TWO WAYS TO DISTINGUISH ONE INERTIAL FRAME FROM ANOTHER

(No general causality without superluminal velocities)

by

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ABSTRACT

According to physicists, the laws of physics don't allow us to discern one inertial frame from another. It does allow. This study shows two ways to distinguish one inertial frame from another.

Physics hasn't defined what is space, what is matter, what is time. In this study (in Space-Matter Theory), space is what matter uses as space, regardless of its texture. Matter is what can exist as matter in the given space. Both matter and space have three spatial dimensions. When action and reaction occurs between matter and space, the result is time. Time appears as a given wave of space. No particle, no frame of reference can exist without generating space waves. A and B inertial frames of reference are not identical if e.g. two identical electrons ($electron_A$ and $electron_B$) create different wavelengths of space waves. One way to distinguish one inertial frame from another is to calculate or measure the length of the wavelength of the space wave.

Via tunneling, a particle (with or without mass) travels through the barrier with superluminal velocity. In this case the barrier is a "special" space made out of matter (matter-space), where the particle travels with c velocity. This velocity appears in our space as superluminal velocity. Saying this, there are more spaces and more times instead of one spacetime. The different spaces make changes in the particle, too. The particle builds its action out of Planck constants h, where h has two parts which depend on the velocity of the particle in the given space. So there is also a phenomenon in the matter that makes it possible to distinguish one inertial frame from another.

Keywords: space-matter theory, wave of time, wave of space, time, space, matter-space, matter.

1. SPACETIME CONTINUUM BY EINSTEIN

The special and the general theory of relativity[1, 2, 3, 4 5, 6, 7] introduced the definition of spacetime. Spacetime has three spatial dimensions and one time dimension, so spacetime is a four-dimensional model. According to Einstein's special theory of relativity, every inertial frame of reference is equivalent. An inertial frame of reference is a system where there is no acceleration but constant velocities in a straight line. The special theory of relativity introduced more new phenomena like time dilation and length contraction. If the inertial frames of reference A and B have different velocities, $v_A \neq v_B$ then both observers (A and B) can measure the time dilatation and the length contraction in their own coordinate systems. The observers A and B will measure different time and space coordinates, but every physics law is the same in all inertial frames of reference. An inertial frame of reference is always local.

The next statement seems to be self-evident: neither observer A nor B can identify which inertial frame of reference moves. In other words: the laws of physics don't allow us to discern one inertial frame from another [8 (p 13)]. This is not true, according to Space-Matter Theory. The inertial frames of reference can be distinguished.

In Einstein's theory, mass–energy equivalence is expressed as $E=mc^2$, where E is the energy and m is the mass and c is the speed of light in a vacuum (299,792,458 meters per second), and is the universal speed limit. The speed of light is isotropic in all inertial frames of reference.

Einstein's general relativity theory gave a more complex system of gravity than Newton's Law of Gravity[9]. In Newton's Law of Gravity, gravity is given by the mass (mass density). The general theory of relativity is a geometric theory of gravity, where gravity is expressed as the curvature of spacetime generated by sixteen attributions of matter (mass, energy). The curvature of spacetime is given by the Einstein tensor, and the stress–energy tensor acts as the source of spacetime curvature. This is a non-local model.

Of course, there are lots of differences between the special and general theory of relativity. The special theory uses the Minkowski geometry; the general theory uses the Riemann geometry.

But there is a major theoretical difference between them in that the time dilatation and the length contraction doesn't create curvatures in spacetime. The time dilatation and the length contraction are symmetrical mathematical constructions. If we suppose that they have real curvatures of spacetime, the symmetry disappears. The detecting of length contraction and time dilatation won't change. The "only" change is that it is possible to distinguish one inertial frame of reference from another.

2. ACTION-REACTON OF SPACE AND MATTER

2.1. Space waves

We know from quantum mechanics that particles of matter are in constant vibration. It is a physical impossibility for matter to come into contact with space without its vibrations having an effect. Based on the Casimir Effect[10] and other physical phenomena like gravity waves[11] measured by LIGO[12, 13] we can state that space exists in waves and vibrations.

Einstein's special theory of relativity describes how the mass of an object increases with its velocity relative to the observer. The increasing velocity of mass decreases the spatial distance. When an object is at rest, and both the object and the observer are in the same (inertial) frame of reference, the object has a rest mass (m_0). The rest mass of an object is the inertial mass that an object has when it is at rest relative to the observer (in the given frame of reference). The rest mass is the smallest value of mass in the given (inertial) frame of reference which is connected with the longest spatial distance s_0. Note, the observer is mass and the object is mass.

Can we describe a model of a moving mass using the waving space? Yes, we can.

2.2. The inertial frames of reference can be distinguished by space waves

If the observer is able to measure the wavelengths of a space wave λ, he would find the shortest wavelengths (λ_0), if the mass is at rest—that is, the mass does not move in the given inertial frame of reference, $v_0 = 0$. If the mass moves in the given inertial frame of reference $v_1 > v_0$, its wavelength of space wave is longer ($\lambda_1 > \lambda_0$).

2.3. Calculation of the change of wavelength of space wave

The calculation is based on the special theory of relativity. The known formula of the length contraction is in Eq. (1).

$$s_1 = s_0\sqrt{1-\frac{v^2}{c^2}}\,, \tag{1}$$

where v is the velocity of the object with mass. According to Space-Matter Theory, the change of wavelength of the space wave is given by Eq. (2).

$$\lambda_1 = \frac{\lambda_0}{\sqrt{1-\frac{v^2}{c^2}}}\,, \tag{2}$$

λ_1 is the wavelength of a modified space wave. In this study a two-dimensional cosine function as space wave made by mass (mass density) will be used, because it is simple. Of course, the model can be more precise, thinking about Newton's Law of Gravity. Using this approach results in different lengths of wavelengths of the given space wave. See FIG. 1.

If we use space waves that contain Einstein's impulse-energy tensor, we should calculate with more than one space wave.

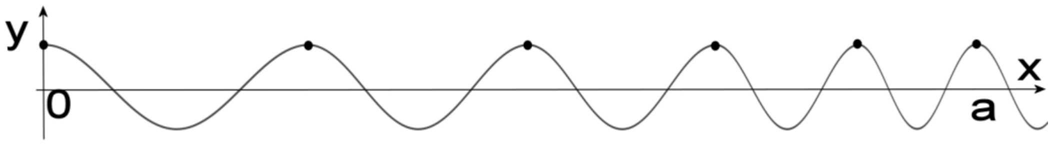

FIG. 1. Wavelength of a space wave that exists in the space. y and x are spatial distances. Mass is at the O point. Newton's Law of Gravity gives the idea of how the wavelength changes. (Model, not proportional.)

From Eq. (1) and (2) comes Eq. (3).

$$\lambda_1 s_1 = \lambda_0 s_0 . \tag{3}$$

The theory of special relativity uses s only and doesn't use λ. Therefore it cannot be said who moves, the observer or the mass object. Knowing λ_0 and λ_1, we know when the object with mass moves and how fast it moves. If we study the space waves, we can say when the mass accelerates. If $\lambda_{t+1} \neq \lambda_t$ and t represents *our* time, where $t = 0,1,2...$, then the acceleration of mass $a \neq 0$. If $\lambda_{t+1} = \lambda_t$, then $a = 0$, that is the object continues to move at a constant velocity in the inertial frame of reference. Newton's First Law of Motion can be given as $\lambda_{t+1} = \lambda_t$, where *our* $t = 0,1,2...$, that is, in an inertial frame of reference, an object either remains at rest or continues to move at a constant velocity, unless acted upon by a force.

Knowing space waves, the modified version of this law sounds like this: $\lambda_{t+1} > \lambda_t$, where $t = 0,1,2...$, that is, in space, an object accelerates, unless acted upon by a force. See Eq. (13).

Since space is always given, we can use it as a general frame of reference. Space always has a common framework with every mass. Saying this, space is an absolute entity behind the relativity. It sound like an old aether model, doesn't it? No, it doesn't.

2.4. No aether, but space waves

Aether theories propose the existence of a substantial medium, the so-called aether. Aether is a space-filling substance, and a transmission medium for the propagation of gravity forces (and even electromagnetic force) according to physicists at the end of the 19th and the beginning of the 20th century. The works of Lorentz[14] represent the theory.
In the aether model, time is a "local time" that connects systems at rest and in motion in the aether.

In my model, there is no aether. The space waves and the changes in wavelengths of space waves represent the re/actions that the re/actions of matter cause. And there is no "local time". The definition of time makes a big difference between the spacetime model and the aether model. In the following model, there is neither "local time", nor spacetime.
In the next chapter, it will be shown that we can use a new model holding the results of the spacetime model.

The name of the new model is the Space-Matter Theory.

3. SPACE-MATTER MODEL: SPATIAL DISTANCES GIVEN BY SPACE WAVES

Can we measure space? Measuring space, we measure matter. The meter is the length of the path travelled by light in a vacuum during a given time interval[15]. We cannot measure space at all. We measure only matter. According to the Space-Matter Theory, spatial distance exists without having been measured.

3.1. Wavelength and spatial distance

The given spatial distances of the object and of the observer can be given as the sums of the wavelengths of space waves: $s_{observer} = \sum_1^n \lambda_{observer}$ and $s_{object} = \sum_1^n \lambda_{object}$,

where

$$s_{observer} = s_{object} = \sum_1^n \lambda_{observer} = \sum_1^n \lambda_{object} \,. \qquad (4)$$

Eq. (4) shows that the observer is in the object's inertial system. If the object moves relative to the observer, because they are in different inertial systems, then $v_{observer} = 0$ and $v_{object} \neq v_{observer}$, so the observer will realize Eq. (5).

$$s_{observer} \neq s_{object} \,. \tag{5}$$

Eq. (5) shows the values we calculate using the theory of special relativity. The observer that can see the wavelengths of space waves finds Eq. (6).

$$\lambda_{observer} < \lambda_{object} \,. \tag{6}$$

That is, the object has greater velocity than the observer according to space waves. Here Eq. (7) will be true.

$$\sum_{1}^{n} \lambda_{observer} = \sum_{1}^{b} \lambda_{object} \,, \tag{7}$$

where $n > b$. The same *s* spatial distance measured from Object A1 to Object A2 can be made out of $n \times \lambda_{observer}$ and out of $b \times \lambda_{object}$. The observer's wavelength of space wave didn't change, but the object's wavelength of space wave did. In other words, the s spatial distance as $s_{observer}$ is built out of more space waves than the s_{object}, if $v_{observer} < v_{object}$ according to space waves. The length contraction of s_{object} is a length dilatation of the wavelength of the space wave. The length dilatation of the wavelength of the space wave is not symmetrical; the wavelengths of space waves are different.

The object travels the *s* spatial distance using its own space waves, that is, the spatial distance for the object is really shorter, now *p* pieces long instead of *n*, where $\lambda_{observer} < \lambda_{object}$. The $\lambda_{observer} < \lambda_{object}$ is a real phenomenon, not the viewpoint of the observer. Behind the relativistic length contraction is a real difference of the space's wavelengths of observer and object.

Note the space waves that connect the observer and the object are their common space waves. These space waves will change between the observer and object, if one moves. The detecting of length contraction and time dilatation remain true, both the object and the observer are able to detect them, since the length contraction and the time dilatation appear using these common, modified space waves. The symmetry is broken, if we study the source of the change of the wavelengths of space waves.

3.2. Waves of space are parts of the frames of reference

No frame of reference can exist without generating space waves. So the space waves are part of the frames of reference. They are also part of every inertial frame of reference, i.e. two inertial frames of reference are not identical, if they create different wavelengths of space waves. To be more precise, if there are e.g. two identical electrons ($electron_A$ and $electron_B$) in the frames of reference A and B, and an observer finds that the wavelengths of the electrons are different, then the observer will know how fast the inertial frames of reference move.

4. TIME IN THE SPACE-MATTER MODEL

What is time? Today's physicists claim that time is what we measure as time.
What does the phrase "what we measure" mean? We can measure only matter.

One second is defined as a changing character of the caesium 133 atom[16] we can measure. One second has its start and has its end that we measure. The main element of time is the change. If there is no change, there is no time. We measure changes of matter measuring time.

According to the Space-Matter Theory, time exists without having been measured.

4.1. Time expressed in meters in the special relativity

An "event" can be specified with "place" and "time" coordinates. It is a common, usual procedure in the Minkowski geometry[17] measuring time in meters or spatial distance in seconds. The constant speed of light in a vacuum makes these conversions possible. Now we can construct a coordinate system showed by FIG. 2. It has two dimensions: time and one spatial dimension, both expressed in meters (axis t is expressed as ct). Here c can be used as one unit, that is c=1.

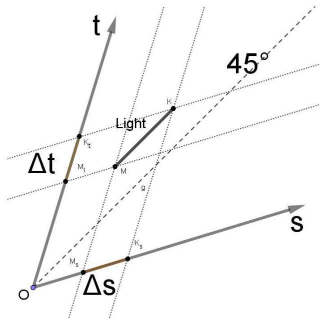

FIG. 2. The speed of light in the Minkowski geometry. t is time in meters, c = 1, and s is the spatial distance in meters. $\Delta s / \Delta t = 1 = c$.

We know that $\Delta s / \Delta t = 1 = c$ is true in every (inertial) frame of reference in spacetime; this phenomenon is the cornerstone of the special theory of relativity.

4.2. Light's speed is constant in every (inertial) frame of reference

How can the speed of light be constant in every (inertial) frame of reference? There is no answer to this question in the theory of relativity, because there are no space waves in this theory. This is something missing in this theory.

The speed of light can be constant only in that case, if light is in the given frame of reference. How can it be there? Using the space wave created by the inertial frame of reference. We know that these waves are part of the frames of reference. The light travels on the space wave created by masses. It will be demonstrated soon that space waves (or space) can also be seen as an inertial frame of reference.

4.3. Time as spatial waves

Space wave is a "normal wave" that has frequency, velocity and action. This velocity is constant like the velocity of light according to the frames of reference. According to LIGO, space waves have c velocity (although in the Space-Matter Theory, space waves have superluminal velocity). Saying this, space waves can be displayed the same way in an inertial frame of reference like light in FIG. 2.

In the Space-Matter model, time comes into existence when matter and space meet. Also, whenever matter and space meet, the result is time. Time is the action-reaction phenomenon of matter and space, and appears as a spatial wave. Time depends on two things: on the given space and on the given matter that travels in the space.

According to modern physics, only mass has time. Accepting this, our time is the action-reaction of mass and space that exists as space waves.

This is not the only space wave, i.e. not the only time, just our time. In other words, everything creates space waves, that is, everything creates time. We use in our life (and in physics models) the time created by mass, but "non-mass" objects may use different space waves as time.

4.4. Time wave and time unit

The actions between space and matter, from the view point of matter, can vacillate between strong and weak. It oscillates. The change is periodic, and one period is one unit of time[18]. This unit of time has two parts:

a) the hit, when space acts upon matter most strongly; and

b) the period between hits, when the force of space acts less strongly upon matter.

If we employ a cosine function to describe time, we get a periodic wavelength. Hence, it appears to be a good model: where a) equals the positive amplitude of the cosine function, and every other value of the function is b). In a time unit (in a single time wave), there is only one positive amplitude. Time is a repetition of these units. Time is the continuous alternation between a) and b). From the viewpoint of matter, time is characteristic of the periodic way that space acts upon mass.

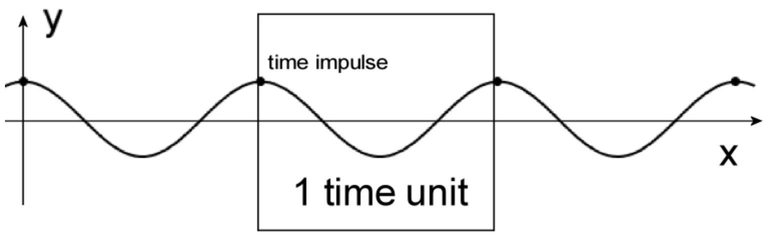

FIG. 3. Time as the space wave. x and y are spatial distances. (Model, not proportional.)

FIG. 3. shows that a pulse of time exists, if $\cos(x) = 1$, here marked as point. This is followed by a lack of time pulse, when $\cos(x) < 1$.

The longer the wavelength of the space wave, the rarer the time impulse. Here we get back the well-known formula of time dilatation of the special theory of relativity.

$$t_1 = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}, \qquad (8)$$

Since the time is given by the space wave, we get back Eq. (2) putting the wavelength of the space wave in Eq. (8)

5. ATTRIBUTIONS OF SPACE WAVES

5.1. Velocity of space waves is constant

If time waves are derived from space waves generated by mass, there arises a strange phenomenon—the time and the distance are the two sides of the same coin from the viewpoint of mass. Saying this, it is impossible for an object with mass to change any spatial distance without changing time, and changing time means changing the position in the given space.

See Eq. (9-11), where f means frequency.

$$f_{space\ wave} = f_{time\ wave} \tag{9}$$

and

$$\lambda_{time\ wave} = \lambda_{space\ wave} \tag{10}$$

If a mass generates growing wavelengths of space, the frequency of the space wave decreases, that is, the time unit for the mass grows in the same portion.

$$v_{space\ wave} = \frac{\lambda_1}{t_1} = \frac{\lambda_0}{\sqrt{1-\frac{v^2}{c^2}}} / \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\lambda_0}{t_0} = \text{constant} = \lambda_0 f_0 \tag{11}$$

5.2. Space unit and time unit given by the same spatial wave

Knowing Eq. (11), we can use the idea of the Minkowski geometry to make the new time and distance model visible. Time is expressed in meters (axis t is expressed as tv_{space}). s_1 is the shortest distance for mass. t_1 is the shortest time unit for mass.

$$v_{space\ wave} = \frac{s_{1\_3.a}}{t_{1\_3.a}} = \frac{s_{1\_3.b}}{t_{1\_3.b}} = 1 \tag{12}$$

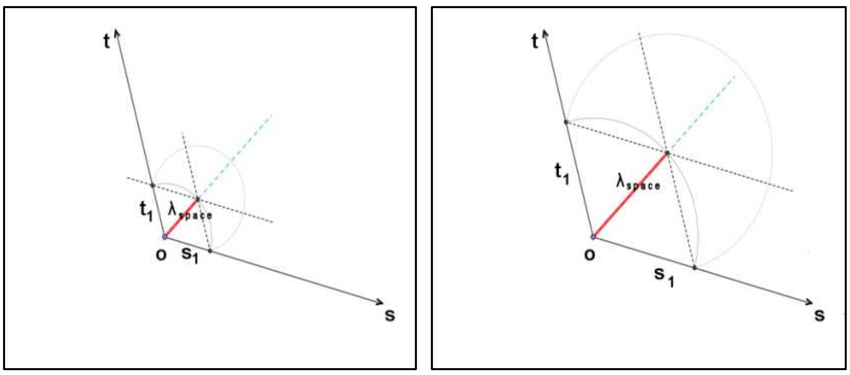

FIG. 4.a. and 4.b. Wavelength of space wave; time and spatial distance of mass i.e. the velocity of space wave and time wave. The λ_{space} is the shortest time unit and the shortest

spatial unit, i.e. t_1 and s_1 cannot be shorter. The velocity of an object with mass changes the length of λ_{space} wavelength of the space wave but not its velocity. FIG. 4.a. and 4.b. show the same mass, when $v_{Mass\_4.a.} < v_{Mass\_4.b.}$ Knowing the special theory of relativity, we can also say that FIG. 4.b. shows a bigger mass, i.e. $m_{Mass\_4.a.} < m_{Mass\_4.b.}$.

FIG. 4. explains how space and matter create time. An observer or an object gets moved in the space. This is the action. The reaction of space is the change of wavelength of the space wave. This is followed by a reaction of the object. It moves faster. This is followed by a reaction of space—the wavelength of the space wave grows…

Therefore time is an action-reaction phenomenon and not a dimension. Eq. (13) expresses it more precisely with terms of logic:

$$(\Delta v_{mass} \Rightarrow \Delta\lambda_{Space}) \wedge (\Delta\lambda_{Space} \Rightarrow \Delta v_{mass}) \equiv \Delta v_{mass} \Leftrightarrow \Delta\lambda_{Space} \qquad (13)$$

In the following, "$space_m$" or "Space" (written with capital S) are synonyms of space, where mass exists. In terms of modern physics: Space is where fermions interact with the Higgs field[19, 20] getting mass this way. According to the modern physics, the interaction is connected with the spins of the elementary particle of the standard model. Since a photon isn't a fermion, and its spin is 1, it doesn't interact with the Higgs filed. The spin is a good attribution that is able to explain the interaction between the Higgs field and fermions—in Space. But spins described in the standard model are not able to explain why fermions lost their mass in a "non-Space" space. If a fermion entered a different space, it lost its mass. Why? I think that the change of the spins of fermions could be a part of a possible explanation, and it will be mentioned once more in this paper. The question is open: can fermions change their spins? In the following, I will show you a different notion. My explanation is in harmony with the standard model[21] of physics (in Space), but it opens new ways. Here it is supposed that photons and fermions travel in different spaces (and we don't know their spins).

Eq. (13) shows more than just the action-reaction of Space and mass. It shows that mass in Space will accelerate, if it started moving, unless acted upon by a force. The accelerating gravity force can be tracked back to Eq. (13). *From the viewpoint of Space waves* Newton's First Law of Motion remains unchanged. In an inertial frame of reference, the velocity of an object $v_t = v_{t+1}$ unless acted upon by a force, where t represents our time, and t=0,1,2,… In the following it will be shown that the Space waves are special inertial systems, where there is no acceleration.

5.3. Action and frequency of space waves

Let's study Eq. (14).

$$E_{Space} = h_{Space} \times f_{Space}, \tag{14}$$

where E_{Space} is the energy and h_{Space} is the action of the Space wave. If, $E_{Space\_1} > E_{Space\_2}$, then $v_{Mass\_Space\_1} < v_{Mass\_Space\_2}$ or $m_{Mass\_Space\_1} < m_{Mass\_Space\_2}$.

Solely through the use of Space waves, we can express spatial distance, time and energy.

- Every spatial distance can be expressed using the wavelength of Space waves.
  In our physics terms: This is the shortest unit of distance.
- Every unit of time can be expressed using the frequency of Space waves.
  In our physics terms: This is the shortest unit of time.
- Every amount of action (energy) can be expressed using the value of the action of Space waves.
  In our physics terms: This is the smallest unit of action.

The time dilatation and the λ_{Space} dilatation (space contraction) do not change our metrics. See the wave number k in Eq. (15). Let's see FIG 4. once more. The shortest distance unit in Space is λ_{Space} (FIG. 4. s_1). 1 meter spatial distance is made out of k pieces of λ_{Space} no matter how long λ_{Space} is. In other words, 1 meter has always the same space units.

$$k = \frac{1\,meter}{\lambda_{space}} = \text{constant}. \tag{15}$$

1 second time is as long as the Space wave creates f_{Space}. The shortest time unit in Space is $t_{shortest}$ (FIG. 4. t_1); see Eq. (16),

$$t_{shortest} = \frac{1}{f_{Space}}. \tag{16}$$

The lengths of the meter and second are dependent upon the space waves. Note this is not the theory of special relativity; here we're speaking about real changes of space waves.

One Space wave has one h_{Space} action. Eq. (17) comes from the Planck constant[22] h.

$$h = h_{Space} \times H_{Space} \text{ or more generally } h = h_{space\_i} \times H_i, \tag{17}$$

where h_{space_i} depends on the given space$_i$ (e.g. on Space) and it is constant in the given space. H_i has no dimension, it shows the relationship between h and h_{space_i}.

Since in space$_i$ $v_{space\_i} = \text{constant}$, and $h_{space\_i} = \text{constant}$ the unit spatial distance, the time unit and the action unit are embedded in λ_{space_i} (in f_{space_i}) and in h_{space_i}.

5.4. Space as inertial frame of reference

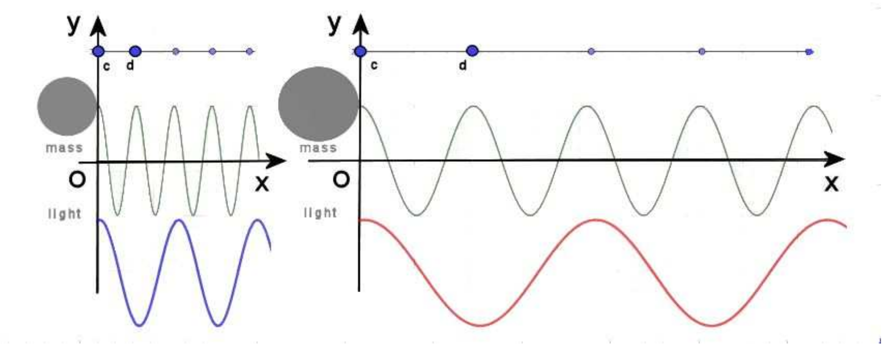

FIG. 5. Mass, light, Space waves. y and x are spatial coordinates. Space's wavelength as spatial unit distance and frequency as time unit for the mass. A bigger or a faster mass (circle in the picture) makes longer wavelengths in Space waves. The mass meets just the **cd** section. The light uses a big section of the Space wave. (Cosine model, not proportional.)

FIG. 5. offers a new way to explain the cooperation of Space and matter. The Space wave is a special inertial frame of reference, where the velocity of the Space wave is constant from the viewpoint of mass and the velocity of mass is constant from the viewpoint of the Space wave. The changing velocity of mass changes the wavelength of the Space wave, but even the accelerating motion of mass seems to be a constant velocity from the viewpoint of the Space wave. Even more, since $\lambda_{space\ wave}$ is a very short distance, it seems to be a motion in a straight line at a constant speed. The Space waves are special, non-mass inertial systems.

5.5. Constant velocity of mass in Space

FIG. 4. shows the constant velocity of the Space wave. The basic unit of spatial distance and the basic unit of time are small. So masses may use more basic units; matter's basic unit of spatial distance and time are built out of more Space units.

Mass always needs the same time expressed as $q \times t_{shortest}$ to travel the unit distance made out of $p \times \lambda_{Space\ wave}$, where p and q are constant. That is, the velocity of mass in the Space is $v_{mass\_in\_Space} = \frac{p}{q}$, because $\lambda_{Space\ wave}$ and $t_{shortest}$ are basic units.

The velocity of mass is constant; it can travel neither faster nor more slowly in the Space. This is true according to Space waves, too. See Eq. (10) and (11). Every change of frequency and wavelength of Space gives the same velocity: $\frac{\Delta\lambda_0}{\Delta t} = \text{constant}$. The wavelength of the Space wave depends on the mass of the object. Objects with bigger mass will create longer wavelengths in Space.

Every mass is connected only with the **cd** (i.e. $p \times cd$) section of the Space wave. **cd** (without p) is shown by FIG. 5. So the wave of Space is the **cd** section for a mass. If the mass enters the **cd** section, it generates a new **cd** section. The Space wave itself is the action-reaction of mass and spreads in the Space.

How does the frame of reference made out of the Space wave show the acceleration of mass? It will appear as the change of wavelength of the Space wave. The Space waves are like light waves. So we expect there to be no acceleration in the frame of reference of Space according to the *velocity* of Space waves. The calculation with the wavelength of the Space wave is in Eq. (18). The Space wavelength is the unit wavelength *from the viewpoint of mass*; its value is always 1 for the given mass, since λ is the basic unit distance in Space.

$$a = \frac{\lambda_1 - \lambda_0}{t} = \frac{1-1}{t} = 0. \tag{18}$$

Look at Eq. (19).

$$a = \frac{\lambda_0}{t_0} / \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{\lambda_0}{t_0^2}\sqrt{1-\frac{v^2}{c^2}} = 0 \tag{19}$$

Indeed, there is no acceleration in the inertial system of the Space wave. Accelerating motion can appear in a non-space frame of reference according to the mass, but it cannot appear in the framework of waving Space; according to the velocity of the Space wave there is no acceleration. Therefore the Space wave is a special inertial frame of reference.

What else does Eq. (19) show? It shows that $v = c$. In the $space_m$ (Space of mass) mass travels with $c_{space\_m} = \frac{p}{q}$ velocity. Note c_{space_m} works inside the $space_m$ from the viewpoint of Space. This is the only velocity of masses in $space_m$. Since there is only mass in this $space_m$, this is the only velocity in this Space. (Space=$space_m$)

This velocity is not the speed of light; this is the velocity that appears between the $space_m$ and the mass. Light travels on the Space waves generated by mass. Light doesn't change these waves. That is, it travels in a different space, see FIG. 5., and its velocity is c. The space of light, i.e. Space wave, is a part of the frame of reference of mass, it is "glued" to the mass, that is, the mass and the space of light is one inertial frame independent of the velocity of mass in the Space. In this inertial frame, the velocity of light is constant.

The speed of $c_{space\_i} = c$ seems to be a very important constant. This is the velocity at which the objects travel in their own "i" spaces. In other words, in every "i" space the objects travel with $c_{space\_i} = c$ velocity, but different "i" spaces have different values of c_{space_i} *from our point of view*; c_{space_i} can be different from our c—from our point of view. In general, $space_i$ is a space, where $object_i$ generates $time_i$,
and where $object_i$ travels with $c_{space\_i} = c$.

Of course, the acceleration motion of mass can be measured by a non-Space observer in a given non-Space frame of reference.

6. WHAT IS MATTER, WHAT IS SPACE?

There are more spaces, and not all objects are able to use all spaces. So it has to be defined what space and matter mean. First let's see some simple definitions.

Space is what matter uses as space. Matter is what space allows to exist as matter in the given space. There are spaces that the given matter cannot use as space, and there is matter that cannot exist in given spaces. For example, light (normally) doesn't exist in the Space. There are more spaces and more forms of one given matter. For example, the particle we know as the electron can exist in a special space as a fast wave. In some cases the space can be made out of an object that we know as matter.

6.1. Action and density of space and matter

The simplest way to define a space is to give its h_{space_i} value. Our known Space has the smallest h value shown in Eq. (20)

$$h_{Space} = é \times h_i \,, \tag{20}$$

where h_i is the action of any different space or matter and $0 < é < 1$.

It is possible to use the density of space, too. If we calculate with little Space cubes whose size can be given as $\lambda^3{}_{space}\,(m^3)$, knowing the action of the Space wave and knowing $\lambda_{Space}\,(m)$, we can calculate the density of space. It is D_{Space}.

Using the simplified Space-Matter model with cosine functions, we can conclude that the density of the proton is nineteen orders of magnitude beyond the density of Space. See Eq. (21). The nuclear density of a proton is $D_{proton} = 1.14 \times 10^{53}\; eV/m^3$. (The radius of the proton is discussed[23]. The discussion may influence the calculation, but not the conclusion.)

$$D_{Space} >> D_{proton} \,, \tag{21}$$

The density of Space is very important. It changes, because of the growing wavelength of the Space wave. If Space's density is small enough, Space can turn into matter.

6.2. What is space, what is matter?

If the actions and the density are given by Eq. (22).

$$h_{object} = h_{Space} \text{ i.e. } D_{object} = D_{Space} \tag{22}$$

then this object is *always* Space for masses and *never* matter in our known world. The Space has the smallest action and the biggest density. The action of matter is always bigger than h_{Space}. The density is always smaller than D_{Space}. If

$$h_{object} > h_{Space} \text{ (or } D_{object} < D_{Space}\text{)}, \tag{23}$$

then this object is matter in Space, says Eq. (23). If the action of an object is bigger than the action of Space, or in other words, the density of an object is smaller than the density of Space, this object can act as space from the viewpoint of a third object, and can act as matter from the viewpoint of another object. Tunneling works this way. The barrier is made out of matter, but electrons and photons use it as space. The barrier can be called a space made out of matter, or in short: matter-space.

Without a new definition of space and time, we will neither understand the working method of spaces like matter-space, nor understand how matter objects exist in matter-space. Here we can use the new, above-mentioned definition of time in a wider meaning: Time is the action-reaction of space and matter, where space is either Space or matter-space.
In every mass made out of more elementary particles, there is a big portion of Space. How can it be that matter doesn't change its size while the wavelength of Space changes? This effect doesn't change the size of the object, this statement crystallized in the early years of the 20th century in the discussions about aether and relativity. Mass is one unit. It has its own rules inside the matter. Or a simpler answer: matter can be seen as matter-space in Space. Matter-space is an independent space, so its internal units can be independent from Space.

7. WAVE-PARTICLE DUALITY IS A TRIALITY

Wave–particle duality is the concept that all matter can exhibit two behaviors—a particle-like behavior and a wave-like behavior. In other words, every elementary particle or quantic entity may be partly described in terms not only of particles, but also of waves. The well-known de Broglie wavelength[24] λ shows the connection between the momentum of the wavelength of the given particle p and Planck's constant. See Eq. (24).

$$\lambda = \frac{h}{p} \tag{24}$$

In general, the momentum of a particle that has mass is $p = m \times v$. The momentum of a particle that has no mass, e.g. a photon, is written in Eq. (25).

$$p = \frac{E}{c}, \tag{25}$$

where E is the photon's energy.

7.1. Hidden presumption behind wave-particle duality

The original version of the de Broglie wavelength means that the particle turns into a wave, if Eq. (26) is true:

$$\lambda_{particle} \geq l_{particle}, \tag{26}$$

where $l_{particle}$ is the size (length) of the particle. $\lambda_{particle}$ is the wavelength of the particle if it is a wave.

Actually, there is a hidden presupposition behind the formula of the wave-particle duality: the space wave doesn't exist. De Broglie didn't know about space waves, therefore there is no space wave in Eq. (24).

7.2. Fast wave-wave-particle triality

If we involve the wavelengths of space waves in the formula of wave-particle duality, and Eq. (27) is true, that is, if the wavelength of the space wave is longer than the wavelength of the wave of the particle, then the fast wave-wave-particle triality comes into being. See *ó* in Table 1.

$$\lambda_{space} > \lambda_{particle} \geq l_{particle}, \tag{27}$$

Tunneling is a good example for fast waves. To understand how tunneling works, we need to understand how light works.

8. FREQUENCY LEVEL AND PRODUCT OF FREQUENCIES OF LIGHT

When the medium is not the vacuum, Eq. (28) is used in calculations of phase-matching in nonlinear optics.

$$p = n\frac{E}{c}, \tag{28}$$

where in general $n = \frac{c}{v_l} > 1$ is the refractive index of a transparent optical medium, also called the index of refraction of the material in which the signal propagates. v_l is the velocity of light in a non-vacuum, that is, in medium. The index of refraction[25] is the factor by which the phase velocity v_{phase} is *decreased* relative to the velocity of light in a vacuum. In the case of one photon wave $v_{phase\_c} > v_{phase\_M}$ and $v_{phase\_c} = \frac{c}{n}$, where v_{phase_c} represents light velocity in the vacuum and v_{phase_M} represents the light velocity in medium. During the refraction, the frequency of the light wave remains unchanged $f_{phase\_c} = f_{phase\_M}$, while the wavelength of the light wave decreases $\lambda_{phase\_c} > \lambda_{phase\_M}$.

Let's take a look at the fast light experiment carried out at the University of Rochester, USA[26]. In this experiment, a “normal” light impulse (with velocity c and made out of a group of lights) travels on an optical medium and a fast light impulse (made out of a group of lights) travels on the “normal” light. Fast light has a longer wavelength than normal light traveling with c $\lambda_{fl} > \lambda_c$ and a measurable superluminal velocity of fast light: $v_{fl} > c$. This velocity of impulse is group velocity (envelop), where generally the following is true:

$v_{fl} = v_{group} \neq v_{phase}$.

In the fast light experiment, the envelop (fast impulses) is built out of a spread of optical frequencies: out of sinusoidal (sine, cosine) component waves[27]; that is—phase velocities v_{phase}. In the given experiment, every component’s wave has one wave number. So the following must be true, because if $v_{fl} = v_{group} = v_{phase}$ is not true, the fast wave impulse collapses. (Here $n - 1 < 0$, and n is a great number with negative sign.)

In the experiment, the wavelength of the fast light *increased* compared to the wavelength of the normal light traveling with c velocity in a vacuum. It means that the wavelengths and velocities of its spectral component waves increased in the given medium[28] (λ_{phase_M}), compared to the wavelengths and velocities of spectral component waves of light in a vacuum v_{phase_c}. The velocities of the component waves of fast light are also superluminal velocities—see Eq. (28), that is, $v_{phase} > c$ and $\lambda_{phase\_M} > \lambda_{phase\_c}$.

From the above-mentioned, we know that during refraction the frequency of the light wave remains unchanged while its wavelength grows. So we may suppose that in a given space the changing wavelength $\lambda_{phase\_c} < \lambda_{phase\_M}$ and the unchanged frequency $f_{phase\_c} = f_{phase\_M}$ are a general working method of light, if $v_{phase\_c} \neq v_{phase\_M}$.

We can write this law in a more general form in Eq. (29) and (30). Light holds its frequency level constant compared to the frequency of the space wave of the given space. The gravitational red shift shows clearly that the frequency isn’t constant, but the frequency level of light is constant. According to a given light (or photon), Eq. (29) is true in the whole lifetime of the given light (photon) in a given space.

$$\frac{f_{light}}{f_{space\_i}} = \text{constant} . \qquad (29)$$

Because there are more spaces, photons use Eq. (30), too. We can call it product of frequencies.

$$f_{light} \times f_{space\_creator} = \text{constant}\ , \qquad (30)$$

where $f_{space\_creator}$ is the frequency of the given space, where the photon was created. Eq. (30) is true in the whole lifetime of the given light (photon) in every space. We haven't identified Eq. (30), since today's physics works with space-time, where Eq. (30) doesn't come up. Eq. (29) seems to be in contradiction with Eq. (30). There is no conflict here, since space waves are also time waves.

In a matter-space the frequency level of light is created by using the frequency of the barrier f_{space_i} and by using $f_{space\_creator}$. According to Eq. (30) in the barrier a very high frequency occurs, therefore a very high velocity. This velocity is realized in the matter-space, so we cannot measure it. Instead of it we measure e.g. the tunneling velocity (which is smaller). More in the chapter on tunneling.

In FIG. 6.1. we can see the light before changing its wavelength and frequency.

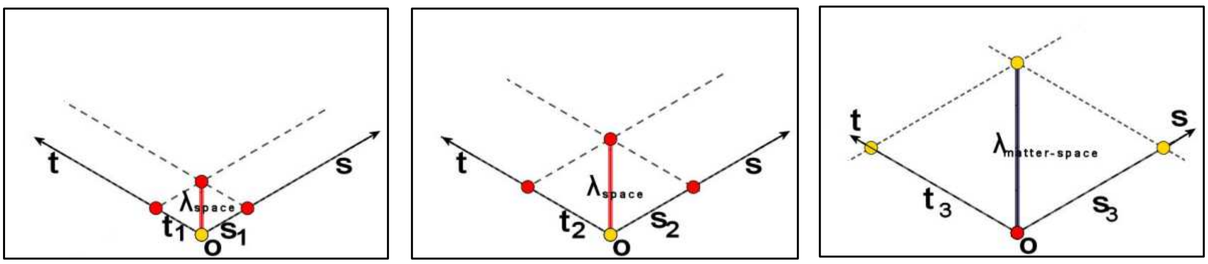

FIG.6.1., 6.2. and 6.3. show how the photon (light) works. t and s are expressed in meters. 6.1. and 6.2. show the photon in its space, when the wavelengths of the Space wave grow. 6.3. shows a tunneling light in a barrier, i.e. in a matter-space. $\frac{s_1}{t_1} = \frac{s_2}{t_2} = \frac{s_3}{t_3} = \text{constant}$. This is constant in the lifetime of the photon ($f = \frac{1}{t}$) i.e. every photon has a constant coordinate system, which results in a constant velocity.

FIG. 6.2. shows a Space with greater gravitation. The wavelength of the Space wave is longer here. We know that the big gravity creates a red shift of the light, that is, the wavelength of the light grows, and its frequency decreases. Why? Because the light holds its

frequency level constant. We find that the light has less energy here, but from the viewpoint of light everything remains unchanged, since its frequency level remains unchanged.

9. TUNNELING: METAMORPHOSES OF PARTICLES

9.1. Tunneling

Quantum tunneling refers to the quantum mechanical phenomenon where a particle (with or without mass) tunnels through a barrier that it classically could not surmount. Particles that travel with superluminal velocities in tunneling will be called fast waves in the following. (The above mentioned fast light is a fast wave, too.)

Nimtz[29], Enders and Spieker first measured superluminal tunneling velocity with microwaves in 1992. According to them, the puzzle is that the jump of the particle over the barrier has no time (it spends zero time inside the barrier) and the particle is undetectable in this condition. The tunneling does take time, so this time can be measured**.**

According to Nimzt, the particle cannot spend any time inside the barrier[30], because the wave function has no missing part (and no missing time). The tunneling method of the particle is unknown and immeasurable. If the wave doesn't spend time inside the barrier, what is the tunneling time? Nimtz supposes that the measured barrier traversal time is spent at the front boundary of the barrier.

The second riddle in tunneling: experiments show[31] that the tunneling particles are faster than light, and these facts are *not* compatible with the theory of relativity. The growing velocity of the particle with a mass (for example an electron) causes growing mass according to the theory of relativity, and if $v \rightarrow c$, then $m \rightarrow \infty$. Since the mass (of the electron) won't be ∞, and the tunneling is fact, we have to suppose that $v=c$ never occurs. There is a discrete jump in the velocities, and after $v<c$ occurs $v>c$.

9.2. Tunneling particles

Every tunneling or not tunneling wave and every particle wave uses Eq. (29) and (30). In tunneling, the light meets a barrier, a matter-space. The light “decides” whether it can enter this space. It depends on the unit action, wavelength and frequency of the matter-space. If it can enter this matter-space, it has to adapt itself to the new space. (Probably it changes its spin, too.) Different space and different time force a metamorphosis of the $object_1$. $Object_1$ will appear in a form that is not written in our books. In tunneling, objects exist as fast waves. Let's see the electron during tunneling. The tunneling shows that $v_{tunneling\_object} > c$, according to us. It is a fact measured. The electron has mass. The tunneling electrons seem to violate the special theory of relativity[32]. They don't violate it, if we suppose electrons have different forms in different spaces, and the barrier acts as matter-space. In matter-space, the tunneling electron became a fast wave[33]. The metamorphoses (from particle into fast wave and back) do not mean that the electron changes its identity—the essence of the electron always remains the same, just the form of the electron changes. Particle, fast wave, particle. Let's see the two metamorphoses of an electron during tunneling[34].

Tunneling from the viewpoint of the form of the electron (or other tunneling particle):

- Before the barrier: electron—particle or wave.
    - * Metamorphosis 1.
- In the barrier: unknown object (fast wave).
    - * Metamorphosis 2.
- After the barrier: electron—particle or wave.

It means that the unknown, faster-than-light-object is the same electron we know, but it *does* have a new form we don't know. The given form of an electron depends always on the space in which it travels.

So there is a 'fast wave–wave–particle triality' instead of the 'wave–particle duality'.

The tunneling shows that photons (with no mass) make metamorphoses too. That is, generally speaking, the given form of $object_1$ (with or without mass) depends on the space in which it travels. $Object_1$ has more forms, and its forms depend on the spaces where it travels. Its every form seems to have its own (range of) velocity. In tunneling it appears as a fast wave and it has superluminal velocities, from our viewpoint.

9.3. How does tunneling work?

Tu.	Topic	Experiment[35] 1	Experiment[36] 2	Experiment[37] 3	Remark
	$ú = \frac{v_{tunneling}}{c}$	4.702	8.559	2.565	$ú = \frac{v_{fw}}{c}$
	$T = t_{fw}$ (sec)	$8.1 \cdot 10^{-11}$	$1.17 \cdot 10^{-10}$	$1.30 \cdot 10^{-10}$	$T = \frac{1}{f_{fw}}$
	f_0 frequency of light before tunneling (1/sec)	$8.7 \cdot 10^{9}$	$9.97 \cdot 10^{9}$	$8.7 \cdot 10^{9}$	
	λ_0 wavelength of light before tunneling (m)	$3.45 \cdot 10^{-2}$	$3.01 \cdot 10^{-2}$	$3.45 \cdot 10^{-2}$	
1	L length of the barrier (m)	$1.142 \cdot 10^{-1}$	$3.00 \cdot 10^{-1}$	$1.00 \cdot 10^{-1}$	L
2	$\lambda_{fw} = L$ (m)	$1.142 \cdot 10^{-1}$	$3.00 \cdot 10^{-1}$	$1.00 \cdot 10^{-1}$	wavelength of fast wave
3	$ó = \frac{\lambda_{fw}}{\lambda_0} = \frac{L}{\lambda_0}$	3.31	9.98	2.90	$ó \neq ú$
4	$f_{fw} = \frac{1}{T}$ (1/sec)	$1.235 \cdot 10^{10}$	$8.547 \cdot 10^{9}$	$7.692 \cdot 10^{9}$	$f_{fw} = \frac{v_{fw}}{\lambda_{fw}}$
	$á = \frac{f_0}{f_{fw}} = \frac{t_{fw}}{t_0}$	0.70	1.16	1.13	$á \neq ú$
	$ő = \frac{h_{kinetic}}{h_{rest}}$	22.11	73.15	6.58	indicator of moving

Table 1. Here are shown the tunneling times and the lengths of barriers in three experiments. The $ó$ values show that λ_{fw} is longer than λ_0. It can be supposed that the unit of the spatial distance of matter-space is longer than the unit of the spatial distance in light's space.
The $á$ value shows that in matter-space there is different time unit than in light's space according to the given particle. A single time unit in matter-space mustn't be shorter than a time unit in Space. Particles use a set of time units, this set can be shorter.
$ő$ is the indicator of the moving of the particle showing the effect of matter-space on the light's action, or in other words, the effect caused by $v_{fw} > c$ on the light's action. The interrelations of units of matter-spaces are displayed in FIG. 11.

$ó \neq ú$ and $á \neq ú$ show that the different units of spatial distance and the different time units explain together the superluminal velocity measured by us: $f(ú) = f'(á) f''(ó)$.

The tunneling particle travels in the matter-space with $c_{matter-space} = c$. This viewpoint is presented in FIG. 11. The barrier is a space$_i$, where the units of time and spatial distance are different from time and spatial distance units of our Space and of light's space. Saying this, every space$_i$ has its own unit of time and spatial distance. The given values depend on the space$_i$ and the given matter that travels in space$_i$. $c_{space\_i} = c$ in every spaces$_i$, the matter travels always with c velocity in every space$_i$. If it cannot travel with c velocity in spaces$_i$, then the given spaces$_i$ is no space for this matter.
(Note this is not about the Cherenkov radiation, it is about spaces.)

How does tunneling work? The question can be answered using the new space and time definitions and knowing the working method of light. The barrier is a space made out of matter, a matter-space, where $h_{barrier} > h_{Space}$. Therefore the photon in the barrier exists as fast waves, and it travels inside the barrier with $c_{matter-space} = c$.

If a matter, a barrier acts as matter-space, the light here works the same way as in its space. It holds its frequency level and coordinate system constant. Light enters the matter-space. This is a very simple step, and is shown by FIG. 6.3. This situation is one step according to light, but an adequate model that describes its details is made out of four steps—see "Tu" in Table 1. Light detects the length of the barrier and adopts it as wavelength. Its frequency will be given by the product of frequencies from Eq. (30). It develops its f_{fw}. In the following light holds the frequency level f_{fw} / f_{space_i} constant in this mater-space according to Eq. (29).

Travel in space or travel in matter-space are different conditions even for the light itself, see the product of frequencies in Eq. (30). The longer or shorter *t* and *s* don't make a difference, if they are a simple change of wavelength of Space. But here the units are changed. Longer units means bigger actions. Matter-space has a bigger action than light's space. This is the reason for the metamorphosis. Light and other tunneling particles should be able to use this bigger action. Using this bigger action uncovers that elementary particles have structure.

9.4. Travelling time in the barrier

We are able to measure only the tunneling time, but the tunneling time is longer than the traveling time in the barrier. As mentioned above, according to Nimzt, the particle doesn't spend any time inside the barrier. It spends, but its actual travelling time inside the barrier is shorter than the tunneling time.

$$t_{tunneling} = t_{Metamorphosis1} + t_{travelling} + t_{Metamorphosis2}\,, \tag{31}$$

Eq. (31) shows that a particle needs time to adapt itself to the new space. Why do traveling particles need time for metamorphosis? Because they must rescale the structure of their action h.

10. THE TWO PARTS OF THE PLANCK CONSTANT

Let's use the functions of Table 1. $\acute{o} = \frac{L}{\lambda_0}$, where λ_0 means the wavelength of light before tunneling. $f_{fw} = \frac{1}{t_{tunneling}}$, where the tunneling particle in the barrier is a fast wave from our point of view.

Now we can study the same particle in two different spaces using a very simple method often used in economics but not in physics. See Eq. (32-38)

$$f_{fw} \times \lambda_{fw} = v_{fw} \quad \text{and} \quad f_0 \times \lambda_0 = c \tag{32}$$

$$\acute{a} = \frac{f_0}{f_{fw}} \tag{33}$$

$$\frac{f_0}{\acute{a}} \times \lambda_{fw} = v_{fw} \quad \text{and} \quad f_0 = \frac{c}{\lambda_0} \tag{34}$$

$$\frac{1}{\acute{a}} \frac{c}{\lambda_0} \times \lambda_{fw} = v_{fw} \tag{35}$$

$$\frac{1}{\acute{a}} \frac{c}{v_{fw}} \times \lambda_{fw} = \lambda_0 \tag{36}$$

Let's study the de Broglie wavelength of λ_0

$$\frac{h}{p} = \lambda_0 = \frac{1}{\acute{a}} \frac{c}{v_{fw}} \times \lambda_{fw}\,, \tag{37}$$

$$\lambda_{fw} = \acute{a}\frac{v_{fw} \times h}{c \times p} = \acute{a}\left(\frac{v_{fw}}{c} \times h\right) \times \frac{1}{p}\,. \tag{38}$$

If $v_{fw} = c$ and $á = 1$, then we get back the original formula. Since h is the attribution of the particle (photon), we can write Eq. (39).

$$h_{particle\_0} = h_{particle\_fw} . \tag{39}$$

Let's use the expression $(\frac{v_{fw}}{c} \times h)$ in the Planck law according to Eq. (40-43)

$$á = \frac{f_0}{f_{fw}} \qquad E_0 = á \times f_{fw} \times (\frac{c}{v_{fw}}) \times (\frac{v_{fw}}{c} \times h) = á \times f_{fw} \times h . \tag{40}$$

$$E_0 = á \times f_{fw} \times \frac{1}{h} \times (\frac{c}{v_{fw}} \times h) \times (\frac{v_{fw}}{c} \times h) , \tag{41}$$

where $v_{fw} \neq 0$, and

$$h_{rest} = \frac{c}{v_{fw}} \times h \tag{42}$$

is the rest energy part and

$$h_{kinetic} = \frac{v_{fw}}{c} \times h \tag{43}$$

is the kinetic energy part of the Planck constant—in the case of light and seen from our Space.

Physics hasn't defined Eq. (42, 43) previously. If $h_{rest} = h_{kinetic}$, then the speed of the light is *c*; Planck's law remains untouched, if $v_{fw} = c$. If $h_{rest} = h_{kinetic}$ then we speak about photon, where its spin is 1.

If $h_{rest} > h_{kinetic}$, we are speaking about particles with mass i.e. fermions with half-integer spins. If $h_{rest} < h_{kinetic}$ we cannot measure this fast wave via the tunneling, but both photons and fermions (e.g. electrons) can realize the tunneling. Therefore fermions are able to lose their mass, so we may suppose that they can change their spin (into an integer or other) spin via tunneling, though changing of spin is not an option according to the standard model. Fermions (and photons) as waves adjust their frequency levels to the waves of Space, using h_{rest} and $h_{kinetic}$.

If we don't want to conflict with the standard model, we can suppose that the change of spaces makes it possible for fermions that they loose their masses. On the other hand, loosing mass in tunneling seems to be connected to the QFT.

Since h is the attribution of the photon particle, it remains the same in Eq. (44).

$$E_{fw} = f_{fw} \times \frac{1}{h} \times (\frac{c}{v_{fw}} \times h) \times (\frac{v_{fw}}{c} \times h). \quad (44)$$

11. HIDDEN STRUCTURE OF ELEMENTARY PARTICLES

Today's physics doesn't use the expression 'rest energy', just 'rest mass'. As the speed of the object is increased, the inertial mass of the object also increases, while the rest mass remains unchanged. In the given inertial frame of reference, the value of the rest mass of an object cannot change[38, 39].

The fast wave-wave-particle triality shows that the 'rest action' exists in the case of electrons and photons too. According to above-mentioned, the 'rest action' can change in the given inertial frame of reference.

If the 'rest energy' reduces, how is it possible that the object remains the same? It seems that the 'rest action' is not the particle (wave) itself. What is the particle itself?

The dimension of *h* action is Js. Js is also the dimension of the angular momentum. In physics, angular momentum is the rotational equivalent of linear momentum. The changing 'rest energy part' of *h* is supposed to mean that the 'rest energy' of the elementary particle is created by a smaller unit of energy (action) that rotates inside the elementary particle. This smaller unit of energy is supposed to be the "information capsule" of the elementary particle that defines the elementary particle as a particle. The distance from the center of the elementary particle changes depending on the velocity of the particle. The faster the particle is, the shorter this distance is. This makes it possible that the 'rest energy' of the particle can decrease and increase without changing its information.

The dimension of the "information capsule" can be given as (eV/c^2). In the case of electrons it is obvious, and it can be also accepted in the case of the photon, since photons can have mass in a quantum nonlinear medium[40].

12. INDICATOR OF MOVING

$$ő = \frac{h_{kinetic}}{h_{rest}}, \tag{45}$$

where *ő* is the indicator of the moving of a particle. The pronunciation of *ő* is *ɜ:* (like *her*). If we know the value of *ő* written in Eq. (45), we know how fast the particle travels—compared to the given space. It means that we are able to detect that our inertial frame of reference moves—without using other inertial frames of reference. If we study the *ő* of an electron or photon of our inertial frame of reference, we can expect how fast our inertial frame of reference moves in the given space. Comparing values of two *ő*s from two different inertial frames of reference, we are able to say which system is the moving one.

Does the loss of mass mean changing spin? If yes, spins depend on *ő*, i.e. the spin written in the standard model is changeable in different spaces. New space needs new conditions of particles, and maybe new condition of spins.

How does ő work in the case of masses? Masses travel in Space with velocity $c_{space\_m} = c$ which is unchangeable. How can ő work in this case? ő works, because the wavelengths of Space waves change. That is, the density of Space changes, so ő changes, too.

ő shows that the Planck constant has a close connection to the special theory of relativity. If $ő < 1$, that is $h_{kinetic} < h_{rest}$, so ($v_{fw} = v < c$), we can write the well-known formula this way:

$$\sqrt{1 - \frac{v^2}{c^2}} = \sqrt{1 - ő} = \sqrt{1 - \frac{h_{kinetic}}{h_{rest}}}, \tag{46}$$

Eq. (46) shows that there is a discrete jump in the velocities of masses that travel in Space. If $ő = 1$, then we speak about light travelling with c velocity in space (and not in Space). This means that it is possible to change spaces. Eq. (47) shows the fast wave form of mass. If

$$ő > 1, \tag{47}$$

then mass has a new form: fast wave. The velocity of mass is surprising. From velocity $v < c$ it develops its velocity into this: $v > c$ without travelling with c. There is a discrete jump in the velocities.

This discrete jump at this "big" scale is unexpected, but we know other shocking discrete jumps like this. Physicists at the Ludwig-Maximilians University and the Max Planck Institute of Quantum Optics in Germany created an atomic gas in the laboratory that nonetheless had negative Kelvin values. These negative Kelvin values came into existence out of positive Kelvin values. The atomic gas had no zero Kelvin value. There was a discrete jump on the Kelvin scale[41].

If a particle with mass (e.g. electron) or without mass (e.g. photon) has a superluminal velocity, then $ő > 1$. In this case we are speaking about a fast wave that has no measurable mass. This cannot work without changing of spaces.

$ő$ works in every particle. $ő$ can be seen as the mirror of wavelengths of a space wave, that is, here can we find a new kind of symmetry. Because of this symmetry, light must create space waves, i.e. gravity is occurred by light, too.

13. SPEED OF SPACE WAVES—GRAVITY CAUSED BY MASS AND PHOTON

13.1. Gravity as the difference of wavelengths of Space waves caused by masses

Gravity occurs when Space accelerates masses, see Eq. (48):

$$\sum \vec{F}_{Space} \neq 0 , \qquad (48)$$

where $\vec{F}_{Space}$ are vectors of the force (action) of Space waves from the viewpoint of mass. Mass moves the direction of the resultant vector (except in special cases not detailed here).

Among bodies experiencing gravity, the frequency of Space waves decreases. That is, the Space “pressure” between the bodies decreases. Gravity arises, because the portions of Space with higher force (action) shift the masses. If on one side of a mass the Space wave has f_{S1} frequency, and on the opposite side of this mass the Space wave has f_{S2} frequency and $f_{S1} < f_{S2}$, then the mass goes into the direction of f_{S1}. The greater f_{S2} frequency—the greater force (action) of space—moves the mass forward. This force will give the direction of the object’s moving in the gravitation. Saying this, the wave of Space flows in the direction of mass. This is logical, since the density of Space is smaller around the mass. The gravitational wave measured by LIGO is not the Space wave, just the change in the Space waves generated by energy and sent away in the Space. The energy travels with c, then the change in the gravitational wave is also c. According to the Space-Matter Theory, this change is not the velocity of Space wave.

Let's see now FIG.1. this way: a big mass is at "O" and a small mass is at "a". If the small mass is much smaller than the big one, so it doesn't significantly change the wavelength of the Space wave, then from the viewpoint of the small mass the wavelength of the Space wave is an accelerator for the small mass, where $a_t = a_{t+1}$ and time t=1,2,3…

If the smaller mass changes the wavelength significantly, the accelerator effect of space remains untouched; see FIG. 4.

The accelerating Universe can be explained with Space waves. The constant acceleration of gravity has been explained above. The growing acceleration measured in the Universe comes from the growing wavelengths of Space waves between galaxy clusters, since gravity makes Space waves longer.

In Einstein's model, the gravity as curvature of spacetime has no velocity—it is a deformity of spacetime. Therefore gravity as a Space wave must have such a large velocity as it was unchanged according to masses; the velocity of the Space wave and time wave must be a very high superluminal velocity—independent of our viewpoint. That is, we'll find that Space waves (time waves) are "over-superluminal" or they seem even motionless.

The wavelengths of the Space wave can be connected with the general relativity. A geometric transformation is possible shown by a draft in FIG. 7.

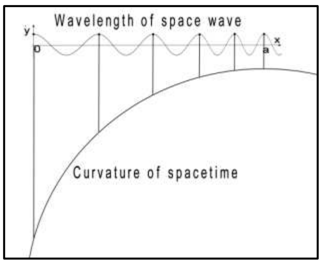

FIG. 7. The spacetime curvature can be transformed into a Space wave as gravity. There is a new theory growing out of the general theory of relativity holding its values. This new theory is the Space-Matter Theory.

In the theory of relativity, there is no place for spooky action at a distance. According to Space-Matter Theory, spooky action at a distance works using a special kind of gravity—gravity between photons, in other words: the spooky action works with the photon's space waves.

13.2. Spooky action at a distance as difference of wavelengths of space waves caused by photons

The spooky action at a distance is the nickname of the non-local correlation in quantum entanglement (*nlcqe*) given by Einstein[42]. Quantum entanglement is a physical phenomenon that occurs when two particles interact in such ways that the quantum state of each particle cannot be described independently. The most known example is the change of spins of photons.

Two independent measurements prove that $v_{nlcqe} > 10{,}000 \times c$, where v_{nlcqe} is the speed of non-local correlation in quantum entanglement[43, 44]. These measured times are longer than the travelling time of the spin-changing information; it is the whole process of the non-local correlation in quantum entanglement, where even $photon_1$ and $photon_2$ need time to develop their spin, so these measurements show three different velocities.

$$t_{nlcqe} = t_{developing\_spin\_1} + t_{traveling\_message} + t_{developing\_spin\_2}, \tag{49}$$

where t_{nlcqe} is the whole time measured. Eq. (49) remembers us for Eq. (31). This is correct, since the spooky action also has more steps that need time.

The spooky action at a distance has four steps. If $photon_1$ meets "something", this is the first action. In reaction, it develops its spin—this is a real change in spin. This real change is followed by a reaction of space waves made by $photon_1$, the wavelength of the space wave grows. This is one single action, this growth is a short period of the wavelength that travels to the $photon_2$. The grown wavelength appears as an action for $photon_2$. As a reaction, $photon_2$ changes its spin.

Saying this, the velocity of the space wave must be a very minor part in the measured values of time of the spooky action, since if Eq. (50) is not true

$$t_{traveling\_message} << t_{developing\_spin\_1},\ t_{traveling\_message} << t_{developing\_spin\_2}, \tag{50}$$

then $photon_2$ may develop its own spin independent from $photon_1$, since it doesn't have information about the changed spin of $photon_1$. See FIG. 8.

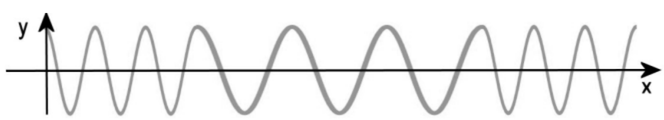

FIG. 8. y and x are spatial distances. Here is the photons' space wave between $photon_1$ and $photon_2$ that change their spins. The longer wavelength shows: $photon_1$ has already changed its spin. (Model, not proportional.) The measured velocity of the "spooky action is 10.000-50.000c. The space wave of photon's space must be at least so fast.

The velocity of the photon's space wave is a very high superluminal velocity; and photons need time to change their structure. Saying this, photons have structures.

14.SUPERLUMNAL VELOCITY AND GENERAL CAUSALITY

Superluminal velocity cannot destroy general causality, because in the Space-Time Theory time travel is impossible, since time has no dimension. General causality remains untouched in theory and in praxis, too. The superluminal velocity (of fast light, fast wave) exists; it has been measured. This velocity doesn't and cannot violate general causality[45]. Even more, the superluminal velocity is the explanation of many unexplained phenomena. Here will be shown a geometrical explanation of how fast waves don't work, using a draft of Minkowski geometry in FIG. 9.

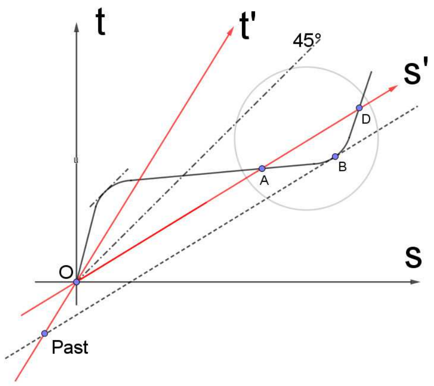

FIG. 9. t and s are expressed in meters. According to Minkowski geometry (of special relativity) the superluminal velocity in the **st** coordinate system is a time travel in the past in the **s't**' coordinate system. AB and BD events are in the past according to **s't'**. Superluminal velocity in one system (e.g. **st**) is time travel in another system (e.g. **s't'**). In the special theory of relativity, it is not possible to display an event with a superluminal velocity.

There is a main problem in FIG. 9. It is supposed that the superluminal velocity occurs in a spacetime, where the angle of the axis of the symmetry is in Eq. (51).

$$\alpha = 45° \qquad (51)$$

Objects travel in every space with velocity c. The superluminal velocity is fact, so Eq. (51) must be false in the case of fast waves. The angle of the axis of the symmetry of the coordinate systems of fast waves is in Eq. (52).

$$\alpha_{fw} < 45° \qquad (52)$$

of matter-space. Eq. (52) shows that there are more kinds of space with different times. See FIG. 10. Spaces in a Minkowski-like geometry.

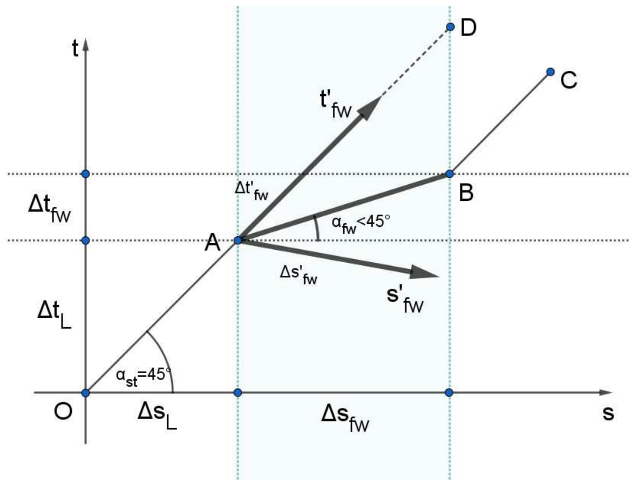

FIG. 10. t and s are expressed in meters. Here there are two different coordinate systems, that is, two frames of reference in different spaces. (In this chapter if I speak about "space" I mean a frame of reference in the given space, since it is impossible to be in a space without having created time, so axis **t** cannot represent a motionless observer in the space but in a frame of reference.) Both frames of reference **st** and **s'$_{fw}$t'$_{fw}$** time and spatial distance are in basic units and given in meters.

The coordinate system **st** is a known coordinate system that can be used in the Minkowski geometry of special relativity, too. Here the velocity of light (marked as event OA or BC) is 1, i.e. $\frac{\Delta s_L}{\Delta t_L} = c = 1$ and $\alpha_{st} = 45°$. Event AB doesn't appear in space **st**—we don't know what happens in the blue area; here $\alpha_{fw} < 45°$ that cannot be in the coordinate system **st** according to FIG. 9. The event BC has no reason in frame of reference **st**, and if we suppose that event AD is the path of the light and this is the fastest path here, event BC remains a mystery, since it cannot originate from events OA or AD.

Though event AB is not in the frame of reference **st**, we can observe it indirectly. The event AB uses $\frac{\Delta s_{fw}}{\Delta t_{fw}} = v_{fw}$, where $v_{fw} > c$ from our viewpoint. The velocity v_{fw} is a calculation according to our known system **st**. The event is in a fast space **s'$_{fw}$t'$_{fw}$** e.g. a matter-space, where objects travel with a superluminal velocity—from the viewpoint of the frame of reference **st**. This superluminal velocity we measure is c from the viewpoint of matter-space **s’$_{fw}$t’$_{fw}$**.

Matter-space **s’$_{fw}$t’$_{fw}$** doesn’t exist as space without travelling particles in it. It exists as matter-space as long as the particle travels in it. After and before it is just matter. So it doesn’t have time without travelling matter in it. Time will be created by travelling particles. Time is the action-reaction of space and matter.

According to the coordinate system **s’$_{fw}$t’$_{fw}$**: $\frac{\Delta s'_{fw}}{\Delta t'_{fw}} = c' = c = 1$. The axis **t’$_{fw}$** of the coordinate system **s’$_{fw}$t’$_{fw}$** lies on the line of the light in the coordinate system **st**. The axis AB of the symmetry of **s’$_{fw}$t’$_{fw}$** is defined by α_{fw}, where $0 < \alpha_{fw} < 45°$. The OA+AB+CB sections show the path and velocities of the light in the experiment. There is no missing part of the path of the light. Eq. (53) states,

$$\text{if } \frac{v_{fw}}{c} \to \infty \text{, then } \alpha_{fw} \to 0° . \quad (53)$$

The smaller is α_{fw}, the faster is the fast wave—from the viewpoint of **st**.

15. UNITS IN SUPERLUMINAL SPACES

Let’s see the concrete units of the three tunneling experiments. Entering the matter-space means changing the unit distance and the time unit. See FIG 11.

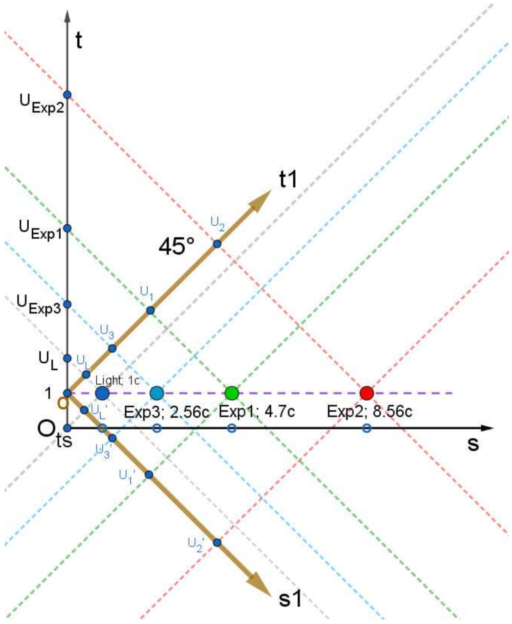

FIG. 11. Here there are two coordinate systems. *t* and *s* are in meters. The light (velocity c) and all the three experiments of tunneling are shown in both systems. The coordinate system **st** is the light's space. The unit is given by light with this function: unit $U_L = \frac{\Delta s}{\Delta t} = \frac{1}{1} = 1 = c$. Every velocity lies on the axis of symmetry (45°). The axes of the coordinate systems of matter-spaces **s1t1** are marked with brown. Here are their units 1, since $c_{Exp\_i} = \frac{U'_i}{U_i} = 1$ e.g. $c_{Exp2} = \frac{OU'_2}{OU_2} = 1 = c$. In this example OU_2 is the time unit of experiment$_2$ U_{Exp2}. This is more times longer than U_L. U_{Exp2} is 1 unit long in the coordinate system of experiment$_2$. This 1 time unit exists in the matter-space of the experiment$_2$, in different matter-spaces are different units.

15.1. Calculation of units of superluminal spaces in the light's coordinate system

Seeing FIG. 12., we will understand immediately why a is matter-space faster than our Space. Its basic units are longer than ours. Here waves travel with $c_{Exp\_i} = c$. This velocity seems to be a fast wave from the viewpoint of **st**, but it is c from the viewpoint of the given matter-space. The units of the different matter-spaces are in Table 1.

"Same step, different country. A step in the country of dwarves is shorter than in the country of giants."

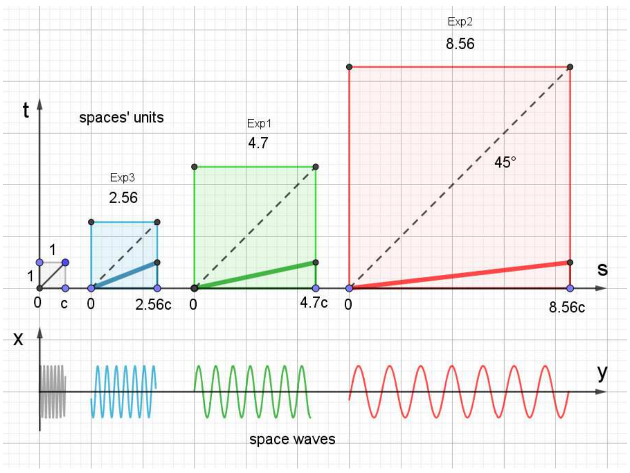

FIG. 12. This picture is a different view of FIG. 11. Now here are the velocities in the Cartesian coordinate systems. t and s are in meters. The first square is the known coordinate system of our light's space. Here U_L=1, according to *our* units. The following squares display

the hidden units of the matter-spaces—in our units. The velocities in these matter-spaces is c (dashed lines), but for us they appear as fast waves (thick lines). Why? Because the units of matter-spaces are longer. For example, in the Experiment$_2$ the fast wave has $v_{fw} = 8.56c$ velocity. The unit of this matter-space is longer than our **st** unit, but from the viewpoint of the matter-space: $U_{Exp2} = \frac{8.56}{8.56} = 1 = c_{Exp2} = c$.

The waves shown in the coordinate system **xy** are space waves in the different spaces. **x** and **y** are spatial distances. (Model, not proportional.) The wavelengths of space waves are longer in faster spaces.

In tunneling there are one traveling time and time of two metamorphoses. I think, the real travelling speed is much higher than the speed of tunneling measured. According to my calculation the travelling time is shorter than one yocto second.

Untill now we haven't measured values about the metamorphoses, so we cannot exactly calculate the pure travelling time. So the values given above are correct according to today's measurements.

As it is written above, the spatial units and the time units of the different matter-spaces have different multiplication factors, see *ú, ó* and *á* in Table 1. Using *ú, ó* and *á* and the units from FIG. 12., it is easy to calculate the actual unit of spatial distance and time of the given matter-spaces. (Naturally, it is also possible to study the coordinate system **st** from the others' systems.)

15.2. Space in "space in space"

It is possible to put a new coordinate system **s''t''** in the coordinate system of **s't'**. I won't go into details here.

15.3. Superluminal velocity in the special relativity?

FIG. 10. shows that the event OA is the reason of the event AB which is the reason of the event BC. Without fast waves, the BC event has no reason. How can we put the fast wave in the special relativity? There are two solutions.

There is a way to put the superluminal velocity in the special relativity. I'll use here two

Cartesian coordinate systems, because they are easy to understand.

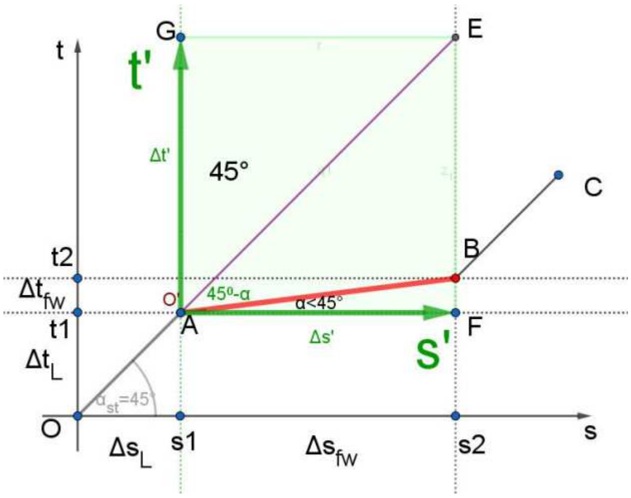

FIG. 13. Time and spatial distance are in meters. The figure shows, how to put a fast wave into the special relativity. **st** and **s't'** are two different coordinate systems, but every rule remains the same in both. In **st** is the light. In **s't'** is the fast wave with velocity c—from the viewpoint of matter-space, here $\Delta t = \Delta s = 1$. Here are different (longer) units than in coordinate system **st**. Using these different units, we can calculate with fast wave like with lights. The green area is the region of fast light. In this figure the E of "unified" fast light in **s't'** and the D of light in **st** are the same point.

How to display that E and D are the same point? We can use more than two coordinate systems: **st**, **s't'** and **s''t''**, see FIG. 14.

Here **s't'** and **s''t''** are coordinate systems of fast waves. They are the same coordinate system, the difference between **s't'** and **s''t''** is a rotation. Now we have to show how the chain of causality goes. So the coordinate system **s't'** must be rotated at K, so a "new" coordinate system **s''t''** will appear. In reality there isn't any rotation; this is a visual solution to show the causality more clearly.

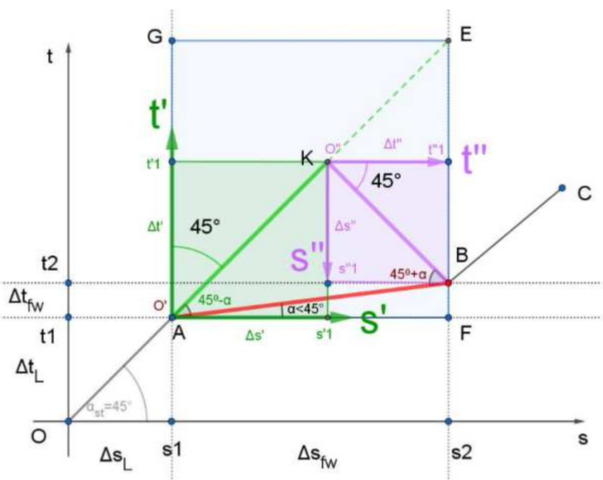

FIG. 14. Time and spatial distance are in meters. The figure shows how to put a fast wave into the special relativity. **st** and **s't'** are two different coordinate systems, but every rule remains the same in both. **s''t''** is the same **s't'** rotated. The **AGEF** region is the region of fast waves shown in three coordinate systems. (**AF** and **FB** are in **st**.)

Note **st** and **s't'** have different units, but $\frac{\Delta s_L}{\Delta t_L} = \frac{\Delta s'}{\Delta t'} = 1$. The two coordinate systems are not independent, c connects them together. To use Eq. (54) we have to know α, that is, the velocity of fast wave v_{fw}.

$$\Delta s_L \times \Delta t' = \Delta t_L \times \Delta s' = 1, \qquad (54)$$

where time and distance have the same dimension.

The "very visual" version of the general causality is FIG. 15.

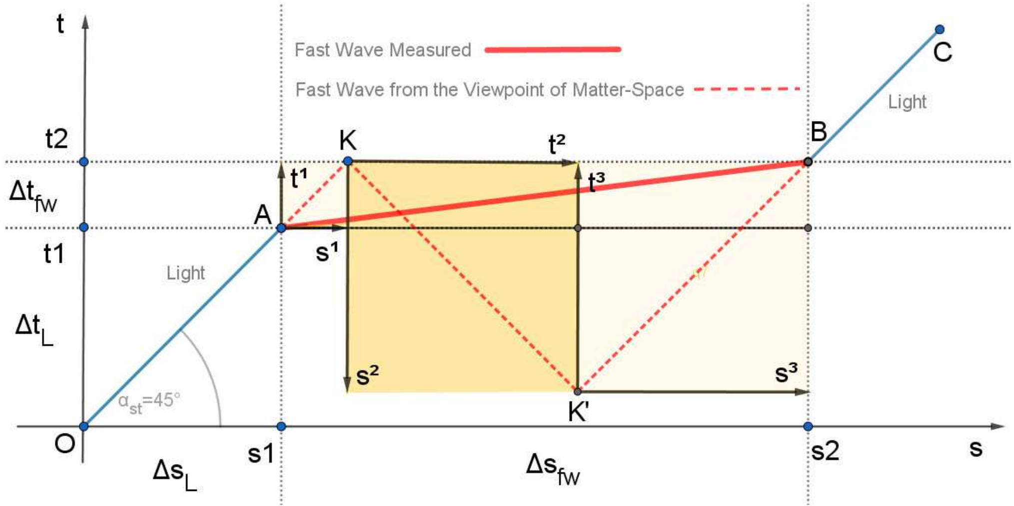

FIG. 15. Light and fast light in the same figure displayed by four coordinate systems. The best way to make the causality and the importance of fast waves visible is using four coordinate systems. The velocities are c in every coordinate system.

The light OA and the fast wave AB result in light BC. These are measured values.

Using the coordinate systems of matter-space after OA comes AK. KK' is the next step and K'B results in BC. The OK and the K'C lines aren't broken while the three yellow sections are the regions of fast waves. The coordinate systems like these can be used in the special theory of relativity. Note the earlier symmetry of the viewpoints of object and observer cannot be held with or without fast waves, because the space waves are parts of the inertial frames of reference. Longer and shorter wavelength of space waves are real differences.

16. CONCLUSION

Space-Matter Theory uses space waves. Space waves together with matter are able to create spatial distance and time. Calculating with space waves, new connections can be discovered.

The tunneling electrons seem to violate special relativity. How can particles with masses travel with superluminal velocity? The question cannot be answered using the theory of relativity. According to the fast wave–wave–particle triality, the tunneling particle doesn't violate the special theory of relativity; tunneling is out of the scope of the special theory of relativity. Fast waves show that in the case of masses, there is a discrete jump in the velocities, and after $v < c$ occurs $v > c$.

The newly-discovered principle of c states light travels in every space at velocity c— according to the given space's unit. Using this and two different coordinate systems, the fast wave can be integrated into the special theory of relativity "reloaded".

In tunneling $ő > 1$, a barrier made out of matter works as matter-space. In this matter-space, the particles (for example photons, electrons) travel faster than *c*. Tunneling particles use the fast wave–wave–particle triality. Via tunneling, the value of Planck's constant *h* doesn't change, but it has two changing parts. The two parts of the Planck constant work together. The values of these parts depend on the velocity of the particle i.e. fast wave. Comparing only these two parts of h, we are able to say how fast the particle (fast wave) travels compared to the given space or even to our Space. If $ő < 1$, we find a connection between the Planck constant and the special theory of relativity.

The velocity of Space waves and the velocity of the photon's space waves must be superluminal velocity with very high frequencies. All these space waves show that particles have structures, and these structures depend on the given space, where the particle travels.

Space-Matter Theory proves that there are two ways to distinguish one inertial frame from another:

One: using the changed wavelengths of Space waves.

Two: using $ő$ which is a newly uncovered attribution of particles.

17. ACKNOWLEDGEMENT

I'd like to thank Günter Nimtz for having sent me the unpublished details of his published experiments.

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