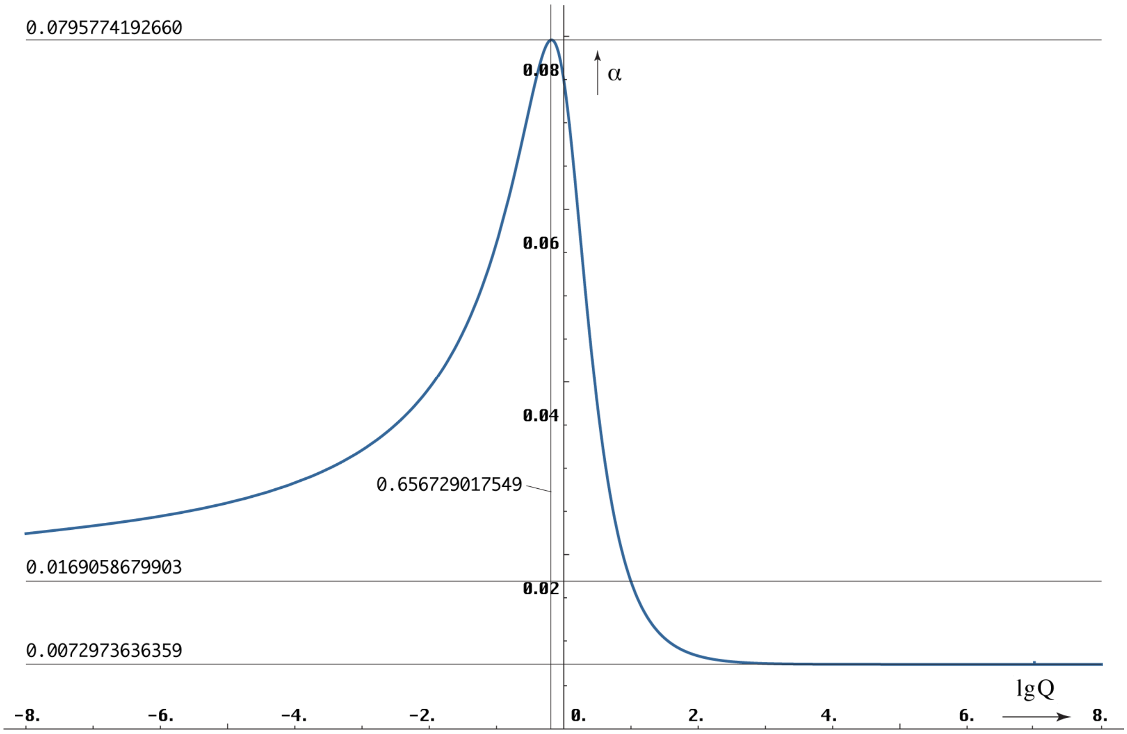



Figure 128
SOMMERFELD's fine-structure-constant
α as a function of the phase angle Q

In this context I have to disappoint the astronomers. The fine-structure-constant varies with time and distance indeed, but the change of α comes into effect only from approx. $10^{-90}$m off the particle horizon (world radius) on. The same applies even to the course as a function of time t after BB, depicted by means of the function δ. So you have to find another explanation for the quasar-problem, unless, these are located outside our universe. Possibly it's about the effigies of our neighbour-universes? But then they should be arranged in the form of a crystal lattice. Take a look and see, if there is also a quasar in the opposite direction. But now enough of speculation.

Further to the correction factor δ. Because of (770) the function has a shape like $\alpha^{-1}$ (right-hand ordinate). For δ the left ordinate applies. The t- and the Q-axis apply to both at once. The t-values arise from (792). Somebody will have doubts at this point, if we really can reckon-back so far in time. It has to be said, that with Q nearly all other natural constants vary too. Shortly after BB photons behave like neutrinos and vice versa. However, the course less than Q=½ in Figure 127-120 is probably theoretical, since the base state of the photon is at ½, that of the electron at approx. ⅔. Besides from that, the metric wave field is not completely established until Q=½. It's even about a model.

Even if the ratio $e/q_0$ is quasi constant everywhere, it nonetheless depends on time, speed, distance and the gravitational potential i.e. the frame of reference $Q_0$. The same applies to PLANCK's quantity of action $\hbar$. Because of (23) applies:

$$e \sim q_0 \sim Q_0^{-\frac{1}{2}} \qquad \hbar = q_0^2 Z_0 = \frac{e^2 Z_0}{\sin^2\gamma} \sim Q_0 \tag{798}$$

Thus, in the predominant part of the universe, spatial and temporal, α and δ are constant. Nevertheless, the previous contemplation is important for the determination of the base state of the electron mass with Q=1.

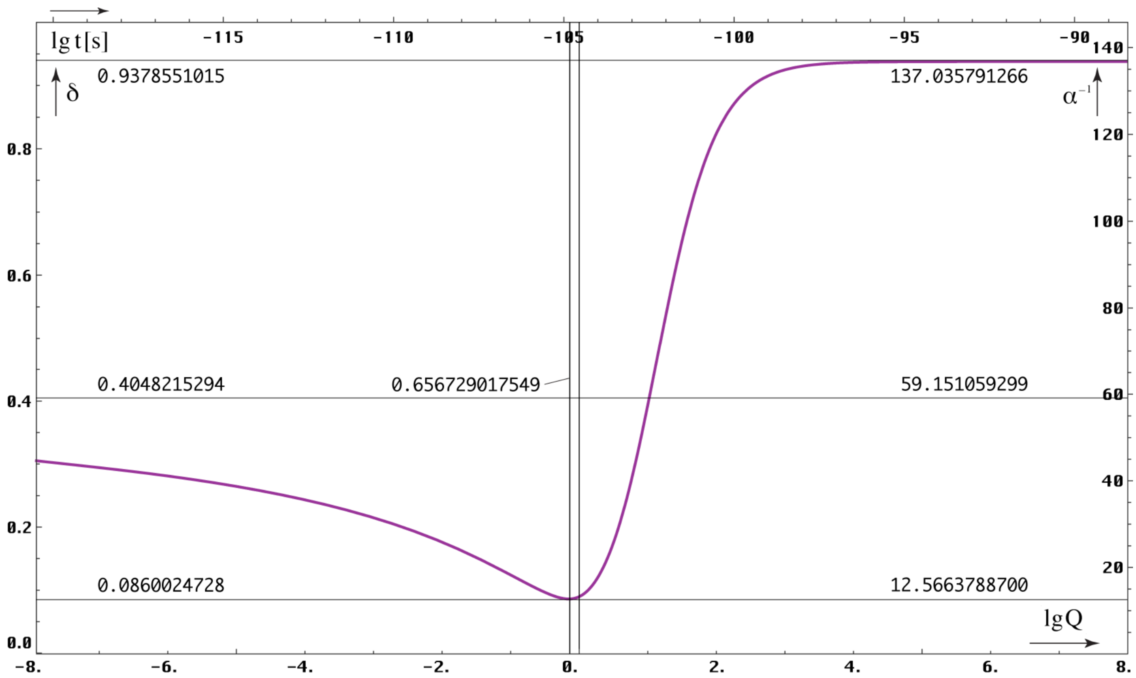



Figure 129
Correction factor δ and reciprocal of the fine-structure-constant α as a function of time after BB and of the phase angle Q

## 6.2.4. The electron mass

### 6.2.4.1. Static contemplation

Having stated, that I hadn't considered the electron mass $m_e$ in my work before, I searched for a relation, with which it can be calculated from the PLANCK-mass $m_0$ resp. vice versa. In contrast to the charge, which resides on the surface, with the electron mass even the inner, invisible part comes into effect. Therefore, a behaviour like in the previous section is not to be expected. By trying, with the values from Table 2 and a phase angle $Q_0=7.95178\cdot10^{60}$, based on expression (1049) $Q_0=\frac{3}{2}(r_e/r_0)^3$, I found the following expression:

$$m_e \approx \frac{1}{12\pi^2} m_0 Q_0^{-1/3} = 9.20759\cdot10^{-31}\,\mathrm{kg} = 1.01078 m_e \qquad m_0 = \sqrt{\frac{\hbar c}{G}} \tag{799}$$

Interestingly enough, this value is near to the real one amounting to $9.10939\cdot10^{-31}$ kg. Thus, it seems to be possible, to calculate $m_e$. In the former editions I already set up a program, with which most of the universal natural constants could be calculated from 10 fixed values. The electron mass was one of the input parameters. The value $Q_0$ has been determined using (1049). This way, it was possible to calculate the specific conductivity of the vacuum $\kappa_0$, so that the values can be determined top down too. But it was impossible, to calculate all values and there was always a residual error. In actual fact, there are even only four values, which can be fixedly defined. These are the three invariants of subspace c, $\mu_0$, $\kappa_0$, and k, as well as the ones, depending on them $\varepsilon_0$ and $Z_0$, furthermore the value $\hbar_1$, the initial quantity of action of the universe shortly after BB (Q=1). The reason is, that these as the only ones, really do not change at all. Neither, they do not depend on any system of reference.

Except for the meter and the second, which are exemplarily defined, CODATA unfortunately took a different part with the other values, in that they fixedly defined particular values arbitrarily, e.g. $\hbar$, latter one to the recent definition of the kilogram. The whole issue is quite problematic, especially since $\hbar$ depends on the frame of reference. Now I tried to optimize the lot, in order to improve accuracy. Extremely important is, that the kilogram won't be modified at all. Otherwise millions and millions of scales would have to be recalibrated. Also I act on the assumption, that the CODATA-values are pretty accurate.

Indeed, these have been determined by a kind of iterative process. Lab A determines the value a with a certain accuracy. Another lab validates a with another accuracy. Based on a lab B determines value b even with another accuracy. Based on a and b lab C determines…etc. This way we approach the real values more and more but it takes a long time..

The more exactly we measure, the more deviations carry weight, being based on the arbitrary predefinition of e.g. $\hbar$ and on the fact, that the lab, value a should be validated by, is in the middle of nowhere, e.g. at a point, the apparent gravity has a different value. The earth is not a ball anyway, but a geoid. So it becomes important more and more, to find a method, with which these deviations can be calculated out.

But further with the electron mass. Just like (1049) expression (799) offers an opportunity, to determine the value $Q_0$. We need it to calculate-up to the initial values, mainly for $\kappa_0$. It applies:

$$Q_0 \stackrel{?}{=} \left(\frac{1}{12\pi^2}\frac{m_0}{m_e}\right)^3 = 8.20969 \cdot 10^{60} \tag{800}$$

The value differs from (1049) and it depends from $m_0$ and $m_e$. The further way leads over the combination of the charge- and mass-path on the initial level with subsequent equating, thus $e \rightarrow q_0 \rightarrow q_1 \rightarrow \hbar_1\omega_1 = M_2c^2 \leftarrow M_1c^2 \leftarrow m_0c^2 \leftarrow m_ec^2$. Thereafter, we are able to determine $\kappa_0$ and G. An important side condition is (770). The whole issue is verified by a Sudoku-proof. If all numbers may be calculated correctly in equal measure, the model finally adds up without deviation, it can be considered to be correct, if not, then not.

With (800) the calculation only adds up using the approximation $\frac{2}{3}\sqrt{2}$ of (769) for $\delta$, then even exactly. But then $\alpha$, $\delta$, $\hbar$, G and other values don't fit reality anymore, so that we have to discard this variant unfortunately. Thus, we must find a more exact expression for (799). If possible, only integer fractions, the value $\pi$ and at most $\sqrt{2}$ should occur therein. After a long trial, days later, I actually succeeded, to find such a relation :

$$m_e = \frac{1}{18\pi^2}\sqrt{2}\,\delta^{-1} m_0 Q_0^{-1/3} = 9.10938 \cdot 10^{-31}\,\text{kg} \qquad \Delta = +5.32907 \cdot 10^{-15} \tag{801}$$

For $\delta$ we take the current value, for $m_0$ expression (799). The standard-MachinePrecision is at approx. $10^{-16}$. The deviation is a measure for the detuning of the SI-system as a whole, especially caused by the imprecision of $G_{2018}$, specified with $\pm 2.2 \cdot 10^{-5}$. This way, accuracy can still be improved significantly. Expression (107) exact obviously. That also applies to all other expressions, if we replace $12\pi^2$ by $9\pi^2\sqrt{2}\,\delta$ in them. Now we can determine $Q_0$ and $m_0$ even exactly with it. It applies:

$$Q_0 = \left(\frac{1}{18\pi^2}\sqrt{2}\,\delta^{-1}\frac{m_0}{m_e}\right)^3 = 8.34047113224285 \cdot 10^{60} \tag{802}$$

$$m_0 = 9\pi^2\sqrt{2}\,\delta\, m_e Q_0^{1/3} = 2.17643409748237 \cdot 10^{-8}\,\text{kg} \tag{803}$$

Obviously, $Q_0$ (802) has another value, as we have determined in former editions. That will be surveyed later on. For $m_0$ the following relations to other mass quantities turn out:

$$M_H = \hbar H_0 / c^2 = m_0 Q_0^{-1}$$ HUBBLE-mass (804)

$$m_0 = 9\pi^2 \sqrt{2}\, \delta\, m_e Q_0^{1/3} = \hbar\omega_0 / c^2 = M_H Q_0$$ PLANCK-mass (805)

$$M_1 = 9\pi^2 \sqrt{2}\, \delta\, m_e Q_0^{4/3} = \mu_0 \kappa_0 \hbar = m_0 Q_0$$ MACH-mass (806)

$$M_2 = 9\pi^2 \sqrt{2}\, \delta\, m_e Q_0^{7/3} = \mu_0 \kappa_0 \hbar_1 = m_0 Q_0^2$$ Initial-mass universe (807)

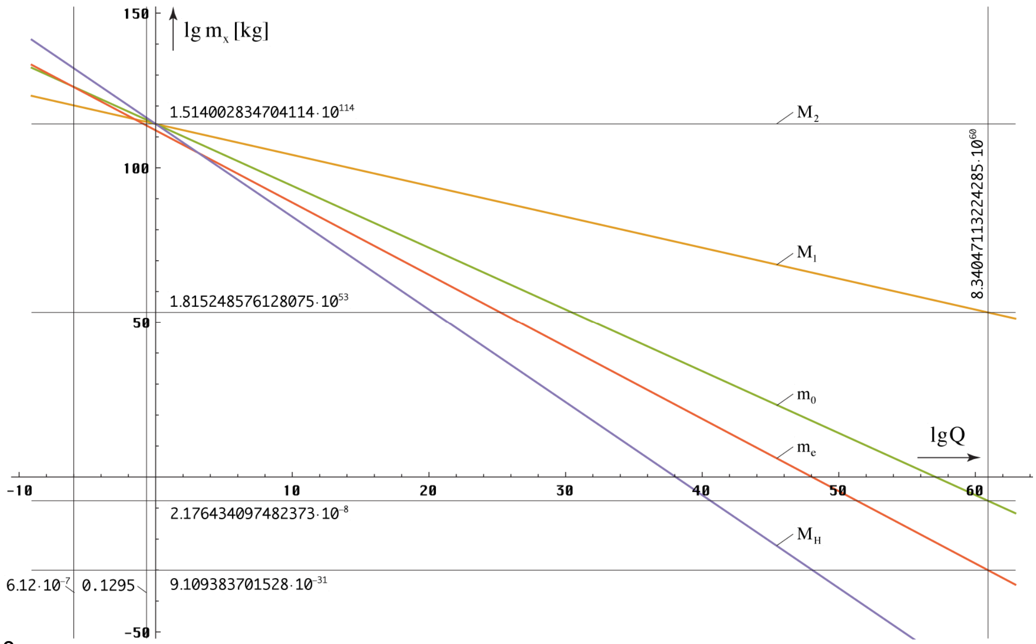



Figure 130
Course of the reference-frame-dependent masses $m_x$ with respect to the phase angle Q, large scale

The course of (804) until (807) for greater values of $Q_0$ is shown in Figure 130. We can see, all masses except for the electron mass intersect in the point Q=1. $M_1$, the MACH-mass, is the counter-mass, postulated by MACH, which shall be the reason for the inertial mass of all bodies. According to [1] it's the sum of the masses of the gravitational field (⅔) and of the EM-field (⅓) of the universe, which are mostly concentrated at the particle horizon. It's the red-shifted remnant of the initial mass $M_2$.

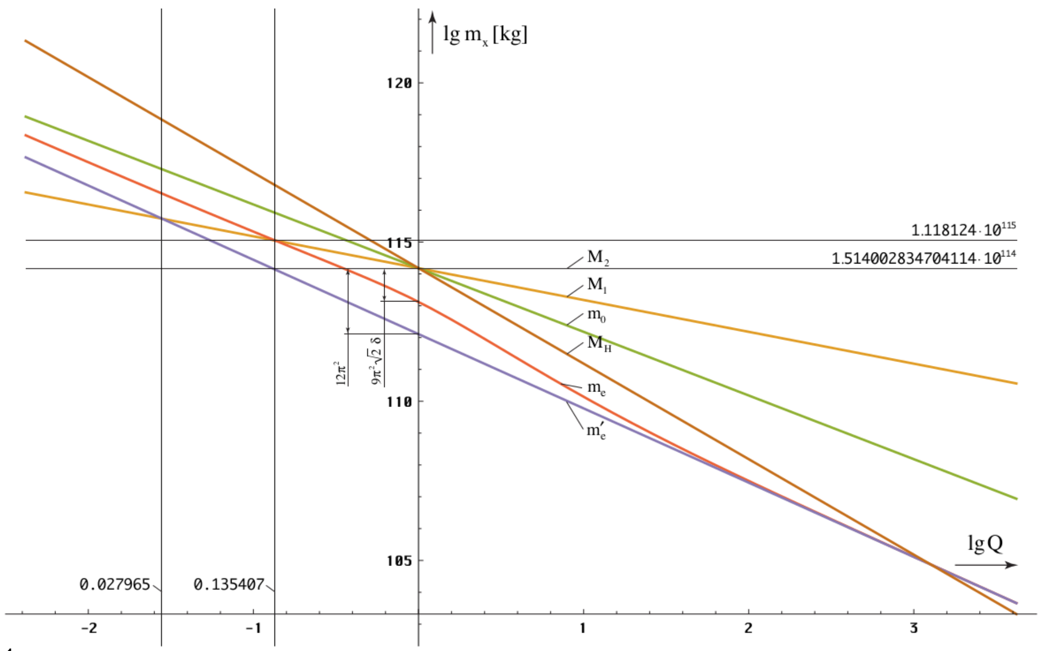



Figure 131
Course of the reference-frame-dependent masses $m_x$ with respect to the phase angle Q, small scale

Figure 131 shows the course near Q=1. Even the exact course of the electron mass $m_e$ according to (801) in comparison with $m'_e$ (799) is depicted there. As we can see, shortly after BB, the so-called HUBBLE-mass $M_H$, a measure for the rest-mass of the photon, is yet greater than the rest-mass of the electron and not to be neglected. Nowadays the value amounts to $2.6094858 \cdot 10^{-69}$kg only. The model makes it possible, to simulate the conditions shortly after BB with simple means.

With the CODATA-value of $\hbar$ we are able to determine $\kappa_0$ and $\hbar_1$ even now:

$$\kappa_0 = \left(\frac{1}{18\pi^2}\sqrt{2}\right)^3 \delta^{-3} \frac{m_0^4}{m_e^3 \mu_0 \hbar} = 1.3697776631902217 \cdot 10^{93}\,\mathrm{Sm}^{-1} \tag{808}$$

$$\hbar_1 = \hbar Q_0 = 8.795625796565464 \cdot 10^{26}\,\mathrm{Js} \tag{809}$$

Now we can apply these values as initial values (subspace parameters). Then we turn around the calculation direction to top-down. The definition of $\kappa_0$ as fixed value also has the advantage, that we don't have to measure it by no means. Due to its extreme size it's also unlikely, that we will be able to carry out such a measurement in the near future. The definition of $\hbar_1$ as fixed value is definitely better, than that of $\hbar$ and even correct. Because of the definition of the Kelvin we also take in addition the BOLTZMANN-constant k as a statistic value and the fixed *genuine* constants are complete. All other stuff is to be calculated. From now on, instead of $Q_0$ we'll use $m_e$ to the identification of the particular frame of reference, because it can be measured (*magic value*). With it, our *concerted metric system* is ready, and it adds-up, exactly! To the calculation of $Q_0$ from $m_e$ we still rearrange (802) in the following manner:

$$Q_0 = \left(9\pi^2\sqrt{2}\,\delta \frac{m_e}{\mu_0 \kappa_0 \hbar_1}\right)^{-3/7} \tag{810}$$

In order to transform measured values being subject to the LORENTZ-transformation, we only have to multiply the input parameter with the factor $(Q/\tilde{Q})^{\pm 3/2}$, depending on, whether the LORENTZ-factor $\gamma$ or $\gamma^{-1}$ finds use. Furthermore it must be pointed out, that not only $\hbar$, but also $m_e$ varies over the years. With $\hbar$ the variation is at approx. $-1.4036 \cdot 10^{-10}\mathrm{a}^{-1}$, with $m_e$ at $-2.1054 \cdot 10^{-10}\mathrm{a}^{-1}$, if only because of the growth of age. That should be taken into account by the SI-panel with the definition of the kg, $\hbar_1$ in contrast is invariable. A definition by means of $m_e$ also would be possible and even recommendable. But the extremely small value is very difficult to scale-up.

### 6.2.4.2. Dynamic contemplation

After the determination of the static, i.e. time-dependent value of the electron mass, we want to deal with the electron in motion. Because of its smallness it can be accelerated by fields or by collisions with other particles only. Latter one we don't want to contemplate here. Since the electron disposes of the charge e, we conveniently use the electromagnetic field for the acceleration. The whole issue takes place in the vacuum.

#### 6.2.4.2.1. Basics

Although it's about school content of curriculum, I want to go into detail with the basics of acceleration of the electron in the electromagnetic field once again, gathered from [10]. The electrons are released by a heating element at the cathode (0V). By impression of the voltage $+U_b$ at the anode, acceleration takes place. If the anode has a hole, the electrons move-on even behind it with the speed achieved by acceleration. The speed depends on the applied voltage. Nonrelativistically applies: $\frac{1}{2} m_e v^2 = U_b e$. The ray can be focussed by electric or magnetic fields.

With accelerating voltages >2.7kV indeed, the velocity v of the electrons must be treated relativistic, v gains a value >0.1c then. The kinetic energy [J] =[V·As] divided by the electron charge $e = 1.602176634 \cdot 10^{-19}$As the value in eV turns out. The values apply in the observer's frame of reference, we cannot „fly with“.

The kinetic energy $W_{kin}$ of an electron equals its total energy $W_{re}$ less the rest energy $W_0$

$$W_{kin} = m_{rel}c^2 - m_e c^2 \tag{811}$$

The kinetic energy according to the energy-conservation-rule equals the performed acceleration-work of the E-field

$$U_b e = m_{rel}c^2 - m_e c^2 \tag{812}$$

The relativistic mass $m_{rel}$ and the rest mass $m_e$ are linked by the Lorentz factor $\gamma$

$$m_{rel} = \gamma m_e = \frac{m_e}{\sqrt{1-\frac{v^2}{c^2}}} = m_e \left(\frac{\tilde{Q}}{Q}\right)^{\frac{3}{2}} \tag{813}$$

Plugging in of the relativistic mass Into the energy equation

$$U_b e = \frac{m_e c^2}{\sqrt{1-\frac{v^2}{c^2}}} - m_e c^2 \tag{814}$$

Out-factoring and division by $m_e c^2$ yields

$$\frac{U_b e}{m_e c^2} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1 = \left(\frac{\tilde{Q}}{Q}\right)^{\frac{3}{2}} - 1 \tag{815}$$

After rearrangement we obtain for $v_{rel}[U_b]$

$$\frac{v}{c} = \sqrt{1-\left(1+\frac{U_b e}{m_e c^2}\right)^{-2}} \tag{816}$$

```
VrelU=Function[ScientificForm[SetPrecision[Sqrt[1-
SetPrecision[1/(1+# qe/me/c^2)^2,180]],180],180]];
```
(817)

In (817) and the subsequent functions the precision is set like that, we can calculate even velocities with e.g. 0.999999’$^{180}$. For the difference $1 - v_{rel}[U_b]$ the function DVrelU (818) can be used.

```
DVrelU=Function[ScientificForm[SetPrecision[1-(Sqrt[1-
SetPrecision[1/(1+# qe/me/c^2)^2,180]]),180],10]];
```
(818)

With the help of (815) we can calculate the phase angle $Q_{rel}[U_b]$, once relative to $\tilde{Q}_0$, the other time absolutely (*italic*). Please don’t change the fraction $1/(\ldots)^{2/3}$ into $(\ldots)^{-2/3}$, otherwise you will get an error message *Division by zero!* with particular values.

$$Q_0 = \tilde{\mathit{Q}}_0 \left(1+\frac{U_b e}{m_e c^2}\right)^{-\frac{2}{3}} \tag{819}$$

```
QrelU=Function[SetPrecision[SetPrecision[1/(1+# qe/me/c^2)^(2/3),180],16]];
QQrelU=Function[Q0*(QrelU[#])];
```
(820)

Also important is the inverse function of (817) UeV, calculating the necessary acceleration-voltage for a particular (v/c). It also yields the kinetic energy in [eV] at the same time.

$$U_b = \frac{m_e c^2}{e} \left(\left[1-\frac{v^2}{c^2}\right]^{-\frac{1}{2}} - 1\right) \tag{821}$$

```
UeV=Function[a4711=SetPrecision[#,1000]; (me c^2(1/Sqrt[1-a4711^2]-1))/qe];
```
(822)

### 6.2.4.2.2. Energetic contemplation

Shortly after the start of operation of the Large Hadron Collider (LHC) at CERN could be read in the press, that it „simulated the BB“ [54]. Thus, we want to verify at this point, if it is possible at all. The prior condition would be, to reach the nonlinear range at a phase angle of $Q_0<10^3$. That would be in the temporal close-up range of the phase jump near $Q_0=1$ approx. $10^{-90}$s after BB (Figure 129).

Just let's try, to accelerate an electron onto such a velocity. What energy we would need for it? To the calculation we use the functions vQ0 (797) and UeV (822). It's a good idea, to suppress the intermediate result of vQ0, otherwise you will get a multiline output with 173 nines after the decimal point in the form of $9.99\ldots9913822\cdot10^{-1}$. So we enter the following: UeV[vQ0[10^3]] obtaining a value of $3.8923\cdot10^{92}$eV. But the LHC has approx. 13TeV only, that's $1.3\cdot10^{13}$eV. Even if the LHC works with protons, energy is energy, thus we are orders of magnitude below that.

| Value | Name | $m_x=W_xe/c^2$ [kg] | $W_x=m_xc^2/e$ [eV] | $Q_0$ [1] | |
|---|---|---|---|---|---|
| $M_2$ | Initial-mass univ | $1.514002834704\cdot10^{114}$ | $1.23085\cdot10^{97}$ | $1.00000\cdot10^{0}$ | |
| $B_L$ | Linearity border | $6.938648236086\cdot10^{56}$ | $3.89230\cdot10^{92}$ | $1.00000\cdot10^{3}$ | |
| $M_1$ | Mach-mass | $1.815248576128\cdot10^{53}$ | $1.01828\cdot10^{89}$ | $2.44470\cdot10^{5}$ | |
| $U_1$ | Mach-voltage | $1.550667802897\cdot10^{52}$ | $8.69861\cdot10^{87}$ | $1.26039\cdot10^{6}$ | |
| $m_0$ | Planck-mass | $2.176434097482\cdot10^{-8}$ | $1.22089\cdot10^{28}$ | $1.00543\cdot10^{46}$ | |
| $U_0$ | Planck-voltage | $1.859208884401\cdot10^{-9}$ | $1.04294\cdot10^{27}$ | $5.18360\cdot10^{46}$ | |
| $m_e$ | Electron-mass | $9.109383701528\cdot10^{-31}$ | $5.10998\cdot10^{5}$ | $5.25417\cdot10^{60}$ | |
| $M_H$ | Hubble-mass | $2.609485798792\cdot10^{-69}$ | $1.4638\cdot10^{-33}$ | $8.34047\cdot10^{60}$ | $\leftarrow Q_0$ |

Table 6
Energy and masses in the Universe

The interesting question is, whether it is even possible, to reach such a high speed, especially for the financiers. For this purpose, I compiled the masses and their energy $m_xc^2/e$ in eV in comparison with the corresponding phase angle $Q_0$, determined in (804) until (807) in Table 6. As we can see, the necessary $3.8923\cdot10^{92}$eV is above the MACH-mass. So there is no longer enough energy in the universe, in order to accelerate one single electron into the nonlinear range $Q_0<10^3$.

As already specified, $M_1$ equals the sum of the gravitational and of the electromagnetic field of the universe. As stated in (1037) the density is at $\frac{3}{2}G_{11}(R/2)=1.94676\cdot10^{-29}$ kg·dm$^{-3}$. But how about the masses, galaxies, stars, planets, dust etc.? So the mass-density is about two orders of magnitude below at $1.845\cdot10^{-31}$ kg·dm$^{-3}$. That's much less. Furthermore, the required acceleration-voltage is greater than $U_0$ (PLANCK) and $U_1$ (MACH). According to [55] these are defined in the following manner:

$$U_0 = \sqrt{\frac{c^4}{4\pi\varepsilon_0 G_{(0)}}} \qquad U_1 = \sqrt{\frac{c^4}{4\pi\varepsilon_0 G_1}} \qquad U_2 = \sqrt{\frac{c^4}{4\pi\varepsilon_0 G_2}} \tag{823}$$

Because of the existence of $m_0$, $M_1$ and $M_2$ there are also three different values for the gravitational constant:

$$G = c^2r_0/m_0 \qquad G_1 = c^2r_1/M_1 = GQ_0^{-2} \qquad G_2 = c^2r_1/M_2 = GQ_0^{-3} \tag{824}$$

$U_2$ and $G_2$ are legacy values at this point, impossible nowadays. Thus, more than $U_1$ won't work. Presuming $U_1$ as the highest possible voltage, if technically feasible at all, with the maximum available energy $M_1c^2$, almost 12 electrons can be accelerated to a top speed below the linearity border. Maybe it even suffices for one proton. So much for „simulating Big Bang“.

In Figure 132-125 the theoretical courses of the phase angle $Q_0$, of the electron charge e and of α as a function of the kinetic energy as well as of the acceleration-voltage are shown once again. Additionally, the energetic boundaries from Table 6 are marked. As we can see, we can't even get close to the BB.

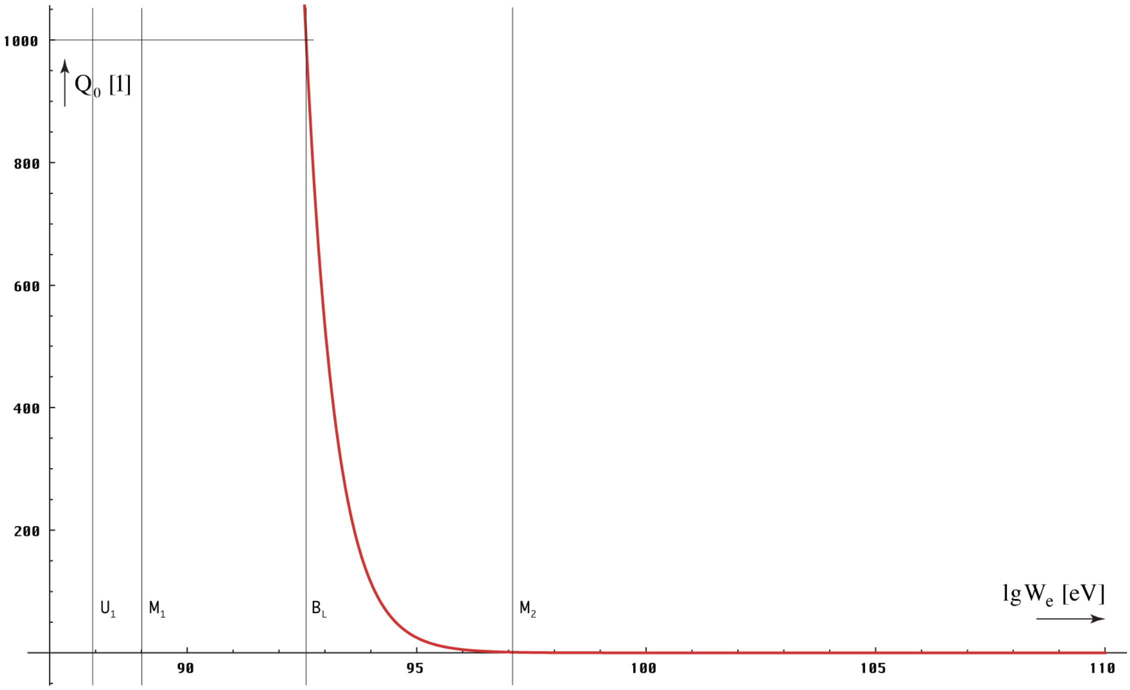



Figure 132
Phase angle $Q_0$ as a function
of the energy of the electron

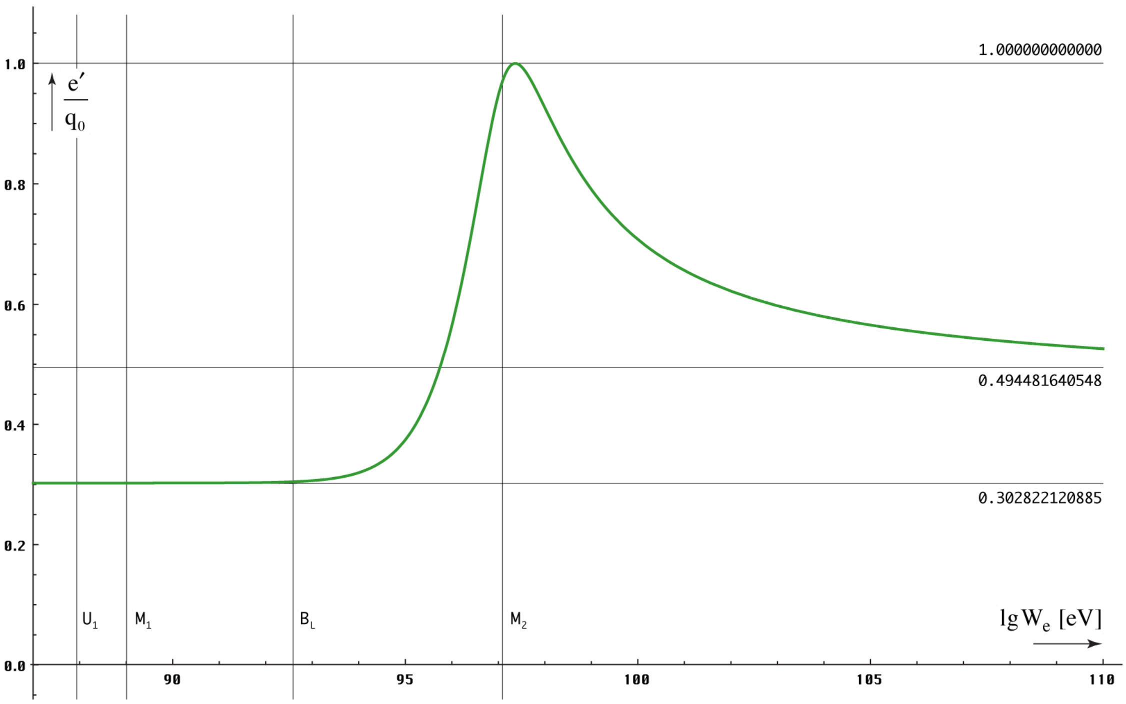



Figure 133
Ratio of the electron- to the PLANCK-charge
as a function of the energy of the electron

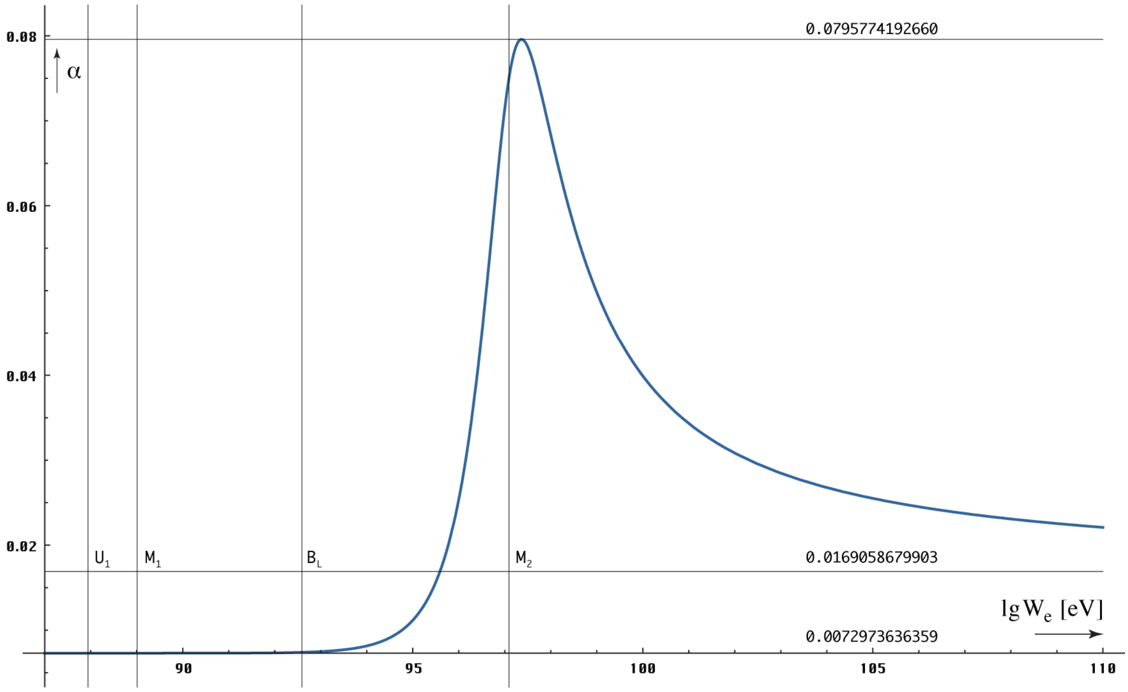



Figure 134
Correction factor α as a function
of the energy of the electron

Finally, on the subject of particle accelerator. I had promised, to address this point again with respect to the additional share of the mass- and charge-increase. The question is, do the additional shares cancel each other even in a particle accelerator? Just let's recall the various dependencies:

$$mc^2 \sim Q_0^{-\frac{5}{2}} \qquad \hbar\omega \sim Q_0^{-\frac{5}{2}} \tag{825}$$

$$\omega \sim Q_0^{-\frac{3}{2}} \qquad \hbar = q_0\varphi_0 \sim Q_0^{-\frac{2}{2}} \quad \rightarrow \quad q_0 \sim Q_0^{-\frac{1}{2}} \qquad \varphi_0 \sim Q_0^{-\frac{1}{2}} \tag{826}$$

For the technically accessible domain suffice the approximation formulae. It is currently generally assumed, that both, the electron charge and PLANCKs quantity of action are genuine constants. The same applies even to the magnetic induction B=dφ/dA, with which the electron is kept on track in the accelerator.

Here we have to do with two types 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 directed against each other. It applies $v\perp r$, thus $F_L=e\,vB$. With it, we obtain the classical expression for the cyclotron (B=const) and even for the synchrotron (B≠const):

$$r = \frac{\beta(\tilde{m}_e v)}{eB} \sim \beta v \qquad \text{with} \qquad \beta = \gamma^{-1} = \sqrt{1-\frac{v^2}{c^2}} \tag{827}$$

Now, according to this model as well $m_e$, e as the induction B are subject to an additional redshift. Shouldn't this be found out somehow in accelerator-experiments? Altogether applies to the electron mass $m_e \sim Q_0^{-5/2} \sim \beta^{5/3}$, to the electron charge $e \sim Q_0^{-1/2} \sim \beta^{1/3}$. If we assume, that the track-radius r and with it, also the elements of area dA of the magnetic field B are *not* subject to a length contraction for the observer, applies to the induction $B \sim \varphi \sim Q_0^{-1/2} \sim \beta^{1/3}$. Thus, plugged into (827) we just obtain

$$r = \frac{\beta^{5/3}(\tilde{m}_e v)}{\beta^{1/3}\tilde{e}\beta^{1/3}\tilde{B}} \sim \beta v \tag{828}$$

The same result as with the classical model, where we assumed e and B to be constant. Thus, the additional mass-increase really cancels out.

### 6.2.4.2.3. Perspective

Before we engage in further characteristics of the electron, I want to answer the following question: Since it already needs an extreme amount of energy in order to accelerate one single electron to a speed within spitting distance to c, is it even possible, to get a macroscopic body up to a similar speed? It’s basically a question of whether we’ll ever be able to travel to other stars with a space-craft.

The answer is „Yes“. In addition to the acceleration of a particle/body in a field, the so-called external acceleration there is namely a second kind of acceleration, the internal or self-acceleration. That is, if the body disposes of its own drive. Then very different relations apply.

In principle, a body with the rest mass $m_0$ contains exactly as much energy ($m_0c^2$), in order to completely accelerate it to light speed. Let’s take a space-craft with photon-drive as an example. The energy shall be generated by matter-antimatter-annihilation and propulsion (mirror) shall work with 100% efficiency. Since it’s about a rocket, in principle the ZIOLKOWSKI-equation applies. But there is a difference because of the constancy of light speed, so that we can work with the same ansatz indeed, but finally a different relation turns out. According to [12] the ZIOLKOWSKI-equation for $v_0=0$ reads as follows:

$$v = -v_g \ln\left(1-\frac{bt}{m_0}\right) \qquad \begin{array}{llll} v_g = c & \text{Specific momentum drive} & b = \dot{m} & \text{Fuel consumption} \\ F = v_g \cdot b = P/c & \text{Thrust} & m_0 = m_L + m_T & \text{Rest mass} \end{array} \tag{829}$$

$m_L$ is the empty weight, $m_T$ tank filling. As we can see, F only depends on the power P, unlike as with a normal rocket. Thus, (829) doesn’t apply. Therefore, we start with the ansatz in [56] . I cite:

»We split the whole continuously proceeding acceleration process into such small steps, so that step by step, a particular value of the current speed of rocket can be assigned to v and also its mass to the value m. In the current barycentric system of the rocket the mass $\Delta m$ is thrusted out with the speed $v_g$, it has the momentum $v_g\Delta m$ therefore. Because of the conservation of momentum the rocket gets a repulsion momentum of the same size $m\Delta v$, increasing speed in the opposite direction about $\Delta v$. After the following limiting process up to even more, even smaller steps it no longer plays a role, that we should schedule $m-\Delta m$ instead of the mass m to be correct. Hereby, the changings $\Delta m$ and $\Delta v$ become the differentials dm as well as dv. Thus, it yields (using the minus sign because v grows while m drops)«.

$$v_g\,dm = -m\,dv \qquad dm = \frac{P}{c^2}dt \qquad dv = -\frac{c}{m_0}dm \tag{830}$$

$$dv = -\cancel{c}\frac{P}{m_0c^{\cancel{2}}}dt \qquad v = -\frac{1}{m_0c}\int P\,dt \tag{831}$$

The whole issue is simply considered, without sophistries like acceleration, distance, travel duration, payload, relativistic effects etc. If you are interested, please read [57]. Only the conclusion from (831) is of interest. In principle it’s possible, to achieve light speed with a space-craft. You just have to „burn“ the complete ship, cargo, the passengers, the crew, the drive and all the rest for that purpose. Then you really move with c, but only in the form of a light ray. You can also push the self-destruction-button instead. But below c a reasonable navigation is possible. As a problem remains the fuel. Antimatter with a negative mass would be very advantageous in this connection.

## 6.2.5. The classical 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 Metric 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:

$$r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2} \tag{832}$$

Since it's about a length, the relations to the PLANCK-units, mainly to $r_0$, are really important. Now, we have already used this value in (1049) to the determination of $Q_0$, but we got a different result. Aside from that, the value determined with (810) seems to be more exact, as a comparison with the CMBR-temperature, measured by the COBE-satellite, suggests. See section 4.6.4.2.5. and [46] for more details. Thus, it's appropriate, to impose expression (1049) with a correction factor $\zeta$, in order to obtain the result of (810). If there is already a curvature with the surface-calculation, we can assume, that even the radius is bent. Maybe, we even obtain the desired relation $r_e/r_0$ then. Equating (810) with (1049) with a subsequent substitution by (833), with the help of (778) and (798) we obtain:

$$Q_0 = \left(9\pi^2\sqrt{2}\,\delta\frac{m_e}{\mu_0\kappa_0\hbar_1}\right)^{-3/7} = \frac{3}{2}\left(\frac{\zeta r_e}{r_0}\right)^3 \tag{833}$$

$$\zeta = \sqrt[3]{\frac{2}{3}}\frac{r_0}{r_e}\left(9\pi^2\sqrt{2}\,\delta\frac{m_e}{\mu_0\kappa_0\hbar_1}\right)^{-1/7} \tag{834}$$

$$\zeta = \frac{1}{9\pi^2}\frac{1}{\sqrt[3]{3\sqrt{2}\alpha\delta}} = \frac{1}{36\pi^3}\frac{1}{\sqrt[3]{3\sqrt{2}}}\frac{m_p}{m_e} = 1.016119033114739 = \text{const} \tag{835}$$

The ratio $m_p/m_e$ is known to be constant. If the curvature were based on the same curve as in Figure 10, $\zeta$ would match the value $Q_0=0.748612\approx3/4$. Now we can also specify the relations to the other PLANCK-lengths:

$$r_1 = \frac{1}{\kappa_0 Z_0} \tag{836}$$

$$r_e = \sqrt[3]{\frac{2}{3}}r_0\zeta^{-1}Q_0^{1/3} = \sqrt[3]{\frac{2}{3}}r_1\zeta^{-1}Q_0^{4/3} \tag{837}$$

$$r_0 = \sqrt[3]{\frac{3}{2}}r_e\zeta Q_0^{-1/3} = r_1 Q_0 = \frac{c}{\omega_0} \tag{838}$$

$$R = \sqrt[3]{\frac{3}{2}}r_e\zeta Q_0^{2/3} = r_1 Q_0^2 = 2cT \tag{839}$$

$r_e$ is greater than $r_0$. The result is exact. Now, even the right-hand expression of (833) yields the correct value. Still remain (931) and (932) from former articles. Since latter expression contained a typo [3], I want to present both, inclusive $\zeta$ correctly once again (h has been substituted by $\hbar$):

$$H_0 = \frac{2}{3}\frac{64\pi^3\varepsilon_0 G\hbar m_e^3}{\zeta^3\mu_0^2 e^6} = \left(144\,\pi^4\sqrt{2}\right)^3\frac{G\hbar c^4\varepsilon_0^3 m_e^6}{e^6 m_p^3} = 2.2239252345813\cdot 10^{-18}\,s^{-1} \quad (840)$$

$$\kappa_0 = \frac{3}{8}\frac{\zeta^3 e^6 c}{16\pi^3\varepsilon_0^2 G^2\hbar^2 m_e^3} = \left(144\,\pi^4\sqrt{2}\right)^{-3}\frac{c\,e^6 m_p^3}{(\varepsilon_0 G\hbar m_e^3)^2} = 1.36977766319\cdot 10^{93}\,Sm^{-1} \quad (841)$$

The converted value of (840) amounts to $68.62410574852406\,km\,s^{-1}\,Mpc^{-1}$. That's very precise, indeed the value depends on the reference frame. Btw. the CODATA-documents also contain a typo with the definition of $r_e$, copied-on from one edition to the next. So it doesn't read $r_e=\alpha^2 a_0$, but $r_e=\alpha a_0$ correctly. Now let's have a look, if and which reference-frame-dependent variations cancel each other. At first the classical expression. I used the relativistic stretch factor $\beta$ for the mass:

$$r_e = \frac{e^2}{4\pi\varepsilon_0\beta\tilde{m}_e c^2} \sim \beta^{-1} \quad (842)$$

With it, the classical electron radius according to the classical understanding (interesting pairing) follows the relativistic length-contraction, which is not a contradiction. Now we apply the real values for mass and charge of the electron obtaining the expression for the „modern" classical electron radius:

$$r_e = \frac{\beta^{2/3}\tilde{e}^2}{4\pi\varepsilon_0\beta^{5/3}\tilde{m}_e c^2} \sim \beta^{-1} \sim Q_0^{3/2} \quad (843)$$

The additional mass- and charge-increase cancel each other even here. Also according to a „modern" view the radius is subject to the single relativistic length-contraction. With it, there is an essential difference to the capacitor of the MLE, whose radius is proportional $Q_0$ only.

The fact, that most of the changes cancel each other, suggests the physical laws to be the same in all reference-frames. But that's only partially correct. Just the references to the subspace-values are changing. Fortunately, these of all are the ones, which finally cancel out. Only the LORENTZ-share remains. That means, we have to do it with a limited relativity principle. The version advocated by EINSTEIN applies:

> *„Die Gesetze, nach denen sich die Zustände der physikalischen Systeme ändern, sind unabhängig davon, auf welches von zwei relativ zueinander in gleichförmiger Translationsbewegung befindlichen Koordinatensystemen diese Zustandsänderungen bezogen werden."[58]*

The subspace itself is known as not to be a reference-frame. There is no preferred frame of reference. No problem, the SRT would correctly do the job even then. But there is something like a superordinate system for the cosmos as a whole. Besides it's not certain, that our value $Q_0$ represents the maximum. Possibly there are even others with a higher $Q_0$.

The question, „Where is the maximum?", is hard to be answered, maybe in that we calculate out the relative speed with respect to the microwave background. According to [59] the value amounts to 368±2 km/s. With the help of (700) it should be possible to calculate $Q_{max}$. We rearrange:

$$Q_{max} = Q_0\left[1-\frac{v^2}{c^2}\right]^{-1/3} = 8.340471132\cdot 10^{60}(1-(3.68\cdot 10^5 ms^{-1}c^{-1})^2)^{-1/3} = 8.340475321\cdot 10^{60} \quad (844)$$

As we can see, the difference is not that big. The deviation amounts to $+5.02\cdot 10^{-7}$. That makes a difference in the age of +14310 years only.

## 6.2.6. The BOHR's hydrogen-radius

Once again a length, which really doesn't exist, which may serve as a rule, if the proportions inside the atom change or not. According to [5] it is defined as follows:

$$a_0 = \frac{4\pi\varepsilon_0\hbar^2}{m_e e^2} = 5.291772105440824\cdot 10^{-11}\text{m} \qquad \Delta = -6.798\cdot 10^{-10} \tag{845}$$

Δ indicates the deviation to the measuring value and is tightly above the measuring inaccuracy. With the help of (679, (801) and (805) we acquire the relations to the PLANCK-lengths:

$$a_0 = 9\pi^2\sqrt{2}\alpha^{-1}\delta\, r_1 Q_0^{4/3} = 576\pi^5\sqrt{2}\,\frac{m_e}{m_p} r_1 Q_0^{4/3}\operatorname{cosec}^4\gamma \tag{846}$$

$$a_0 = 9\pi^2\sqrt{2}\alpha^{-1}\delta\, r_0 Q_0^{1/3} = 576\pi^5\sqrt{2}\,\frac{m_e}{m_p} r_0 Q_0^{1/3}\operatorname{cosec}^4\gamma \tag{847}$$

As well α (proton), as even δ (electron) are applied in this connection. It should also be noted, that $m_e$ behaves differently shortly after BB, and that according to (801). But according to previous understanding, hydrogen atoms do not exist at all at this time. Since even the angle γ is involved, it however could not be true. Now let's see again, if and which reference-frame-dependent changes cancel out:

$$a_0 = \frac{4\pi\varepsilon_0\hbar^2}{\beta\tilde{m}_e e^2} \sim \beta^{-1} \tag{848}$$

BOHR's hydrogen-radius is also subject to the single relativistic length-contraction, i.e. the atomic scales are observed shortened by $\beta^{-1}$, just like a macroscopic body. But what about the additional shares?

$$a_0 = \frac{4\pi\varepsilon_0\beta^{4/3}\tilde{\hbar}^2}{\beta^{5/3}\tilde{m}_e\beta^{2/3}\tilde{e}^2} \sim \beta^{-1} \sim Q_0^{3/2} \tag{849}$$

The additional shares cancel each other even here. That means, as well the dimensions of particles, as even the „track-radii", i.e. the dimensions of orbitals, are subject to the single relativistic length-contraction only. Otherwise the atoms would have been different chemical properties at an early point of time of the evolution of the universe.

## 6.2.7. The COMPTON wave-length of the electron/proton/neutron...

The COMPTON-wavelength is a characteristic size for a particle with mass. It specifies the increase of wavelength of a photon rectangularly scattered on it [60]. As a representative we only consider the electron and the so-called reduced COMPTON-wavelength $\lambda\!\!\!^{-}_C(\hbar)$. According to [60] is $\lambda\!\!\!^{-}_C = \lambda\!\!\!^{-}_{C,e}$ defined as follows:

$$\lambda\!\!\!^{-}_C = \frac{\hbar}{m_e c} = 3.8615926772447883\cdot 10^{-13}\text{m} \qquad \Delta = -6.13\cdot 10^{-10} \tag{850}$$

By application of (801) and (805) we acquire the relation to the PLANCK-lengths again:

$$\lambda\!\!\!^{-}_C = 9\pi^2\sqrt{2}\delta r_0 Q_0^{1/3} = 9\pi^2\sqrt{2}\delta r_1 Q_0^{4/3} \tag{851}$$

Altogether quite simple expressions, reflecting the „mechanism" behind in principle. Also they are related to the invariables of subspace and with it, even better than the relations, in which other natural „constants" are related to each other, without knowing, if and how they are changing. But to the determination, how the additional relativistic shares cancel out, we make use of (850):

$$\lambda\!\!\!^{-}_{C} = \frac{\hbar}{\beta\tilde{m}_e c} \sim \beta^{-1} \tag{852}$$

$$\lambda\!\!\!^{-}_{C} = \frac{\beta^{2/3}\tilde{\hbar}}{\beta^{5/3}\tilde{m}_e c} \sim \beta^{-1} \sim Q_0^{3/2} \tag{853}$$

The shares cancel each other even here. But the exact expression should read different in fact, since it's about a (space-like) wave-function. This is considered by (851).

### 6.2.8. The RYDBERG-constant

The RYDBERG-constant $R_\infty$ natural constant named after Johannes RYDBERG. It occurs in the RYDBERG-formula, an approximation to the calculation of atomic spectra. Its value is the ionisation energy of the hydrogen atom, expressed as wave-count neglecting relativistic effects and the co-movement of the nucleus, thus with infinite nuclear mass, that's why the index $\infty$ (citation [61]). Under application of the reduced value $\lambda\!\!\!^{-}_C(\hbar)=\lambda\!\!\!^{-}_{C,e}=\lambda\!\!\!^{-}_C$ and of $\hbar$ instead of $h$, determined in the previous section, we have to rewrite the definition in [61] in the following manner:

$$R_\infty = \frac{1}{4\pi}\frac{\alpha^2}{\lambda\!\!\!^{-}_C} = \frac{m_e e^4}{64\pi^3\varepsilon_0^2\hbar^3} = \frac{\alpha}{4\pi a_0} = 1.0973731568160\cdot 10^7\mathrm{m}^{-1} \quad \Delta = \pm 1.9\cdot 10^{-12} \tag{854}$$

Shown is the measuring value at this point. The first expression is best suited, to establish the references to the PLANCK-units with the help of (851):

$$R_\infty = \frac{1}{72\pi^3}\sqrt{2}\alpha^2\delta^{-1}r_1^{-1}Q_0^{-4/3} = \frac{1}{18432\pi^7}\sqrt{2}\,\frac{m_p}{m_e}\,r_1^{-1}Q_0^{-4/3}\sin^6\gamma \tag{855}$$

$$R_\infty = \frac{1}{72\pi^3}\sqrt{2}\alpha^2\delta^{-1}r_0^{-1}Q_0^{-1/3} = \frac{1}{18432\pi^7}\sqrt{2}\,\frac{m_p}{m_e}\,r_0^{-1}Q_0^{-1/3}\sin^6\gamma \tag{856}$$

Obviously, the RYDBERG-constant is no constant at all. Since it's about the natural constant most exactly measured of all, it's also best suited to determine the detuning of the SI-system. The deviation of (855) to the measured value (854) namely amounts to $7.44431\cdot 10^{-10}$. That's much more than the measuring inaccuracy in the size of $1.9\cdot 10^{-12}$. The calculated value amounts to $1.097373157632939\cdot 10^7\mathrm{m}^{-1}$.

This example shows, that the SI-system in its present configuration is reaching its limits. A further increase of exactness is impossible without considering the reference frame and the relations of the natural constants among themselves. This way, even the outliers can be identified much better. Using the value $m_e/m_p=5.44617021$ (487$\cdot 10^{-4}$ specified in CODATA$_{2018}$ instead of the genuine quotient and re-determining $Q_0$, $\kappa_0$ and $\hbar_1$ thereafter, the accuracy decreases by up to 3 orders of magnitude. That's also a weak point. The ratio $m_e/m_p$ is something like a second magic value or an important side-condition. Since it's considered to be constant, one could theoretically define it as a fixed value. But I think, that's not a good idea. With a reconfiguration even $R_\infty$ instead of $m_e$ would be suitable as a magic value.

Often used is also the RYDBERG-frequency $R = cR_\infty = 3.2898419603 \cdot 10^{15}$ Hz. To the comparison with $\omega_0$ and $\omega_1$ we still calculate the related angular frequency $\omega_R = 2\pi c R_\infty$ with the amount $2.0670686668 \cdot 10^{16} s^{-1}$. It applies:

$$\omega_1 = \frac{\kappa_0}{\varepsilon_0} = \frac{1}{2t_1} \tag{857}$$

$$\omega_0 = 18\pi^2\sqrt{2}\alpha^{-2}\delta\omega_R Q_0^{1/3} = 4608\pi^6\sqrt{2}\frac{m_e}{m_p}\omega_R Q_0^{1/3}\sin^6\gamma = \omega_1 Q_0^{-1} = \frac{1}{2t_0} \tag{858}$$

$$\omega_R = \frac{1}{36\pi^2}\sqrt{2}\alpha^2\delta^{-1}\omega_1 Q_0^{-4/3} = \frac{1}{9216\pi^6}\sqrt{2}\frac{m_p}{m_e}\omega_1 Q_0^{-4/3}\sin^6\gamma = 2\pi c R_\infty \tag{859}$$

$$H_0 = 18\pi^2\sqrt{2}\alpha^{-2}\delta\omega_R Q_0^{-2/3} = 4608\pi^6\sqrt{2}\frac{m_e}{m_p}\omega_R Q_0^{-2/3}\sin^6\gamma = \omega_1 Q_0^{-2} = \frac{1}{2T} \tag{860}$$

By character, the HUBBLE-parameter $H_0$ is an angular frequency too, see also section 4.5.2.3. Because of the definition in (854) it's easy to verify the behaviour of the reference-frame-dependent sizes. As well classically, as even recently, everything cancels out again:

$$R_\infty = \frac{1}{4\pi}\frac{\alpha^2}{\lambda\!\!\!^{-}_C} \sim \beta \sim Q_0^{-3/2} \qquad \omega_R = 2\pi c R_\infty \sim \beta \sim Q_0^{-3/2} \tag{861}$$

## 6.2.9. The BOHR's magneton/nuclear magneton

According to [20] in quantum mechanical view the track angular momentum $\vec{\mathbf{L}}$ of a charged point particle with the mass m and the charge q generates the magnetic moment (165)

$$\vec{\mu} = \mu\frac{\vec{\mathbf{L}}}{\hbar} \tag{862}$$

$$\mu = \frac{q}{2m}\hbar \tag{863}$$

Then, expression (863) is the magneton $\mu$ of the particle. BOHR's magneton $\mu_B$ is the magnetic dipole moment of the electron, the nuclear magneton $\mu_N$ the magnetic dipole moment of the proton. Both only differ in the mass ($m_e$ resp. $m_p$) in the denominator. We only regard the electron at this point. According to [62] $\mu_B$ is defined as follows:

$$\mu_B = \frac{e\hbar}{2m_e} = -9.274010078328 \cdot 10^{-24} JT^{-1} \qquad \Delta = \pm 3 \cdot 10^{-10} \tag{864}$$

It should be noted, that the magnetic moment $\vec{\mathbf{L}}$ of the electron is always directed opposite to its track angular momentum due to the negative charge, hence the negative sign [62]. Now let's look for the relations to the PLANCK-units. With the help of (801) and of (21) $m_0 = \mu_0 q_0^2 r_0$ we substitute e and $m_e$ by $q_0$ and $m_0$. We get:

$$\mu_B = -\frac{9}{2}\pi^2\sqrt{\frac{2\hbar_1}{Z_0}}\frac{\delta\sin\gamma}{\mu_0\kappa_0}Q_0^{5/6} = -9.2740100726513 \cdot 10^{-24} JT^{-1} \qquad \Delta = -6.12 \cdot 10^{-10} \tag{865}$$

Here, the deviation of the measured to the calculated value is twice as big, as the given measuring accuracy. Obviously, inaccuracies of other measurands have been passed through here. Also it's strange, that all values specified in this section are having the same inaccuracy of $\pm 3 \cdot 10^{-10}$. The expressions relating the PLANCK-units all are rechecked and yield the same result as the original definition, in that case (864). Latter one a deviation to the measuring value same as (865) turns out. There, probably something else is jinxed.

A comparison with other PLANCK-units of the same kind is impossible in this case. Still, the behaviour of the reference-frame-dependent values remains. Starting with (864) according to the classical view, applies:

$$\mu_B = \frac{e\hbar}{2\beta\tilde{m}_e} \sim \beta^{-1} \tag{866}$$

Inserting the additional shares we obtain:

$$\mu_B = \frac{\beta^{1/3}\tilde{e}\beta^{2/3}\hbar}{2\beta^{5/3}\tilde{m}_e} \sim \beta^{-2/3} \sim Q_0 \tag{867}$$

In this case we get a different result. But since the magnetic moment always appears in connection with a charge or a magnetic flux, which both are proportional $\beta^{-1/3}$, there is a cancellation of the additional shares too. All in all we can say, the spatial share of total redshift does not take any effect to the physical laws at the observer, neither qualitative nor quantitative. It only has a cosmologic meaning and plays an important role with the creation of a gravitational theory.

With it, we analyzed most of the values associated with the electron. Of course, there is a lot of further possible candidates. I want to leave them over for the reader. I pointed the way to add new values. Doing so always must be substituted in such a manner, that the relation depend on $Q_0$ and/or invariants only. As next I want to have a look at some other values, which surprisingly also can be calculated with the concerted system. One of them is the temperature of the CMBR (See section 4.6.4.2.5.) and not to forget NEWTON's gravitational constant.

### 6.2.10. 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 $\kappa_0$ (55) arises, that this must be applied even to NEWTON's gravitational-constant. We get after rearrangement:

$$G = \frac{c^3}{\mu_0\kappa_0\hbar H} = \frac{2c^3 t}{\mu_0\kappa_0\hbar} = c^2\frac{R}{M_1} = c^2\frac{r_0}{m_0} \tag{868}$$

The gravitational constant is obviously a function of the local conditions. By insertion of (129) we finally get:

$$G = \frac{c^2}{\mu_0\kappa_0\hbar_1} Q_0 R \tag{869}$$

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 cosmologic background-radiation, be continued accordingly, would form the metric radiation-field of that superordinated universe then.

On the other hand there is the mass $M_1$ in the denominator of (868) and the mass $M_2$ (fixed value) in (869). The term $R=2cT$ indicates G acting along the constant wave count vector. In section 6.2.4.1. in Figure 130 we can see, that $M_1$ depends on time and distance, $m_0$ has the value $M_1$ at intervals of R, whereas with $M_2$ it's about a historic value, only possible, if we go back in time. Thus, we can assign R to time, $Q_0$ however to space-time.

6.2.10.1. Temporal dependence

We replace $Q_0$ and R with the corresponding temporal functions, then we transform it onto our local coordinates or vice-versa:

$$G = \frac{c^2}{M_2}\tilde{R}\left(1+\frac{t}{\tilde{T}_0}\right)\tilde{Q}_0\left(1+\frac{t}{\tilde{T}_0}\right)^{\frac{1}{2}} \qquad G = \tilde{R}\tilde{Q}_0\frac{c^2}{M_2}\left(\frac{2\kappa_0 t}{\varepsilon_0}\right)^{\frac{3}{2}} \sim t^{3/2} \tag{870}$$

$$G = \tilde{R}\tilde{Q}_0\frac{c^2}{M_2}\left(1+\frac{t}{\tilde{T}_0}\right)^{\frac{3}{2}} \sim Q_0^3 \sim \beta^{-2} \qquad G = \tilde{R}\tilde{Q}_0\frac{c^2}{M_2}\left(\frac{t}{t_1}\right)^{\frac{3}{2}} = \tilde{G}Q_0^3 \tag{871}$$

The term before the bracket equals the local $\tilde{G}$ (frame of reference) of the gravitational constant G. The right-hand expressions apply to t, reckoned from BB on.

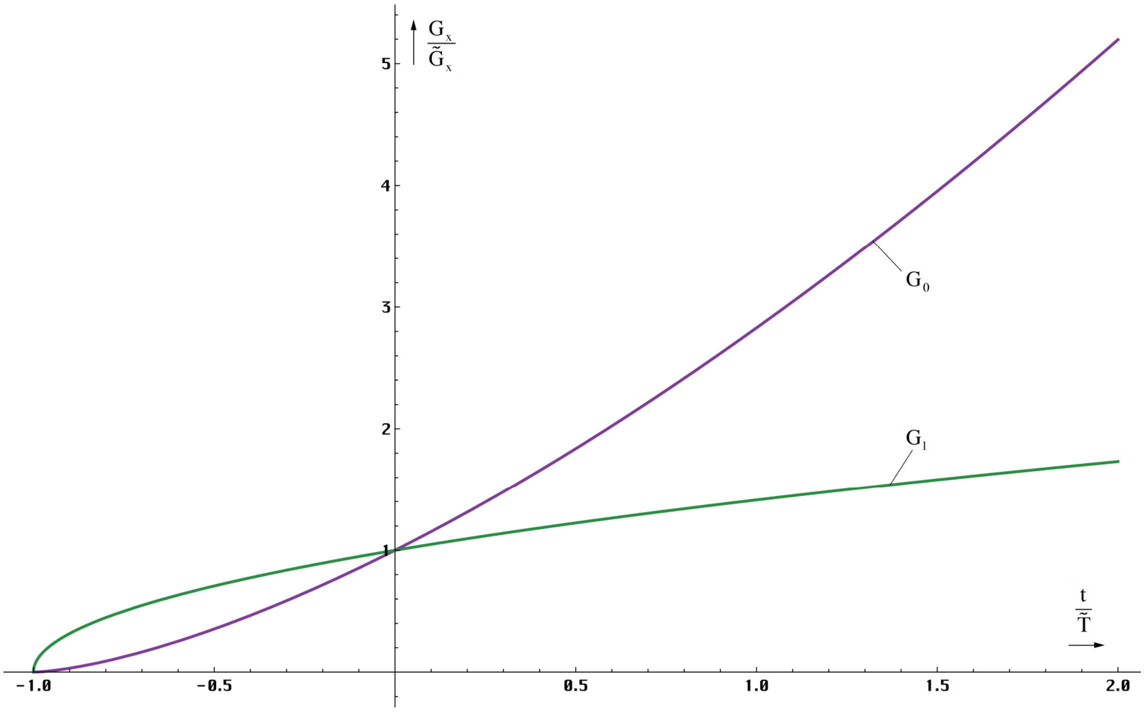



Figure 135
Temporal course the gravitational-constant at the point r=0 (linear scale)

The temporal course at the point r=0 is shown in Figure 135 and 127. In the early beginning of expansion the value of the gravitational constant was equal to zero increasing steadily later on, as we can see in Figure 135 very well. To the point of time $t_1$ with $Q_0$=1 as well $G_{(0)}$, as even $G_1$ have had the value $G_2$. This can be clearly seen in Figure 136. For the value $G_2$ we obtain:

$$G_2 = c^2 \cdot 1 \cdot \frac{r_1}{M_2}\left(\frac{t_1}{t_1}\right)^{\frac{3}{2}} = GQ_0^3 = 1.15036 \cdot 10^{-193} m^3 kg^{-1} s^{-2} \tag{872}$$

Therefrom results, that gravity could not have played an essential role to a point of time t<7.7ns (quantum-universe). The same applies even today on a sub microscopic scale. In the range of the PLANCK length $r_0=2ct_0$ the amount of G is about 90 magnitude orders below the macroscopic value. Therefore gravity and quantum-effects are excluding each other. But 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 speaking, shortly thereafter there was no gravity at all.

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.

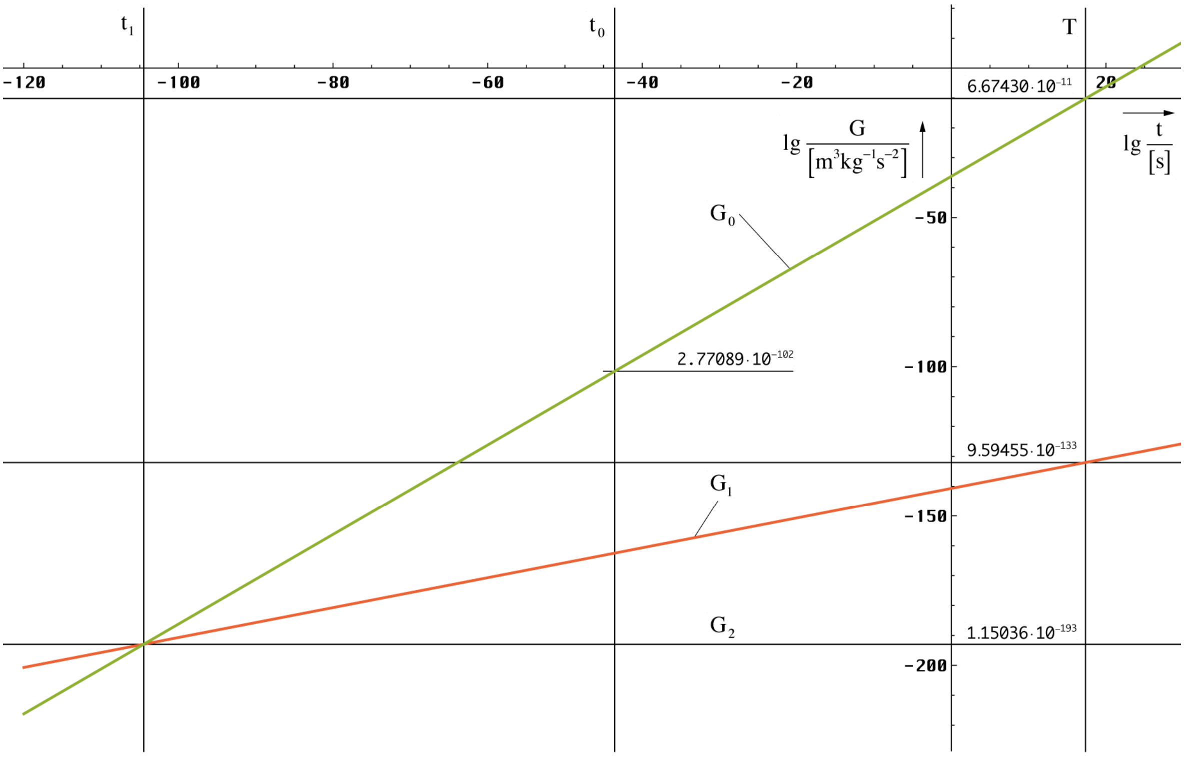



Figure 136
Temporal course of the gravitational- constant
with respect to the local age (logarithmic scale)

### 6.2.8.2. Spatial dependence

If a temporal dependence exists, so there is also a spatial dependence. We directly get the relation by expansion of (869) with the navigational gradient (64), the world radius R depends on the time only.

$$G = \frac{2c^3 t}{\mu_0 \kappa_0 \hbar}(2\omega_0 t - \beta_0 r) \tag{873}$$

$$G = \tilde{R}\tilde{Q}_0 \frac{c^2}{\mu_0 \kappa_0 \hbar_1} \underbrace{\left(1+\frac{t}{\tilde{T}}\right)}_{\text{Temporal}} \underbrace{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)}_{\text{Spatial}} \tag{874}$$

The course for t=0 is shown in Figure 137. 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.

That's due to the fact, that gravity acts along the constant wave count vector with the maximum length 2cT and it doesn't leave the universe, far from it, it reapproaches the observer with distances >cT. Now the attractive force is opposite to the moving direction, leading to the negative sign of G. Both, the observer and even the starting point of the constant wave count vector are *located* at the event horizon, that is to say. The original expansion centre (BB) is „smeared" across the entire universe due to expansion today. That's an effect of the 4D-topology. The course of G behind the second event horizon increases, because it's *situated* in the future.

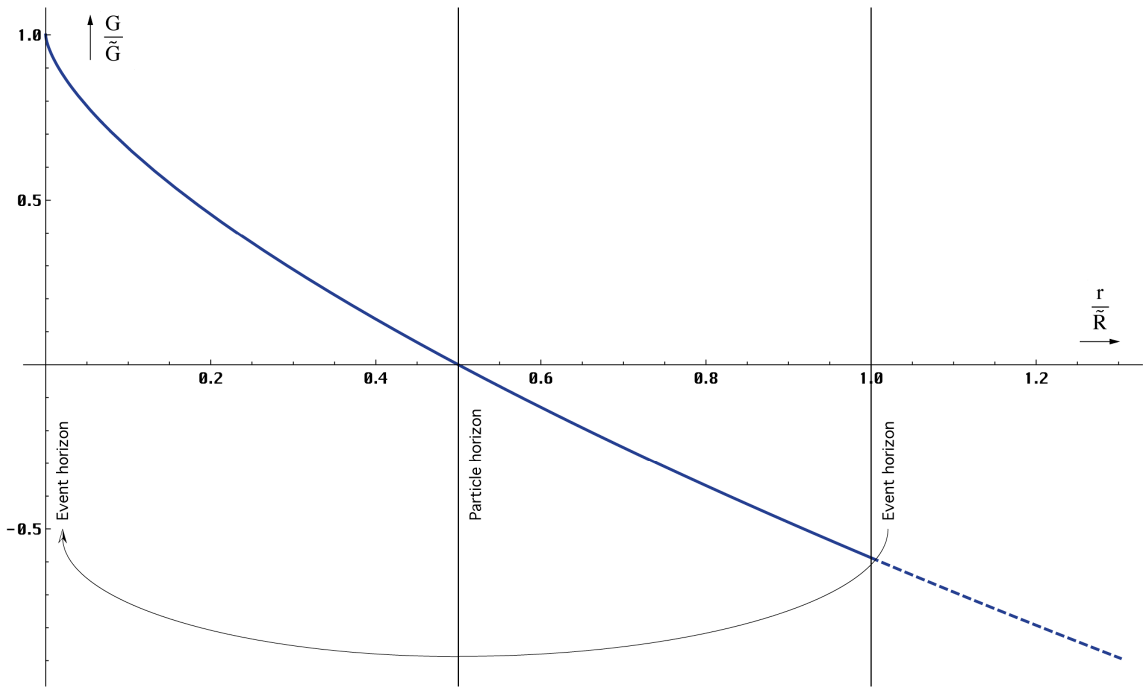



Figure 137
Spatial dependence of the gravitational-constant
to the point of time T (linear scale)

The calculation of $G_1$ at intervals of $r=R/2$ for $t=0$ is somewhat more complicated. With $r=R/2$ namely, it is equal to zero. The value, we are actually looking for is a few steps from there at intervals of $r=R/2-r_1$ and (874) is not suited for such a small distance to the edge. We need to embed the exact expression (240):

$$G = \tilde{R}\tilde{Q}_0 \frac{c^2}{\mu_0\kappa_0\hbar_1} \underbrace{\left(1+\frac{t}{\tilde{T}}\right)}_{\text{Temporal}} \underbrace{\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}} - \frac{1}{\tilde{Q}_0}\right)^{\frac{2}{3}}\right)}_{\text{Spatial}} \quad (875)$$

The value $G_1$ occurs with $Q_0=1$. It applies:

$$G_1 = \frac{r_1c^2}{M_1}(1-(1-1/1)^{2/3}) = \frac{r_1c^2}{M_1} = GQ_0^{-2} = 9.594550966819\cdot 10^{-133}\mathrm{m}^3\mathrm{kg}^{-1}\mathrm{s}^{-2} \quad (876)$$

Thus, G decreases towards the edge $R/2-r_1$ to the value $G_1$. There is no frame of reference possible behind, $G_2$ is not reached.

Since the attractive force $F_G$ decreases geometrically with $r^2$ and G with $r^{2/3}$, it adds up to $F_G\sim r^{-8/3}$. In addition, there is the ever increasing delay. That means, that the gravitational constant no longer plays a role with greater distance. Because of the definition (868) G is a local parameter in fact.

The attractive force $F_G$ between two bodies, moved with the metrics, is defined alongside a constant wave count vector. If we calculate the value in a certain distance, it means, that G doesn't have the same size everywhere on the way there. For a correct equation of motion we have to build the integral across the whole reach with $dr=r_0$. A greater distance means distances of $r>0.01R$. From this point on, other effects come into play. We have already examined them in detail in → *Section 4.5.*

Furthermore, we can draw the following important conclusions:

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 (uninhibited 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 (758), 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» 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 (812). 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 $\alpha$ and $\gamma_\gamma$ 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 $\phi$ [V] as well as $\psi$ [A], at which point after division by a length unit $2\pi r$ (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:

$$\mathbf{H} = \left(\frac{\psi}{\infty} - \frac{\psi}{2\pi r}\right)\mathbf{e_r} = -\frac{\psi}{2\pi r}\,\mathbf{e_r} \qquad \text{Magnetic field-strength} \quad \text{H-field} \qquad (877)$$

$$\mathbf{E} = \left(\frac{\phi}{\infty} - \frac{\phi}{2\pi r}\right)\mathbf{e_r} = -\frac{\phi}{2\pi r}\,\mathbf{e_r} \qquad \text{Electric field-strength} \quad \text{E-field} \qquad (878)$$

In this case, $\mathbf{e_r}$ is the unit-vector. With the magnetic field in general, $\psi$ is to equate with the current i through a conductor. Thus 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 ($\neq 0$)), and the potential in the distance r. For this reason, the field-strength of a single punctual or linear source is defined negatively in general.

What does it look like with the gravitational field-strength however? The unit in the denominator would be [m] probably in turn. But what the numerator consists of? The answer is: also a length. The unit of measurement would be [m/m] then, that means [1]. But which length could it be here? Best suitable would be PLANCK's fundamental length ($r_0$), which, as 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:

$$\mathbf{U} = \left(\frac{r_0}{2\infty} - \frac{\cancel{2} r_0}{\cancel{2} r_0}\right)\mathbf{e_r} = \left(\frac{r_0}{\infty} - \frac{r_0}{r_0}\right)\mathbf{e_r} = -\mathbf{e_r} \qquad (879)$$

The factor $2\pi$ 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. From the preceding contemplations we know that the maximum space-like distance in the universe is R/2. But that's not applied to the electric and the magnetic field since both fields are oriented in an inverse manner, i.e. time-like. The utmost time-like vector is R, the difference microscopic. The corresponding term is not exactly but only almost equal to zero then. Else with the gravitational-field. Expression (879) correctly reads here:

$$\mathbf{U} = \left(\frac{\cancel{2} r_0}{\cancel{2} R} - \frac{r_0}{r_0}\right)\mathbf{e_r} = \left(\frac{r_0}{R} - 1\right)\mathbf{e_r} = \left(\frac{1}{Q_0} - 1\right)\mathbf{e_r} \qquad (880)$$

$$-\mathbf{U} = \left(1 - Q_0^{-1}\right)\mathbf{e_r} \qquad (881)$$

From the URT we now know the relation for the $g_{00}$ -component of the metric tensor, which has the form of expression (881) approximately. It applies:

$$-g_{00} = 1+\frac{2\Phi}{c^2}+O\left(\frac{v}{c}\right) \approx 1-\frac{2MG}{rc^2} \qquad \text{with} \qquad \Phi = -\frac{MG}{r} \tag{882}$$

Here is Φ 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 (882) 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 (794) we obtain at first:

$$-g_{00} = 1-2\frac{\frac{M}{r}}{\frac{m_0}{r_0}} \qquad \text{with} \qquad \frac{r_0}{m_0} = \frac{G}{c^2} = \frac{R}{\hbar\mu_0\kappa_0} = \frac{r_0^2}{\hbar\varepsilon_0 Z_0} \tag{883}$$

a simple ratio mass/radius to the corresponding values of the Metric line-element. The right-hand expression of (883) equals, with the exception of a factor 8π, the coupling-constant κ in the field-equations of the URT [30] and (1035):

$$G^{ik} = \kappa T^{ik} = 8\pi\frac{r_0}{m_0}T^{ik} = \frac{8\pi r_0^2 c}{\hbar}T^{ik} \tag{884}$$

Here is $G^{ik}$ the inverse geometry of space, whatever should be that, $T^{ik}$ the inverse energy-momentum tensor (both within the realms of 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 $\beta_\gamma$. 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:

$$\beta^{-1} = \sqrt{-g_{00}} = \sqrt{1-\frac{v^2}{c^2}} \qquad \text{Classical} \tag{885}$$

Really, the value $\beta_\gamma$:

$$\beta_\gamma^{-1} = \sqrt{-g_{00}} = \frac{v}{c}\cos\alpha+\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha} = \frac{\sin\gamma_\gamma}{\sin\alpha} \tag{886}$$

becomes effective, by which the reciprocal of the relativistic shrink factor $\beta_\gamma$ 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 (886) 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 (802) with respect to v:

$$\sqrt{-g_{00}} = \sqrt{\frac{2MG}{rc^2}}\cos\alpha+\sqrt{1-\frac{2MG}{rc^2}\sin^2\alpha} = \frac{\sin\gamma_\gamma}{\sin\alpha} \tag{887}$$

$$\sqrt{-g_{00}} = \frac{\sin\gamma_\gamma}{\sin\alpha} \qquad \text{Gravity field-strength g-field} \tag{888}$$

But does expression (887) apply with disregard of $c_M$ and for $v_M = 0$? Which velocity v′ must be used on the calculation of the trigonometric function $\sin\gamma_\gamma$ and $\sin\alpha$ in (888)?

$$v' \overset{?}{=} c_M + v + v_G = c_M + v + \sqrt{\frac{2MG}{r}} \tag{889}$$

Expression (889) turns out false. At first v′ is equal to $c'_M$ in the new reference frame built by v. Thus, $c_M$ is already contained in the root expression of (889) and v does not adds up completely. Otherwise M, G and r are functions of v too, i.e. with an α, different from 90° there is an implicit solution only. However, this does not pose a major problem with the mathematics programs available today. The gist of the matter is, that the velocity caused by the mass and the one caused by movement add up according to the classical-relativistic expression (877). However, it does not take into account the different angular relations near c and the dependence on v of the root expression in (889). That's why it's important, to calculate the last mentioned dependence primarily.

We already solved a similar problem with the calculation of the diffraction of a light ray in a gravitational field in section 6.1.2.1.1. In order to find a solution we have to convert the original frame of reference to the new one. With $q=Q'_0/\tilde{Q}_0$ we get under application of (698) and (794):

$$\frac{v'}{c} = \sqrt{1-\left(\frac{Q'_0}{\tilde{Q}_0}\right)^3} = \sqrt{1-\left(1-\frac{2M'G'}{r'c^2}\right)} = \sqrt{2\frac{\tilde{M}q^{-5/2}\,\tilde{r}_0 q^{2/2}}{\tilde{r}q^{2/2}\,\tilde{m}_0 q^{-2/2}}} \tag{890}$$

$$\frac{v'}{c} = \sqrt{\frac{2M'G'}{r'c^2}} = \sqrt{\frac{2\tilde{M}\tilde{G}}{\tilde{r}c^2}\left(\frac{Q'_0}{\tilde{Q}_0}\right)^{-\frac{3}{2}}} = \sqrt{\frac{2\tilde{M}\tilde{G}\beta}{\tilde{r}c^2}} = \sqrt{\frac{2\tilde{M}\tilde{G}}{\tilde{r}c^2}\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}} \tag{891}$$

Thus, the gravitational share ascends with ascending speed and descends with increasing distance. The velocity v is defined towards (+) resp. away from (−) the mass centre. It's about a radial vector. Now we have to add v. Applying (877) we get:

$$\frac{v''}{c} = \frac{\frac{v}{c}+\frac{v'}{c}}{1+\frac{vv'}{c^2}} = \frac{\frac{v}{c}+\sqrt{\frac{2\tilde{M}\tilde{G}}{\tilde{r}c^2}\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}}}{1+\frac{v}{c}\sqrt{\frac{2\tilde{M}\tilde{G}}{\tilde{r}c^2}\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}}} \tag{892}$$

The behaviour of the classical solution (lhs) is shown in Figure 138. It is e.g. suitable, to add two kindred velocities, such as at the EINSTEIN-train or with the following example: Rocket A moves with the speed v with regard to the earth. Rocket B moves with v′ with regard to rocket A on the same track. With which speed moves rocket B with regard to the earth?

With the expression on the right however, we expect a different behaviour due to the motion of the observer with respect to the mass, since the expression MG/r now depends on v.

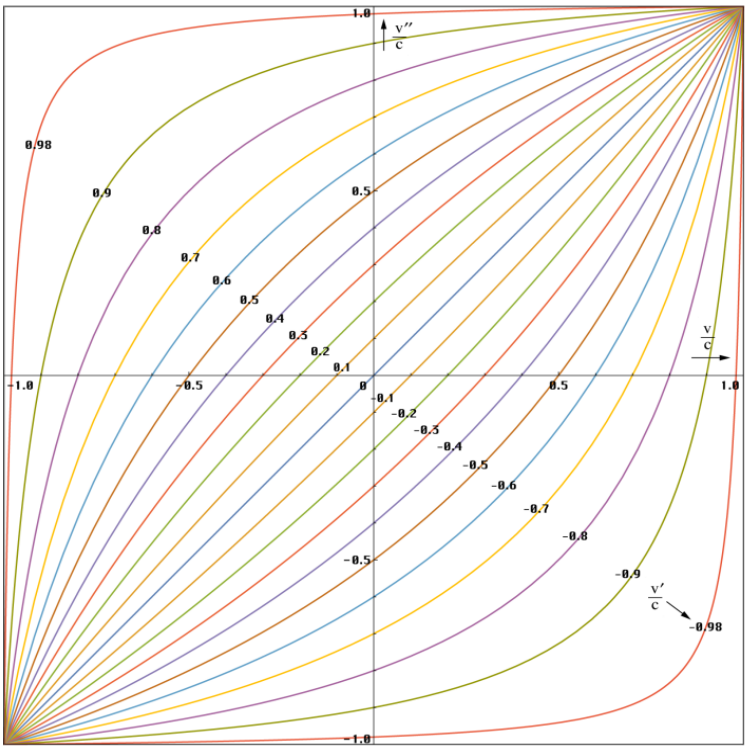



Figure 138
Behaviour of the classical expression of the relativistic speed-addition

The course is depicted in Figure 139. The first thing that comes to mind at first glance is that you shouldn't fly too fast near a large mass, otherwise you possibly might be accelerated in the opposite direction.

Most important for escaping a mass is the 3rd quadrant bottom left. You can't go wrong here. But if you brake instead of accelerating, it may happen that you are accelerated instead and it's even possible, to reach a speed greater than c (4th quadrant bottom right).

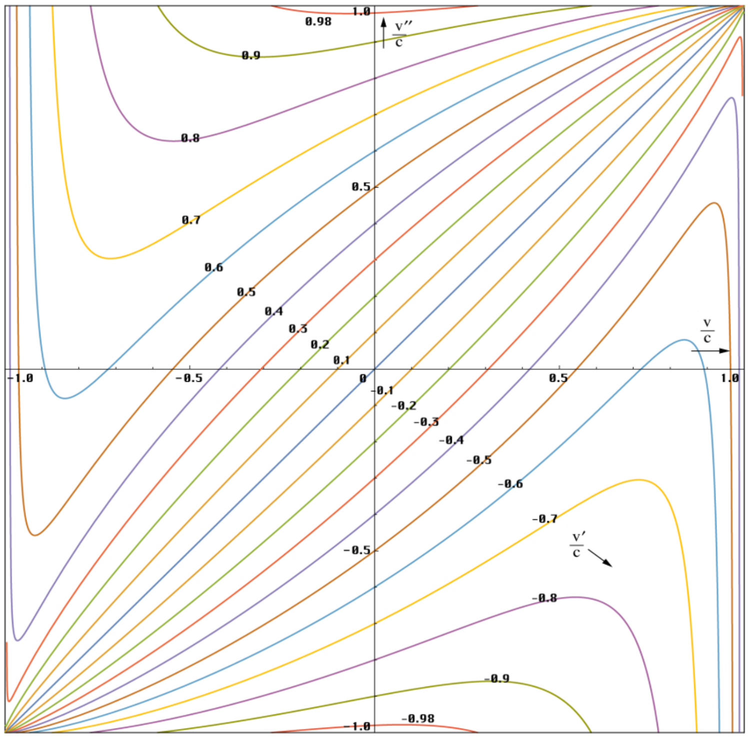



Figure 139
Relativistic speed-addition with variable components MG/r

Figure 139 has been cropped. There are also curve progressions >±c. In one case the event horizon is passed, in the other case it's about a pole. Here it's even possible, to reach velocities $v''>c$. You are tied to the mass until the minimum. Then the gravitational rubber tears and you are flicked away. I don't want to discuss what happens when you can surmount the pole. It has already been observed several times that celestial bodies were thrown away in the vicinity of a black hole. Maybe we can use a black hole as a catapult… For a better overview, Figure 140 shows the poles and the course outside of Figure 139 using the example $v'=0.7c$.

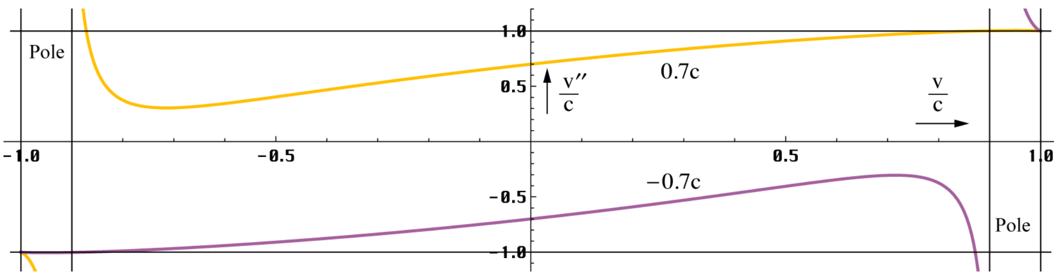



Figure 140
Position of the poles using the example of v′= ±0,7c

All in all, except for $v=0$, it is only a snapshot, since one moves in relation to the centre of mass and after a period of time dt, completely different values apply then, as well for v, v′, M, G as for r. An observer in a circular orbit does not move with respect to the centre, since $v=-v'$ applies. The sum amounts to zero, the g-field is cancelled (microgravity).

Still the tangential vector remains, caused by the rotational speed affecting the temporal component $g_{00}$ only. Therefore with navigational satellites only the clocks have to be corrected. The dilation calculates with $v'=v_{rot}$ only using (885) or (886). At an observer in inhibited free fall there is $v=0$ and no need for speed-addition, but (892) still holds. Then dilation calculates according to (887) or its approximation.

With it, we would have clearly determined the function *O(x)* for the velocity, with the result, that it's no longer required, if we assume MG/r to be variable. Strictly speaking however, expression (892) only applies at the present time $\tilde{T}$ and in the immediate vicinity ($r\leq 0.01\tilde{R}$) of the observer. We acquire the complete expression for an observed object in the distance r at the point of time $\tilde{T}+t$ by combination of (757), (799) and (888) to:

$$\frac{2MG}{rc^2} = \frac{2\tilde{M}\tilde{G}}{rc^2}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)\frac{\sin\alpha}{\sin\gamma_\gamma} \tag{893}$$

The tilded values are the ones at the observer, 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. In fact, r and t should also have a tilde. The navigation-gradient appears here once again. By comparison of coefficients with (881) we get for the Q-factor:

$$Q_0' = Q_0\frac{v^2}{v'^2} = Q_0\frac{\dfrac{2\tilde{M}\tilde{G}}{\tilde{R}_*}}{\dfrac{2\tilde{M}\tilde{G}}{r}} = \frac{Q_0}{\tilde{R}_*}\frac{r}{\left(1+\dfrac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\dfrac{2r}{\tilde{R}}\right)^{\frac{2}{3}}}\frac{\sin\gamma_\gamma}{\sin\alpha} \tag{894}$$

$$Q_0' = Q_0\frac{r}{\tilde{R}_*}\frac{\sin\gamma_\gamma}{\sin\alpha} = Q_0\frac{r}{\tilde{R}_*}\sqrt{-g_{00}} = Q_0\frac{r}{\tilde{R}_*}\sqrt{1-\frac{2GM_*}{rc^2}} \approx Q_0\frac{r}{\tilde{R}_*} \quad t=0,\ R_S \ll r > R_* \tag{895}$$

$R_*$ is the radius of a mass-distribution with the mass $M_*$. Image 133 shows the course of $Q_0$ as a function of the distance using the examples Earth and black hole.

The approximation only applies to distances of $r \gg R_S$ respectively $r \geq R_*$. It should however be noted, that if r is too large, the result will be overlaid by other masses up to $M_1$. Within a normal sized celestial body $Q_0$ drops slightly with r.

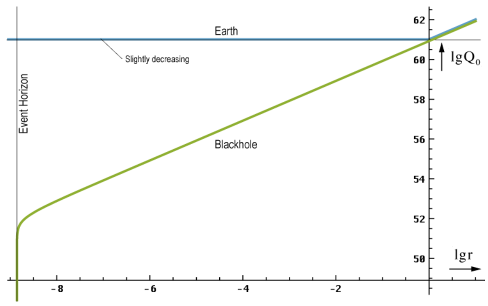



Figure 141
Phase angle $Q_0$ as a function of the distance r

Another case in which the trigonometric factor cannot be neglected are objects in the free fall at a distance of $r \cong R/2$, i.e. close to the particle horizon of the entire universe. With disregard of the trigonometric functions we now are able to rearrange (894) in the following manner:

$$\frac{\tilde{m}_0\tilde{G}}{c^2} = \frac{r_0}{\left(1+\dfrac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\dfrac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} = \tilde{r}_0 \qquad d\tilde{r} = \frac{dr}{\left(1+\dfrac{t}{\tilde{T}}\right)^{\frac{1}{2}} - \left(\dfrac{2r}{\tilde{R}}\right)^{\frac{2}{3}}} \tag{896}$$

With larger values of r, we have to replace r by dr in turn, see also (334). With it, we acquire the same result as with the half-classic approach even here, the distance-function with constant wave count vector. Since the radius r ascends continuously during expansion, the Q-factor in the immediate vicinity of a body moved with the metrics ascends continuously too. Interestingly enough solution (896) voids the $1/r^2$-rule for the gravitational force. That leads to a kind of apsidal precession in the galaxy scale and greater, which may be the reason for the spiral shape of most galaxies.

After equate of (881) and (882) with the approach $g_{00}$=U and comparison of coefficients, starting with (886), we obtain an important relation:

$$\sqrt{-g_{00}} = \sqrt{\tilde{Q}_0^{-1}}\cos\alpha + \sqrt{1-\tilde{Q}_0^{-1}\sin^2\alpha} \approx \sqrt{1-\tilde{Q}_0^{-1}} \quad \text{Field-strength g-field} \tag{897}$$

That means nothing other than, that the value $\tilde{Q}_0$ is identical to the frame of reference, as we already had suspected ($\alpha$ is a direct function of $Q_0$ depending from v too).

$$\tilde{Q}_0 = \frac{c^2\tilde{R}}{\tilde{m}_0\tilde{G}} = \frac{c^2}{\tilde{c}_M^2} = \frac{1}{\rho_0^2} \tag{898}$$

In the URT, space and time are equal dimensions. The definition of the gravitational strength as dimensionless quantity admits even a different 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. PLANCK's quantity of action doesn't remain unaffected. 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.

### 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/m²] for the magnetic induction as well as [As/m²] for the electric charge-density, also called influence. The proportionality-factors for the calculation from **H** and **E** are $\mu_0$ and $\varepsilon_0$ resp. $\mu$ and $\varepsilon$.

$$\mathbf{B} = \frac{d\varphi}{dA}\,\mathbf{e_r} = \mu_0 \mathbf{H} \qquad \text{Induction} \quad \text{B-field} \tag{899}$$

$$\mathbf{D} = \frac{dq}{dA}\,\mathbf{e_r} = \varepsilon_0 \mathbf{E} \qquad \text{Influence} \quad \text{D-field} \tag{900}$$

These are exactly the factors of the COULOMB's and the FARADAY's rule (see Table 7). Both have large similarity with the NEWTON's gravitational-rule. In this the gravitational-constant steps in place of $\varepsilon_0$ as well as of $\mu_0$. 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:

$$\mathbf{a} = \frac{MG}{r^2}\,\mathbf{e_r} \qquad \text{Gravitation} \quad \text{a-field} \tag{901}$$

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/s²]. 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 (896) 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 m², we can write the unit of measurement even as [(m³/s²)/m²], at which point the bracketed expression corresponds to the product MG, and that without change of the physical content. Because we don't know exactly yet, what it's about, we will call this product the gravitational »flux« $\Psi$ for the moment.

$$\mathbf{a} = \frac{d\Psi}{dA}\,\mathbf{e_r} \qquad \text{Gravitation} \quad \text{a-field} \tag{902}$$

A calculation from the field-strength (889) with the help of a coefficient, as usual in the electrotechnics, is impossible unfortunately. Now, we are able to declare both, the relations for the charge as well as for the flux:

$$\varphi = \oint \mathbf{B}\,d\mathbf{A} \qquad \text{Magnetic flux} \tag{903}$$

$$q = \oint \mathbf{D}\,d\mathbf{A} \qquad \text{Electric charge} \tag{904}$$

$$\Psi = \oint \mathbf{a}\,d\mathbf{A} \qquad \text{Gravitational »flux«} \tag{905}$$

Now we want to examine, what's the physical meaning of expression $\Psi$. So, the unit of measurement [m³/s²] 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 (884) 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). From the same reason, the application of Ψ is unusual. Instead, the classic NEWTON's gravitational-potential Φ (882) is being used. Nevertheless we can excellently calculate with Ψ. Here just some examples ($M \gg m$):

$$a = \frac{\Psi}{r^2} = \frac{Mc^2}{r^2}\frac{r_0}{m_0} \quad \Bigg| \quad F = m\frac{\Psi}{r^2} = \frac{mM}{r^2}\frac{r_0}{m_0}c^2 \quad \Bigg| \quad R_S = \frac{2\Psi}{c^2} = 2M\frac{r_0}{m_0} \quad \Bigg| \quad v_G = \sqrt{\frac{2\Psi}{r}} \qquad (906)$$

$$G = c^2\frac{r_1}{m_H} = c^2\frac{r_0}{m_0} = c^2\frac{R}{M_1} = \frac{2c^3T}{\mu_0\kappa_0\hbar} \qquad \Phi = -c^2\left[\frac{M\,r_0}{m_0 r}\right] \qquad (907)$$

$R_S$ is the SCHWARZSCHILD-radius, $v_G$ the escape velocity. And NEWTON's law of gravitation $F = M \cdot a$ in the second expression even can be written in a form like COULOMB's law (Then G is in the denominator) see Table 7.

| Field quantity | Magnetic field | | Electric field | | Gravity field | | Nomenclature |
|---|---|---|---|---|---|---|---|
| Description | MMF | -- | EMF | -- | MLE | -- | -- |
| Potential | $\psi$ | [A] | $\phi$ | [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] | $\Psi = GM$<br>$\Psi = \oint a dA$ | $\left[\frac{m^3}{s^2}\right]$ | Unusual |
| Description | Induction | -- | Influence | -- | Gravitation | -- | -- |
| Fieldstr. 2 | $B = \frac{d\varphi}{dA}$<br>$B = \mu_0 H$ | $\left[\frac{Vs}{m^2}\right]$ | $D = \frac{dq}{dA}$<br>$D = \varepsilon_0 E$ | $\left[\frac{As}{m^2}\right]$ | $a = \frac{d\Psi}{dA}$<br>-- | $\left[\frac{m}{s^2}\right]$ | 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])<br>-- | $\left[\frac{V}{m^2}\right]$ | $S = \frac{dI}{dA}$<br>$S = \kappa E$ | $\left[\frac{A}{m^2}\right]$ | $G_{00} = \frac{dF}{dA}$<br>-- | $\left[\frac{N}{m^2}\right]$ | Geometry |

Table 7
Field-quantities of the electric, magnetic and gravitational-field in the comparison

1) Physically pointless
2) Permanent magnet
3) $Q_0 \geq 10^5$

NEWTON's gravitational constant can be described both, as function of the local PLANCK-units, and of the locally observed quantities of the universe as a whole. But we even do well totally without G. But we must not forget, that all values are being influenced by the mass M and by m too. These on the other hand, depend on the conditions of the surrounding space and also on speed. The value $r_1$ is a constant, $M_H$, $m_0$, $M_1$ is the HUBBLE-, the PLANCK- and the MACH-mass. The former is equal to the rest mass of the photon, the latter to the mass of the metric wave field. It applies:

$$M_H = \frac{\hbar H_0}{c^2} \;\Big|\times Q_0 \;\rightarrow\; m_0 \;\Big|\times Q_0 \;\rightarrow\; M_1 \;\Big|\times Q_0 \;\rightarrow\; M_2 \qquad (908)$$

Interesting is the right-hand expression of (907). The bracketed expression is invariant against external changes of $Q_0$ but only, if M is in the free fall.

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 $\hbar\omega_D/c^2$ ($\omega_D$ is the DEBROGLIE- angular frequency of a particle) and G by (794), we acquire the following relations:

$$\Psi = MG = \frac{c}{\mu_0\kappa_0}\frac{\omega_D}{H} = r_1 c^2 \frac{\omega_D}{H} = r_0 c^2 \frac{\omega_D}{\omega_0} = r_0^2 c\,\omega_D \qquad (909)$$

$$R_S = \frac{2\Psi}{c^2} = \frac{2}{\kappa_0 Z_0}\frac{\omega_D}{H} = 2r_1\frac{\omega_D}{H} = 2r_0\frac{\omega_D}{\omega_0} = 2\frac{r_0^2}{c}\omega_D \qquad (910)$$

Except for the frequency $\omega_D$ 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 $\mu_0$ and $\varepsilon_0$ 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 $\omega_D$. 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 $\omega_0$.

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, $\Psi$ 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 former editions, I often used the expression MINKOVSKIan line-element without going into it's actual meaning. Rather, I 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 question because 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 manoeuvrable 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 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 ([1] 23) in the form:

$$s^2 = x^2 + y^2 + z^2 - \underline{c}^2 t^2 \tag{911}$$

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 (904) is used, which leads to the expression stated in [30]:

$$ds^2 = dt^2 - dx^2 - dy^2 - dz^2 \tag{912}$$

Here we are unfortunately concerned once again with the standard notation of the SRT and URT, veiling the correlations by setting c 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 (912) had to be correctly then:

$$ds^2 = d(ct)^2 - dx^2 - dy^2 - dz^2 \qquad \text{resp.} \tag{913}$$

$$ds^2 = d(x^0)^2 - d(x^1)^2 - d(x^2)^2 - d(x^3)^2 = \eta_{ab}\, dx^a dx^b \tag{914}$$

with $d(x)^2 = dx^2$. And just this $ds^2$ figures the real MINKOVSKIan 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 (914) are identical, i.e. they describe the same, namely the MINKOVSKIan line-element. Although, only the right expression admits direct calculations with tensors (matrices). The expression $\eta_{ab}$ is called as well *metrics* as *metric tensor*, at which point the letter $\eta$ is reserved to the MINKOVSKIan 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 $\eta_{ab}$ is meant, which is defined as follows:

$$\eta_{ab} \equiv \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} = \operatorname{diag}(1,-1,-1,-1) \tag{915}$$

The individual elements of the matrix are called $\eta_{00}$, $\eta_{01}$, $\eta_{02}$, $\eta_{03}$, $\eta_{10}$, $\eta_{11}$,… $\eta_{33}$ at which point the line is specified by the first, the column by the second number. In this case, only the elements $\eta_{00}$, $\eta_{11}$, $\eta_{22}$ and $\eta_{33}$ 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 $\eta^{ab}$ 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 MINKOVSKIan metrics $g_{ik}$ in spherical coordinates looks as follows:

$$g_{ik} \equiv \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -r^2 & 0 \\ 0 & 0 & 0 & -r^2\sin^2\vartheta \end{bmatrix} = \operatorname{diag}\left(1,-1,-r^2,-r^2\sin^2\vartheta\right) \tag{916}$$

The transition to Cartesian coordinates is defined in the following manner:

$$\underline{c}t = \underline{c}t \qquad x = r\sin\vartheta\cos\phi \qquad y = r\sin\vartheta\sin\phi \qquad z = r\cos\vartheta \tag{917}$$

Then, the line-element written out becomes to:

$$ds^2 = d(\underline{c}t)^2 - dr^2 - r^2 d\vartheta^2 - r^2\sin^2\vartheta\, d\phi^2 \tag{918}$$

$$ds^2 = d(x^0)^2 - d(x^1)^2 - d(x^2)^2 - d(x^3)^2 = g_{ik}\,dx^i dx^k \tag{919}$$

In this connection the $g_{00}$-component of the metrics (this is equal to $\eta_{00}$ ) 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 (915) and (916) there is on position (0,0) the factor 1 in each case. That indicates a genuine MINKOVSKIan 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 $\underline{c}$ of the metric wave-field (255). Then, with expression (260) we got the following expression (now in new notation):

$$ds^2 = -\frac{4dr_0^2}{1-(A(\phi)-jB(\phi))^2} - dr^2 - r^2 d\vartheta^2 - r^2 \sin^2\vartheta\, d\varphi^2 \tag{920}$$

Because of $\dot{r}_0 dt = dr_0$ even time has vanished here, albeit $r_0$ remains time-dependent. On this occasion, we also 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 (920), 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:

$$\left|(dx^0)^2\right| = \frac{2c^2dt^2}{\omega_0^2 t^2 \sqrt{(1-A^2+B^2)^2+4A^2B^2}} = \frac{c^2dt^2}{4\rho_0^2\omega_0^2 t^2} \tag{921}$$

$$\arg((x^0)^2) = -\arctan\frac{2AB}{1-A^2+B^2} = \arctan\theta \tag{922}$$

Because of the quadratic function, even the duplicate phase-angle $\theta$ appears here. Considering the value-function (921) more exactly, so there our non-rectangular triangle (Figure 102) is actually already implicitly included. This is an universal characteristic of the Hankel function. Furthermore congruences with (651) and (614) can be found.

With the comparison of $-g_{00}$ from (921) with expression (896), immediately attracts attention, that both components are strongly differing in the magnitude. While $-g_{00}$ in (896) is about equal to 1, the value in (916) 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 does not mean that the whole calculation has been for nothing. So (896) describes the dependence of the time-coordinate in the surroundings of a mass (when applying (892)), whereas in (920) 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 (920) to be incorrect respectively partially correct only. If we apply expression (898) instead of (892) with (896), 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 $\pi/2$ approximately, then we can make the guess that (920) actually has the following form:

$$ds^2 = \left(1-\frac{1}{4\rho_0^2\omega_0^2t^2}\right)c^2dt - dr^2 - r^2d\vartheta^2 - r^2\sin^2\vartheta\, d\varphi^2 \tag{923}$$

$$(dx^0)^2 = \left(1-\frac{1}{4\rho_0^2\omega_0^2t^2}\right)c^2dt^2 \approx \left(1-\frac{c_M^2}{c^2}\right)c^2dt^2 \rightarrow \left(1-\frac{v^2}{c^2}\right)c^2dt^2 \tag{924}$$

The right-hand expression corresponds to (897). That means, it's valid for time-like photons ($g_{00}$). To it applies the reciprocal of the bracketed expression. Now, the angle $\alpha$ is not a right one as you know then again, so that (923) and (924) not can be accurate at all. On the other hand, in the mentioned expressions the same angles occur, as in Figure 102, 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. (577). 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 (578). 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 (724) usefully. In this case (wavelength!) applies the reciprocal however.

With neutrinos in contrast (725) is applied. Then however, we are concerned with four different line-elements at the same time, or better, with three line-elements, because $\sin\gamma_{\bar{\nu}}$ 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:

$$g_{ik} \equiv \operatorname{diag}\left(\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}\left(1+\frac{t}{\tilde{T}}\right)^{-1}, -\frac{\sin^2\alpha}{\sin^2\gamma_{\bar{\gamma}}}\left(\left(1+\frac{t}{\tilde{T}}\right)^{\frac{1}{2}}-\left(\frac{2r}{\tilde{R}}\right)^{\frac{2}{3}}\right)^2, -r^2, -r^2\sin^2\vartheta\right) \tag{925}$$

Considering bodies in the free fall only, so (925) simplifies once again:

$$g_{ik} \equiv \operatorname{diag}\left(\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}\left(1+\frac{t}{\tilde{T}}\right)^{-1}, -\frac{\sin^2\alpha}{\sin^2\gamma_{\bar{\gamma}}}\left(1+\frac{t}{\tilde{T}}\right), -r^2, -r^2\sin^2\vartheta\right)_{v_M+v_G=0} \tag{926}$$

Overall, we are no longer concerned with a genuine MINKOVSKIan – this only applies to the subspace – but with an almost- MINKOVSKIan 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 (881) 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 space not only in dependence on time, distance and velocity (892), 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 (882) we had already found such a relation. But considering this expression more exactly, so it indeed fulfils the requirements of the URT with a mass of M=0, that means, the curvature vanishes and the line-element becomes exactly MINKOVSKIan, 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 (877) 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. The addition however takes place according to the classical EINSTEIN expression for speed-addition (943).

In the case of the existence of a mass-distribution we can proceed similarly, whereat the expression MG/r additionally depends on the radial velocity v′ (886). We just have to find a metric velocity $\mathbf{v_G}$, whose magnitude depends on the mass and the distance to the centre of that mass. There is really such a velocity. If we split the approximate expression (877) by analogy with $1-v_G^2/c^2$ we obtain the expression for the orbit speed or the 1st cosmic velocity:

$$v_G = \sqrt{\frac{\tilde{M}\tilde{G}}{\tilde{r}}} = c\sqrt{\frac{\tilde{M}\,\tilde{r}_0}{\tilde{r}\,\tilde{m}_0}} \qquad (927)$$

M, G and r depend on the reference frame. But what about in absence of a mass in the vicinity, apart from the observer's own mass? That would be the case M=0. Strictly speaking, such a scenario does not exist. There is namely a smallest mass amounting to $M_H = \hbar H_0/c^2 = 2.60949\cdot 10^{-69}$ kg (according to Table 11) which is also identical to the rest mass of the photon. $H_0$ as known, has the character of an angular frequency with the wavelength $\lambda_0$=R, more does not fit into the universe. The PLANCK-mass $m_0$ is quite small, but there are much smaller masses. With it, there is also a smallest speed $v_G$. Analogously to (927) this is calculated as:

$$v_G = \sqrt{\frac{\tilde{M}_H\tilde{G}}{\tilde{r}_0}} = \sqrt{\frac{\tilde{m}_0\tilde{G}}{\tilde{R}}} = c\sqrt{\frac{\tilde{m}_0\,\tilde{r}_0}{\tilde{R}\,\tilde{m}_0}} = \frac{c}{\sqrt{Q_0}} \approx c_M = Q_0\rho_0 c \qquad (928)$$

It can also be viewed as the speed with which the observer moves away from the centre in the distance R, the propagation speed of the metric wave field $c_M = 1.03807\cdot 10^{-22}\,\mathrm{ms}^{-1}$. $M_H$, G, $r_0$ and R even depend on the reference frame and with it, also on v. That means that $c_M$ is always already contained in MG/r. So you don't have to add anything, just v itself, and $c_M$ and $v_G$ are equivalent. In the approximation for velocities $v \gg c_M$, with small curvatures as well as with disregard of the spatial share we can write then.

$$\sqrt{-g_{00}} = \frac{\sin\gamma_\gamma}{\sin\alpha} = \frac{v}{c}\cos\alpha + \sqrt{1-\frac{v^2}{c^2}\sin^2\alpha} \approx +\sqrt{1-\frac{v^2}{c^2}} \qquad (929)$$

To a body with a fixed position at the surface, applies $v_M = 0$ and the following expression:

$$-g_{00} = 1-\frac{2\tilde{M}\tilde{G}}{rc^2} \qquad \text{for } M \gg 0 \text{ and/or } Q_0 \gg 1 \tag{930}$$

Here the space-like vector r/2 comes into effect. For $M \to 0$ still the basic curvature of the metric wave-field remains:

$$-g_{00} = 1-\frac{1}{4\rho_0^2\omega_0^2t^2} \approx 1-\frac{1}{\tilde{Q}_0} \qquad \text{for } M \to 0 \tag{931}$$

It would be favourable for the component $g_{11}$, if we could replace $\sin\gamma_{\bar{\gamma}}$ by $\sin\gamma_{\gamma}$. Usefully, we use the relations (720) and (722) for it. It applies without the navigation-gradient again:

↓(932)

$$\sqrt{-g_{11}} = \frac{\sin\alpha}{\sin\gamma_{\bar{\gamma}}} = \frac{1}{\frac{v}{c}\cos\alpha-\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}} = \frac{\frac{v}{c}\cos\alpha+\sqrt{1-\frac{v^2}{c^2}\sin^2\alpha}}{\frac{v^2}{c^2}-1} = -\frac{1}{1-\frac{v^2}{c^2}}\frac{\sin\gamma_\gamma}{\sin\alpha}$$

Here, also the conversion-factor β between space-like and time-like distance appears, as already anticipated with (283). For the approximation by analogy with (930) we get the following expression:

$$\sqrt{-g_{11}} \approx -\left(1-\frac{2MG}{rc^2}\right)^{-1}\sqrt{1-\frac{2MG}{rc^2}} = -\left(1-\frac{2MG}{rc^2}\right)^{-\frac{1}{2}} \tag{933}$$

$$g_{11} \approx -\left(1-\frac{2MG}{rc^2}\right)^{-1} \tag{934}$$

After substitution in (926) 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 $\beta^{-1}$ 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. We use the ratio v″/c from (892). To the angle δ commonly applies:

$$\delta = \arcsin\left(\frac{v''}{c}\sin\alpha\right) \qquad \frac{v''}{c} = \frac{\frac{v}{c}+\sqrt{\frac{2\tilde{M}\tilde{G}}{\tilde{r}c^2}\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}}}{1+\frac{v}{c}\sqrt{\frac{2\tilde{M}\tilde{G}}{\tilde{r}c^2}\left(1-\frac{v^2}{c^2}\right)^{-\frac{1}{2}}}} \tag{935}$$

and to the angle γ according to the kind of photon:

| | | |
|---|---|---|
| $\gamma_\gamma = \arg\underline{c}+\arccos\left(\frac{v''}{c}\sin\alpha\right)+\frac{\pi}{4}$ | Time-like photons | (936) |
| $\gamma_{\bar{\gamma}} = -\arg\underline{c}-\arcsin\left(\frac{v''}{c}\sin\alpha\right)+\frac{\pi}{4}$ | Space-like photons | (937) |
| $\gamma_\nu = -\arg\underline{c}+\arcsin\left(\frac{v''}{c}\cos\alpha\right)-\frac{\pi}{4}$ | Neutrinos | (938) |
| $\gamma_{\bar{\nu}} = \arg\underline{c}-\arccos\left(\frac{v''}{c}\cos\alpha\right)-\frac{\pi}{4}$ | Antineutrinos | (939) |

Then, NEWTON's classical gravitational potential is defined in the following manner:

$$\Phi = \frac{1}{2}\left(\frac{v''}{c}\right)^2 \qquad \text{with} \quad a = -\operatorname{grad}\Phi \tag{940}$$

As next, we want to examine the relation for the orbit velocity (919) more exactly once again. According to the kind, it's about a propagation-velocity too. After substitution of G by (794) and of $M=\hbar\omega_D/c^2$ we obtain the following relation:

$$v_G = \sqrt{\frac{\tilde{M}\tilde{G}}{\tilde{r}}} = c\sqrt{\frac{\tilde{R}}{r}\frac{\omega_D}{\omega_1}} = c\sqrt{\frac{\tilde{r}_0}{r}\frac{\omega_D}{\tilde{\omega}_0}} = c\sqrt{\frac{\tilde{r}_0}{r}\frac{\omega_0-\tilde{\omega}_0}{\tilde{\omega}_0}} \tag{941}$$

In this case, $\omega_D$ is the DEBROGLIE- angular frequency of an arbitrary particle. We had already noticed that „normal" particles (fermions) reduce 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 stretching and compression would be swapped. Then, expression (941) for antimatter would read as follows:

$$v_G = -\sqrt{\frac{-\tilde{M}\tilde{G}}{\tilde{r}}} = -c\sqrt{\frac{\tilde{R}}{r}\frac{-\omega_D}{\omega_1}} = -c\sqrt{\frac{\tilde{r}_0}{r}\frac{-\omega_D}{\tilde{\omega}_0}} = -c\sqrt{\frac{\tilde{r}_0}{r}\frac{\tilde{\omega}_0-\omega_0}{\tilde{\omega}_0}} \tag{942}$$

The negative sign of the root-function is applied to antimatter, M is negative. Expression (942) well agrees with the doctrine, that antimatter even possesses 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 (892) resp. (934) rhs whenever the mass is negative. Thus, we are concerned with a symmetry-breaking between „normal" and antimatter even here, which never carries weight at the present time because of the 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 $v_M$. In general, this cannot be chosen freely, unless, it's about a spacecraft. To do this, we want to conduct a gedankenexperiment. As already determined, any observer in the free fall always is situated in the 3D-centre of the universe. In fact he resides on a 4D-hypersurface, the event horizon. This is correct in so far, as it's 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, two cases must be distinguished. The first case is that, with which 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). He 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 orbit velocity to the propagation-velocity $c_M$ of the metric wave-field, in turn using (892) resp. (934) rhs. The space is just curved more strongly than normal.

The second case is, when the body is in the gravitational field of a body being in a non-inhibited free fall at the same time. That's 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 empty space, (only $c_M$ applies). The same case applies to an observer moving in the orbit with the 1st cosmic velocity. Even this is a free fall, also associated with the phenomenon „weightlessness".

In this case, only the share $c_M=c_M+v_G+v_M$ should be effective to the observer. But it can only be achieved, when the speed-component $v_M$ becomes negative. However, according to our definition, for an observer in the centre of the universe there are only negative velocities anyway. These are defined toward the particle horizon (4D-expansion-centre), which is equally far away irrespective of direction. Thus, all forces exerted on the observer by the marginal singularity cancel themselves, so that the observer remains in the centre. I also chose this definition because one moves against the flow of time, i.e. the magnitudes and natural constants change in such a way that they result in values as they prevailed in the past.

Now, we had already posed the question, what a positive velocity, if there should be such a one, actually could mean. This is per definitionem a velocity directed from the particle horizon to the event horizon. Thus, $c_M$ is positive, but ends at the event horizon, where we all live. It cannot overcome this limit, that would be the future. Rather, it pushes this limit in front of itself. Even an observer in the centre is unable to overcome this limit.

But for an observer located in the vicinity of a mass distribution, e.g. a black hole, there is a second event horizon, that can now be overcome after all. The vector $v_G$ is positive, directed towards the black hole and it adds up to $c_M$. 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 3D-centre of the universe. His relative-velocity in reference to the metrics is equal to zero. In reality he resides on a 4D-hypersurface, the event horizon.*

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 just 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 142 once again. It's about the relations for a mass-system, consisting of „normal" matter.

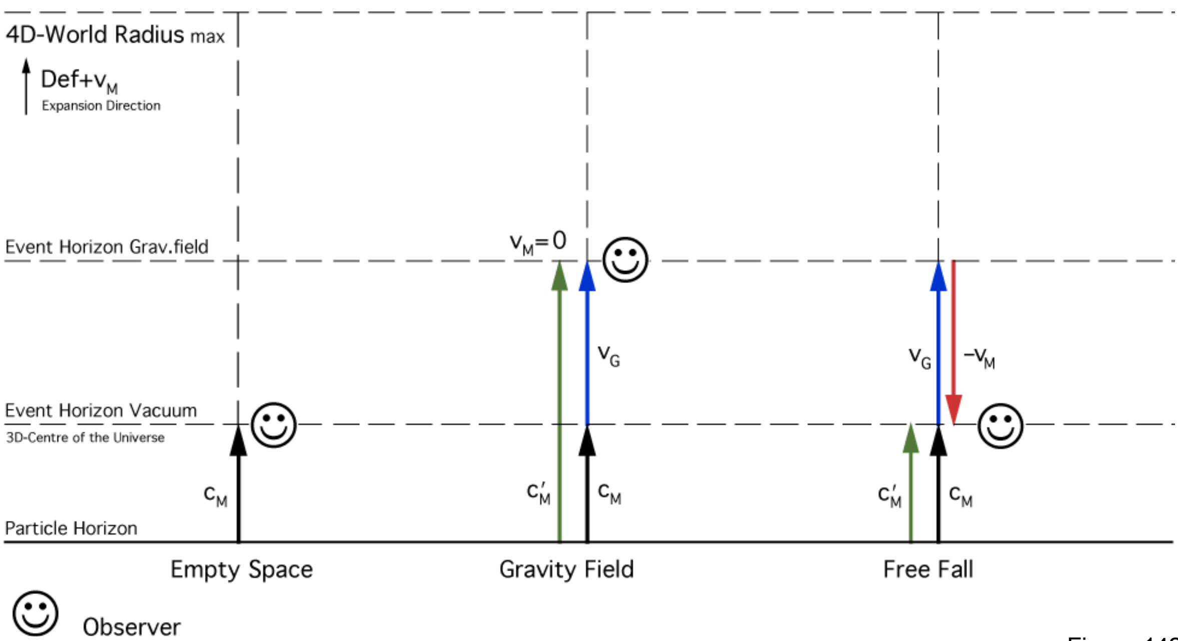



Figure 142
Definition of the velocity and the centre of the universe for the cases empty space, body in the gravitational-field and free fall for „normal" matter

In the case, that the gravitating mass consists of antimatter, the relations according to this model are completely different. Now the escape-velocity is negative, as we can well se in Figure 143. That means, an observer (of antimatter) in the free fall must have a positive velocity, whereas a freely navigating body of antimatter is moving with a negative speed 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.

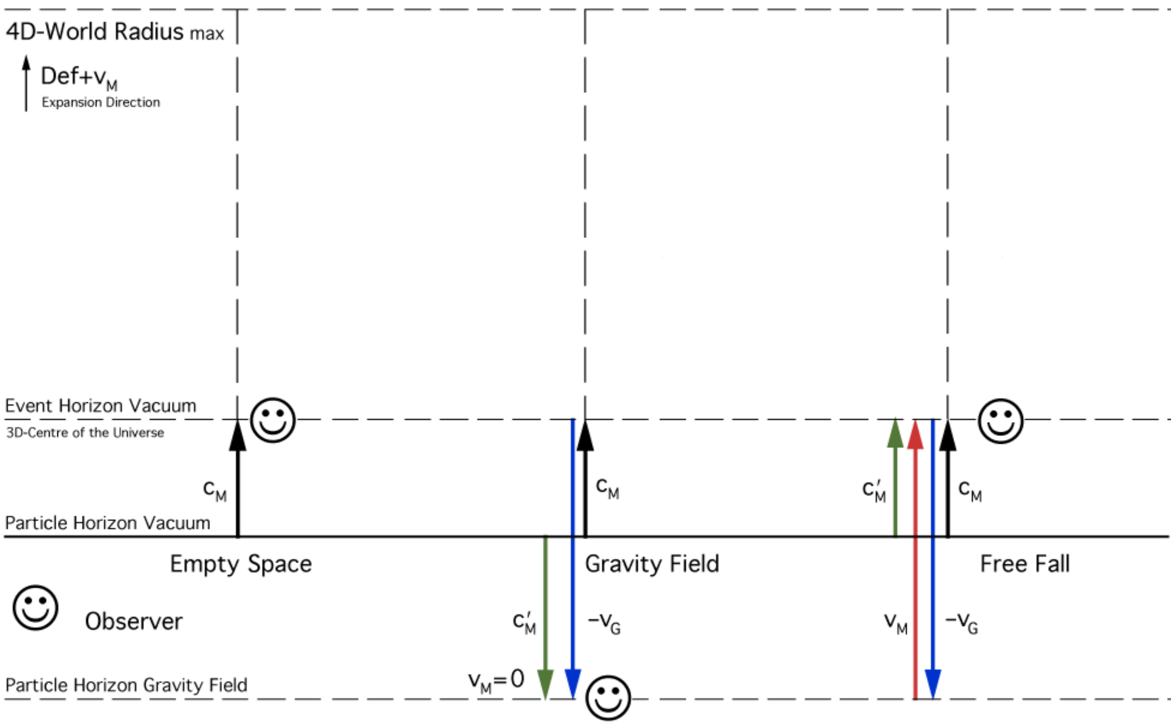



Figure 143
Definition of the velocity and the centre of the universe for the cases empty space, body in the gravitational-field and free fall for antimatter

Thus, we obtain a frequency $\omega_V$ which is equal to the number of line-elements, a body „streaks" with the velocity v within a certain time period. 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 $\underline{c}t$ 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 $2\omega_0 t$. However, the $c_M$ component can also be compensated for by a skilful choice of $v_M$.

Another conclusion is, that two bodies, the first of matter, the second of antimatter, would repel, two similar bodies would attract each other. A free fall of a normal body in the gravity field of a body of antimatter and vice versa would be impossible then. So the third example in Figure 143 applies only to a free fall of a body of antimatter in the gravity field of a body also of antimatter. The particle horizon turns into an event horizon for antimatter. This would be attracted, normal matter repelled. Since with the 4D-expansion centre it's about a particle horizon (for normal matter), it would answer the question of where the antimatter has gone.

### 7.2.3. LORENTZ-transformation and addition of velocities

With (917) 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 editions but added airily all three vectorial part-velocities in fact. This has had a specific reason, which applies even in accordance with the classic theory: All three velocities seemed to be defined in reference to the same frame of reference. However, it has now turned out that $c_M$ is identical to $v_G$ which in addition depends on v due to the changing natural constants, so that we ended up in the different expression (892). Then, the classic addition theorem only applies if $c_M$ resp. $v_G$ is negligibly small compared to v, i.e. far away from any large masses:

$$v'' = \frac{v + v'}{1 + \frac{v v'}{c^2}} \qquad \text{Classic speed-addition} \qquad (943)$$

The famous EINSTEIN train is an example, another one e.g. B moves with v in relation to A, C moves with v′ in relation to B, what is the speed v″ of C in relation to A. 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:

$$\cos\xi = \frac{1}{\sec\xi} = \frac{1}{\sqrt{1+\tan^2\xi}} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (944)$$

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 (211) 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:

$$S'[t', x', y', z'] = L\{S[t, x, y, z]\} \qquad (945)$$

at which point the system S′ should move with the velocity v in reference to S. This transformation is even called LORENTZ-transformation ($L$). 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) MINKOVSKIan line-elements, whereby we will always use the sign-convention of the SRT in this section:

$$x^2 + y^2 + z^2 - c^2t^2 = x'^2 + y'^2 + z'^2 - c^2t'^2 \qquad (946)$$

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:

$$x^2 - c^2t^2 = x'^2 - c^2t'^2 \qquad \text{resp.} \qquad r^2 - c^2t^2 = r'^2 - c^2t'^2 \qquad (947)$$

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,

$$T = jct \qquad T' = jct' \tag{948}$$

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 144.

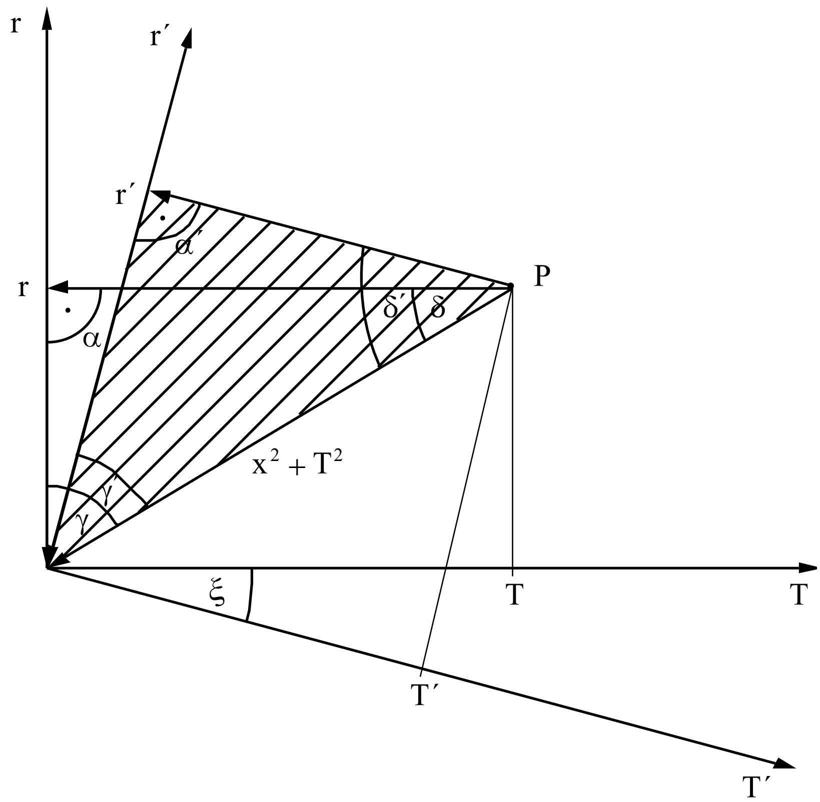



Figure 144
Rotation in the (T,r)-plane during the LORENTZ-transformation

After insertion of (948) in (947) we obtain the following expression:

$$r^2 + T^2 = r'^2 + T'^2 = \rho^2 \tag{949}$$

For $v = 0$ both frames of reference coincide and the angles are equal to the angles $\alpha$, $\gamma$ and $\delta$ 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 $c_\gamma$ and $\rho$ to the zero vector c. This is inevitably alike in both systems. Let's have a look at (949) more exactly, so it's about the relation for the radius $\rho$ 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 $\rho$ doesn't change. In this connection, the rotatory-angle is represented by $\xi$.

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:

$$r' = 0 \qquad r = vt \qquad r = -j\frac{v}{c}T \tag{950}$$

We obtain the right expression by insertion of (948) into the middle expression. Now, with a rotation of the coordinate-system according to [21] the following relations apply:

$$r' = r\cos\xi + T\sin\xi \qquad T' = -r\sin\xi + T\cos\xi \tag{951}$$

$$0 = r\cos\xi + T\sin\xi \qquad \text{because of (950)} \tag{952}$$

The angle $\xi$ is actually negative however. If we define it positive from now on, after substitution of the right expression of (950) applies for r:

$$0 = -j\frac{v}{c}T\cos\xi - T\sin\xi \qquad \text{resp.} \qquad j\frac{v}{c}\cos\xi = \sin\xi \tag{953}$$

$$\tan\xi = j\frac{v}{c} \qquad \text{resp.} \qquad \xi = \arctan j\frac{v}{c} = j\,\mathrm{artanh}\frac{v}{c} \tag{954}$$

$$\cos\xi = \frac{1}{\sqrt{1+\tan^2\xi}} = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{1}{\sqrt{-g_{00}}} = \beta \tag{955}$$

As said, we use $\beta$ instead of the most usual $\gamma$. If we take up a comparison of coefficients, we get the following important expressions:

$$\cos\xi = \frac{1}{\cos\delta} \qquad \xi = j\,\mathrm{artanh}\sin\delta = j\,\mathrm{artanh}\frac{v}{c} \qquad \sin\delta = \frac{v}{c} \tag{956}$$

The relations for the LORENTZ-transforms finally can be determined by rearrangement of (951) and substitution of (950):

$$r' = \cos\xi(r+T\tan\xi) = \beta\,[r+jct(jv/c)] = \beta\,(r-vt) \tag{957}$$

$$T' = jct' = \cos\xi(-r\tan\xi+T) = \beta\,[-r(jv/c)+jct] \qquad |: jc \tag{958}$$

$$t' = \beta\,(t-vr/c^2) \tag{959}$$

and in summary:

$$\boxed{t' = \beta(t-vr/c^2), \quad r' = \beta(r-vt), \quad \vartheta' = \vartheta, \quad \phi' = \phi \qquad \text{Classical}} \tag{960}$$

Now, according to [30] he sum of two velocities arises from the addition of the angles $\xi$. By analogy with the addition-theorem of the area-functions applies:

$$j\left(\mathrm{artanh}\frac{v}{c} + \mathrm{artanh}\frac{v'}{c}\right) = \frac{\frac{v}{c}+\frac{v'}{c}}{1+\frac{vv'}{c^2}} \tag{961}$$

$$\tan\xi'' = j\frac{v''}{c} = j\frac{\frac{v}{c}+\frac{v'}{c}}{1+\frac{vv'}{c^2}} \qquad \text{as always} \tag{962}$$

It becomes interesting, when the angle $\alpha$ 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 (951) occurs even here, we must look once again for an expression for the angle $\xi$ describing this rotation. Inevitably this will differ from (954). In the special-case $\alpha=\pi/2$ however it must turn out the same solution. The substitution (948) 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

$$\cos\xi \equiv \frac{1}{\sqrt{-g_{00}}} = \beta_\gamma \approx \beta \tag{963}$$

*must* apply. If we just assume, that this is the case, using the component $g_{00}$ from our line-element (917) we get the following expressions for the trigonometric functions and the value of the angle $\xi$:

$$\cos\xi \equiv \frac{1}{\sqrt{-g_{00}}} = \frac{\sin\alpha}{\sin\gamma_\gamma} = \beta_\gamma \approx \beta \tag{964}$$

$$\sin\xi \equiv j\sqrt{\frac{1}{-g_{00}}-1} = j\sqrt{\frac{\sin^2\alpha}{\sin^2\gamma_\gamma}-1} \tag{965}$$

$$\tan\xi \equiv j\sqrt{1+g_{00}} = j\sqrt{1-\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}} \approx j\frac{v}{c} \tag{966}$$

$$\xi \equiv j\,\mathrm{artanh}\sqrt{1+g_{00}} = j\,\mathrm{artanh}\sqrt{1-\frac{\sin^2\gamma_\gamma}{\sin^2\alpha}} \approx j\,\mathrm{artanh}\frac{v}{c} \tag{967}$$

To the determination of the LORENTZ-transform we proceed by analogy with the classic case:

$$r' = \cos\xi(r+T\tan\xi) = \frac{1}{\sqrt{-g_{00}}}\left(r+jT\sqrt{1+g_{00}}\right) = \frac{1}{\sqrt{-g_{00}}}\left(r-ct\sqrt{1+g_{00}}\right) \tag{968}$$

$$T' = jct' = \cos\xi(T-r\tan\xi) = \frac{1}{\sqrt{-g_{00}}}\left(jct-jr\sqrt{1+g_{00}}\right) \qquad \Big|: jc \tag{969}$$

$$t' = \frac{1}{\sqrt{-g_{00}}}\left(t-\frac{r}{c}\sqrt{1+g_{00}}\right) \tag{970}$$

and in summary:

$$\boxed{t' = \frac{1}{\sqrt{-g_{00}}}\left(t-\frac{r}{c}\sqrt{1+g_{00}}\right),\ r' = \frac{1}{\sqrt{-g_{00}}}\left(r-ct\sqrt{1+g_{00}}\right),\ \vartheta'=\vartheta,\ \phi'=\phi \qquad (971)}$$

Btw. these relations apply independently from our model and using „our“ $g_{00}$ even simultaneously for effects of velocity, matter-distribution, distance and time, just in general (SRT+ART). In the special-case $\alpha=\pi/2$ (971) yields the classic solution of the LORENTZ-transform. With velocities $v \ll c$ the solution turns into the one of the GALILEI-transformation. With it, we have found a contradiction-free solution, which fills the made requirements.

Now, we want to deal with the addition-theorem of the velocities. One can assume that the individual angles $\xi$ will add up again even here. Thus, the following relation applies $\xi''=\xi+\xi'$, respectively:

$$\xi'' = \mathrm{j}\left(\operatorname{artanh}\sqrt{1+g_{00}}+\operatorname{artanh}\sqrt{1+g'_{00}}\right)= \mathrm{j}\operatorname{artanh}\frac{\sqrt{1+g_{00}}+\sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}} \tag{972}$$

$$\sqrt{1+g''_{00}} = \frac{\sqrt{1+g_{00}}+\sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}} \quad \Bigg| \quad \sqrt{1+g''_{00}} = \frac{\sqrt{1+g_{00}}+\sqrt{(1+g'_{00})\sqrt{1+g_{00}}}}{1+\sqrt{(1+g_{00})^{3/2}(1+g'_{00})}} \tag{973}$$

The rhs expression applies in the presence of a mass M′ with $1+g'_{00}=(c_M/c)^2 \rightarrow$ (891)

$$-g''_{00} = 1-\left(\frac{\sqrt{1+g_{00}}+\sqrt{1+g'_{00}}}{1+\sqrt{(1+g_{00})(1+g'_{00})}}\right)^2 = X^2 \tag{974}$$

$$\sqrt{-g''_{00}} = \frac{v''}{c}\cos\alpha''+\sqrt{1-\frac{v''^2}{c^2}\sin^2\alpha''} = X \tag{975}$$

$$\sqrt{1-\frac{v''^2}{c^2}\sin^2\alpha''} = X-\frac{v''}{c}\cos\alpha'' \qquad \frac{v''^2}{c^2}-2(X\cos\alpha'')\frac{v''}{c}+(X^2-1)=0 \tag{976}$$

$$\frac{v''_{1,2}}{c} = X\cos\alpha''\pm\sqrt{1-X^2\sin^2\alpha''} \tag{977}$$

The upper sign applies to time-like vectors

$$\boxed{\frac{v''_{1,2}}{c} = \sqrt{1+g''_{00}}\cos\alpha''\pm\sqrt{1-(1+g''_{00})\sin^2\alpha''}} \tag{978}$$

For $\alpha=\alpha'=\alpha''=\pi/2$ solution (978) turns out the classical expression (943). Apart from theoretical considerations, calculations shortly after Big Bang and in the vicinity of the event horizon of a black hole, the angle $\alpha$ will hardly have to be taken into account. In the latter case a relevant mass is nearby and you should advantageously use expression (973)

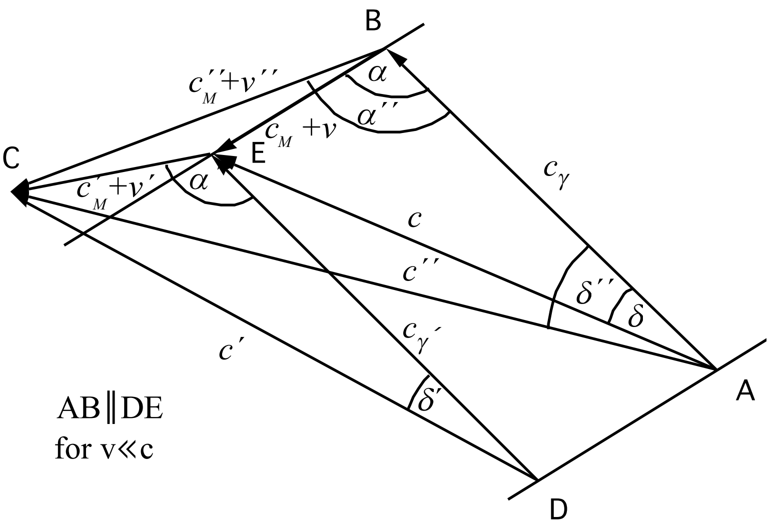



Figure 145
Effect of different angles α on addition of speed-vectors (schematic presentation)

on the right. In addition, the respective angles $\alpha$, $\alpha'$, $\gamma_\gamma$, and $\gamma'_\gamma$ must be taken into account when calculating $g_{00}$ und $g'_{00}$. These are calculated according to (886) and (888) using $Q_0$ and $Q'_0$ (700). To calculate (978) we additionally need the angle $\alpha''$. We get it by a repeated application of (700). An example is shown in Figure 145. Conclusion: A model with variable natural constants requires a revision of the expression of speed-addition, but at the same time it has the advantage that SRT and URT can be combined with it. More on that in the next section.

### 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 $\omega_D$ depend on the frame of reference ($r_0$) in turn. The mass just already somehow is contained in the energy-momentum 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 $\Gamma^{a}_{bc}$ called the metric connection. According to [30] this is defined as follows:

$$\Gamma^{a}_{bc} = \frac{1}{2} g^{ad}\left(\partial_b g_{dc} + \partial_c g_{db} - \partial_d g_{bc}\right) \tag{979}$$

On this occasion, $g^{ad}$ is equal to the component $g_{ad}$ of the inverse matrix $g^{ab}$ and $\partial_b$ 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 (979). 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 MINKOVSKIan line-element we obtain then:

```
Mx={{1, 0, 0, 0}, {0, -1, 0, 0}, {0, 0, -1, 0}, {0, 0, 0, -1}};     (980)
Inx=Inverse[Mx];                                                     (981)
Di=Function[Part[{ct,x,y,z},#+1]];                                   (982)
```

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 (979) 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]];                            (983)
MGamma=Function[For[Mg=0;n=0,n<4,n++,                                (984)
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 (979), 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 MINKOVSKIan line-element.

With (980) 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 MINKOVSKIan 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 $\Gamma^{a}_{bc}$ 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: $\theta \to \vartheta$

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 (980) and (982)

```
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]];
```
(985)

we obtain with the exception of the component $\Gamma^{1}_{33}$ the same results, as in (8.5 [30]). The negative sign is missing with $\Gamma^{1}_{33}$. With the exact values:

$$\left.\begin{array}{ll} \Gamma^{1}_{22} = -r; & \Gamma^{1}_{33} = -r\sin^2\vartheta \\ \Gamma^{2}_{12} = r^{-1}; & \Gamma^{2}_{33} = -\sin\vartheta\cos\vartheta \\ \Gamma^{3}_{13} = r^{-1}; & \Gamma^{3}_{23} = \ \ \cot\vartheta \end{array}\right\} \qquad (986)$$

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:

$$R^{a}{}_{bcd} \;=\; \partial_c\Gamma^{a}_{bd} - \partial_d\Gamma^{a}_{bc} + \Gamma^{e}_{bd}\Gamma^{a}_{ec} - \Gamma^{e}_{bc}\Gamma^{a}_{ed} \qquad (987)$$

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]];        (988)
Simplify[RA+D[MGamma[#1,#2,#4,#5],Di[#3]]-
D[MGamma[#1,#2,#3,#5],Di[#4]]]];
```

With the genuine MINKOVSKIan 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:

$$R_{abcd} \quad = \quad g_{aa} R^a{}_{bcd} \tag{989}$$

The following permutation-rules apply:

$$R_{abcd} \;=\; -R_{bacd} = -R_{abdc} = R_{badc} \qquad\qquad R_{abcd} \;=\; R_{cdab} \tag{990}$$

It becomes more difficult with it to sort out the dependent components. Expression (989) can be transformed into the following simple program:

```
Rabcd=Function[MPart[#5,#1,#1] RAbcd[#1,#2,#3,#4,#5]];        (991)
```

A summation doesn't take place here. With Cartesian coordinates, all results are equal to zero, as well with spherical coordinates. The conditions (990) 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:

$$R_{ab} = R^c{}_{acb} = g^{cd} R_{dacb} \tag{992}$$

Let's just start from (992) 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]];
```
(993)

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]];
Rr=Function[For[R1=0;n2=0,n2<4,n2++,R1+=RaB[n2,n2,#]];Simplify[R1]];
```
(994)
(995)

RaB is the raised tensor $R_a{}^b = g^{bb} R_{ab}$. The value of the scalary curvature for the genuine MINKOVSKIan 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[GammaPQU[Q,0]]/Sin[AlphaQ[Q]])^2, 0, 0, 0},
{0, -(Sin[GammaPQU[Q,0]]/Sin[AlphaQ[Q]] )^2/(1-RhoQ[Q]^2)^2, 0, 0},
{0, 0, -r^2, 0}, {0, 0, 0, -(r^2*Sin[theta]^2)}};
Inx=Inverse[Mx];
```
(996)
(997)

For reasons of simplification we reckon with the angle $\gamma_\gamma$ only. Therefore, we must still multiply $g_{11}$ with $\beta^2$. Since the angle $\alpha$ 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 $\Gamma^a_{bc}$:

$$\left.\begin{aligned}
&\Gamma^1_{22} = -r\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha} && \Gamma^1_{33} = -r\sin^2\vartheta\,\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\\
&\Gamma^2_{12} = \ \ r^{-1} && \Gamma^2_{33} = -r\sin\vartheta\cos\vartheta\\
&\Gamma^3_{13} = \ \ r^{-1} && \Gamma^3_{23} = \ \ \cot\vartheta
\end{aligned}\right\} \tag{998}$$

Just only $\Gamma^1_{22}$ und $\Gamma^1_{33}$ are involved. All other solutions resemble those of the MINKOVSKIan line-element. As next, we want to specify the solutions, different from zero, for the RIEMANN curvature tensor $R^a{}_{bcd}$:

$$R^2{}_{323} \ = -R^2{}_{332} \ = \ \sin^2\vartheta\left(1-\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right) \qquad R^3{}_{223} \ = -R^3{}_{232} \ = \ -\left(1-\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right) \tag{999}$$

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 (920), on the following approximation:

$$1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \;=\; 1-g_{11} \;=\; \frac{1}{\tilde{Q}_0} \tag{1000}$$

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 (991) as well as the input-values (996) and (997). We get only one single independent, component, different from zero. It reads:

$$R_{2323} \;=\; -R_{2332} \;=\; -R_{3223} \;=\; R_{3232} \;=\; -r^2\sin^2\vartheta\left(1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \tag{1001}$$

For the RICCI-tensor $R_{ab}$ we obtain the following solution:

$$R_{ab} \;=\; \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & \left(1-\dfrac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) & 0 \\ 0 & 0 & 0 & \sin^2\vartheta\left(1-\dfrac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \end{bmatrix} \tag{1002}$$

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:

$$R \;=\; -\frac{2}{r^2}\left(1-\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \qquad \text{Scalary curvature} \tag{1003}$$

Interestingly enough, the factor 2 in (1003) 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 (1003):

$$R \;\approx\; -\frac{2}{r^2\tilde{Q}_0} \qquad \text{Scalary curvature approximation} \tag{1004}$$

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 $\gamma_\gamma$ 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 (925) as template. Since now there is a cross-over-dependence between r and t, we must remove the speed of light c from the 00-coordinate incorporating it into 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)}};                (1005)
Inx=Inverse[Mx];                                                 (1006)
```

From reasons of performance, it's opportune, to calculate expression (1006) 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 (1006) 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/      (1007)
((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]];                          (1008)
```

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:

$$\mathit{t} = \left(1+\frac{\mathrm{t}}{\tilde{\mathrm{T}}}\right)^{\frac{1}{2}} \qquad \mathit{r} = \left|\frac{2\mathrm{r}}{\tilde{\mathrm{R}}}\right|^{\frac{2}{3}}_{\text{macroscopically}} \qquad \mathit{r}_* = \left|\frac{2\mathrm{r}-\tilde{\mathrm{r}}_0}{\tilde{\mathrm{R}}}\right|^{\frac{2}{3}} = \left|\frac{2\mathrm{r}}{\tilde{\mathrm{R}}}-\frac{1}{\tilde{\mathrm{Q}}_0}\right|^{\frac{2}{3}}_{\text{exactly}} \tag{1009}$$

More final expression arises directly from (239). 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:

$$\left.\begin{aligned}
&\Gamma^0_{00} = -\mathrm{H}\,; && \Gamma^0_{11} = \frac{\beta^4}{\tilde{\mathrm{R}}\mathrm{c}}\,t(t-r) \\
&\Gamma^1_{01} = \tilde{\mathrm{H}}\frac{1}{t(t-r)}\,; && \Gamma^1_{11} = -\frac{2}{3}\mathrm{r}^{-1}\frac{r}{t-r} \\
&\Gamma^1_{22} = -\mathrm{r}\,\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\,; && \Gamma^1_{33} = -\mathrm{r}\sin^2\vartheta\,\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \\
&\Gamma^2_{12} = \mathrm{r}^{-1}; && \Gamma^2_{33} = -\sin\vartheta\cos\vartheta \\
&\Gamma^3_{13} = \mathrm{r}^{-1}; && \Gamma^3_{23} = \cot\vartheta
\end{aligned}\right\} \qquad (1010)$$

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:

$$\tilde{\mathrm{H}} = \frac{1}{2\tilde{\mathrm{T}}} \qquad \mathrm{H} = \frac{1}{2(\tilde{\mathrm{T}}+\mathrm{t})} \qquad \tilde{\mathrm{R}} = 2\mathrm{c}\tilde{\mathrm{T}} \qquad \mathrm{R} = 2\mathrm{c}(\tilde{\mathrm{T}}+\mathrm{t}) \qquad (1011)$$

and from (932). The expression $\beta$ is the classic relativistic dilatation-factor $(1-\mathrm{v}^2/\mathrm{c}^2)^{-1/2}$, in which we apply the propagation-velocity of the metric wave-field $\mathrm{c_M}$ in place of v. In the normal case, the value is extremely close to one. For $\mathrm{t}=0$ (nowadays) even $t$ in italics is one and it applies $r(0)=0$. Then solution (1010) passes into in (998), 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)*
              (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]];
```

(1012)

The number (1012) doesn't belong to it of course. The formula has been checked with (984). 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 ($\neq 0$):

$$R^0{}_{212} = -\frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_\gamma} \qquad R^0{}_{221} = \frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_\gamma}$$

$$R^0{}_{313} = -\frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\sin^2\vartheta\,\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_\gamma} \qquad R^0{}_{331} = \frac{\tilde{\mathrm{H}}\mathrm{r}}{\mathrm{c}^2}\sin^2\vartheta\,\frac{t}{t-r}\frac{\sin^2\alpha}{\sin^2\gamma_\gamma}$$

$$R^1{}_{220} = -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha} \qquad R^1{}_{202} = \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}$$

$$R^1{}_{212} = -\frac{2}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha} \qquad R^1{}_{221} = \frac{2}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}$$

$$R^1{}_{330} = -\tilde{\mathrm{H}}\mathrm{r}\sin^2\vartheta\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha} \qquad R^1{}_{303} = \tilde{\mathrm{H}}\mathrm{r}\sin^2\vartheta\,\frac{1}{t(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}$$

$$R^1{}_{313} = -\frac{2}{3}\sin^2\vartheta\,\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha} \qquad R^1{}_{331} = \frac{2}{3}\sin^2\vartheta\,\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}$$

$$R^2{}_{012} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)} \qquad R^2{}_{021} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^2{}_{102} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)} \qquad R^2{}_{120} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^2{}_{121} = -\frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r} \qquad R^2{}_{112} = \frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

$$R^2{}_{332} = -\left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right)\sin^2\vartheta \qquad R^2{}_{323} = \left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right)\sin^2\vartheta$$

$$R^3{}_{013} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)} \qquad R^3{}_{031} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^3{}_{103} = -\tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)} \qquad R^3{}_{130} = \tilde{\mathrm{H}}\mathrm{r}^{-1}\frac{1}{t(t-r)}$$

$$R^3{}_{131} = -\frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r} \qquad R^3{}_{113} = \frac{2}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

$$R^3{}_{223} = -\left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right) \qquad R^3{}_{232} = \left(1-\frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar\gamma}}{\sin^2\alpha}\right)$$

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:

$$
\begin{aligned}
R_{0212} &= -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} & R_{0221} &= \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \\
R_{1202} &= -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} & R_{1220} &= \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \\
R_{2021} &= -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} & R_{2012} &= \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} \\
R_{2120} &= -\tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)} & R_{2102} &= \tilde{\mathrm{H}}\mathrm{r}\,\frac{1}{t(t-r)}
\end{aligned}
$$

$$
\begin{aligned}
R_{0313} &= -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} & R_{0331} &= \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \\
R_{1303} &= -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} & R_{1330} &= \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \\
R_{3031} &= -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} & R_{3013} &= \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} \\
R_{3130} &= -\tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)} & R_{3103} &= \tilde{\mathrm{H}}\mathrm{r}\,\sin^2\vartheta\,\frac{1}{t(t-r)}
\end{aligned}
$$

$$
\begin{aligned}
R_{1221} &= -\frac{2}{3}\,\frac{r}{t-r} & R_{1212} &= \frac{2}{3}\,\frac{r}{t-r} \\
R_{2112} &= -\frac{2}{3}\,\frac{r}{t-r} & R_{2121} &= \frac{2}{3}\,\frac{r}{t-r}
\end{aligned}
$$

$$
\begin{aligned}
R_{1331} &= -\frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta & R_{1313} &= \frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta \\
R_{3113} &= -\frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta & R_{3131} &= \frac{2}{3}\,\frac{r}{t-r}\,\sin^2\vartheta
\end{aligned}
$$

$$
\begin{aligned}
R_{2323} &= -\mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) & R_{2332} &= \mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \\
R_{3232} &= -\mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) & R_{3223} &= \mathrm{r}^2\sin^2\vartheta\left(1-\frac{1}{(t-r)^2}\,\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)
\end{aligned}
$$

The related components have been collected to the better overview. So we can better see, that condition (990) 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:

$$R_{01} = \frac{1}{\tilde{\mathrm{T}}}\mathrm{r}^{-1}\frac{1}{t\,(t-r)} \qquad R_{10} = \frac{1}{\tilde{\mathrm{T}}}\mathrm{r}^{-1}\frac{1}{t\,(t-r)} \qquad R_{11} = -\frac{4}{3}\mathrm{r}^{-2}\frac{r}{t-r}$$

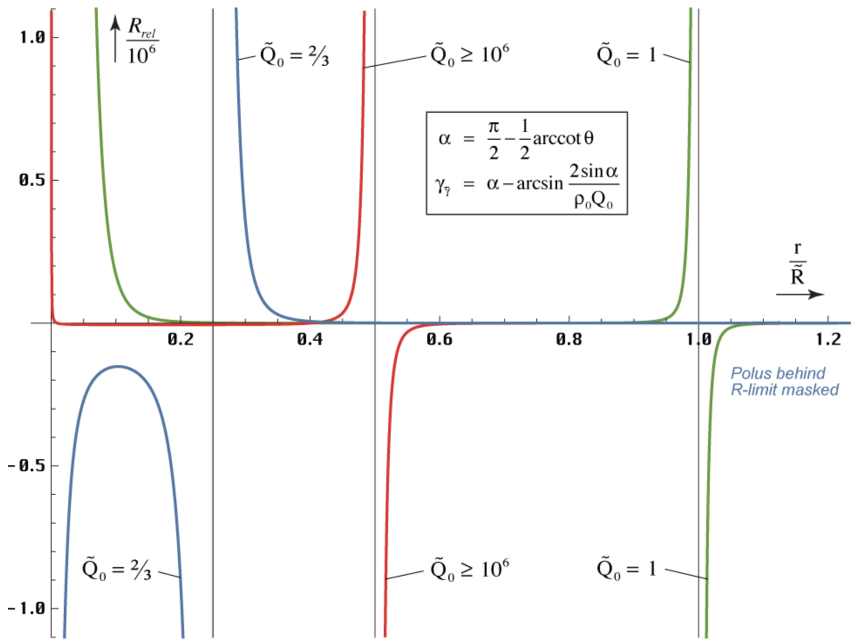
$$R_{22} = \left(1-\left(\frac{1}{(t-r)^2}+\frac{2}{3}\frac{r}{(t-r)^3}\right)\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \qquad \text{RICCI-tensor} \qquad (1013)$$

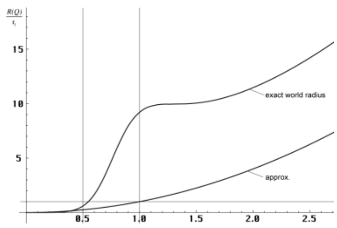
$$R_{33} = \left(1-\left(\frac{1}{(t-r)^2}+\frac{2}{3}\frac{r}{(t-r)^3}\right)\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right)\sin^2\vartheta$$

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 MINKOVSKIan manner, exactly, as anticipated by LANCZOS. For the scalary curvature applies:

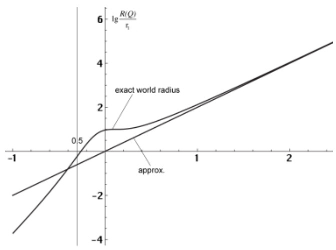
$$R = -\frac{2}{\mathrm{r}^2}\left(1-\left(\frac{1}{(t-r)^2}+\frac{4}{3}\frac{r}{(t-r)^3}\right)\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha}\right) \qquad \text{Scalary curvature} \qquad (1014)$$

The course of the scalary curvature for several initial-Q-factors is presented in Figure 146. The complete expression $r_*$ for $r$ (1009) ), the values 0…1 corr. 0…R for r, as well as $\rho_0$ according to (211) were used. 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.




Exact world radius $f$(Q) linear




Exact world radius $f$(Q) $\log_{10}$

Figure 146
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 147. In principle, no difference appears there, only a small asymmetry around the point zero.

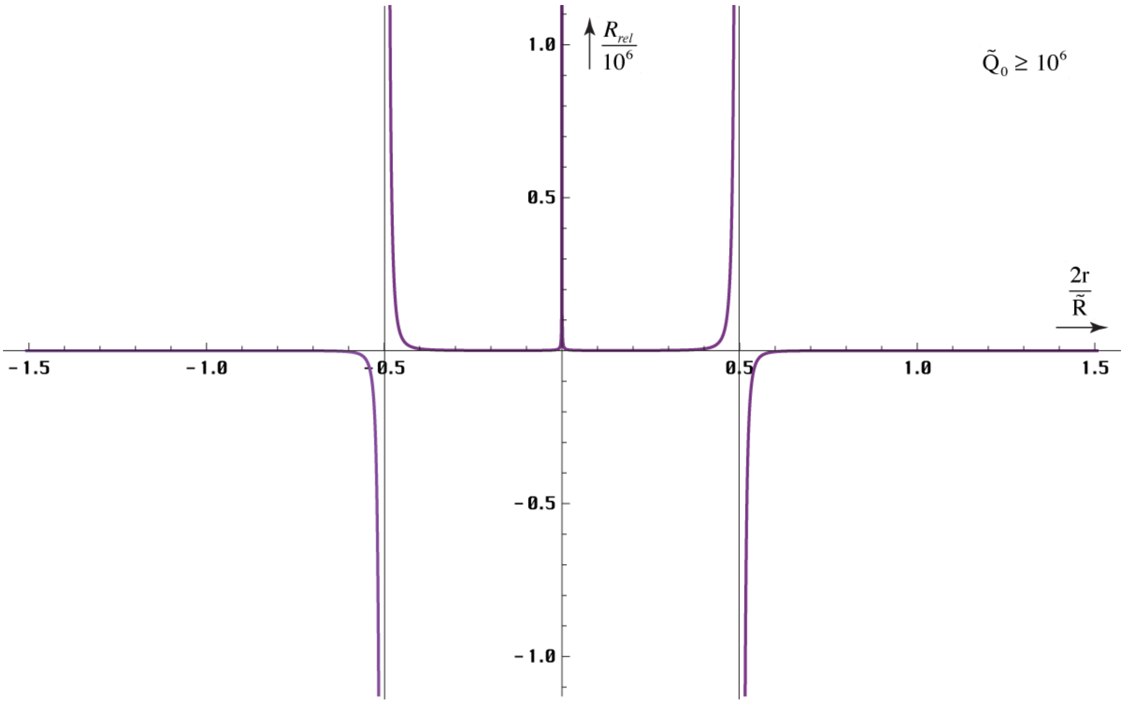



Figure 147
Relative scalary curvature for
the standard-case $Q_0>10^6$

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 domain. A singularity resides at both ends. Outside, the space is open, in so far as an „outside“ should exist at all.

It becomes interesting, if the initial factor becomes smaller, e.g. if we put the origin of our frame of reference into an area of high curvature or if we simply go back along the time-scale to a point shortly after 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. That happens by a short-term increase of the expansion rate. The particle horizon moves to 2cT in order to re-drop later. The world radius R shrinks shortly after the maximum. Thereafter it re-swells again up to compensation. The course R(Q) is shown in the small pictures right of Figure 146. It has been taken from [46] Figure 2.

If we go back any farther, so we come upon an open universe with negative curvature. The singularities in the chosen case $Q_0=2/3$ are at the point R/4 and 5/4R, but only for positive (space-like) distances. Thus there is an unbalance not to be neglected. The exact course is shown in Figure 148, anew under application of the exact expression $r_*$ of (1009).

That might be the reason why material particles (ground state $Q_0=2/3$) cannot propagate like time-like photons (negative direction). Into their own (positive) direction they are blocked by a couple of unbreachable poles. They are trapped between $(0.25\ldots1.25)\,\frac{2}{3}\,r_1$ that is $(\frac{1}{6}\ldots\frac{5}{6}r_1)$. Therefore they can only exist in the form of circular standing waves, the so-called DEBROGLIE-matter-waves. Space-like photons (see Figure 108) just haven't a real solution until $Q_0=2{,}318249$. That value approximately corresponds to the fourth power of 1.25. In contrast, an imaginary solution corresponds to a propagation, right-angled to the propagation direction, which is a circular path in fact.

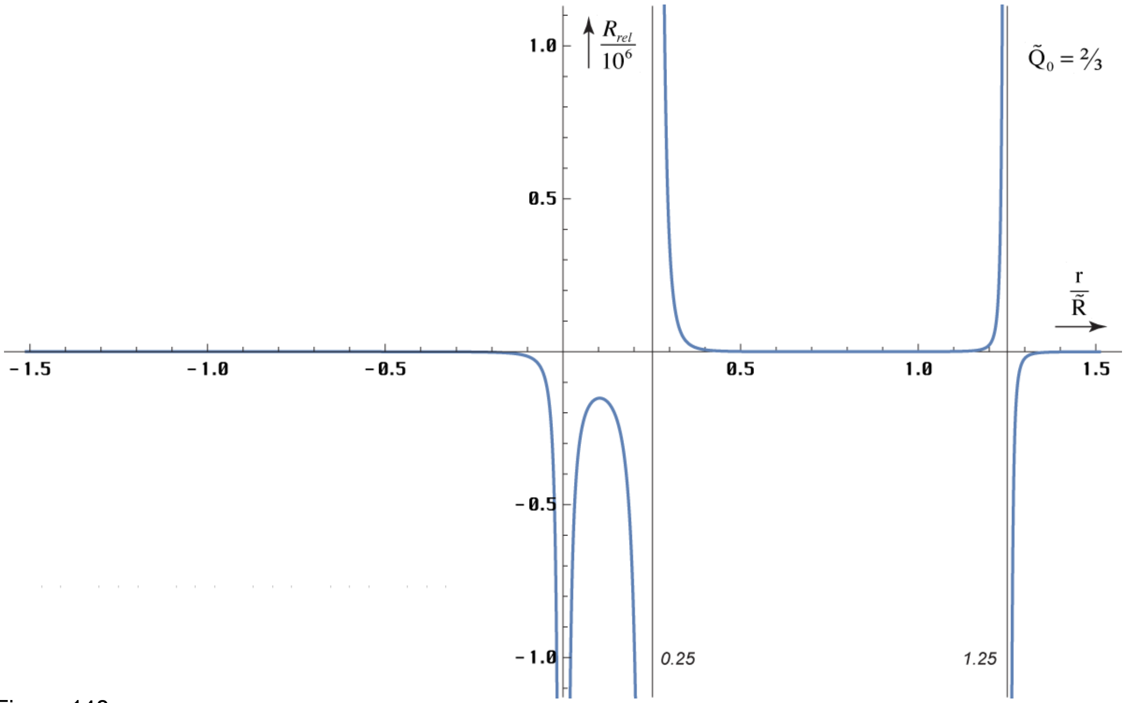


Figure 148
Relative scalary curvature
for the case $Q_0$ =2/3

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] to calculate:

$$\sqrt{-g} \;=\; cr^2\sin^2\vartheta\,\frac{t-r}{t}\,\frac{\sin^2\alpha}{\sin^2\gamma_{\bar{\gamma}}} \qquad \text{Determinant} \qquad (1015)$$

Thus, we have established a sound basis, in order to compute the energy-momentum tensor of the vacuum, based on this model.

## 7.2.6. The energy-momentum 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 ([1]25) which is generally valid. Expression ([1]25) means at the same time, that the so-called cosmologic constant $\lambda$ is equal to zero. As input variable, we require the metrics and the therefrom derived functions RICCI-tensor and the scalary curvature.

$$R_{ik} - \frac{1}{2}Rg_{ik} \;=\; T_{ik} \qquad ([1]25)$$

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)}};

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}};
```
(1016)

The calculation itself takes place by the execution of the following line:

```
Simplify[Rik-1/2*Rr00*Mx]
```
(1017)

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:

$$T_{00} = -\frac{1}{\beta^4}\frac{c^2}{r^2}\left(\left(\frac{1}{(t-r)^2}+\frac{4}{3}\frac{r}{(t-r)^3}\right)-\frac{\sin^2\alpha}{\sin^2\gamma_{\tilde{\gamma}}}\right)\frac{1}{t^2}$$

$$T_{01} = -\frac{1}{\tilde{T}}\,r^{-1}\frac{1}{t(t-r)} \qquad T_{10} = -\frac{1}{\tilde{T}}\,r^{-1}\frac{1}{t(t-r)} \tag{1018}$$

$$T_{11} = \frac{1}{r^2}\left(1-(t-r)^2\frac{\sin^2\alpha}{\sin^2\gamma_{\tilde{\gamma}}}\right)$$

$$T_{22} = \frac{2}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\tilde{\gamma}}}{\sin^2\alpha} \qquad T_{33} = \frac{2}{3}\sin^2\vartheta\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\tilde{\gamma}}}{\sin^2\alpha}$$

Please pay attention again to the italic variables, which have been defined in the previous section (1011). 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-momentum 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 (1018), 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-momentum 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}};
```
(1019)

```
TIK2=Simplify[Inverse[Tik1]]
```
(1020)

```
        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);
```
(1021)

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]]
```
(1022)

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:

$$\mathrm{A}^2 = \frac{1}{(t-r)^2}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \qquad \mathrm{B}^2 = \frac{4}{3}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} \tag{1023}$$

Then, the components different from zero of the inverse energy-momentum tensor $T^{ik}$ are as follows:

$$T^{00} = \frac{1-\mathrm{A}^2}{\mathrm{A}^2}\frac{\tilde{\mathrm{T}}^2 t^2 (t-r)^2}{1+r^{-3}\beta^{-4}\mathrm{A}^{-4}(1-\mathrm{A}^2)((1-\mathrm{A}^2)-\mathrm{B}^2)} \tag{1024}$$

$$T^{01} = -\frac{\mathrm{r}\tilde{\mathrm{T}}t(t-r)}{1+r^{-3}\beta^{-4}\mathrm{A}^{-4}(1-\mathrm{A}^2)((1-\mathrm{A}^2)-\mathrm{B}^2)} \tag{1025}$$

$$T^{11} = -\frac{\tilde{\mathrm{R}}^2}{4}\frac{\beta^{-4}\mathrm{A}^{-2}(1-\mathrm{A}^2)((1-\mathrm{A}^2)-\mathrm{B}^2)}{1+r^{-3}\beta^{-4}\mathrm{A}^{-4}(1-\mathrm{A}^2)((1-\mathrm{A}^2)-\mathrm{B}^2)} \tag{1026}$$

$$T^{10} = T^{01} \qquad T^{22} = \frac{2}{\mathrm{B}^2} \qquad T^{33} = \frac{2}{\mathrm{B}^2}\operatorname{cosec}^2\vartheta \tag{1027}$$

As it shows, the components of the inverse energy-momentum 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 MINKOVSKI-world namely applies:

$$\partial_k T^{0k} \equiv 0 \tag{1028}$$

This expression is generally [30] interpreted as the energy-conservation-rule. It can be easily shown, that expression (1028) doesn't apply for this model, whether to the universe as a whole, nor in the individual reference frame. But just as the masses can cancel out there, this can also happen with energy parts. An example is the red shift. Here, energy is quasi discreated by the increase of the wavelength. Eventually this effect may not be registered in another reference system. According to [5] the energy-conservation-rule is »only an empirical rule, thus it could be violated by yet unknown physical phenomenons«. Thus, there is just no definite proof for its universal validity. Also (1028) only applies to an empty MINKOVSKI world.

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-momentum 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:

$$G^{ik} = \kappa T^{ik} \tag{1029}$$

In this connection, $\kappa$ 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 $\kappa_0$. 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 (1029), as it has been presented in [30] from p.189 on.

We first of all assume, that the energy-momentum tensor in MINKOVSKI-coordinates fills the conservation-equations:

$$\partial_k T^{ik} = 0 \tag{1030}$$

However we are concerned neither with MINKOVSKI-coordinates, nor (1030) 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:

$$\nabla_k T^{ik} = 0 \tag{1031}$$

(covariant derivative). Furthermore, the Einstein-tensor should vanish because of the contracted Bianchi-identity:

$$\nabla_k G_i^{\ k} \equiv 0 \qquad \text{therefrom follows} \qquad \nabla_k G^{ik} \equiv 0 \tag{1032}$$

The condition (1032) is really filled, as from the properties of the RIEMANN curvature tensor in section 7.2.5.5. under application of

$$\nabla_a R_{debc} + \nabla_c R_{deab} + \nabla_b R_{deca} \equiv 0 \qquad ([30]\ 6.82)$$

easily can be shown. From (1031) and (1032) 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 (1031) 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:

$$\kappa = 8\pi \frac{\mathrm{G}}{\mathrm{c}^2} \qquad \text{or} \qquad \kappa = 8\pi \frac{\tilde{\mathrm{G}}}{\mathrm{c}^2} \tag{1033}$$

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 (1029) always and everywhere, otherwise the NEWTON's borderline case would be fulfilled only in the point $r=0$. But since the energy-momentum tensor already contains a space-temporal dependence, only the right-hand expression (1033) remains as single option. Therefore, after substitution of (799) applies:

$$\kappa = \frac{8\pi\tilde{\mathrm{R}}\tilde{\mathrm{Q}}_0}{\mu_0\kappa_0\hbar_1} = \frac{8\pi\tilde{\mathrm{R}}}{\mu_0\kappa_0\tilde{\hbar}} = \frac{8\pi\ \mathrm{c}\tilde{\mathrm{r}}_0^2}{\tilde{\hbar}} \tag{1034}$$

Since expression (1034) contains reference-frame-dependent values ($\tilde{\mathrm{R}}$, $\tilde{\mathrm{r}}_0$, $\tilde{\hbar}$) 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-momentum 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-momentum 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-momentum 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 (1029) 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:

$$G_{ik} = \frac{1}{\kappa} T_{ik} \tag{1035}$$

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:

$$\begin{aligned}
G_{00} &= -\frac{1}{8\pi}\frac{\tilde{\hbar}\tilde{\omega}_0}{\tilde{\mathrm{r}}_0}\frac{1}{\beta^4 t^2}\left(\left(\frac{1}{(t-r)^2}+\frac{4}{3}\frac{r}{(t-r)^3}\right)-\frac{\sin^2\alpha}{\sin^2\gamma_{\bar{\gamma}}}\right)\frac{1}{\mathrm{r}^2} && \left[\frac{\mathrm{N}}{\mathrm{m}^2}\right]\\
G_{01} &= -\frac{1}{4\pi}\frac{\tilde{\hbar}}{\tilde{\mathrm{R}}\tilde{\mathrm{r}}_0^2}\mathrm{r}^{-1}\frac{1}{t(t-r)} && \left[\frac{\mathrm{Ns}}{\mathrm{m}^3}\right]\\
G_{10} &= -\frac{1}{4\pi}\frac{\tilde{\hbar}}{\tilde{\mathrm{R}}\tilde{\mathrm{r}}_0^2}\mathrm{r}^{-1}\frac{1}{t(t-r)} && \left[\frac{\mathrm{Ns}}{\mathrm{m}^3}\right]\\
G_{11} &= \frac{1}{8\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{\mathrm{R}}}\frac{1}{\mathrm{r}^2}\left(1-(t-r)^2\frac{\sin^2\alpha}{\sin^2\gamma_{\bar{\gamma}}}\right) && \left[\frac{\mathrm{kg}}{\mathrm{m}^3}\right]\\
G_{22} &= \frac{1}{12\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{\mathrm{R}}}\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} && \left[\frac{\mathrm{kg}}{\mathrm{m}}\right]\\
G_{33} &= \frac{1}{12\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{\mathrm{R}}}\sin^2\vartheta\frac{r}{(t-r)^3}\frac{\sin^2\gamma_{\bar{\gamma}}}{\sin^2\alpha} && \left[\frac{\mathrm{kg}}{\mathrm{m}}\right]
\end{aligned} \tag{1036}$$

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 (1036) 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 $\mathrm{r}_S$. For a test, we just want to calculate the density for the entire universe (r = R/2). Then, we get:

$$G_{11}(\tilde{R}/2) \;=\; \frac{1}{2\pi}\frac{\mu_0\kappa_0\tilde{\hbar}}{\tilde{R}^3} = 1.29784\cdot 10^{-29}\,\mathrm{kg\,dm^{-3}} \qquad\qquad \frac{3}{2}G_{11}(R/2) \;=\; \frac{3}{4\pi}\frac{\tilde{M}_1}{\tilde{R}^3} \qquad (1037)$$

with $M_1 = Q_0 m_0$. The result is exact 2/3 of the density of the metric wave field (370), determined in section 4.6.2. which is obviously much more than the gravitational field only (⅔ gravitation, ⅓ EM-field). Furthermore the value is about 3 magnitudes greater than the matter-density of $1.845\cdot 10^{-31}\,\mathrm{kg\,dm^{-3}}$ determined in section 4.6.4.2.5., which may be regarded as proof, that we are living in a radiation-dominated universe or else said, 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 (1036) once again, so it shows, that they are containing (partially hidden) quantities of the subspace ($\mu_0$, $\kappa_0$, c), the metric wave-field ($\omega_0$, $r_0$), 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 (1036) 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 149 once again. It consists of three overlapping layers. Therefore, I would like to name this model the 3-layer-model of the metrics.

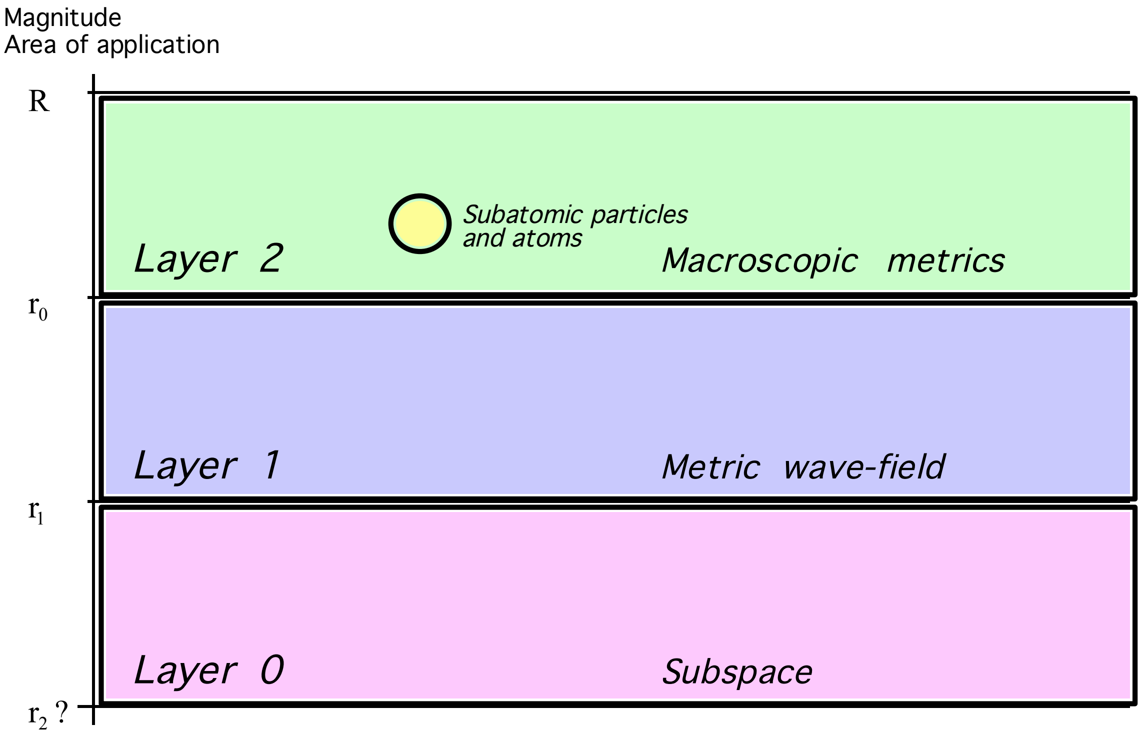



Figure 149
The 3-layer-model of the metrics

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 $\mu_0$, $\varepsilon_0$, $Z_0$ 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 analogue 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 150 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.

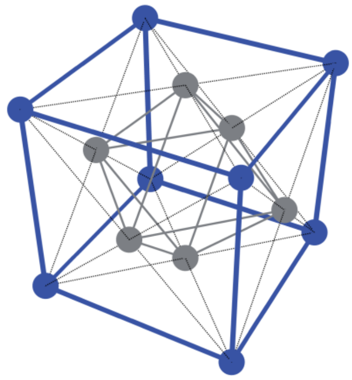


Figure 150
$h_{22}$ -component of an oscillating even-frontal gravitational wave (+ polarization)

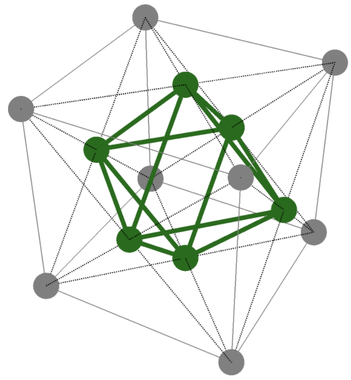


Figure 151
$h_{23}$ - component of an oscillating even-frontal gravitational wave (× polarization)

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. 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. But the value can be calculated extremely precise and may be fixedly defined.*

7. *Determination of the* <u>*exact*</u> *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. Here we were able to get a very good result even for other natural constants as well. Sudoku-proof successful.*

8. *Determination of the value of the HUBBLE-parameter on the basis of locally measurable quantities. See section 6.2.2. and 7.5.*

9. *Determination of the value of the HUBBLE-parameter on the basis of the exact temperature of the cosmologic 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 within the measurement accuracy of the COBE/WMAP satellites. In section 7.5.5. is taken up a comparison with other values.*

Maybe, the proof even takes place in a completely different domain.

## 7.5. Relations between the HUBBLE-parameter and locally measurable quantities

We set up a model, which describes the relations between the natural constants and the frame of reference. With it it's important to determine the exact value of the HUBBLE-parameter, which is closely linked to the phase angle $Q_0$. It could be shown, that $Q_0$ is identical to the reference frame. The exact value could be determined and verified by means of the electron mass. But there are other ways to determine $Q_0$ with the help of locally measurable quantities and relations of the microcosm, which lead to different results.

Therefore, this section is also intended as an aid for those who think they have already found the right result. Because with *one* result, no matter how wrong it is, you can well calculate-on. However, if you have *several* different results available, you need to verify them and make a choice. The order of the presentation is also identical to the path I have taken up to this point.

### <u>7.5.1. EDDINGTON's numbers and the unity of the physical world</u>

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[1] 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:

$$C=\frac{1}{4\pi\varepsilon_0 G}\frac{e^2}{m_e m_p} \tag{1038}$$

Of course, EDDINGTON had omitted the factor $4\pi$ at the time, since $\varepsilon_0$ normally always was left out, since it „is equal to one" → recovery error. However, for the sake of completeness, we insert it at this point because we would get a wrong result otherwise. Expression (1038) 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 $2.26866\cdot10^{39}$ resp. $2.85088\cdot10^{40}$, when omitting the factor $4\pi$. Now it would appear, that C somehow

[1] In [54] however this statement is attributed to Dirac. At this point I would like to leave it open who is right.

corresponds with a dimensionless number of this model. Here the Q-factor $Q_0=8.34047\cdot10^{60}$ 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):

$$C=\frac{1}{4\pi\varepsilon_0 G}\frac{q_0^2}{m_0^2} = \frac{1}{4\pi\varepsilon_0 G}\frac{\hbar G}{Z_0\hbar c} = \frac{1}{4\pi} \tag{1039}$$

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:

$$C=\frac{1}{\varepsilon_0 G}\frac{e^2}{m_e m_p} = 2.85088\cdot10^{40} \tag{1040}$$

This equals to $Q_0^{2/3}$ approximately, as a comparison with the astronomically determined value from Table 1 shows:

$$C^{3/2}=\left(\frac{1}{\varepsilon_0 G}\frac{e^2}{m_e m_p}\right)^{\frac{3}{2}} = 4.81359\cdot10^{60} \qquad [7.5419\cdot10^{60}] \tag{1041}$$

Now, with the help of $H_0=\omega_0/Q_0$ (54) the HUBBLE-parameter can be calculated:

$$H_0(C^{3/2}) = 118.904\ \mathrm{km\,s^{-1}Mpc^{-1}} \qquad [75.9] \tag{1042}$$

Obviously, the left-hand value doesn't match the astronomic observations. Maybe there is a constant factor, to multiply expression (1041) with, in order to find out a better matching result. With a constant factor (we already omitted $4\pi$) the expression still can be used in the thought manner, if it's not arbitrary. During the determination of $H_0$ 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:

$$\frac{3}{2}C^{\frac{3}{2}} = \frac{3}{2}\left(\frac{1}{\varepsilon_0 G}\frac{e^2}{m_e m_p}\right)^{\frac{3}{2}} = 7.22039\cdot10^{60} \qquad [7.5419\cdot10^{60}] \tag{1043}$$

$$H_0 = \frac{2}{3}\sqrt{\frac{c^5}{G\hbar}}\left(\frac{\varepsilon_0 G m_e m_p}{e^2}\right)^{\frac{3}{2}} = 79.2696\ \mathrm{km s^{-1}Mpc^{-1}} \qquad [75,9] \tag{1044}$$

The result agrees fairly well with the value determined in section 4.3.4.4.6. in the amount of 75.9 $\mathrm{kms^{-1}Mpc^{-1}}$, but it's miles away from the electron-based one (860). But this match can be a pure coincidence. Thus, we must examine, whether the temporal shift as well as the shift with $Q_0$ of the values, used in (1043), are being consistent with the shift of $H_0$. Therefore we combine (1043) with (29) and (54) under consideration of the following dependences:

$$H_0 = \frac{2}{3}\omega_0\left(\frac{\varepsilon_0 G m_e m_p}{e^2}\right)^{\frac{3}{2}} \quad Q_0\sim T^{1/2} \quad H_0\sim Q_0^{-2} \quad G\sim Q_0^2 \quad \omega_0\sim\hbar\sim e^2\sim Q_0^{-1} \quad m_x\sim Q_0^{-5/2} \tag{1045}$$

Applying these dependences to the left expression, we get the following:

$$H_0 \sim Q_0^{-5/2} \quad \text{Actual as per expression (1045)} \qquad H_0 \sim Q_0^{-4/2} \quad \text{Reference due to } H_0 = \frac{1}{2T} \tag{1046}$$

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. But what like to interpret this difference? The most simply answer would be to argue that it's really about a coincidence, that the left value of (1044) 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 (1045) 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) (345). 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 (1042) and why we had to multiply it just with 3/2. This alone could already be regarded as appearance-proof. But further applies:

| | | | |
|---|---|---|---|
| $\frac{r_0}{2} \sim Q_0^{2/2}$ | *Local Metrics* | $\frac{R}{2} \sim Q_0^{3/2}$ | *Universe as a Whole* |
| $x \sim Q_0^{3/2}$ | *Material Bodies* | $\lambda \sim Q_0^{3/2}$ | *Wave-lengths* |
| $a_0 \sim Q_0^{3/2}$ | *Atomic Distances* | $r_e \sim Q_0^{3/2}$ | *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:

$$v = H_0 r = \tilde{H}_0 \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{4}{2}} \tilde{r} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{2}{2}} = \tilde{v} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{2}{2}} \sim Q_0^{-1} \sim t^{-2} \tag{1047}$$

$$v = H_1 \frac{R}{2} = \tilde{H}_1 \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{5}{2}} \frac{\tilde{R}}{2} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{\frac{3}{2}} = \tilde{v} \left(\frac{Q_0}{\tilde{Q}_0}\right)^{-\frac{2}{2}} \sim Q_0^{-1} \sim t^{-2} \tag{1048}$$

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 (1045) 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...

In addition to the calculation based on the electron mass, we have found second way to determine $H_0$ using locally measurable quantities. In contrast to this model, which is based on the PLANCK length (1:1), it is based on the hydrogen atom ($1:10^{40}$). The question is, is there a third one? As a matter of fact. From (1047) one can see that the elementary length $r_0$ and the electron radius $r_e$ change according to different functions of $Q_0$. This way $Q_0$ can also be determined and thus $H_0$ too. We have already considered this case in section 6.2.5. For $Q_0$ we get then:

$$Q_0 = \frac{3}{2}\left(\frac{r_e}{r_0}\right)^3 = \frac{3}{2}\left(\frac{1}{4\pi}\frac{e^2 Z_0}{m_e}\sqrt{\frac{c}{G\hbar}}\right)^3 = 7.94981\cdot 10^{60} \qquad [7.5419\cdot 10^{60}] \qquad (1049)$$

This corresponds to the value $H_0$=71.9963 $\mathrm{km s^{-1} Mpc^{-1}}$ I have favoured so far (actually 71.9845 with the BRUKER value of G). This value also does not match the measurement results of the COBE satellite. However, the electron radius $r_e$ is contained three times in (1049) and in Section 7.2.5. we had noticed that the electron is a 4D object whose radius is curved and therefore has to be multiplied by a correction factor $\zeta$. This then leads to the correct result, which agrees with both the electron mass and the COBE value:

$$Q_0 = \frac{3}{2}\left(\frac{\zeta r_e}{r_0}\right)^3 = \left(9\pi^2\sqrt{2}\delta\frac{m_e}{\mu_0\kappa_0\hbar_1}\right)^{-\frac{3}{7}} = 8.34047\cdot 10^{60} \qquad [68.6] \qquad (1050)$$

$$H_0 = \frac{\omega_0}{Q_0} = \frac{2}{3}\frac{64\pi^3\varepsilon_0 G\hbar m_e^3}{\zeta^3\mu_0^2 e^6} = \begin{cases} 2.447866\cdot 10^{-18}\,\mathrm{s^{-1}} = 71.9963\,\mathrm{km s^{-1} Mpc^{-1}} \\ 2.223925\cdot 10^{-18}\,\mathrm{s^{-1}} = 68.6241\,\mathrm{km s^{-1} Mpc^{-1}} \text{ with } \zeta \end{cases} \qquad (1051)$$

$$\zeta = \frac{1}{9\pi^2}\frac{1}{\sqrt[3]{3\sqrt{2}\alpha\delta}} = \frac{1}{36\pi^3}\frac{1}{\sqrt[3]{3\sqrt{2}}}\frac{m_p}{m_e} = 1.016119033114739' = \text{const} \qquad (835)$$

Now we have already found three different ways to calculate $Q_0$ and $H_0$, getting several different results. Only the electron values led to a correct result. But that's not all, there is also a fourth possibility. 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:

$$Q_0 = \frac{3}{2}\frac{r_e}{r_0}\frac{1}{\varepsilon_0 G}\frac{e^2}{m_e m_p} \qquad \text{with} \qquad r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}, \quad \frac{1}{r_0} = \sqrt{\frac{c^3}{G\hbar}} \qquad (1052)$$

$$Q_0 = \frac{3}{8\pi}\frac{e^4}{\varepsilon_0^2 m_e^2 m_p}\frac{1}{\sqrt{G^3\hbar c}} \qquad \text{with} \qquad H_0 = \frac{\omega_0}{Q_0} = \frac{1}{Q_0}\sqrt{\frac{c^3}{G\hbar}} \qquad (1053)$$

$$H_0 = \frac{8}{3}\pi\frac{G}{\mu_0 Z_0}\frac{m_e^2 m_p}{e^4} = 76.7670\,\mathrm{km s^{-1} Mpc^{-1}} \qquad [75.9] \qquad (1054)$$

$$H_1 = 4\pi\frac{G}{\mu_0 Z_0}\frac{m_e^2 m_p}{e^4} = 115.151\,\mathrm{km s^{-1} Mpc^{-1}} \qquad (1055)$$

Here, even the factor $4\pi$ has been taken into account, being omitted in (1040). 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.

It is to be noted, that all values are reference-frame-dependent. To the better overview, once again all results in tabular form in comparison with the COBE measured value:

| Expression | $Q_0$ | $H_0$ | $H_0$ | $H_1$ | $H_1$ | QED | |
|---|---|---|---|---|---|---|---|
| | [1] | $[s^{-1}]$ | $[kms^{-1}Mpc^{-1}]$ | $[s^{-1}]$ | $[kms^{-1}Mpc^{-1}]$ | Correction Factor | |
| (1043) | $7.2204\cdot10^{60}$ | $2.569\cdot10^{-18}$ | 79.2696 | $3.853\cdot10^{-18}$ | 118.904 | 1.10102 | $\delta^{-3/2}$ |
| (1052) | $7.4558\cdot10^{60}$ | $2.488\cdot10^{-18}$ | 76.7670 | $3.732\cdot10^{-18}$ | 115.151 | 1.06627 | $\delta^{-1}$ |
| (TAB1) | $7.5419\cdot10^{60}$ | $2.460\cdot10^{-18}$ | 75.8966 | $3.690\cdot10^{-18}$ | 113.845 | – | – |
| (1049) | $7.9498\cdot10^{60}$ | $2.448\cdot10^{-18}$ | 71.9963 | $3.500\cdot10^{-18}$ | 107.995 | 1.00000 | $\delta^{0}$ |
| (1050) | $8.3405\cdot10^{60}$ | $2.224\cdot10^{-18}$ | 68.6241 | $3.336\cdot10^{-18}$ | 102.936 | 1.01612 | $\zeta$ |
| (802) | $8.3405\cdot10^{60}$ | $2.224\cdot10^{-18}$ | 68.6241 | $3.336\cdot10^{-18}$ | 102.936 | – | – |
| (COBE) | $8.3415\cdot10^{60}$ | $2.223\cdot10^{-18}$ | 68.6071 | $3.335\cdot10^{-18}$ | 102.911 | – | – |

Table 8
HUBBLE-parameters as a function
of local quantities (overview)

Interestingly, the values (1043), (1052) and (1049) can be converted into one another using a factor $\delta^{n/2}$. However, the table is not complete. Strictly speaking, the number of possible solutions is unlimited. But there is only one correct solution. If you happen to have chosen a value from the table and found that the real measured values do not match your model, simply try a different one.

## 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. But 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 152 and 145 $r_T$ 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.

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.

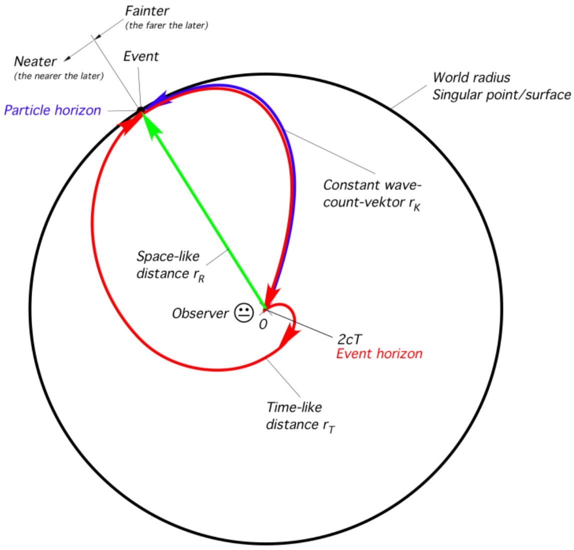



Figure 152
Distance-vectors with an object
at the edge of the universe (schematized)

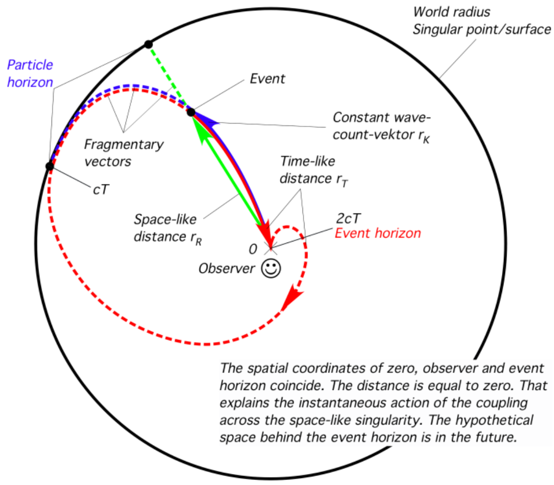



Figure 153
Distance-vectors with an object
in the close-up range of the observer (schematized)

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 move away from each other 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* turns out ($r_R$ green pictured). This is the shortest way between the observer or better the traveller 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 resistance 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 traveller 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 needed.

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 $r_{Tmax}=R=2cT$.

All these vectors are coming from the same point $\{r_1, r_1, r_1, 2t_1\}$ and are ending at all points of the hyper-surface $\{R, R, R, 2T\}$ at the same time. Both are superimposed for any observer. The point $\{r_1, r_1, r_1, 2t_1\}$ is quasi „smeared" across the whole universe, i.e. all points on the hyper-surface are interconnected via $\{r_1, r_1, r_1, 2t_1\}$ and, since photons are timeless, even instantaneously. That may be the cause for such effects like quantum entanglement etc.

In the course of this work, we had learned that the maximum *space-like distance* amounts to only the half of it: $r_{Rmax}=R/2=cT$. It would be interesting if we were able to convert the above values into one another. First of all, expression (283) would be suitable for this:

$$r_T = -\frac{r_R}{\sqrt{1-\frac{4r_R^2}{R^2}}} \qquad r_R = -\frac{r_T}{\sqrt{1+\frac{4r_T^2}{R^2}}} \tag{283}$$

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 addition, since $r_T$ returns to its starting point over time, there should be a second solution for the left expression. 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. This contradiction has been solved in section 4.5.2.2.

With the *time-like vector* we must pay 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 space-like singularity (event horizon). The farthest ($r_R$) 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.

Of particular interest are the signals directly from the Big Bang –2T. These have reached their starting point again and are to be observed as cosmologic background-radiation, although with extreme red-shift. The picture, which it generates, is really the view of 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).

With it, both expressions are been suitable only conditionally for the calculation of problems involving the universe as a whole. For further considerations we need the correct expressions considering the angle $\alpha$. It can be determined with the help of (212) as a function of Q. Since Q in turn depends on the distance r, it has the value $Q_0$ at the observer, at the distance R/2 it is equal to one, we need a function $Qr=Q(r)$. We get it by rearranging (895) to (1056), since r is oriented in the opposite direction in this case. The expression $\sqrt{-g_{00}}$ is only effective at a microscopic distance from R/2, so it can be neglected. We apply $Q_0$ for $Q_{max}$, which we assume to be pretty much the maximum value (844). I chose this form in order to be able to calculate the course even for other reference frames and to create equality with the RhoQ function. The course of $\alpha$ as a function of $Q_0$ is depicted in Figure 153 and 146.

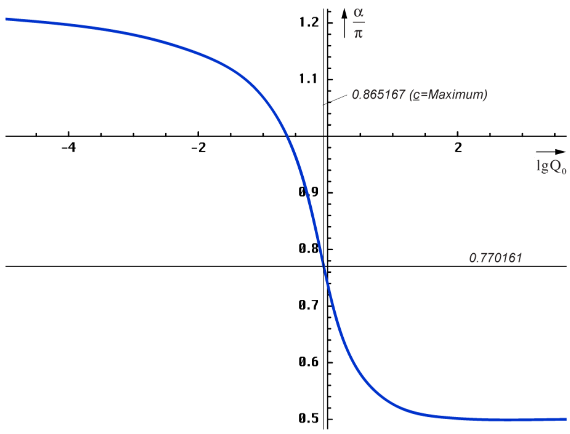



Figure 154
Angle $\alpha$ as a function of $Q_0$

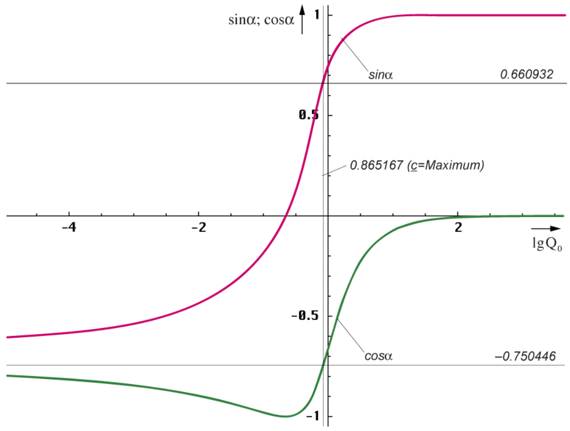



Figure 155
Functions $\sin\alpha$ and $\cos\alpha$ as a function of $Q_0$

Now we come to the actual calculation. However, only the function $r_R(r_T)$ can be presented explicitly.

$$Q(r) = \frac{\tilde{Q}_0}{Q_{max}} \frac{\tilde{R}}{2r} \tag{1056}$$

```
Qr = Function[#1/Q0/2/#2];
PhiQ = Function[If[# >10^4, -Pi/4-3/4/#, Arg[1/Sqrt[1-(HankelH1[2, #]/HankelH1[0, #])^2]]- Pi/2]];
PhiR = Function[PhiQ[Qr[#1, #2]]];
AlphaR = Function[N[Pi/4 - PhiR[#1, #2]]];
```

$$r_R = -r_T \left( \frac{r_T}{R} \cos\alpha(r_T) + \sqrt{1 - \left(\frac{r_T}{R}\right)^2 \sin^2\alpha(r_T)} \right)^{\frac{1}{3}} \tag{1057}$$

```
rtrr = Function[# (# Cos[AlphaR[Q0, #]] + Sqrt[1 - #^2 Sin[AlphaR[Q0, #]]^2])^(1/3)];
```

I determined expression (1057) based on (366) in combination with (698). There was already a similar problem with the calculation of entropy. The inverse functions $r_{T1}$ (RTR1) and $r_{T2}$ (RTR2) we obtain with the help of Interpolation[list] by calculating rR(rT) and swapping the x and y values in the list of support points:

```
inrt1={};
For[d=0.001; i=0,d<.739,(++i),d+=.001; AppendTo[inrt1,{rtrr[d],d}]]
inrt2={};
For[d=0.739; i=0,d<.999,(++i),d+=.001; AppendTo[inrt2,{rtrr[d],d}]]
RTRR1=Interpolation[inrt1];
RTRR2=Interpolation[inrt2];
RTR1=Function[If[#<=0.49034 ,RTRR1[#],Null]];
RTR2=Function[If[#<=0.49034 ,RTRR2[#],Null]];
```
(1058)

For the constant wave count vector $r_K$ we obtain:

$$r_R = r_K \left(1 - \left(\frac{3}{4}\frac{r_K}{R}\right)^2\right)^{\frac{2}{3}} \tag{1059}$$

```
rkrr = Function[# (1 - (3/4 #)^2)^(2/3)];
```

The factor ¾ results from our finding that the HUBBLE-parameter $H_1$ has the value $\frac{3}{4}T^{-1}$ at the edge of the universe in contrast to the local value $H_0=\frac{1}{2}T^{-1}$. Or rather, the entire distance between the observer and R/2 expands with the exponent ¾ with respect to T. With $H_0=\frac{1}{2}T^{-1}$, $r_K$ would not reach the edge at R/2 at all and would take an earlier „turn". Even with $r_K$ the inverse function can be defined using the function Interpolation[list] only. Since $r_K$ points away from the observer, we don't need it either. The course of the above mentioned functions is shown in Figure 156.

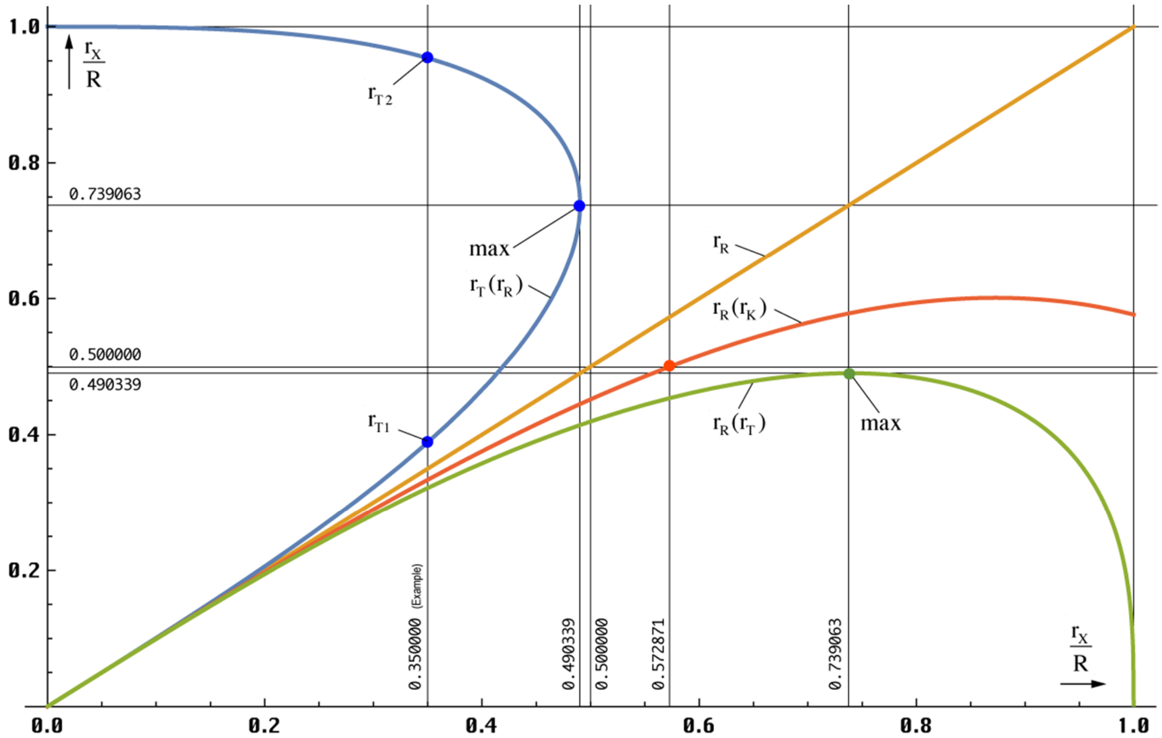



Figure 156
Distance-vectors in the universe (1D)

It can be seen that all three vectors coincide at close range and far beyond. At a distance of e.g. 400 Mpc, the deviation between $r_R$ and $r_T$ is only 2% and thus far below the observation error. The function $r_T$ does not leave the universe, which is correct, but it does not reach R/2 either, but is redirected back to the starting point shortly before. With it, we are able to observe 94.31% of the universe.

The faster expansion just after the BB is also taken into account. The turning point, i.e. the greatest distance, is already reached in the first third. Thus, expression (1057) fulfils the requirements placed on it. But what's about $r_K$? Because of $H_1=¾T^{-1}$ the edge at R/2 is reached and passed with the angle φ, see Figure 44b and Figure 157. The space beyond is in the future of the observer. Figure 156 was created with the following program:

```
GH=Function[Graphics[Line[{{#2,#1},{#3,#1}}]]];
GV=Function[Graphics[Line[{{#1,#2},{#1,#3}}]]];

x01=.35 (* The example distance *);
y02=FindMaximum[rtrr[r], {r,.5,.8}]
y2=First[y02];
x2=r/.First[Rest[y02]];
y03=FindMaximum[rkrr[r], {r,.5,.8}]
y3=First[y03];
x3=r/.First[Rest[y03]];
z3=xx/.FindRoot[R3[2Pi xx]-.5==0, {xx,0.5,.7}]                    (1060)

Plot[{RTR2[r]}, {r,0,1}, PlotRange->{0,1.03}, ImageSize->Large];
Plot[{RTR1[r], r, rtrr[r], rkrr[r]}, {r,0,1},
PlotRange->{0,1.03}, ImageSize->Large, PlotStyle->{Thickness[0.0038]}];
Show[%, %%, GH[y2,0,2], GH[1/2,0,2], GH[1,0,2], GH[x2,0,2],
GV[.5,-1,2], GV[x2,-1,2], GV[1,-1,2], GV[y2,-1,2], GV[x01,-1,2], GV[z3,-1,2],
Graphics[{PointSize[0.01], Blue, Point[{{x01,RTR1[x01]}, {x01,RTR2[x01]}}]}],
Graphics[{PointSize[0.01], ColorData[1,12], Point[{x2,y2}]}],
Graphics[{PointSize[0.01], ColorData[2,2], Point[{z3,0.5}]}],
PlotLabel->„Blue Rt(Rr), Orange Rr(Rr), Green Rr(Rt), Red Rr(Rk)“,
LabelStyle->{FontFamily->„Chicago“,10,GrayLevel[0]}, ImageSize->Large]
```

Figure 157 shows the 2D-presentation r(T) in polar coordinates, whereat the time T is represented by the angle ϑ. The observer is located a the point {0,0}. The Age 2T equals to one complete revolution. Every observer always has the impression to be at the point 2T (event horizon). That's correct. Therefore there is no continuation of $r_K$ along the dashed black line.

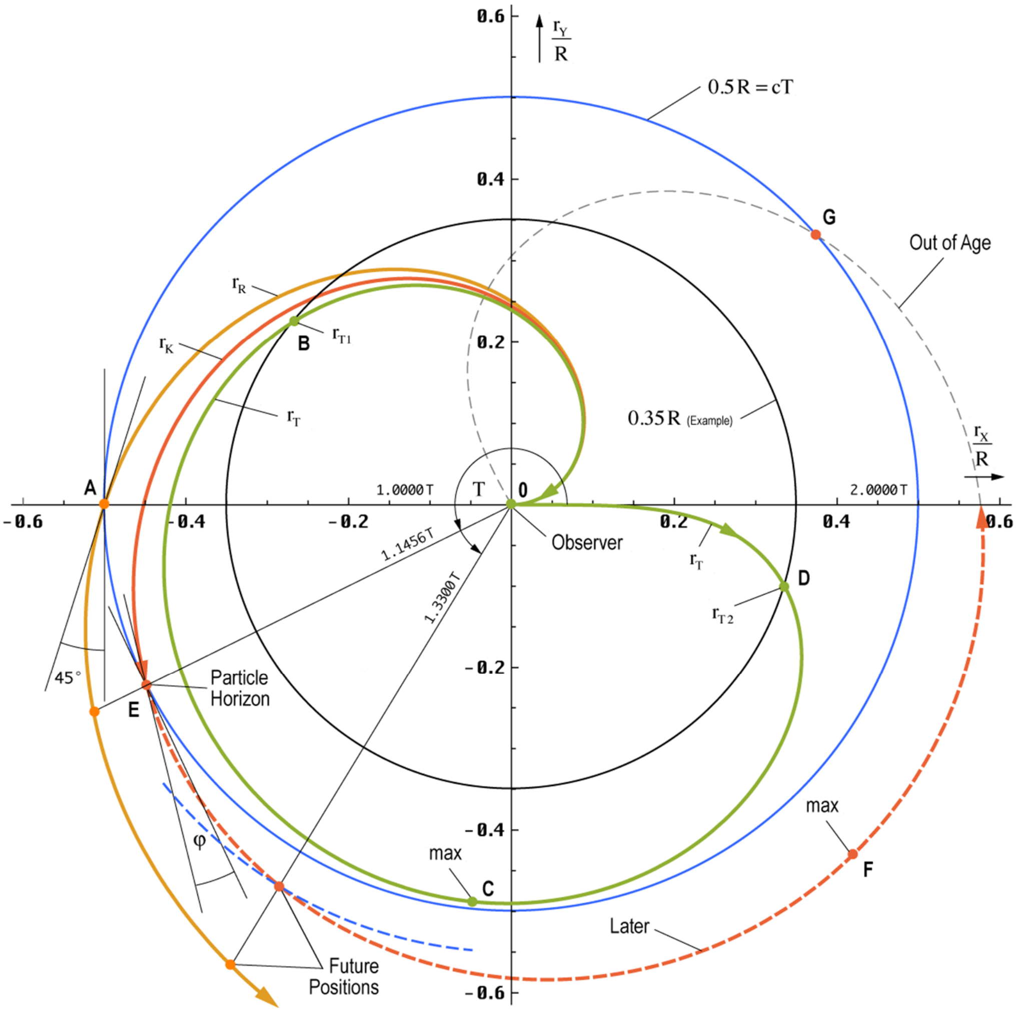



Figure 157
2D-course of the distance-vectors
$r_R$, $r_K$ and $r_T$ as a function of time

The vector $r_R$ mutates to the generic logarithmic spiral. Figure 157 has been created using the following program:

```
z31=r/.FindRoot[R3[r]-.5==0, {r,.1,.5}]
z32=r/.Chop[FindRoot[R3[r]-.5==0, {r,5,6}]]
z33=r/.First[Rest[FindMaximum[R3[r], {r,5,6}]]]
R2=Function[rtrr[#/2/Pi]];
R3=Function[rkrr[#/2/Pi]];

Plot[{Pi*r+Pi/2}, {r,-.6,-.45}, ImageSize->Large,
PlotRange->{-0.52,0.52}, PlotStyle->{Thickness[0.001],Black}, AspectRatio->1];
PolarPlot[{Null,r/2/Pi,R2[r],R3[r]}, {r,0,8/3 Pi}, PlotRange->0.59,
ImageSize->Large, AspectRatio->1];

Show[%, %%, GU[-0.5,-0.6,0.6],
Graphics[{Circle[{0,0},1], Circle[{0,0},0.5], Circle[{0,0},x01]}],
Graphics[{PointSize[0.01], Orange, Point[{{-.5,0}}]}],
Graphics[{PointSize[0.01], Red, Point[{
{R3[z31]Cos[z31], R3[z31]Sin[z31]},
{R3[z32]Cos[z32], R3[z32]Sin[z32]},
{R3[z33]Cos[z33], R3[z33]Sin[z33]}}]}],
Graphics[{PointSize[0.01], ColorData[1,12], Point[{{0,0},
{y2 Cos[2 Pi RTR1[y2]],  y2 Sin[2 Pi RTR1[y2]]},
{x01 Cos[2 Pi RTR1[x01]], x01 Sin[2 Pi RTR1[x01]]},
{x01 Cos[2 Pi RTR2[x01]], x01 Sin[2 Pi RTR2[x01]]}}]}],
LabelStyle->{FontFamily->„Chicago", 10, GrayLevel[0]}, ImageSize->Large]
```

(1061)

The 2D-representation gives the impression that the incoming vector $r_T$ is coming from the direction in which it was originally emitted. But that's not the case. In fact, he's coming from the opposite direction. This can be seen very well in the 3D-representation in Figure 158.

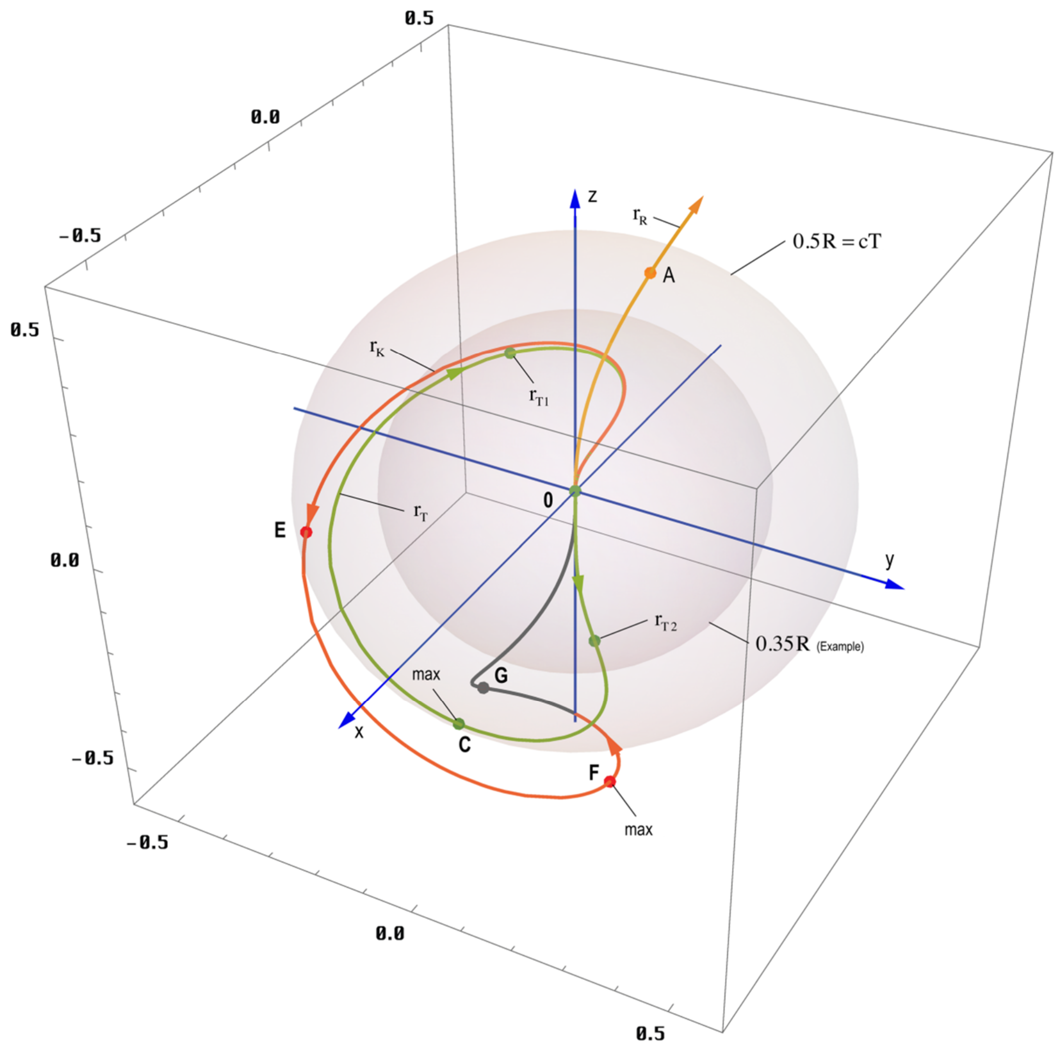



Figure 158
3D-course of the distance-vectors
$r_R$, $r_K$ and $r_T$ as a function of time

At this point we make use of the fact that $H_0$ is an angular frequency. And for every observer, no matter in which reference system or where he is, the universe has always completed exactly one revolution around all three spatial axes. However, only two of them are shown in Figure 158, giving the impression that the maximum observable radius $r_R$ is at the point C. However, the images arriving from one direction are actually from a circle of diameter 0.490339R passing through point C. Therefore, an exact localization of the sources actual position is impossible.

But we can not only observe objects on this circle. Since it's about an $R^4$-universe, we have one additional degree of freedom left, which means, the circle also rotates about its diameter. With it, we are able to observe all objects within a sphere with the radius 0.490339R, whereby the signals then arrive from the entire solid angle $4\pi$.

Figure 158 shows the example sphere and the R/2 sphere. As in Figure 157, the extrema and the intersections are marked with coloured dots and letters. Unfortunately it was not possible to show the section D-F-z as a dashed line. One can also see that the vector $r_R$ deviates extremely from $r_K$ very early on, a challenge for navigation. Figure 158 has been created with the following program:

```
z1=Line[{{{0,0,-.7},{0,0,.7}},{{0,-.7,0},{0,.7,0}},{{-.7,0,0},{.7,0,0}}}]   (*The axes cross*);
```

```
ParametricPlot3D[{{1,1,1}, {r Cos[r]Sin[r/2], r Sin[r]Sin[r/2], r Cos[r/2]},
{R2[r]Cos[r]Sin[r/2],R2[r]Sin[r]Sin[r/2],R2[r]Cos[r/2]},
{R3[r]Cos[r]Sin[r/2],R3[r]Sin[r]Sin[r/2],R3[r]Cos[r/2]}},
{r,0,8/3 Pi}, PlotRange->0.6, ImageSize->Large, AspectRatio->1,
LabelStyle->{FontFamily->„Chicago“,10,GrayLevel[0]}, ImageSize->Large];

Show[%,
Graphics3D[{Opacity[0.1], Sphere[{0,0,0}, 0.5]}],
Graphics3D[{Opacity[0.1], Sphere[{0,0,0}, x01]}],
Graphics3D[{Thickness[0.0025], Blue,z1}],
Graphics3D[{PointSize[0.0125], Orange, Point[{
{.5 Cos[.5]Sin[.25],.5 Sin[.5]Sin[.25],.5 Cos[.25]}}]}],
Graphics3D[{PointSize[0.0125], Red, Point[{
{R3[z31]Cos[z31]Sin[z31/2],R3[z31]Sin[z31]Sin[z31/2],R3[z31]Cos[z31/2]},
{R3[z32]Cos[z32]Sin[z32/2],R3[z32]Sin[z32]Sin[z32/2],R3[z32]Cos[z32/2]},
{R3[z33]Cos[z33]Sin[z33/2],R3[z33]Sin[z33]Sin[z33/2],R3[z33]Cos[z33/2]}}]}],
Graphics3D[{{PointSize[0.0125],ColorData[1,12],Point[{{0,0,0},
{y2 Cos[2 Pi RTR1[y2]]Sin[Pi RTR1[y2]],y2 Sin[2 Pi RTR1[y2]]Sin[Pi RTR1[y2]], y2 Cos[Pi RTR1[y2]]},
{x01 Cos[2 Pi RTR1[x01]]Sin[Pi RTR1[x01]],
x01 Sin[2 Pi RTR1[x01]]Sin[Pi RTR1[x01]],
x01 Cos[Pi RTR1[x01]]},
{x01 Cos[2 Pi RTR2[x01]]Sin[Pi RTR2[x01]],
x01 Sin[2 Pi RTR2[x01]]Sin[Pi RTR2[x01]],
x01 Cos[Pi RTR2[x01]]} }]}}]]
```

(1062)

But there is an additional way of presentation. If we replace the temporal dimension by the third spatial one, we can let rotate the $r_T$-curve obtaining a body of revolution with interesting properties:

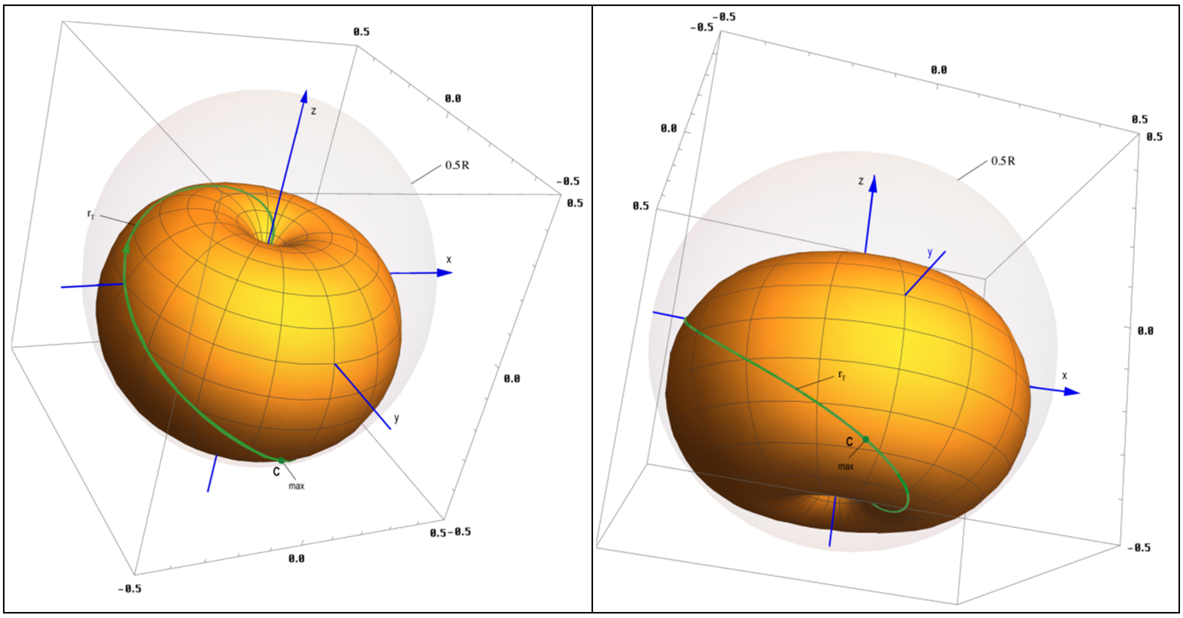



Figure 159
Possible shape of the electron
and/or of the PLANCK charge

The representation is similar to Figure 8, which would close the circle. The model has the property of logarithmic periodicity, i.e. there are similarities between the microcosm and the macrocosm.

My assumption is therefore that the object in Figure 159 could be identical to the PLANCK's charge and/or the electron, as its freely occurring form, just on a different scale. Instead of rotating with $H_0$ it would rotate with $\omega_0$ then and a part of the charge would reside in the interior, so that the observable part would depend on the viewing angle. This would also explain the need to correct $r_e$. Then, the electron would be the 3D-manifestation of a 4D-object. But as I said, this is just a guess on my part. The object can be displayed with the following program:

```
Pl1=ParametricPlot3D[{{R2[r]Cos[s]Sin[r/2],R2[r]Sin[s]Sin[r/2],R2[r]Cos[r/2]}},
{r,0,2 Pi}, {s,0,2 Pi}, PlotRange->0.5, ImageSize->Large,
PlotStyle->{Opacity[1],FillingStyle->Opacity[0.1]}, AspectRatio->1,
LabelStyle->{FontFamily->„Chicago",10,GrayLevel[0]}];

Pl2=ParametricPlot3D[{{R2[r]Cos[r]Sin[r/2],R2[r]Sin[r]Sin[r/2],R2[r]Cos[r/2]}},
{r,0,2 Pi}, PlotRange->0.5, ImageSize->Large, AspectRatio->1,
PlotStyle->{ColorData[1,8],Thickness[0.005]},                                    (1063)
LabelStyle->{FontFamily->„Chicago",10,GrayLevel[0]}];

Show[Pl2, Pl1, Graphics3D[{Opacity[0.075], Sphere[{0,0,0},0.5]}],
Graphics3D[{Thickness[0.0025],Blue,z1}],
Graphics3D[{{PointSize[0.013],ColorData[1,8], Point[{{0,0,0},
{y2 Cos[2 Pi RTR1[y2]]Sin[Pi RTR1[y2]],y2 Sin[2 Pi RTR1[y2]]Sin[Pi RTR1[y2]],
y2 Cos[Pi RTR1[y2]]} }]}}]]
```

### 7.5.3. Determination of the HUBBLE-parameter with the help of the CMBR-temperature

In section 4.6.4.2.5. with (802) we already formulated a relation between the phase-angle/Q-factor of the metrics $Q_0$ and the resulting temperature of the cosmologic background-radiation. With the astronomically specified value of the HUBBLE-parameter from section 4.3.5.4.6. (75.9 $\mathrm{kms^{-1}Mpc^{-1}}$) and the value $Q_0=7.5419\cdot10^{60}$ resulting from it, a temperature of 2.86632K turns out for the cosmologic background-radiation. The updated value 68.6241 $\mathrm{kms^{-1}Mpc^{-1}}$ resp. $Q_0=8.340471\cdot10^{60}$ from [49] even yields a temperature of 2.725436K. The average radiation temperature, determined with the help of the COBE-satellite, is around 2.72548±0.00057K (Wikipedia).

Interestingly enough, all these values are close to that of 3.18K (=82.63$\mathrm{kms^{-1}Mpc^{-1}}$) predicted as early as 1896 by GUILLAUME and EDDINGTON. At the time, both assumed, that there were the equivalent of 2000 stars on average in the 10 pc-surroundings of a star with the magnitude $1^{\mathrm{m}}$. 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. It was assumed at the time, that the supposed average star-density should be available throughout the whole universe, because the existence of external galaxies neither has been commonly accepted nor has been known until 1924.

Now fortunately, we are in a better situation. So, we don't need to calculate the radiation-temperature but we can measure it absolutely accurate. Of course, it's not a problem, to determine the related values $Q_0$ and $H_0$ by rearrangement of (802). Indeed, it is to be pointed out, that neither $\omega_1$ nor $\hbar_1$ are exactly defined by locally measurable quantities. Rather, they themselves depend on $Q_0$ and $H_0$, on the values, we actually want to determine. But we know the values of $\hbar$ and $\omega_0$. It applies $\omega_1=Q_0\omega_0$ and $\hbar_1=Q_0\hbar$:

$$T_k = \frac{\hbar_1\omega_1}{18\mathrm{k}}Q_0^{-\frac{5}{2}} = \frac{\hbar\omega_0}{18\mathrm{k}}Q_0^{-\frac{1}{2}} \qquad \omega_1=\frac{\kappa_0}{\varepsilon_0} \tag{1064}$$

$$Q_0 = \left(\frac{\hbar\omega_0}{18\mathrm{k}T_k}\right)^2 \qquad \omega_0=\sqrt{\frac{c^5}{G\hbar}} \tag{1065}$$

$$Q_0 = 0.0030864198\left(\frac{\hbar\omega_0}{\mathrm{k}T_k}\right)^2 = \frac{1}{324}\left(\frac{\hbar\omega_0}{\mathrm{k}T_k}\right)^2 \qquad H_0=\frac{\omega_0}{Q_0} \tag{1066}$$

$$H_0 = \omega_0\left(\frac{\hbar\omega_0}{\mathrm{k}T_k}\right)^2 \qquad H_0 = 324\omega_0\left(\frac{\hbar\omega_0}{\mathrm{k}T_k}\right)^2 \tag{1067}$$

All expressions are based on the assumption that the frequency $\omega_U$ is not reduced by the factor of $2\sqrt{2}$ during coupling and refraction, but by the proportionality factor of WIEN's displacement law $\tilde{x}$ (See Figure 68). Both values are very close to each other.

Applying the above-mentioned measured value 2.72548K, we get a value of $8.3415 \cdot 10^{60}$ for $Q_0$ (802). This corresponds to a value of $H_0 = 68.6071\,\text{kms}^{-1}\text{Mpc}^{-1}$. The tabular value of $H_0$ has been corrected using the updated $Q_0$. It most likely matches our solution (1049). However, the new value according to (802) is closer, but is not considered in the entire work because it is more recent. For a better overview, all values are summarized again in Table 9.

| **Value** | **$Q_0$** | **$H_0$** | **$H_0$** | **Temperature CMBR** | **Absolute offset** | **Relative offset** |
|---|---|---|---|---|---|---|
| | [1] | [$s^{-1}$] | [$\text{kms}^{-1}\text{Mpc}^{-1}$] | [K] | [K] | [%] |
| (1043) | $7.2222 \cdot 10^{60}$ | $2.569 \cdot 10^{-18}$ | 79.2562 | 2.92907 | +0.20359 | +7.46988 |
| (1052) | $7.4576 \cdot 10^{60}$ | $2.487 \cdot 10^{-18}$ | 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 |
| (1049) | $7.9518 \cdot 10^{60}$ | $2.333 \cdot 10^{-18}$ | 71.9843 | 2.79146 | +0.06598 | +2.42086 |
| (802) | $8.3405 \cdot 10^{60}$ | $2.224 \cdot 10^{-18}$ | 68.6241 | 2.72544 | $-4.3951 \cdot 10^{-5}$ | −0.0001626 |
| (COBE) | $8.3415 \cdot 10^{60}$ | $2.223 \cdot 10^{-18}$ | 68.6071 | 2.72548 | ±0.00000 | ±0.00000 |

Table 9
Calculated and measured CMBR-temperature in comparison with the values of the HUBBLE-parameter determined in section 7.5.1.

In addition to the electron mass, this is another way to determine $H_0$. However, due to the various possible solutions, a verification is required. To confirm the favoured value (802) 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 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 reality. Indeed, the examination has caused more confusion, than that it has led to rational results, as we will see yet. However, the reason, 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 yet another section, which deals with the fundamental values of observation, being focused to physicists, astronomers and technicians, which as known, work with different units of measurement. So it's difficult to understand one another.

7.5.4.1. Measurands and conversions

Since we want to deal 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. I recommend [44] to any interested person, which the information given here, is 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 (310) and have been collated with the luminosities predicted by the various world-models. What do we mean by luminosity however?

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:

$$M_b = -2.5\lg\frac{F}{F_0} = -2.5\lg\frac{L/4\pi r^2}{L_0/4\pi r^2} = -2.5\lg\frac{L}{L_0} \qquad \text{Brightness} \qquad (1068)$$

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:

$$F_0 = 2.51\cdot 10^{-8}\,Wm^{-2} \qquad L_0 = 3.09\cdot 10^{28}\,W \qquad (1069)$$

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):

$$S = P = 10\lg\frac{S}{S_0}\,dB = 10\lg\frac{P/4\pi r^2}{P_0/4\pi r^2}\,dB = 10\lg\frac{P}{P_0}\,dB \qquad \text{Field-strength/level} \qquad (1070)$$

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:

$$S_0 = 1\,pWm^{-2} = 10^{-12}\,Wm^{-2} \qquad P_0 = 1\,pW = 10^{-12}\,W \qquad (1071)$$

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:

$$P[dBpW] = S[dBpWm^{-2}] + 10\lg A[m^2] + G[dB] \qquad (1072)$$

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:

| | | | |
|---|---|---|---|
| $P = 404.9 - 4M_b$ | $M_b = 101.225 - 0.25P$ | Power<br>Absolute bolom. brightness | (1073) |
| $S = 44 - 4m_b$ | $m_b = 11 - 0.25S$ | Poynting-vector<br>Apparent bolom. brightness | (1074) |
| $P = 120 + 10\lg L$ | $L = 10^{0.1P-12}$ | Power<br>Luminosity | (1075) |
| $S = 120 + 10\lg F$ | $F = 10^{0.1S-12}$ | Poynting-vector<br>Flux | (1076) |
| $L = 10^{28.5-0.4M_b}$ | $M_b = 71.225 - 2.5\lg L$ | Luminosity<br>Absolute bolom. brightness | (1077) |
| $F = 10^{-7.6-0.4m_b}$ | $m_b = 19 - 2.5\lg F$ | Flux<br>Apparent bolom. brightness | (1078) |

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. For a better understanding of what a type Ia supernova actually is, I recommend the work of HERRMANN [42]. Most important is, a SN Ia has a maximum absolute brightness, which results from its structure. If the star is greater, a supernova of different type develops, which can be distinguished by its characteristic. Therefore it's possible to use a SN Ia as a standard-candle, at which point the brightness is mostly something smaller than the maximum, 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 classical 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 ($\Lambda$=0). The case $\Lambda$=0 just doesn't fits the observations. The possibility that SN Ia could have had other properties earlier is ruled out by all the authors, including myself.

Rather, the deviation is interpreted in such a way that $\Lambda$ should have a value other than zero, which means that the expansion rate of the universe, i.e. the HUBBLE-parameter, is not decreasing at the present time, as has always been assumed, but increasing 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. However this leads to incongruities with other observations. In order to avoid them, 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 $\Lambda\neq0$, 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 erroneous, since the discrepancy can be explained even more simply, only with the help of known physical rules (Ockham's razor). Only then, one must have the courage to use an alternative model. The standard-big-bang-model has flopped for a long time, even in respect of 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 if the HUBBLE-parameter continues to decrease and the observed objects are being located in the correct distance, the only possible explanation is, that the photons are subject to an additional attenuation during their propagation, 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 the attenuation rate $\alpha$ is different from zero there. It has the value 1/R. Therefore we want to forecast the observed brightnesses of SNae Ia with the help of this function. For the graphic representation, we need the function $m_b(z)$. Starting from (1068) we obtain for the apparent magnitude $m_b$:

$$m_b = -2.5\lg\frac{F}{F_0} = -2.5\lg\left(\frac{1}{4\pi r^2}\frac{L_{Ia}}{L_0}\right) = -2.5\lg\frac{L_{Ia}}{4\pi r^2\cdot 2.51\cdot 10^{-8}\,\mathrm{Wm}^{-2}} \tag{1079}$$

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 (1079) 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 (312) without correction-term. It applies:

$$m_b = -2.5\lg\frac{10^{36}\,\mathrm{m}^2}{4\pi r^2\cdot 2.51\cdot 10^{-8}\,\mathrm{Wm}^{-2}} = -2.5\lg\left(\frac{1}{\tilde{R}^2}\frac{10^{44}\,\mathrm{m}^2}{2.51\pi}\frac{1}{((z+1)^{4/3}-1)^2}\right) \tag{1080}$$

$$m_b = -2.5\lg\left(\frac{\tilde{H}_0^2}{c^2}\frac{10^{44}\,\mathrm{m}^2}{2.51\pi}\frac{1}{((z+1)^{4/3}-1)^2}\right) = -2.5\lg\left(1.41103\cdot 10^{26}\,\mathrm{s}^2\frac{\tilde{H}_0^2}{((z+1)^{4/3}-1)^2}\right) \tag{1081}$$

This is the function $m_b(z)$ without consideration of the additional attenuation. Since also the z-axis needs to have a logarithmic scale, we apply the value $10^w$ with $-2\leq w\leq 0$ instead of z. Now indeed, PERLMUTTER has published all measurements in [45], but since I do not dispose of any procedure, to present it so nice, including the tolerance-limits, I decided, to take up the comparison with (1081) by overlay of both charts.

Figure 160 presents the relative brightnesses, calculated with the help of (1081), in comparison with the observations of the supernova-cosmology-project. Also to be seen are the curves of the standard-big-bang-model for various adjustments calculated by PERLMUTTER. The overlay-markers (+) are located at all corners except for top left.

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 160 also shows, that solution (1049) with $71.985\,\mathrm{kms}^{-1}\mathrm{Mpc}^{-1}$ for the HUBBLE-parameter (red) comes quite very close to reality, because it is located at the outer margin of the error tolerance corridor. Using the

[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.

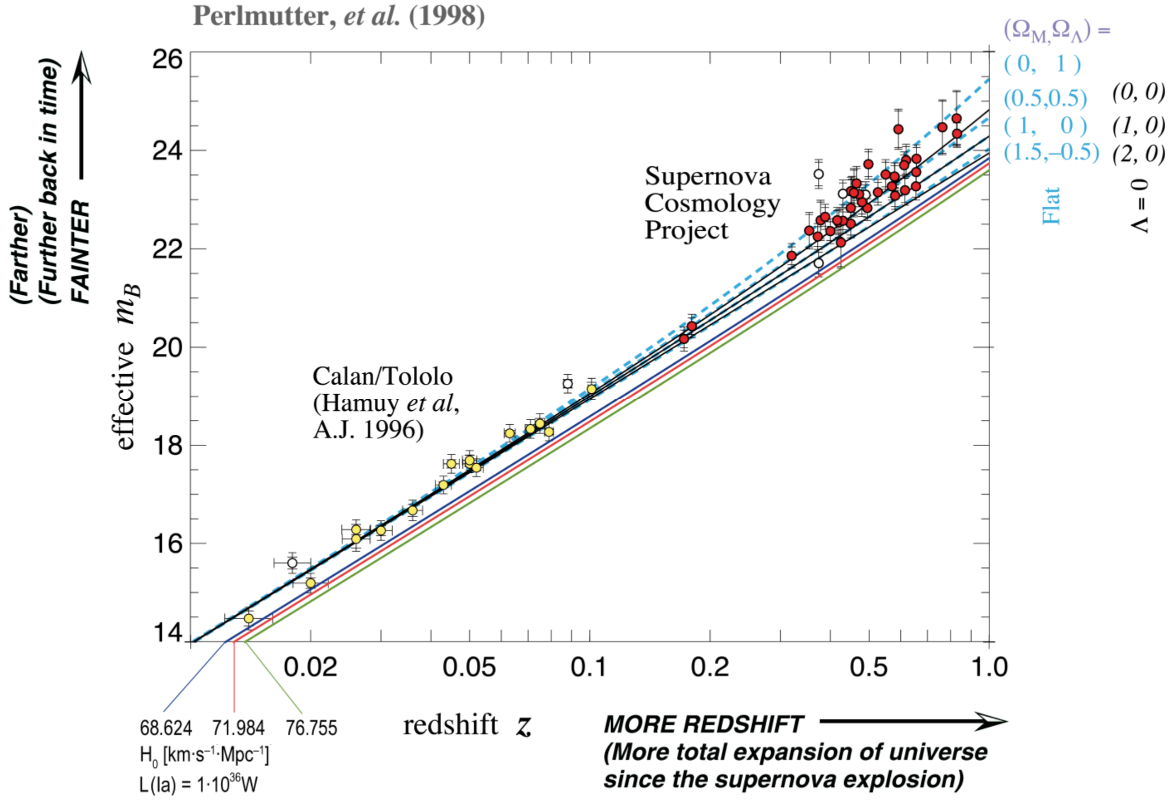



Figure 160
Calculated apparent bolometric brightness for the three values of the HUBBLE-parameter in comparison with the observations of the supernova-cosmology-project (standard-candle = maximum)

updated value (549) in the amount of $68.6241 \mathrm{kms}^{-1}\mathrm{Mpc}^{-1}$ we are already within. The same applies to the value derived from the COBE-measurements, which would follow the same curve (blue) in the graphics. Now, in contrast to the previous editions we'll use value (549) for the following contemplations. We determine the updated value of the standard-candle, which is the statistical average of all observed SNae Ia, numerically with the help of (549) for a value at the lower end of the z-axis to $L_{Ia} = 6.40949 \cdot 10^{35}\mathrm{W}$. Applied to (1079) using the example of $\tilde{H}_0(549)$ we obtain :

$$m_b = -2.5\lg\left(\frac{\tilde{H}_0^2}{c^2}\,\frac{6.41\cdot 10^{35}\,m^2}{2.51\cdot 10^{-8}\pi}\,\frac{1}{((z+1)^{4/3}-1)^2}\right) = -2.5\lg\frac{4.4734\cdot 10^{-10}}{((z+1)^{4/3}-1)^2} \qquad (1082)$$

$$m_b = -2.5\lg 4.4734\cdot 10^{-10} + 2\cdot 2.5\lg((z+1)^{4/3}-1) = 23.3734 + 5\lg((z+1)^{4/3}-1) \qquad (1083)$$

We need the function $m_b(z)$ with parametric attenuation as well. On this occasion we have to consider the factor $e^{-r/\tilde{R}} = 10^{-r/\tilde{R}\cdot \lg e}$ from the propagation-function (308). It applies:

$$m_b = -2.5\lg\left(\tilde{H}_0^2\, 9.0447\cdot 10^{25} s^2 \frac{e^{-r/\tilde{R}}}{((z+1)^{4/3}-1)^2}\right) = -2.5\lg\frac{4.4734\cdot 10^{-10}}{((z+1)^{4/3}-1)^2}\, e^{-\frac{1}{2}((z+1)^{4/3}-1)} \qquad (1084)$$

$$m_b = -2.5\lg\frac{4.4734\cdot 10^{-10}}{((z+1)^{4/3}-1)^2}\, 10^{-\frac{1}{2}((z+1)^{4/3}-1)\lg e} \qquad (1085)$$

$$m_b = 23.3734 + 5\lg((z+1)^{4/3}-1) + 0.5429((z+1)^{4/3}-1) \qquad \text{With param. attenuation} \qquad (1086)$$

Figure 161 shows the graphs of expression (1083) and (1086) in comparison with the measurements of the supernova-cosmology-project for solution (549) 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

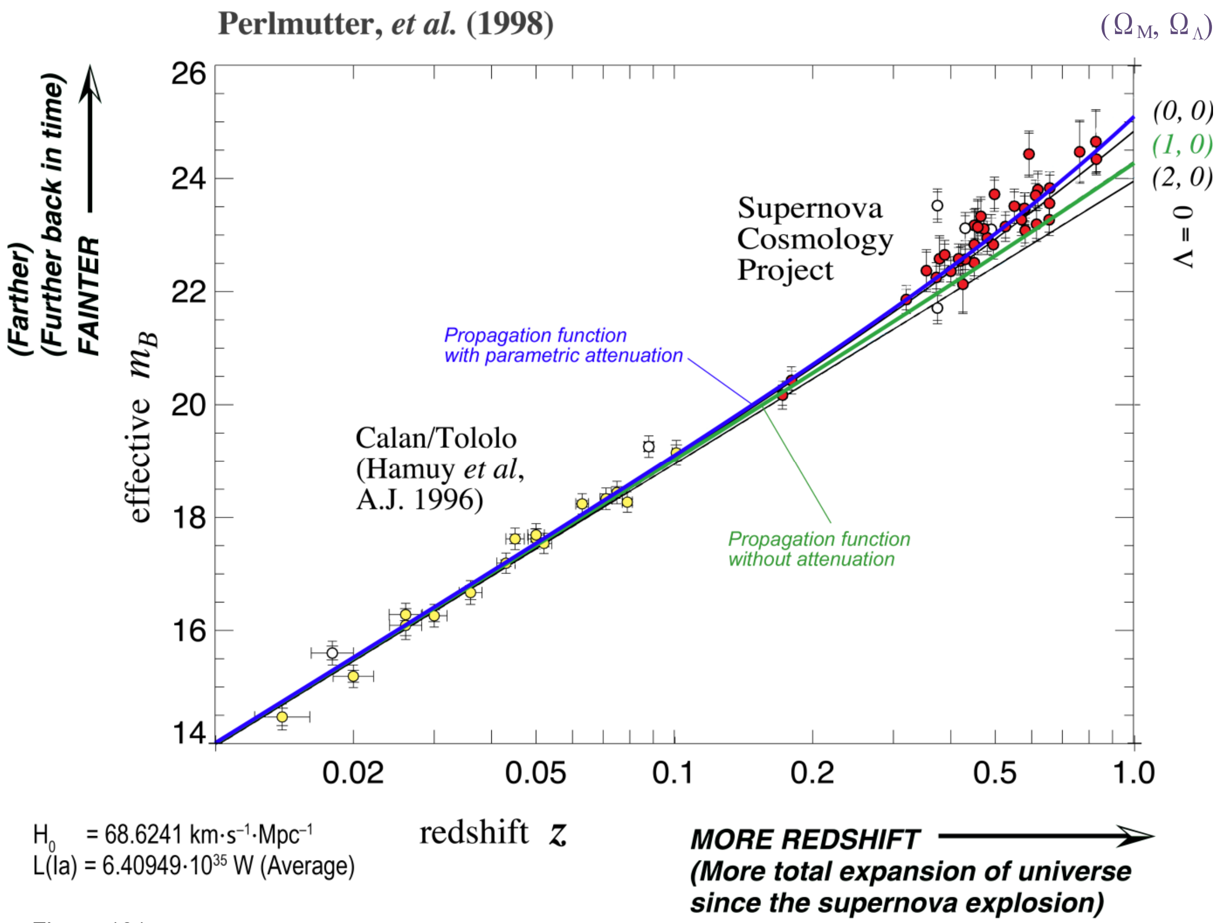



Figure 161
Calculated apparent bolometric brightness for solution (1049) of the HUBBLE-parameters in comparison with the observations of the supernova-cosmology-project (standard-candle = average)

the other time a universe with „normal“ energy-density (1) and at last a 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 (1083). That is also no miracle, because both have the same exponent 4/3 in (312). This case however is not confirmed by the observations, neither an empty universe. For $\Lambda$=0 even an universe with negative mass-energy-density (filled with antimatter) would be necessary. For an optimal match we’d have to successfully ignore EINSTEIN’s conclusion „The introduction of the cosmological constant was the biggest folly I’ve 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 $\Omega_\Lambda$ is the so-called „dark energy-density“ which indeed could be identical to our metric wave-field (0K = absolutely dark).

*XIV. The observed values of the supernova-cosmology-project are exactly described by the propagation-function (308) under consideration of the geometric and parametric attenuation (287). 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!!***

As I said, the whole thing sounds rather improbable, especially since this optimal course is „coincidentally” exactly described by our function (1086). (blue graph in Figure 161), and the whole issue only with the help of known physical objects and relations. It fits!

The only dark matter is in the mind, that has to be said. But since science needs 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 (1083) and (1086). They are presented in Figure 162. Surely, the opportunity arises to observe such an object in the closer or farther future.

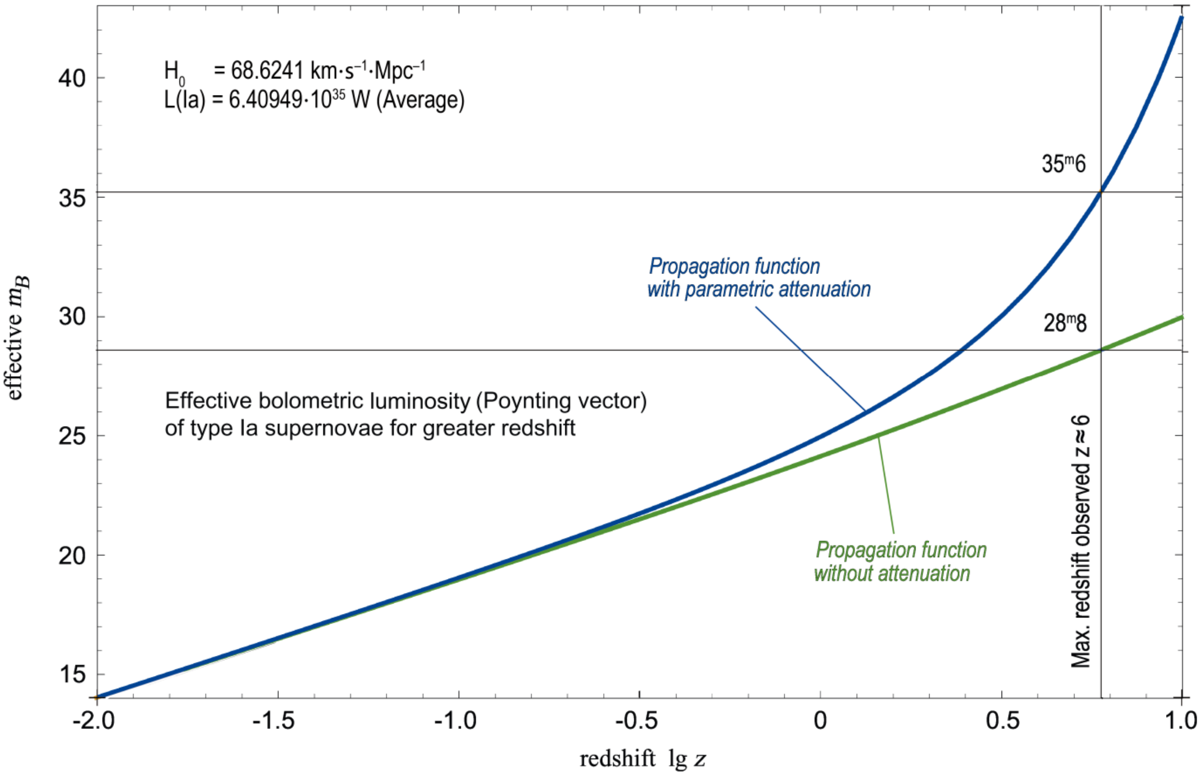



Figure 162
Calculated apparent bolometric brightness for solution (1049) of the HUBBLE-parameter for farther SNae Ia

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 68.6241 $kms^{-1}Mpc^{-1}$ exactly. That corresponds to solution (549).

### 7.5.5. The Concerted International System of Units

With the help of this model, it was possible to calculate a series of natural constants associated with the electron, the proton and the $^1H$ atom via their relationship to the reference system $Q_0$ and this exactly. The maximum deviation of $\pm 1.0 \cdot 10^{-9}$ for the THOMSON cross section $\sigma_e$ corresponds to the standard deviation of the numerical value given in Table [63]. Thus, the proof according to the Sudoku method is provided.

In fact, most values are not true constants. At the same time, the value of $H_0$ could be specified more precisely, as well as the value of $\kappa_0$, the specific conductivity of the vacuum, on which this model is based. Since we have uncovered the relations between the individual fundamental constants, it is appropriate to develop a program with which these are recalculated on the spot each time according to the reference system and to use it instead of a list of values determined independently of one another in different laboratories. With regard to the list, this would also have the advantage that the errors would not add up.

All that remains is to incorporate the values and relations obtained into the program already published in the previous editions and in [49] and to compare the calculated values with the $CODATA_{2018}$ values. The whole is shown in Table 10 at the end. The updated program can be found in the annex.

The model is based on the fundamentals of subspace, which are fixed values and independent of the frame of reference. At this point it suffices to define only five genuine constants ($\mu_0$, c, $\kappa_0$, $\hbar_1$ and k) as fixed basic values plus a so-called *magic value*, here $m_e$, in order to identify the reference frame $Q_0$.

The comparison with the $CODATA_{2018}$ values is a bit more complicated, since not all values of this model appear in the corresponding documents. On the other hand, some values are given there which lead to a divergent result compared with other values been calculated with the help of the former ones. The PLANCK units fared the worst. The given values partially deviate from each other and by up to $6.5 \cdot 10^{-8}$ from the values calculated with the root expressions from c, $\varepsilon_0$, G and $\hbar$. However, according to the present model, the root expressions are considered to be exact. Hence I calculated the corresponding root expressions of all PLANCK units using the $CODATA_{2018}$ values for c, $\varepsilon_0$, G and $\hbar$ disregarding the numerical values and compared them with the values of mine. Furthermore, the use of the value $m_e/m_p$ specified there leads to a reduction in accuracy. Therefore I used the quotient of the individual values. Another criticism is that a rounded value of the BOLTZMANN constant k is used.

With the PLANCK-temperature there is a further difference. Even if we can calculate such a value, the actual value is 0K, since thermal energy is completely eliminated by the angular momentum (see section 4.6.3.). The CMBR-temperature is considered instead. This depends on $Q_0$ too. If we rearrange (477) after $Q_0$, the frame of reference also depends on its temperature. With smaller $Q_0$, e.g. in the vicinity of the SCHWARZSCHILD-radius of a BH, the CMBR-temperature increases extremely.

There is also no addition of several different effects, such as temperature plus gravity in comparison to another frame of reference with the velocity v. All values are linked with $Q_0$, if one value changes, all other change too. If one effect supervenes, it is already a new frame of reference. With it all values, except for the fixed ones, form a so-called *Canonical Ensemble*.

During set-up of the table I incorporated yet some other values, simply dependent on the already defined ones, into the system, as there are $\sigma_e$, $a_e$, $g_e$, $\gamma_e$, $\mu_e$, $\mu_N$, $\Phi_0$, $G_0$, $K_J$ and $R_K$. Except for $r_e$, whose definition was wrong (eternal typo), I used the expressions and symbols stated in the $CODATA_{2018}$-document [22] for the other values. Therefore, the definition of the symbols can be found in [63]. The quantities alpha ($\alpha$) and delta ($\delta$) are marked as fixed values, since they are typically invariable. But there are also the functions alphaF[Q] and deltaF[Q] for special cases near $Q \approx 1$ as in section 6.2.3.2.

## 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, without contradiction to the knowledge already saved, 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 value of the HUBBLE-parameter stated in the previous editions (71.9845 $kms^{-1}Mpc^{-1}$), as well as the updated one (840) amounts to:

$$H_0 = \frac{2}{3}\frac{64\pi^3\varepsilon_0 G\hbar m_e^3}{\zeta^3\mu_0^2 e^6} = \left(144\pi^4\sqrt{2}\right)^3\frac{G\hbar c^4\varepsilon_0^3 m_e^6}{e^6 m_p^3} = 2.2239252345813\cdot 10^{-18}\,s^{-1} \quad (840)$$

$$\zeta = \frac{1}{9\pi^2}\frac{1}{\sqrt[3]{3\sqrt{2}\alpha\delta}} = \frac{1}{36\pi^3}\frac{1}{\sqrt[3]{3\sqrt{2}}}\frac{m_p}{m_e} = 1.016119033114739' = \text{const} \quad (835)$$

The factor $\zeta$ (835) corrects the curvature of the electron radius, which is three times contained in (840). Converted we get for $H_0$:

$$\boxed{H_0 = 68.6241\ \mathrm{kms^{-1}Mpc^{-1}}}$$

The calculation of the temperature of the cosmologic background radiation with the new value turns out an extremely small deviation of $-4.3951 \cdot 10^{-5}$ K to the measured value, so that this point also can be regarded as fulfilled. The problem will be examined in [46] more detailed.

The technical determination of the value of the specific conductivity of subspace $\kappa_0$ still remains open, which probably will remain unfeasible even in the remote future, due to it's excessively high value. At least, this value can be determined exactly on the basis of other relations. This way, a typo in (841), the former (932) is also corrected here:

$$\kappa_0 = \frac{3}{8}\frac{\zeta^3 e^6 c}{16\pi^3 \varepsilon_0^2 G^2 \hbar^2 m_e^3} = \left(144\,\pi^4\sqrt{2}\right)^{-3}\frac{c\,e^6 m_p^3}{(\varepsilon_0 G\hbar m_e^3)^2} = 1.36977766319 \cdot 10^{93}\,\mathrm{Sm^{-1}} \quad (841)$$

The value stated in the former editions amounted to $1.30605 \cdot 10^{93}\mathrm{Sm^{-1}}$. If you re-calculate the legacy values you get a result, which differs marginally, since they have been calculated using the CODATA$_{2014}$-value in combination with the BRUKER-value of G, which don't match each other. Maybe, there is someone or other similarly differing value in the previous sections. Nevertheless, I decided to update Table 10.

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 follow the classic doctrine. This work may contain sections, which you will disagree. Nevertheless, I ask you to do not discard everything because of that.

THE END

## 8. Affidavit

Herewith, I declare that I created this work off my own bat having used no other aids as stated. With publications of this work in German language, a transcription according to the rules of the new orthography (1999 and later) is not allowed. This work and all translations of it must not be gendered under any circumstances.

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# 10. Table of figures

# 11. Table of charts



| Symbol | Variable | Calculated (CA) | Source | $CODATA_{2018}$ (CD) © COBE Data | ± Accuracy | Δy (CA/CD–1) | Unit |
|---|---|---|---|---|---|---|---|
| c | c | $2.99792458 \cdot 10^{8}$ | S | $2.99792458 \cdot 10^{8}$ | defined | defined | $m\ s^{-1}$ |
| $\varepsilon_0$ | ep0 | $8.854187817620390 \cdot 10^{-12}$ | S | $8.854187817620390 \cdot 10^{-12}$ | defined | defined | $As\ V^{-1}m^{-1}$ |
| $\kappa_0$ | ka0 | $1.369777663190222 \cdot 10^{93}$ | S | n.a. | n.a. | defined | $A\ V^{-1}m^{-1}$ |
| $\mu_0$ | my0 | $1.256637061435917 \cdot 10^{-6}$ | S | $1.256637061435917 \cdot 10^{-6}$ | exactly | exactly | $Vs\ A^{-1}m^{-1}$ |
| k | k | $1.3806485279 \cdot 10^{-23}$ | S | $1.380649 \cdot 10^{-23}$ | statistic | $+3.41941 \cdot 10^{-7}$ | $J\ K^{-1}$ |
| $\hbar_1$ | hb1 | $8.795625796565460 \cdot 10^{26}$ | S | n.a. | n.a. | defined | J s |
| $\hbar$ | hb0 | $1.054571817000010 \cdot 10^{-34}$ | C | $1.054571817 \cdot 10^{-34}$ | defined | $+8.88178 \cdot 10^{-15}$ | J s |
| $Q_0$ | Q0 | $8.340471132242850 \cdot 10^{60}$ | C | $8.3415 \cdot 10^{60}$ © | $3.3742 \cdot 10^{-2}$ | $-1.23343 \cdot 10^{-4}$ | 1 |
| $Z_0$ | Z0 | 376.7303134617700 | F | 376.73031366857 | $1.5 \cdot 10^{-10}$ | $-5.48932 \cdot 10^{-10}$ | Ω |
| G | G0 | $6.674301499999827 \cdot 10^{-11}$ | C | $6.674301499999999 \cdot 10^{-11}$ | $2.2 \cdot 10^{-5}$ | $-5.48932 \cdot 10^{-10}$ | $m^3kg^{-1}s^{-2}$ |
| $G_1$ | G1 | $9.594550966819210 \cdot 10^{-133}$ | C | n.a. | n.a. | unusual | $m^3kg^{-1}s^{-2}$ |
| $G_2$ | G2 | $1.150360790738584 \cdot 10^{-193}$ | F | n.a. | n.a. | unusual | $m^3kg^{-1}s^{-2}$ |
| $M_2$ | M2 | $1.514002834704114 \cdot 10^{114}$ | F | n.a. | n.a. | unusual | kg |
| $M_1$ | M1 | $1.815248576128075 \cdot 10^{53}$ | C | n.a. | n.a. | unusual | kg |
| $m_p$ | mp | $1.6726219236951 \cdot 10^{-27}$ | C | $1.6726219236951 \cdot 10^{-27}$ | $1.1 \cdot 10^{-5}$ | $-2.22045 \cdot 10^{-16}$ | kg |
| $m_e$ | me | $9.109383701528 \cdot 10^{-31}$ | M | $9.109383701528 \cdot 10^{-31}$ | $3.0 \cdot 10^{-10}$ | magic ±0 | kg |
| $m_0$ | m0 | $2.176434097482374 \cdot 10^{-8}$ | C | $2.176434097482336 \cdot 10^{-8}$ | calculated | $+1.70974 \cdot 10^{-14}$ | kg |
| $M_H$ | MH | $2.609485798792167 \cdot 10^{-69}$ | C | n.a. | n.a. | unusual | kg |
| $m_e/m_p$ | mep | $5.446170214846793 \cdot 10^{-4}$ | F | $5.4461702148733 \cdot 10^{-4}$ | $6.0 \cdot 10^{-11}$ | $-4.867 \cdot 10^{-12}$ | 1 |
| $T_p$ | Tp | 0.000000000000000 | C | $1.416784486973588 \cdot 10^{32}$ | calculated | MOOP | K |
| $T_{k1}$ | Tk1 | $5.475357175411492 \cdot 10^{152}$ | C | n.a. | n.a. | unusual | K |
| $T_k$ | Tk0 | 2.725436049425770 | C | 2.72548 © | $4.3951 \cdot 10^{-5}$ | $-1.61258 \cdot 10^{-5}$ | K |
| $r_1$ | r1 | $1.937846411698606 \cdot 10^{-96}$ | F | n.a. | n.a. | unusual | m |
| $r_0$ | r0 | $1.616255205549261 \cdot 10^{-35}$ | C | $1.616255205549274 \cdot 10^{-35}$ | calculated | $-8.21565 \cdot 10^{-15}$ | m |
| $r_e$ | re | $2.817940324662071 \cdot 10^{-15}$ | C | $2.817940326213 \cdot 10^{-15}$ | $4.5 \cdot 10^{-10}$ | $-5.50377 \cdot 10^{-10}$ | m |
| $\lambda\!\!\!^-{}_C$ | ΛbarC | $3.861592677230890 \cdot 10^{-13}$ | C | $3.861592679612 \cdot 10^{-13}$ | $3.0 \cdot 10^{-10}$ | $-6.16614 \cdot 10^{-10}$ | m |
| $\lambda_C$ | ΛC | $2.426310237188940 \cdot 10^{-12}$ | C | $2.4263102386773 \cdot 10^{-12}$ | $3.0 \cdot 10^{-10}$ | $-6.13425 \cdot 10^{-10}$ | m |
| $a_0$ | a0 | $5.291772105440689 \cdot 10^{-11}$ | C | $5.291772109038 \cdot 10^{-11}$ | $1.5 \cdot 10^{-10}$ | $-6.79793 \cdot 10^{-10}$ | m |
| R | R | $1.348032988422084 \cdot 10^{26}$ | C | n.a. | at issue | at issue | m |
| R | RR | 4.368617335409830 | C | n.a. | at issue | at issue | Gpc |
| $t_1$ | 2 t1 | $6.463959849512312 \cdot 10^{-105}$ | F | n.a. | n.a. | unusual | s |
| $t_0$ | 2 t0 | $5.391247052483426 \cdot 10^{-44}$ | C | $5.391247052483470 \cdot 10^{-44}$ | calculated | $-8.43769 \cdot 10^{-15}$ | s |
| T | 2 T | $4.496554040802734 \cdot 10^{17}$ | C | $4.497663485280829 \cdot 10^{17}$ | $1.1385 \cdot 10^{-3}$ | $-2.46671 \cdot 10^{-4}$ | s |
| T | 2 T | $1.424902426903056 \cdot 10^{10}$ | C | $1.425253996152531 \cdot 10^{10}$ | $1.1385 \cdot 10^{-3}$ | $-2.46671 \cdot 10^{-4}$ | a |
| $R_\infty$ | R∞ | $1.097373157632934 \cdot 10^{7}$ | C | $1.097373156816021 \cdot 10^{7}$ | $1.9 \cdot 10^{-12}$ | $+7.44426 \cdot 10^{-10}$ | $m^{-1}$ |
| $\omega_1$ | Om1 | $1.547039312249824 \cdot 10^{104}$ | F | n.a. | n.a. | unusual | $s^{-1}$ |
| $\omega_0$ | Om0 | $1.854858421929227 \cdot 10^{43}$ | C | $1.854858421929212 \cdot 10^{43}$ | calculated | $+8.65974 \cdot 10^{-15}$ | $s^{-1}$ |
| $\omega_{R\infty}$ | OmR∞ | $2.067068668297942 \cdot 10^{16}$ | C | $2.067068666759112 \cdot 10^{16}$ | $1.9 \cdot 10^{-12}$ | $+7.44451 \cdot 10^{-10}$ | $s^{-1}$ |
| $cR_\infty$ | cR∞ | $3.289841962699988 \cdot 10^{15}$ | C | $3.289841960250864 \cdot 10^{15}$ | $1.9 \cdot 10^{-12}$ | $+7.44450 \cdot 10^{-10}$ | Hz |

| Symbol | Variable | Calculated (CA) | Source | $CODATA_{2018}$ (CD) © COBE Data | ±Accuracy | Δy (CA/CD–1) | Unit |
|---|---|---|---|---|---|---|---|
| $H_0$ | H0 | $2.223925234581364 \cdot 10^{-18}$ | C | $2.223376656062923 \cdot 10^{-18}$ | $1.1385 \cdot 10^{-3}$ | $+2.46732 \cdot 10^{-4}$ | $s^{-1}$ |
| $H_0$ | HPC[Q0] | 68.62410574852400 | C | 68.60717815146482←↑© | $1.1385 \cdot 10^{-3}$ | $+2.46732 \cdot 10^{-4}$ | $kms^{-1}Mpc^{-1}$ |
| $q_1$ | q1 | $1.527981474087040 \cdot 10^{12}$ | F | n.a. | n.a. | unusual | As |
| $q_0$ | q0 | $5.290817689717126 \cdot 10^{-19}$ | C | $5.2908176897171 \quad \cdot 10^{-19}$ | calculated | $+4.44089 \cdot 10^{-15}$ | As |
| e | qe | $1.602176634000007 \cdot 10^{-19}$ | C | $1.602176634 \quad \cdot 10^{-19}$ | exactly | $+4.44089 \cdot 10^{-15}$ | As |
| $U_1$ | U1 | $8.698608435529670 \cdot 10^{87}$ | F | n.a. | n.a. | unusual | V |
| $U_0$ | U0 | $1.042939697003725 \cdot 10^{27}$ | C | $1.042939697286845 \cdot 10^{27}$ | calculated | $-2.71463 \cdot 10^{-10}$ | V |
| $W_1$ | W1 | $1.360717888312544 \cdot 10^{131}$ | F | n.a. | n.a. | unusual | J |
| $W_0$ | W0 | $1.956081416291675 \cdot 10^{9}$ | C | $1.956081416291641 \cdot 10^{9}$ | calculated | $+1.73195 \cdot 10^{-14}$ | J |
| $W_{k1}$ | Wk1 | $6.301953910302633 \cdot 10^{126}$ | C | n.a. k→CMBR | n.a. | unusual | J |
| $S_1$ | S1 | $5.605711433987692 \cdot 10^{426}$ | F | n.a. | n.a. | unusual | $Wm^{-2}$ |
| $S_0$ | S0 | $1.388921881877266 \cdot 10^{122}$ | C | n.a. | n.a. | unusual | $Wm^{-2}$ |
| $\overline{S}_{k1}$ | Sk1 | $2.596200130940090 \cdot 10^{422}$ | C | n.a. k→CMBR | n.a. | unusual | $Wm^{-2}$ |
| $\overline{S}_{k0}$ | Sk0 | $1.251454657497949 \cdot 10^{-5}$ | C | $1.25013 \quad \cdot 10^{-5}$ | $+1.0596 \cdot 10^{-3}$ | calculated [59] | $Wm^{-2}$ |
| $\sigma_e$ | σe | $6.652458724888907 \cdot 10^{-29}$ | C | $6.6524587321600 \quad \cdot 10^{-29}$ | $9.1 \cdot 10^{-10}$ | $-1.09299 \cdot 10^{-9}$ | $m^2$ |
| $a_e$ | ae | $1.159652181281556 \cdot 10^{-3}$ | C | $1.1596521812818 \quad \cdot 10^{-3}$ | $1.5 \cdot 10^{-10}$ | $-2.10054 \cdot 10^{-13}$ | 1 |
| $g_e$ | ge | –2.00231930436256 | C | –2.00231930436256 | $1.7 \cdot 10^{-13}$ | $-2.22045 \cdot 10^{-16}$ | 1 |
| $\gamma_e$ | γe | $1.760859630228709 \cdot 10^{11}$ | C | $1.7608596302353 \quad \cdot 10^{11}$ | $3.0 \cdot 10^{-10}$ | $-3.74278 \cdot 10^{-12}$ | $s^{-1}T^{-1}$ |
| $\mu_e$ | μe | $-9.28476469866128 \cdot 10^{-24}$ | C | $-9.284764704328 \quad \cdot 10^{-24}$ | $3.0 \cdot 10^{-10}$ | $-6.10325 \cdot 10^{-10}$ | $JT^{-1}$ |
| $\mu_B$ | μB | $-9.27401007265130 \cdot 10^{-24}$ | C | $-9.274010078328 \quad \cdot 10^{-24}$ | $3.0 \cdot 10^{-10}$ | $-6.12109 \cdot 10^{-10}$ | $JT^{-1}$ |
| $\mu_N$ | μN | $5.050783742986264 \cdot 10^{-27}$ | C | $5.0507837461150 \quad \cdot 10^{-27}$ | $3.1 \cdot 10^{-10}$ | $-6.19456 \cdot 10^{-10}$ | $JT^{-1}$ |
| $\Phi_0$ | Φ0 | $2.067833847194937 \cdot 10^{-15}$ | C | $2.067833848 \ldots\ldots \cdot 10^{-15}$ | exactly | $-3.89327 \cdot 10^{-10}$ | Wb |
| $G_0$ | GQ0 | $7.748091734611053 \cdot 10^{-5}$ | C | $7.748091729000002 \cdot 10^{-5}$ | exactly | $+7.24185 \cdot 10^{-10}$ | S |
| $K_J$ | KJ | $4.835978487132911 \cdot 10^{14}$ | C | $4.835978484 \ldots\ldots \cdot 10^{14}$ | exactly | $+6.47834 \cdot 10^{-10}$ | $HzV^{-1}$ |
| $R_K$ | RK | $2.581280744348851 \cdot 10^{4}$ | C | $2.581280745 \ldots\ldots \cdot 10^{4}$ | exactly | $-2.52258 \cdot 10^{-10}$ | Ω |
| α | alpha | $7.297352569776440 \cdot 10^{-3}$ | F | $7.297352569311 \quad \cdot 10^{-3}$ | $1.5 \cdot 10^{-10}$ | $+6.37821 \cdot 10^{-11}$ | 1 |
| δ | delta | $9.378551014802563 \cdot 10^{-1}$ | F | $9.378551009654370 \cdot 10^{-1}$ | $1.5 \cdot 10^{-10}$ | $+5.48932 \cdot 10^{-10}$ | 1 |
| $\tilde{x}$ | xtilde | 2.821439372122070` | F | 2.821439372 …….. | mathematical | real number | 1 |
| $\sigma_1$ | σ1 | $9.773258655978905 \cdot 10^{-191}$ | F | n.a. | calculated | unusual | $Wm^{-2}K^{-4}$ |
| σ | σ | $5.670366673885496 \cdot 10^{-8}$ | C | $5.670366673885496 \cdot 10^{-8}$ | exactly | exactly | $Wm^{-2}K^{-4}$ |

S Subspace value (const) M Magic value MachinePrecision → $\pm 2.22045 \cdot 10^{-16}$
F Fixed value (invariable) C Calculated (calculated) MOOP Matter of Opinion

Table 10:
Universal natural constants
Concerted International System of Units

## 12. Notes on the Appendix

The basic formulas and definitions used in this work, as well as the program to calculate Table 10 are shown in the appendix. The programs for displaying the graphics, which were taken from earlier publications, can be found in [46], [49] and [52]. It is the source code for *Mathematica/Alpha*. The data can be copied and pasted to the clipboard. It is also possible to save in a text file (UTF8), which can then be opened and evaluated directly.

However, it is advantageous if you do not evaluate the entire source code in a single cell. To divide, use the function Cell/Divide Cell. If you do not want to calculate Table 10 and the graphics, you can delete the notebook below the „End of Metric System Definition" item. The variables shown in the „Variable" column are then available for your own calculations. Expressions within (*…*) are commented out.

Suggestion to the reader: If one adds up all the errors in Table 10, it should be possible to find a minimum by slightly manipulating $\kappa_0$, $\hbar_1$ and $Q_0$. Then all values should have to be calculated correctly.

# The Concerted International System of Units

## Declarations

```
Off[InterpolatingFunction::dmval]
Off[FindRoot::nlnum]
Off[General::Spell]
Off[Greater::nord]
Off[Power::infy]
```

## Units

```
km=1000;
Mpc=3.08572*10^19 km;
minute=60;
hour=60 minute;
day=24*hour;
year=365.24219879*day;
M⊙=1.98840*10^30;
R⊙=6.96342*10^8 ;
M⊕=5.9722*10^24;
R⊕=6.371000785*10^6;
```

## Basic Values

```
c=2.99792458*10^8;                                            (*Speed of light*);
my0=4 Pi 10^-7;                                       (*Permeability of vacuum*);
ka0=1.3697776631902217*10^93;                         (*Conductivity of vacuum*);
hb1=8.795625796565464*10^26;                    (*Planck constant slashed init*);
k=1.3806485279*10^-23;                                   (*Boltzmann constant*);
me=9.109383701528*10^-31;            (*Electron rest mass with Q0 Magic value 1*);
mp=1.6726219236951*10^-27;                      (*Proton rest mass Magic value 2*);
```

## Auxilliary Values

```
mep=SetPrecision[me/mp,20];                                     (*Mass ratio e/p*);
ma=1822.8884862171988 me;                                     (*Atomic mass unit*);
ϵ=ArcSin[0.30282212088197429933345006247691344471]-3Pi/4; (*RnB angle ϵ null(fix)*);
γ=Pi/4-ϵ;                                             (*RnB angle γ nullvector*);
ζ=1/(36Pi^3)(3Sqrt[2])^(-1/3)/mep;                        (*re-correction factor*);
xtilde=xtilde=3+N[ProductLog[-3E^-3]];      (*Wien displacement law constant (ν)*);
alpha=Sin[Pi/4-\[Epsilon]]^2/(4Pi);         (*Correction factor QED \[Alpha](Q0)*);
delta=4Pi/alpha*mep;                        (*Correction factor QED \[Delta](Q0)*);
(*Q0=(9Pi^2 Sqrt[2]delta me/my0/ka0/hb0SI)^(-3/4)(*Phase Q0=2ω0t during calibration*);*)
Q0=(9 Pi^2 Sqrt[2]delta me/my0/ka0/hb1)^(-3/7);(*Phase Q0=2ω0t after calibration*);
```

## Composed Expressions

```
Z0=my0 c;                                       (*Field wave impedance of vacuum*);
ep0=1/(my0 c^2)                                       (* Permittivity of vacuum*);
R∞=1/(72 Pi^3)/r1 Sqrt[2] alpha^2 /delta Q0^(-4/3);            (*Rydberg constant*);
Om1=ka0/ep0;                                    (*Cutoff frequency of subspace*);
Om0=Om1/Q0;                                                (*Planck's frequency*);
OmR∞=2 Pi c R∞;                                    (*Rydberg angular frequency*);
cR∞=c R∞;                                                 (*Rydberg frequency*);
H0=Om1/Q0^2;                                           (*Hubble parameter local*);
H1=3/2*H0;                                    (*Hubble parameter whole universe*);
r1=1/(ka0 Z0);                                        (*Planck's length subspace*);
a0=9Pi^2 r1 Sqrt[2] delta/alpha Q0^(4/3);                          (*Bohr radius*);
ΛbarC=a0 alpha;                                      (*Reduced Compton wavelength*);
ΛC=2 Pi ΛbarC;                                     (*Compton wavelength electron*);
re= r1 (2/3)^(1/3)/ζ Q0^(4/3);                          (*Classic electron radius*);
r0= r1 Q0;                                               (*Planck's length vac*);
R= r1 Q0^2;                                                       (*World radius*);
RR=R/Mpc/1000;                                                (*World radius Gpc*);
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*);
```

```
 hb0=hb1/Q0;                                                    (*Planck constant slashed*);
 h0=2Pi*hb0;                                                  (*Planck constant unslashed*);
 q1=Sqrt[hb1/Z0];                                                       (*Universe charge*);
 q0=Sqrt[hb1/Q0/Z0];                                (*or qe/Sin[π/4-ε] Planck charge*);
 qe=q0 Sin[Pi/4-ε];                                                (*Elementary charge e*);
 M2=my0 ka0 hb1;                                                   (*Total mass with Q=1*);
 M1=M2/Q0;                                                                    (*Mach mass*);
 m0=M2/Q0^2;                                                   (*Planck mass downwardly*);
(*m0=(9Pi^2Sqrt[2]*delta*me)^.75*(my0*ka0*hb0SI)^.25;         (*Planck mass upwardly*);*)
 mp=4Pi me/alpha/delta;                                       (*Proton rest mass with Q0*);
(*me=Sqrt[hb1/Q0/Z0]*Sin[Pi/4-ε];                          (*if using Q0 as Magic value*);*)
 MH=M2/Q0^3;                                                                (*Hubble mass*);
 G0=c^2*r0/m0; (*hb0*c/m0^2*)                                   (*Gravity constant local*);
 G1=G0/Q0^2;                                                     (*Gravity constant Mach*);
 G2=G0/Q0^3;                                                     (*Gravity constant Init*);
 U0=Sqrt[c^4/4/Pi/ep0/G0];                                      (*Planck voltage generic*);
 U1=U0*Q0;                                                          (*Planck voltage Mach*);
 W1=Sqrt[hb1 c^5/G2];                                                  (*Energy with Q=1*);
 W0=W1/Q0^2;                                                              (*Planck energy*);
 S1=hb1 Om1^2/r1^2;                                   (*Poynting vector metric with Q=1*);
 S0=S1/Q0^5;                                             (*Poynting vector metric actual*);
 Sk1=4Pi^2*E^2/18^4/60*hb1*Om1^2/r1^2;                         (*Poyntingvec CMBR initial*);
 Sk0=Sk1/Q0^4/Q0^3/E^2;                                         (*Poyntingvec CMBR actual*);
 wk1=Sk1/c ;                                                (*Energy density CMBR initial*);
 wk0=Sk0/c ;                                                 (*Energy density CMBR actual*);
 Wk1=wk1*r1^3;                                                      (*Energy CMBR initial*);
 μB=-9/2Pi^2 Sqrt[2 hb1/Z0]delta Sin[γ]/my0/ka0 Q0^(5/6);                 (*Bohr magneton*);
 μN=-μB*mep;                                                           (*Nuclear magneton*);
 μe=1.0011596521812818 μB                                     (*Electron magnetic moment*);
 Tk1=hb1 Om1/18/k;                                                (*CMBR-temperature Q=1*);
 Tk0=Tk1/Q0^(5/2);                                                     (*CMBR-temperature*);
 Tp0=0.; Tp1=0.;                                                     (*Planck-temperature*);
 Φ0=Pi Sqrt[hb1 Z0/Q0 ]/Sin[Pi/4-ε];                    (*Magnetic flux quantum Pi ħ/e)*);
 GQ0=1/Pi/Z0*Sin[Pi/4-ε]^2;                              (*Conductance quantum e^2/Pi ħ*);
 KJ=2q0 Sin[Pi/4-ε]/h0;                                         (*Josephson constant 2e/h*);
 RK=.5 my0 c/alpha;                                     (*von Klitzing constant μ0c/2α*);
 σe=8Pi/3 re^2;                                      (*Thomson cross section (8Pi/3)re^2*);
 ae=SetPrecision[μe/μB,20]-1;                          (*Electron magnetic moment anomaly*);
 ge=-2(1+ae);                                                        (*electron g-factor*);
 γe=2 Q0 Abs[μe]/hb1;                                       (*electron gyromagnetic ratio*);
 σ1=SetPrecision[Pi^2/60 k^4/c^2/hb1^3, 16];          (*Stefan-Boltzmann constant initial*);
 σ=σ1*Q0^3;                                                    (*Stefan-Boltzmann constant*);
```

## *Basic Functions*

```
cMc=Function[-2 I/#/Sqrt[1-(HankelH1[2,#]/HankelH1[0,#])^2]];
Qr=Function[#1/Q0/2/#2];
PhiQ=Function[If[#>10^4,-Pi/4-3/4/#,
Arg[1/Sqrt[1-(HankelH1[2,#]/HankelH1[0,#])^2]]-Pi/2]];      (*Angle of c arg θ(Q)*);
PhiR=Function[PhiQ[Qr[#1,#2]]];
RhoQ=Function[If[#<10^4,N[2/#/Abs[Sqrt[1-
(HankelH1[2,#]/HankelH1[0,#])^2]]],1/Sqrt[#]]];
RhoR=Function[RhoQ[Qr[#1,#2]]];
AlphaQ=Function[Pi/4-PhiQ[#]];                                              (*Angle α*);
AlphaR=Function[N[Pi/4-PhiR[#1,#2]]];
BetaQ=Function[Sqrt[#1]*((#2)^2+#1^2*(1-(#2)^2)^2)^(-.25)];
GammaPQ=Function[N[PhiQ[#]+ArcCos[RhoQ[#]*Sin[AlphaQ[#]]]+Pi/4]];
rq={{0,0}};
For[x=-8;i=0,x<4,++i,x+=.01;AppendTo[rq,{10^x,N[10^x*RhoQ[10^x]]}]];
RhoQ1=Interpolation[rq];
RhoQQ1=Function[If[#<10^3,RhoQ1[#],Sqrt[#]]];                   (*Interpolation RhoQ*);
Rk=Function[If[#<10^5,3/2*Sqrt[#]*NIntegrate[RhoQQ1[x],{x,0,#}],6#]];
Rn=Function[Abs[3/2*Sqrt[#]*NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])],{x,0,#}]]];
RnB=Function[Arg[NIntegrate[RhoQQ1[x]*Exp[I*(PhiQ[x])],{x,0,#}]]];
alphaF=Function[Sin[Pi/2+ε-RNBP[#]]^2 /(4Pi)];         (*Correction factor QED α(Q)*);
deltaF=Function[4Pi/alphaF[#]*mep];                     (*Correction factor QED δ(Q)*);
```

## *End of Metric System Definition*

## Functions Used for Calculations in Articles

```
GV=Function[Graphics[Line[{{#1,#2},{#1,#3}}]]];          (*Graphics help function*);
GH=Function[Graphics[Line[{{#2,#1},{#3,#1}}]]];          (*Graphics help function*);
Xline=Function[10^33*(#1-#2)];                            (*Value_x vertical line*);
Expp=Function[If[#<0,1/Exp[-#],Exp[#]]];            (*To avoid calculation errors*);
BRQP=Function[Rk[#] Sqrt[(Sin[AlphaQ[#]]/Sin[GammaPQ[#]])^4-1]];
BGN=Sqrt[2]*BRQP[.5]/3;

gdc=Function[10^(Log10[E]*(-1) (1*#)^2/(1 + 1*#^2)^2)]; (*Group Delay Correction*);
cc = 7.519884824;
b  = xtilde;
s1 = 8*(#1/(2*((#1/2)^2 + 1)))^2 & ;
s3 = (b*(#1/2))^3/(Expp[b*(#1/2)] - 1) & ;
brq = {{0, 0}};
For[x = -8; i = 0, x < 50, (++i), x += .05;
 AppendTo[brq, {10^x, N[BRQP[10^x]/BGN/(2.5070314770581117*10^x) ]}]]
BRQ0 = Interpolation[brq];
BRQ1 = Function[If[# < 8*10^4, BRQ0[#], Sqrt[#]]];
Psi1 = NIntegrate[(1/2)*Log[1 + (#1/(cc*Sqrt[Q]))^2] -
       ((#1/(cc*Sqrt[Q]))^2)/(1 + (#1/(cc*Sqrt[Q]))^2) -
       Log[Cos[-ArcTan[#1/(cc*Sqrt[Q])] +
          #1/(cc*Sqrt[Q])/(1 + (#1/(cc*Sqrt[Q]))^2)]],
      {Q, 0.5, 3000}] & ;                                        (*Approximation*);
Psi2 = NIntegrate[(1/2)*Log[1 + (#1/(cc*BRQ1[Q]))^2] -
       ((#1/(cc*BRQ1[Q]))^2)/(1 + (#1/(cc*BRQ1[Q]))^2) -
       Log[Cos[-ArcTan[#1/(cc*BRQ1[Q])] +
          #1/(cc*BRQ1[Q])/(1 + (#1/(cc*BRQ1[Q]))^2)]],
      {Q, 0.5, 3000}] & ;                                              (*Exact ξ*);
HPC=Function[Om1/#^2/km*Mpc];                         (*H0=f(Q0)[km*s-1*Mpc-1]*);
Qv=Function[a4712=SetPrecision[#2,309];#1*(1-a4712^2)^(1/3)];   (*Q(v/c) generic*);
Qv0=Function[a4713=SetPrecision[#,309];Q0*(1-a4713^2)^(1/3)];       (*Q(v/c, Q0)*);
vQ=Function[a4714=SetPrecision[(#2/#1)^3,309];
Sqrt[SetPrecision[1-a4714,309]]];                                (*v/c(Q) generic*);
vQ0=Function[a4715=SetPrecision[(#/Q0)^3,309];
Sqrt[SetPrecision[1-a4715,309]]];                                   (*v/c(Q0), Q0)*);
Q890=3/2*(re/r0)^3 ;                                  (*Phase angle/(890 [1])*);
VrelU=Function[ScientificForm[SetPrecision[Sqrt[1-SetPrecision[1/
(1+# qe/me/c^2)^2,180]],180]180]];                                  (*vrel(U)/c*);
DVrelU=Function[ScientificForm[SetPrecision[1-(Sqrt[1-SetPrecision[1/
(1+# qe/me/c^2)^2,180]]),180],10]];                               (*1-vrel(U)/c*);
QrelU=Function[SetPrecision[SetPrecision[1/
(1+# qe/me/c^2)^(2/3),180],16]];                                   (*Qrel(U)/Q0*);
QQrelU=Function[Q0*(QrelU[#])];                                      (*Qrel(U)*);
UeV=Function[a4711=SetPrecision[#,1000];
(me c^2(1/Sqrt[1-a4711^2]-1))/qe];                                    (*U(v)309*);
```

## Helpful Interpolations

Not really needed. Evaluate only once the lines below the upper lines, then store data in e.g. rs={data} and close the cells. Evaluation can take a while. Don' t delete but always evaluate them. Disable evaluation for the lines below the upper line until Interpolation line then. Save notebook.

---

```
rs={"Insert output from below"};
rs={};
For[x=(-3); i=0,x<3,(++i),x+=.025;
AppendTo[rs,{10^x,NIntegrate[RhoQQ1[z],{z,0,10^x}]/Abs[NIntegrate[RhoQQ1[z]*
Exp[I/2*ArgThetaQ[z]],{z,0,10^x}]]}]]
rs

RS=Interpolation[rs];                                        (*Relation rk/rn*);
RS1=Function[1/RS[#]];
```

---

```
rnb={"Insert output from below"};
rnb={};
For[d=-6.01; i=0,d<6.01,(++i),d+=.05; AppendTo[rnb,{d,RnB[10^d]/Pi}]]
rnb

RNB1=Interpolation[rnb];                          (*RnB angle ε nullvector from Q*);
RNB=Function[If[#<10^-8,Null,If[#<10^6,RNB1[Log10[#]],-.25]]];
```

```
RNBP=Function[If[#<10^-8,Null,If[#<10^6,Pi RNB1[Log10[#]],-Pi/4]]];
```

---

```
qq1={"Insert output from below"};
qq1={};
For[xy=(-17); i=0,xy<5,(++i),xy+=.05; AppendTo[qq1,{10^xy,N[Sin[(Pi/2-
RnB[10^xy]+ε)]]}]]
qq1

QQ0=Interpolation[qq1];                                    (*Relation qe/q0*);
QQ=Function[If[#<10^5,QQ0[#],0.3028223504900885]];
QQ1=Function[If[#<10^5,1/QQ0[#],3.3022661582990733]];
```

---

```
inb={"Insert output from below"};
inb={};
For[d=-6.01; i=0,d<6.01,(++i),d+=.05; AppendTo[inb,{RnB[10^d]/Pi,d}]]
inb

INB1=Interpolation[inb];                     (*InvRnB Q from angle ε nullvector*);
INB=Function[Which[-1<#<0,INB1[#],#==0,3/2Pi Q0^.25,#>0,Null]];
INBP=Function[Which[-Pi<#<0,INB1[#/Pi],#==0,3/2 Q0^.25,#>0,Null]];
```

## *Reference Values CODATA$_{2018}$ to the Comparison only*

```
hb0SI=1.054571817*10^-34;                             (*Planck constant slashed*);
h0SI=6.62607015*10^-34;                             (*Planck constant unslashed*);
ep0SI=8.854187812813*10^-12;                          (*Permittivity of vacuum*);
kSI=1.380649*10^-23;                                      (*Boltzmann-constant*);
G0SI=6.6743015*10^-11;                                     (*Gravity constant *);
ka0SI=1.30605*10^93;                           (*1.3057 Conductivity of vacuum*);
qeSI=1.602176634*10^-19;                                 (*Elementary charge e*);
q0SI=Sqrt[hb0SI/Z0];                                           (*Planck-charge*);
meSI=9.109383701528*10^-31;                          (*Electron rest mass with Q0*);
mpSI=1.672621923695l*10^-27;                                   (*Proton rest mass*);
alphaSI=7.297352569311*10^-3;                             (*Fine structure constant*);
deltaSI=(4Pi)^2 hb0SI/Z0SI/qeSI^2 *meSI/mpSI;                          (*Factor QED*);
mnSI=1.6749274980495*10^-27;                                  (*Neutron rest mass*);
maSI=1.6605390666050*10^-27;                                   (*Atomic mass unit*);
mepSI=5.4461702148733*10^-4;                                     (*Mass ratio e/p*);
m0SI=Sqrt[hb0SI c/G0SI](*2.17643424*10^-8 garbage*);                (*Planck-mass*);
r0SI=hb0SI/m0SI/c(*1.61625518*10^-35 garbage*);                  (*Planck-length*);
t0SI=.5Sqrt[hb0SI G0SI/c^5](*5.39124760*10^-44 garbage*);           (*Planck-time*);
Φ0SI=2.067833848*10^-15;                      (*Magnetic flux quantum 2Piħ/(2e)*);
GQ0SI=7.748091729*10^-5;                        (*Conductance quantum 2e^2/2Piħ*);
U0SI= Sqrt[c^4/(4 Pi ep0SI G0SI)](*1.04295*10^27 garbage*);      (*Planck-voltage*);
U1SI=U0SI Q0;                                         (*Planck-voltage universe*);
W0SI=Sqrt[hb0SI c^5/G0SI];                                     (*Planck-energy*);
TpSI=SetPrecision[Sqrt[hb0SI c^5/G0SI]/k,16](*1.41678416*10^32 Planck-temperature*);
TCOBE=2.72548;                                (*±0.00057K CMBR-temperature/COBE*);
Z0SI=376.73031366857;                            (*Field wave impedance of vacuum*);
KJSI=483597.8484*10^9;                                (*Josephson constant 2e/h*);
RKSI=25812.80745;                                 (*von Klitzing constant μ0c/2α*);
μBSI=-9.274010078328*10^-24;                                   (*Bohr Magneton*);
μNSI=5.050783746115*10^-27;                                  (*Nuclear magneton*);
R∞SI=1.097373156816021*10^7;                                 (*Rydberg constant*);
cR∞SI=3.289841960250864*10^15;                              (*Rydberg frequency*);
OmR∞SI=2Pi*cR∞SI;                                   (*Rydberg angular frequency*);
a0SI=5.2917721090380*10^-11;                                      (*Bohr radius*);
reSI=2.817940326213*10^-15;                            (*Classical electron radius*);
ΛCSI=2.4263102386773*10^-12;                        (*Compton wavelength electron*);
ΛbarCSI=3.861592679612*10^-13;                        (*Reduced Compton wavelength*);
σeSI=6.652458732160*10^-29;                      (*Thomson cross section (8Pi/3)re^2*);
μeSI=-9.284764704328*10^-24;                             (*electron magnetic moment*);
aeSI=1.1596521812818*10^-3;                       (*Electron magnetic moment anomaly*);
geSI=-2.0023193043625635;                                   (*electron g-factor*);
γeSI=1.7608596302353*10^11;                         (*electron gyromagnetic ratio*);
σSI=5.670366673885496*10^-8;                           (*Stefan-Boltzmann constant*);
QCB=8.3415*10^60;                                            (*Phase angle COBE*);
```

## *Calculating Table 10*

```
data={
{"c",ScientificForm[c,16],ScientificForm[c,16], "defined"},
{"ep0",ScientificForm[N[ep0],16],ScientificForm[N[ep0],16], "defined"},
{"ka0",ScientificForm[N[ka0],16],"n.a.", "defined"},
{"my0",ScientificForm[N[my0],16],ScientificForm[N[my0],16], "exactly"},
{"k",ScientificForm[N[k],16],ScientificForm[kSI,16],
 ScientificForm[kSI/k-1,NumberSigns->{"-","+"}]},
{"hb1",ScientificForm[hb1,16],"n.a.", "defined"},
{"hb0",ScientificForm[hb0,16],ScientificForm[hb0SI,16],
 ScientificForm[hb0/hb0SI-1,NumberSigns->{"-","+"}]},
{"Q0",ScientificForm[Q0,16],ScientificForm[QCB,16],
 ScientificForm[Q0/QCB-1,NumberSigns->{"-","+"}]},
{"Z0 ",NumberForm[Z0,16],NumberForm[Z0SI,16],
 ScientificForm[Z0/Z0SI-1,NumberSigns->{"-","+"}]},
{"G0 ",ScientificForm[G0,16],ScientificForm[G0SI,16],
 ScientificForm[Z0/Z0SI-1,NumberSigns->{"-","+"}]},
{"G1 ",ScientificForm[G1,16],"n.a.","unusual"},
{"G2 ",ScientificForm[G2,16],"n.a.","unusual"},
{"M2",ScientificForm[M2,16],"n.a.","unusual"},
{"M1",ScientificForm[M1,16],"n.a.","unusual"},
{"mp",ScientificForm[mp,16],ScientificForm[mpSI,16],
 ScientificForm[mp/mpSI-1,NumberSigns->{"-","+"}]},
{"me",ScientificForm[me,16],ScientificForm[meSI,16], "magic±0"},
{"m0",ScientificForm[m0,16],ScientificForm[m0SI,16],
 ScientificForm[m0/m0SI-1,NumberSigns->{"-","+"}]},
{"MH",ScientificForm[MH,16],"n.a.","unusual"},
{"mep",ScientificForm[mep,16],ScientificForm[mepSI,16],
 ScientificForm[mep/mepSI-1,NumberSigns->{"-","+"}]},
{"Tp",NumberForm[Tp0,16],ScientificForm[TpSI,16], "MOOP"},
{"Tk1",ScientificForm[Tk1,16],"n.a.","unusual"},
{"Tk0",NumberForm[Tk0,16],ToString[NumberForm[TCOBE,16]]<>" ©",
 ScientificForm[Tk0/TCOBE-1,NumberSigns->{"-","+"}]},
{"r1",ScientificForm[r1,16],"n.a.","unusual"},
{"r0",ScientificForm[r0,16],ScientificForm[r0SI,16],
 ScientificForm[r0/r0SI-1,NumberSigns->{"-","+"}]},
{"re",ScientificForm[re,16],ScientificForm[reSI,16],
 ScientificForm[re/reSI-1,NumberSigns->{"-","+"}]},
{"ΛbarC",ScientificForm[ΛbarC,16],ScientificForm[ΛbarCSI,16],
 ScientificForm[ΛbarC/ΛbarCSI-1,NumberSigns->{"-","+"}]},
{"ΛC",ScientificForm[ΛC,16],ScientificForm[ΛCSI,16],
 ScientificForm[ΛC/ΛCSI-1,NumberSigns->{"-","+"}]},
{"a0",ScientificForm[a0,16],ScientificForm[a0SI,16],
 ScientificForm[a0/a0SI-1,NumberSigns->{"-","+"}]},
{"R     [m]",ScientificForm[R,16],"n.a.","at issue"},
{"R   [Gpc]",ScientificForm[RR,16],"n.a.","at issue"},
{"2t1",ScientificForm[2t1,16],"n.a.","unusual"},
{"2t0",NumberForm[2t0,16],NumberForm[2t0SI,16],
 ScientificForm[t0/t0SI-1,NumberSigns->{"-","+"}]},
{"2T    [s]",ScientificForm[1/H0,16],ScientificForm[Mpc/HPC[QCB]/km,16],
 ScientificForm[HPC[QCB]/Mpc*km/H0-1,NumberSigns->{"-","+"}]},
{"2T    [a]",ScientificForm[1/H0/year,16],ScientificForm[Mpc/HPC[QCB]/km/year,16],
 ScientificForm[HPC[QCB]/Mpc*km/H0-1,NumberSigns->{"-","+"}]},
{"R∞",ScientificForm[R∞,16],ScientificForm[R∞SI,16],
 ScientificForm[R∞/R∞SI-1,NumberSigns->{"-","+"}]},
{"Om1",ScientificForm[Om1,16],"n.a.","unusual"},
{"Om0",ScientificForm[Om0,16],ScientificForm[c/r0SI,16],
 ScientificForm[Om0*2*t0SI-1,NumberSigns->{"-","+"}]},
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## 13. Abbreviations

### *

| | |
|---|---|
| $\cdot$ | Labelling of the first temporal derivative |
| $\cdot\cdot$ | Labelling of the second temporal derivative |
| ^ | Labelling of a peak value |
| * | Labelling of a conjugate complex value |
| ~ | Labelling of a reference-frame-dependent quantity (constant) without labelling it's about a variable |

### *A*

| | |
|---|---|
| a | Acceleration |
| $a_0$ | Bohr's hydrogen-radius |
| $a_i$ | Factor i |
| A | Factor, amplitude |
| $A(\omega)$ | Amplitude response |
| $\alpha$ | Angle, attenuation rate |
| $\alpha_\gamma$, $\alpha_{\bar{\gamma}}$, $\alpha_\nu$, $\alpha_{\bar{\nu}}$ | Angle in the metric triangle |

### *B*

| | |
|---|---|
| $\mathbf{B}$ | Induction |
| $\mathbf{B_0}$ | Induction in the MLE |
| B | Factor |
| $B(\omega)$ | Phase response |
| $\beta$ | Angle, phase rate, relativistic dilatation-factor $(1-v^2/c^2)^{-1/2}$ |
| $\beta_0$ | Phase rate of the metric wave-field |

### *C*

| | |
|---|---|
| c | Speed of light (constant in reference to the subspace) |
| $\underline{c}$, $\underline{\mathbf{c}}$ | 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*

| | |
|---|---|
| $\mathbf{D}$ | Electric charge-density (influence) |
| $\delta$ | Phase-angle of the MLE, angle |
| $\delta^i_k$ | Kronecker-symbol |
| $\partial$ | Partial differential-operator |
| $\partial_b$ | Partial differential-operator $\partial/\partial b$ |

### *E*

| | |
|---|---|
| $\mathbf{E}$, $\underline{\mathbf{E}}$ | 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 |
| $\varepsilon$ | Angle |
| $\varepsilon_0$ | Dielectric constant of the subspace (vacuum) |
| $\varepsilon_\nu$ | Coefficient of absorption of the *gray body* |
| $\eta$ | Factor |
| $\eta_{ab}$ | MINKOVSKIan 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 |
| $\phi$ | $2\omega_0 t - \underline{\gamma} r$, electric potential |
| $\varphi$ | Angle of intersection of the metr. speed-vector with the x-axis |
| $\varphi_0$ | Magnetic flux in the MLE (momentary value) |
| $\varphi_i$ | Initial value of $\varphi_0$ |
| $\Phi$ | 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 $Q_0=1$ |
| $\gamma_\gamma$, $\gamma_{\bar{\gamma}}$, $\gamma_n$, $\gamma_{\bar{v}}$ | angle in the metric triangle |
| $\underline{\gamma}$ | Complex propagation rate |
| $\Gamma$ | Gamma-function |
| $\Gamma^a_{bc}$ | 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 $J_n(x)+jY_n(x)$ |
| $H^{(2)}_n(x)$ | Conj. complex Hankel function of n'th order $J_n(x)-jY_n(x)$ |
| **H**, <u>**H**</u> | 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 |

| | |
|---|---|
| $\kappa$ | Coupling-constant of the URT |
| $\kappa_0$ | Specific conductivity of the subspace |
| $\kappa_{0R}$ | 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) |
| $\lambda$ | Wavelength |
| $\Lambda$, $\boldsymbol{\Lambda}$ | Wave count vector |

## *M*

| | |
|---|---|
| m | Factor, mass |
| $m_*$ | SR-rest-mass |
| $M_H$ | HUBBLE-Mass $H\hbar/c^2 = m_0 Q_0^{-1}$ |
| $m_0$ | PLANCK-mass, UR-rest-mass |
| $M_1$ | MACH's counter mass $m_0 Q_0$ |
| $M_2$ | Initial mass universe $m_0 Q_0^2$ |
| $m_e$ | Electron mass |
| $m_p$ | Proton mass |
| M | Mass |
| $M_\odot$ | Sun mass |
| $M_n(x)$ | Modulus of the HANKEL-function $\sqrt{J_n^2(x) + Y_n^2(x)}$ |
| MLE | Metric line-element (physical object) |
| $\mu$ | Induction-constant generally ($\mu_0 \mu_r$) |
| $\mu$ | Ratio $m_p/m_e$ |
| $\mu_0$ | Induction-constant of the subspace (vacuum) |

## *N*

| | |
|---|---|
| n | Quantity, factor |
| $\nu$ | Neutrino, frequency |

## *O*

| | |
|---|---|
| $0_0(x)$ | Series, tending against zero |
| $0_2(x)$ | Series, tending against zero |
| $\Omega$ | 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 |
| $\pi$ | Ratio of circumference and diameter at the circle (3.1415....) |
| $\psi$ | Magnetic potential |
| $\Psi$ | Product MG |
| $\Psi(\omega)$ | Share of the attenuation-factor $\alpha$, 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 $\left(\frac{2\mathrm{r}}{\tilde{\mathrm{R}}}\right)^{\frac{2}{3}}$ |
| $r_0$ | 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 |
| $R_\odot$ | Average sun radius |
| $R_0$ | 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 (211) |

# *S*

| | |
|---|---|
| s | Way |
| S | Entropy, electr. current-density |
| S, $S_b$ | Entropy |
| $\underline{S}_{\gamma\,0}$ | Entropy per nucleon |
| **S**, $\mathbf{S_k}$, $\mathbf{S_{k0,1,U}}$, $\overline{S}_{k\ldots}$ | Power-density (POYNTING-vector), k=CMBR |
| σ, $\sigma_1$ | STEFAN-BOLTZMANN-constant |
| σ(t) | Dirac-impulse |
| $\sigma_i$ | Eigenvalues |

# *T*

| | |
|---|---|
| t | Time absolute (in the frame of reference) |
| $t$ | Time relative $\left(1+\frac{\mathrm{t}}{\tilde{\mathrm{T}}}\right)^{\frac{1}{2}}$ |
| $t_1$ | 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 |
| $T_\omega$ | Period of the function sinω |
| $T$, $T_b$ | Temperature |
| τ, $\tau_0$, $\tau_1$ | Time-constants |
| θ | Trigonometric function (211) |
| 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), magneto motive force |

## *W*

| | |
|---|---|
| $w$ | Energy-density |
| $w_k$ | Energy-density CMBR |
| W | Energy |
| $W_0$ | Energy of the MLE |
| $W_k$ | Energy of the CMBR |
| $\omega$ | Angular frequency universal |
| $\omega_0$ | Angular frequency of the MLE |
| $\omega_1$ | Angular frequency of the MLE with $Q_0 = 1$ |
| $\omega_D$ | De-Broglie-angular frequency of matter |
| $\omega_e$ | Angular frequency of emission of CMBR |
| $\omega_s$ | Angular frequency of immission of CMBR |
| $\omega_k$ | Angular frequency CMBR nowadays |
| $\omega_T$ | Thermal maximum CMBR |

## *X*

| | |
|---|---|
| x | Way |
| $\tilde{x}$ | Factor at WIEN's replacement law |
| $\xi$ | Rotatory-angle with the LORENTZ-transformation |
| $\Xi$ | 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 |