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Time in Physical Spaces

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Abstract: Relative uniform motion between two inertial reference frames (coordinate systems) have been considered. Solutions in according to boundary value problems and initial conditions to prove that time in physical space is not dependent on velocity of motion have been given. Examples of definition of the intervals (or durations) of events in physical space have been presented. It was shown that the interaction of all physical objects and fields occur through the basic hyperspace, at points(cells) with zero time! It has been shown that Physical Universe in principal could consist of quantum-phase spaces and subspaces.

1. Introduction

Lorenz only has considered the case of the translative uniform motion of the moving reference frame relative to unmoving reference frame (coordinate system) in the ether space [1]. Notice: But the simple interesting question follows in this case: What is the unmoving reference frame (coordinate system) and where is it placed!? Unfortunately, he has made methodical mistake, for example see [2,3]. But and later the so known scholar Einstein has repeated this mistake in the derivation of his famous "Special Relativity Theory, SRT", [4,5]. In fact, it is difficult to believe that anyone could not notice this simple mistake. The cause of it was probably that, the results of Michelson-Morley experiment has shown absent of the ether's wind [6,7]. Also further a lot of scientific evidences and contradictions have accumulated, which have shown us that SRT is not working [3,8,9,10,11,12,13,14]. For example in the article [3], have been shown that it is mathematically impossible for Einstein's Special Relativity Theory (SRT) to use its own Lorentz transformation (LT), and it also reveals the origin of this error in the pre-relativistic Electrodynamics, and the main causes of misunderstandings between the advocates of SRT and the critics of SRT, regarding the relativistic paradoxes of LT. Therefore, to help clear some still existing contradictions in these problems, the novel and rightly mathematically based solutions of the uniform relative motion between two equivalent inertial reference frames (coordinate systems) in the physical space has been given in the proposed article. Also, explanations about processes and events under interactions between points(cells) in the physical space being in relative motion each to other have been given.

2. The relative uniform motion between two inertial reference frames (or coordinate systems)

It is known: "The basic postulate of SRT is that all physical laws are valid in all inertial systems" [4]. "All inertial frames are equivalent for the performance of all physical experiments" [3,4,5]. Thus, according to these references, the relative uniform motion between two inertial reference frames (or coordinate systems) can be considered as the process of their mutual moving, namely when the observer in the frame **K'** is moving relative to the stationary frame **K** with the relative velocity v, and in the same time the observer in the frame **K** is moving relative to the stationary frame **K'** with the relative velocity v'. It is logically

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obvious here, that the inertial reference frame **K** is the stationary frame for an observer being in this frame **K**, since **K'** is moving relative to it! But, on the other hand, the inertial reference frame **K'** is the stationary frame for an observer being in this frame **K'**, since **K** is moving relative to it! Here it is obvious that these inertial reference frames **K** and **K'** are absolutely equivalent and alternative! Also, it is obvious, the two variants of coordinates directions in the reference frames (or coordinate systems) can be possible considered here, as shown in schematic illustrations in Figure 1 and in Figure 2.

Variant 1: Let two inertial reference frames (coordinate systems) **K** and **K′** be in uniform relative motion and let their coordinate axes x and x' direct in opposite ways, as it is depicted in Fig. 1.

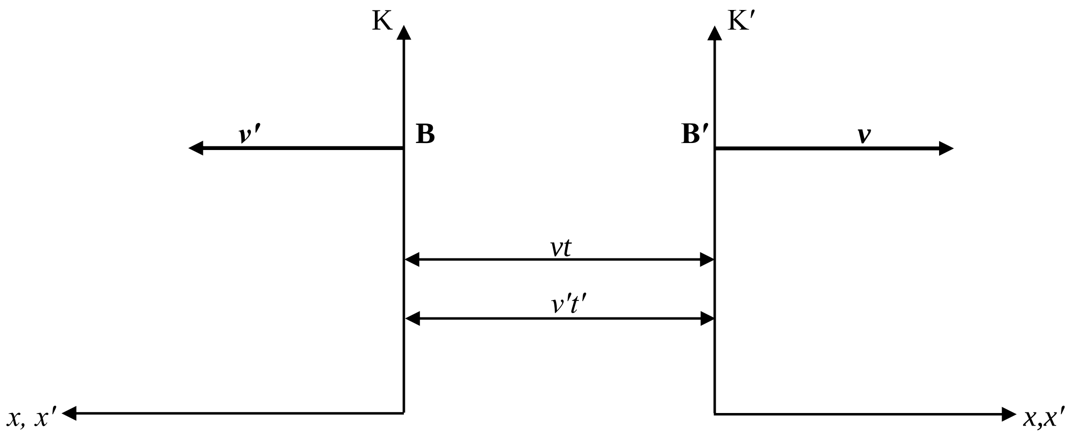

Figure 1. Variant 1. Schematic illustration when for observer **B** in the frame **K** the direction of the axes x,x' coincides with vector of velocity $\boldsymbol{v}$, and for observer **B′** in the frame **K′** the direction of the axes x,x' coincidence with vector of velocity $\boldsymbol{v'}$**.**

Or better to say, let for observer **B** in the frame **K** the direction of the axes x,x' coincidence with vector of velocity $\boldsymbol{v}$, but on the other hand, for observer **B′** in the frame **K′** the direction of the axes x,x' coincides with vector of velocity $\boldsymbol{v'}$. Also, taking in account that in this variant we should take $\boldsymbol{v} = \boldsymbol{v}'$, (also see [3]), it follows

$$x' = \gamma(x - vt), \tag{1}$$

$$x = \gamma(x' - vt'), \tag{2}$$

where t is the time in the frame (coordinate system) **K** and t' is the time in the frame (coordinate system) **K'**. Now, after substitutions $x' = ct'$ and $x = ct$, where c is the velocity of propagation of interaction, respectively we get

$$ct' = \gamma t(c - v), \tag{3}$$

$$ct = \gamma t'(c - v) \tag{4}$$

Then after dividing (3) at (4) we get that, $t^2 = (t')^2$, or finally it follows that $t = t'$.

Remark: Now in modern physics the velocity of propagation of interaction c is taking as in SRT [4] equals to the speed of light. But we should understand that speed of light is indeed

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the velocity of quantum of light and it equals to the velocity of photon! Usually this speed is taken as the fundamental constant in our physical space of Universe! But simple question has arisen, why should the speed of light equal the velocity of propagation of interaction?

Variant 2: Two inertial reference frames (coordinate systems) **K** and **K′** are being in uniform relative motion and let their coordinate axes x and x' direct in one way, as it is depicted in Fig. 2.

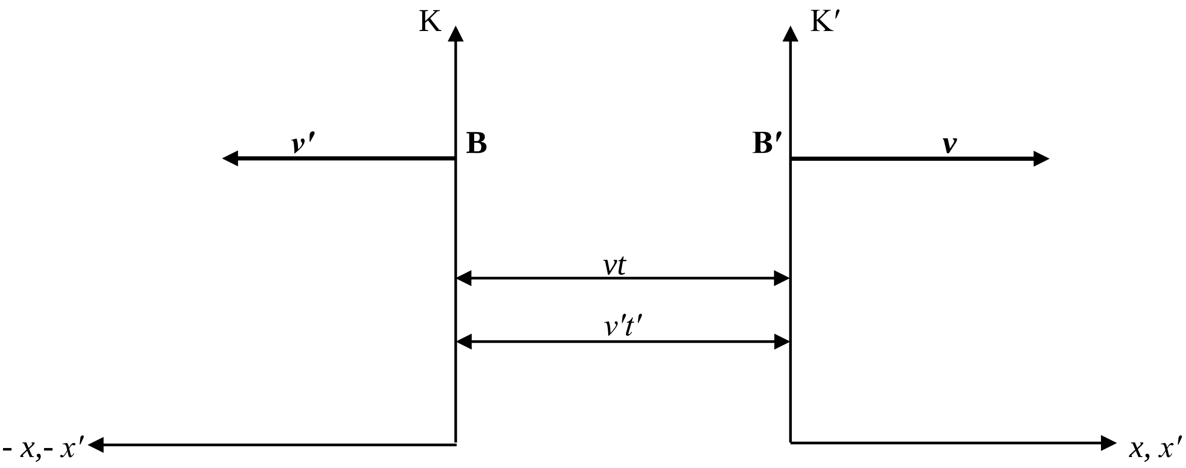

Figure 2. Variant 2. Schematic illustration when for both observers **B** and **B′** in the frames **K** and **K′** the direction of the axes x,x' coincide with vector of velocity v.

Or better to say, let for both observers **B** and **B′** in the frames **K** and **K′** the direction of the axes x, x' coincide with vector of velocity $\boldsymbol{v}$. Also, taking in account that in this variant we should take $\boldsymbol{v} = -\boldsymbol{v}'$, (also see [3]), it follows

$$x' = \gamma(x - vt), \tag{5}$$

$$-x = \gamma(-x' - v't') \tag{6}$$

But since in this case we should take $v = -v$, we get same result as in Eq. (2),

$$x = \gamma(x' - vt') \tag{7}$$

Substituting $x' = ct'$ and $x = ct$, and then after dividing (5) at (7) we get again finally that $t = t'$.

3. Solutions according to boundary value problems and initial conditions

In addition to the result already received above, we can easily prove once more that the time in any two uniformly reference frames (coordinate systems) relative moving always same, for example:

<u>The proof 1.</u> As we know [15], the intervals between synchronized moments of time of two same events in two inertial reference frames (coordinate systems) **K** and **K′** in their uniform relative motion, when the observer **B′** in the frame (or coordinate system) **K'** is moving relative to the stationary frame (or coordinate system) **K,** can be found as

$$S_{B'}^2 = c^2t^2 - v^2t^2 = t^2(c^2 - v^2) \tag{8}$$

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$$S'^2_{B'} = \ c^2 t'^2 \tag{9}$$

Since *c* is constant and *v* is constant in each case of uniform motion, we can write that

$$S^2_{B'} \ = aS'^2_{B'} \tag{10}$$

Thus, it follows

$$t^2(c^2 - v^2) = ac^2 t'^2 \tag{11}$$

It is obvious and it follows from Eq. (11) that according to "Boundary value problem" in any moment of the time, $t > 0$ and $t' > 0$, if $v = c$, it should be that $ac^2 = 0$. This result is possible only when

$$a = \left(1 - \frac{v^2}{c^2}\right) \tag{12}$$

Hence $\boldsymbol{t = t'}$. It is obvious that coefficient a dependents of chosen velocity *v*.

<u>**The proof 2.**</u> Also, according to the initial conditions: $t = 0$, $t' = 0$, v = constant, we can find the parameter a as the limit of a function, namely as

$$a = \lim_{\substack{t\to 0^+ \\ t'\to 0^+}} \frac{S^2_{B'}}{S'^2_{B'}} = \frac{\lim_{t\to 0}\left(S^2_{B'}\right)''}{\lim_{t'\to 0}\left(S'^2_{B'}\right)''} = \frac{\lim_{t\to 0}\left(t^2(c^2-v^2)\right)''}{\lim_{t'\to 0}\left(c^2 t'^2\right)''} = \left(1 - \frac{v^2}{c^2}\right) \tag{13}$$

It follows that $\boldsymbol{t} = \boldsymbol{t'}$. Thus, it proves that the time in physical space is not dependent on velocity of motion.

<u>**The proof 3.**</u> Alternatively, the intervals between synchronized moments of time of two same events in two inertial reference frames **K** and **K′** in their uniform relative motion, when the observer **B** in the frame **K** is moving relative to the stationary frame **K′,** can be found as

$$S^2_B = c^2 t'^2 - v^2 t'^2 = t'^2(c^2 - v^2), \tag{8*}$$

$$S'^2_B = \ c^2 t^2 \tag{9*}$$

Since *c* and *v* are constants, we can write that

$$S^2_B \ = aS'^2_B \tag{10*}$$

Thus, we get

$$t'^2(c^2 - v^2) = ac^2 t^2 \tag{11*}$$

It is obvious again and it follows from Eq. (11*) that according to "Boundary value problem" in any moment of the time, $t > 0$ and $t' > 0$, if $v = c$, it should be that $ac^2 = 0$. This result is possible only when

$$a = \left(1 - \frac{v^2}{c^2}\right) \tag{12*}$$

Hence again $\boldsymbol{t} = \boldsymbol{t'}$. But it is obvious here that coefficient a is dependent of chosen velocity *v*.

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The proof 4. Also, again, according to the initial conditions: $t = 0$, $t' = 0$, v = constant, we can find the parameter a as the limit of a function, namely as

$$a = \lim_{\substack{t\to 0^+ \\ t'\to 0^+}} \frac{S_B^2}{S'^2_B} = \frac{\lim_{t'\to 0}\left(S_B^2\right)''}{\lim_{t\to 0}\left(S'^2_B\right)''} = \frac{\lim_{t'\to 0}\left(t'^2\left(c^2-v^2\right)\right)''}{\lim_{t\to 0}\left(c^2t^2\right)''} = \left(1-\frac{v^2}{c^2}\right) \qquad (13^*)$$

It follows again that $\boldsymbol{t} = \boldsymbol{t'}$.

The proof 5. The dividing Eq.11 at Eq.11* gives us respectively that, $t^4 = (t')^4$. Thus, it is obvious that, it should be $S_B^2 = S_B^2$, and $S'^2_B = S'^2_B$, and hence, it is finally proved that $\boldsymbol{t} = \boldsymbol{t'}$.

The proof 6. Also, since $|x| = |x'|$ it follows that $|vt| = |v't'|$ and since $|v| = |v'|$, it follows finally the simplest obvious conclusion that

$$\boldsymbol{t = t'} \qquad (14)$$

Thus, it proves that the time in physical space is not dependent on velocity of motion.

4. Definition of intervals (or durations) of events in physical space

It is obvious that the velocity of light or the velocity of electromagnetic waves, is the velocity of an information transfer (or it is the velocity of propagation of information) between moments in the time of two events in the space! What is generally understood as the moment of event in the time? An event is some kind of action or process that leads to some kind of change, for example, a change in the location of a point (particle) in space. It is also understood that such an action and change can be recorded or registered by an observer (receiver or detector). But it is also obvious that any moment of event in time occurs instantly!

The Figure 3 shows the schematic illustration of a placement and a direction in physical space of the vectors of velocity of information transfer (or the velocity of propagation of information) and the vectors between two moments of events in the points **A**$_1$, **A**$_2$ relative to an observer or to a receiver in the zero point of coordinates ***0***.

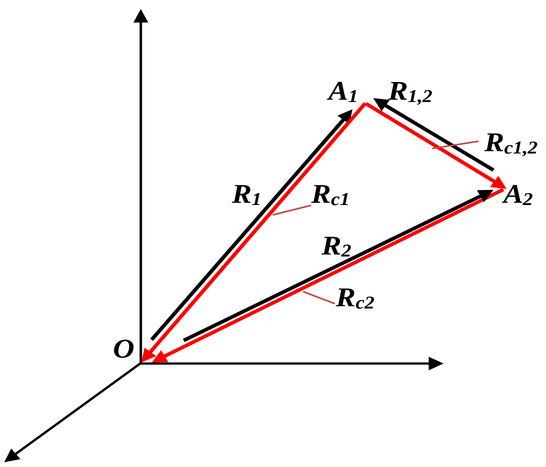

Figure 3. The schematic illustration of a placement and a direction in physical space of the vectors of velocity of information transfer (or the velocity of propagation of information) and the vectors between two moments of events in the points **A**$_1$, **A**$_2$ relative to an observer or to a receiver in the zero point of coordinates ***0***.

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Let in the moment of time t_1 at the point of **A₁** a flash or an impulse of light begun and ended at the moment of time t_2. We see that there are two events between two moments of time t_1 and t_2, such as beginning and ending of a flash (or an impulse) of light. Therefore, the time interval (period) between these two moments of events at the $\mathbf{A_1}$ point will be equal to the difference between the times t_1 and t_2, namely:

$$\Delta t_A = t_2 - t_1 \tag{15}$$

Let the position of the $\mathbf{A_1}$ point be determined by the vector $\boldsymbol{R_1} = \sqrt{x_{A1}^2 + y_{A1}^2 + z_{A1}^2}$. And let us first of all to consider the case where the $\mathbf{A_1}$ point does not move ($R_1 = R_2$) relative to the observer being at the coordinate origin at the point ***0***. Obviously, information about these moments of events will come to an observer in the form of an electromagnetic wave or a quantum of light, respectively, at times t_3 and t_4 and will be determined by the vector of the speed of information propagation, see Fig. 3., as

$$R_{c1} = R_{c2} = c\Delta t_{c1} = c(t_3 - t_1) = c(t_4 - t_2), \tag{16}$$

where $\Delta t_{c1}$is the interval in time between the moment of the start of radiation and the moment of obtaining light or electromagnetic information by a receiver (observer) at the origin at point *0*. So thus, we get that

$$\Delta t_A = (t_4 - t_3) \tag{17}$$

$$t_4 = t_3 + (t_2 - t_1) = t_3 + \Delta t_A \tag{18}$$

The vectors R_1 and R_{c1} are equal and opposite in direction, so

$$R_1 = R_{c1} \tag{19}$$

and therefore

$$R_1 - R_{c1} = 0 \tag{20}$$

It should be understood here that equation (20) is valid only if condition (19) is satisfied. This means that if the R_1 vector is zero, the R_{c1} vector must also be zero!! Other options will not be valid! That is, this means that events of information transfer between a source and a recipient at the same point occurs instantly and quantum quickly, since $R_1 = R_{c1} = 0$. It is obvious therefore that at this same point, physical space and time equal zero, namely $c\Delta t_1 = R_1 = 0$. This is the specific zero-time quantum space. But maybe in this zero-time space an information about events could be stored? Conventionally, the Quantum of Light in zero space accelerates from zero to c, but it cannot move where there is no physical space! Also, note the fact that the origin ***0*** and the $\mathbf{A_1}$ and $\mathbf{A_2}$ points lie in the same ***0***, $\mathbf{A_1}$, $\mathbf{A_2}$ plane! Therefore indeed, any motion in this plane is the plane motion in the two-dimensional frame (or in the two-dimensional coordinate system). And now let us to consider two variants of relative motion, such as:

Source moves away from a receiver (observer).

First of all, let's consider the option when the source of a flash or an impulse of light or electromagnetic waves is located in the coordinate system *y0x* and moves away from a receiver, as shown in Figure 4.

Corresponding Author: Nikolay Goloshchapov, glshchpv@yahoo.co.uk

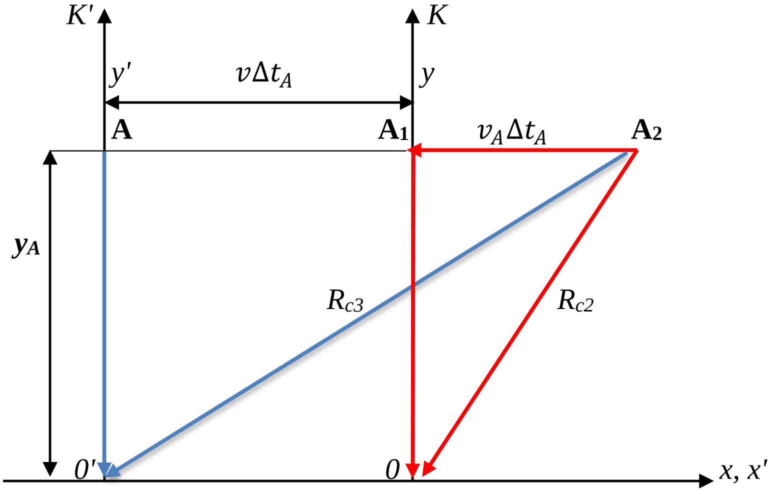

Figure 4. The motion of source of impulse or flash of light relative to receivers which are placed in the initial points *0* and *0'* of the coordinate reference frames (systems) **K** and **K'**

Let a flash or an impulse of light begin at the point **A1** at the moment of time t_1 and then it ends at the point **A2** at the moment of time t_2. And, let the source of impulse or flash moves over a period of time $\Delta t_A = t_2 - t_1$ from point **A1** to point **A2** at a constant velocity v_A and let the movement between these points occurs in a straight line (see Fig. 3 and Fig.4.). Then the distance between the point at moment of radiation ending and the point in moment of obtaining light or electromagnetic information by a receiver (observer) at the origin *x0y* at point *0* can be determined as

$$R_{c2}^2 = y_A^2 + (v_A \Delta t_A)^2 \qquad (21)$$

and since $R_{c2} = c\Delta t_{c2}$, $y_A = c\Delta t_{c1}$, see Figure 4, it follows

$$\Delta t_{c2}^2 = \Delta t_{c1}^2 + \frac{v_A^2}{c^2}\Delta t_A^2 \qquad (22)$$

On the other hand, the interval in time between the moment of radiation ending and the moment of obtaining light or electromagnetic information by a receiver (observer) at the origin *x*0*y* at point *0* can be determined as $\Delta t_{c2} = (t_4 - t_2)$, and since $R_{c2} = c\Delta t_{c2}$, see Fig. 4, follows

$$c\Delta t_{c2} = c(t_4 - t_2) = R_{c2} = R_2 \qquad (23)$$

and since $t_2 = \Delta t_A + t_1$, and $R_2 = \sqrt{y_A^2 + (v_A \Delta t_A)^2}$, it follows

$$t_4 = \frac{1}{c}\sqrt{y_A^2 + (v_A \Delta t_A)^2} + (\Delta t_A + t_1) \qquad (24)$$

In a simpler variant, if $y_A = 0$, it follows respectively that

$$t_4 = \frac{v_A \Delta t_A}{c} + \Delta t_A + t_1 = \Delta t_A\left(1 + \frac{v_A}{c}\right) + t_1 \qquad (25)$$

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And if we take the initial moment of time in beginning a flash (or an impulse) of light equals zero (t_1= 0) , we get

$$t_4 = t_2\left(1 + \frac{v_A}{c}\right) \tag{26}$$

Also, as well, let the system (frame) **K'** move (replace) relative to the system coordinate (frame) **K** at velocity v. Then the distance between the point at moment of radiation ending and the point in moment of obtaining light or electromagnetic information by a receiver (observer) at the origin $x'0'y'$ at point $0'$ can be determined as

$$R_{c3}^2 = y_A^2 + ((v + v_A)\Delta t_A)^2 \tag{27}$$

and since $R_{c3} = c\Delta t_{c3}$, $y_A = c\Delta t_{c1}$, see Fig.4, it follows

$$\Delta t_{c3}^2 = \Delta t_{c1}^2 + \frac{(v+v_A)_A^2}{c^2}\Delta t_A^2 \tag{28}$$

Also, similarly, the interval in time between the moment of radiation ending and the moment of obtaining light or electromagnetic information by a receiver (observer) at the origin $x'0'y'$ at the point 0' can be defined as the $\Delta t_{c3} = (t_5 - t_2)$, and therefore

$$c\Delta t_{c3} = c(t_5 - t_2) = R_{c3} = R_3 \tag{29}$$

And since $t_2 = \Delta t_A + t_1$, and $R_3 = \sqrt{y_A^2 + ((v_A + v)\Delta t_A)^2}$, it follows

$$t_5 = \frac{1}{c}\sqrt{y_A^2 + ((v_A + v)\Delta t_A)^2} + (\Delta t_A + t_1) \tag{30}$$

In a simpler variant, if y_A= 0 and t_1= 0, it follows that

$$t_5 = t_2\left(1 + \frac{v_A+v}{c}\right) \tag{31}$$

As we see here, the velocity of movement of a radiation source or also any object relative to an observer or receiver is not limited!

The source moves back towards approach to a receiver (observer).

Now let the movement of the source takes place in the opposite order, when the **K'** system approaches the **K** system at speed v. Let at the point $\mathbf{A_2}$ the light emission ends and motion stops in the moment of time t_2, but then, let in this same moment of time t_2, the new movement of the source of light begins in back order without radiation, and also, let at time t_6 at the point $\mathbf{A_1}$ this state ends, and the source begins to emit again (see Fig.4.). Thus, it is obvious in this case that $\Delta t_A = (t_6 - t_2) = (t_2 - t_1)$. Or in a simpler variant, if t_1 = 0, it follows

$$t_6 = 2t_2 \tag{32}$$

It is also obvious that at the moment of the time equals t_6, the reference frames (coordinate systems) **K** and **K'** will coincide again, as at the initial moment of the time t_1 = 0. That is, the movement cycle in both reference frames (coordinate systems) will end at the same moment of

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the time equals to t_6! But both observers (or receivers) will receive information about this event at the same moment of the time equals t_7,

$$t_7 = t_6 + \Delta t_{c1} = 2t_2 + \Delta t_{c1}, \tag{33}$$

where $\Delta t_{c1} = y_A/c$.

As we can see, the time and the passage of time in the same physical space are the same in all inertial and non-inertial reference frames (coordinate systems)! The transmission rate of light or electromagnetic information is constant in the same physical space! It becomes clear now that $t_1, t_2, t_3, t_4, t_5, t_6, t_7$ ….. these are the moments of the time of one common physical time, and it is obvious that, these are not different times (the passage of times) in different moving relative to each other reference frames (or coordinate systems)!

5. Zero quantum hyperspace

Let's now look at the relative motion of points in these two (see Fig. 5), moving relative to each other, reference frames (coordinate systems) **K** and **K'**. Let at the initial moment of reference of the time $t = 0$ the coordinates $y(0) = y'(0)$ of systems (or frames) **K** and **K'** coincide, and let then these coordinate systems (frames) move away in free space each relative to the other with relative velocity v, see Fig. 5

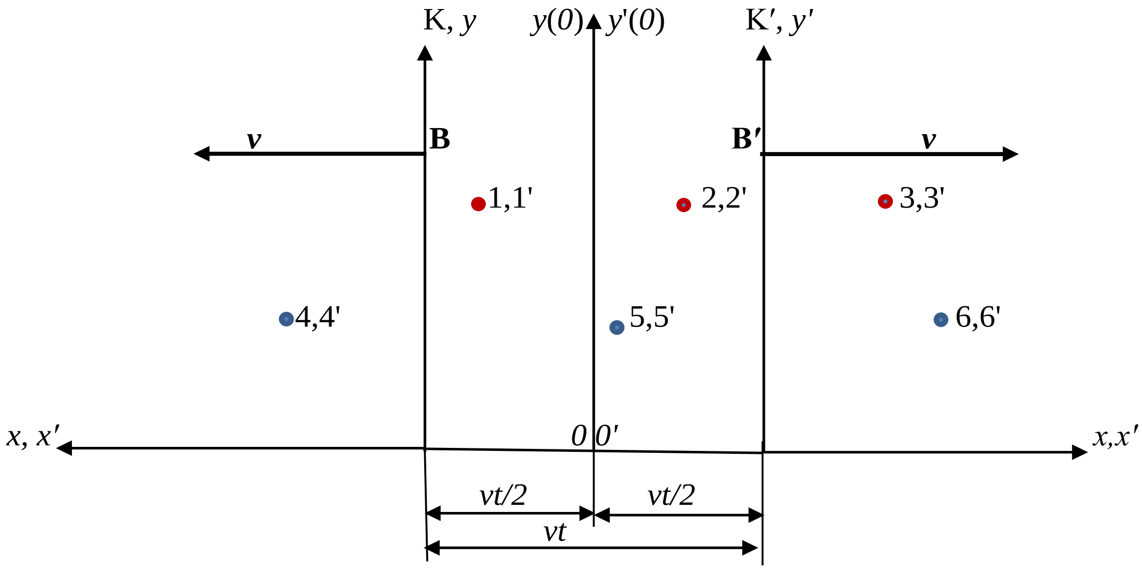

Figure 5. Illustration of the relative motion of points in two, moving relative to each other, reference frames (coordinate systems) **K** and **K**'

And let it be further, at some point in the current time t, the frames **K**, **K'** and respectively ordinates y and y' will be moved away from each other by a distance vt. At the same time, it is obvious that the distances that the systems **K** and **K'** will be moved away relative each other in space from the position $(0,0')$ that they had at the moment of time $t = 0$ will be equal to $vt/2$, respectively. Also, it is obvious that at any time t one can distinguish an infinite set (quantity) of points in both coordinate systems **K** and **K'** that will instantly coincide, for example, such as shown in Figure 5, these pairs of points: (1,1'); (2,2'); (3,3'); (4,4'); (5,5'); (6,6') ….! Thus, any of these pairs can be taken as the one initial starting point! And the most interesting thing,

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it is obvious that in the moment of time when these points instantly fully coincide, the instantaneous velocity between them equals zero value, see Figure 6. We can see here that a reverse in a relative motion and in the direction of relative velocity occur at these points! It is obvious that the direction of motion and as well the relative velocity change instantly at these points from the approach moving to the moving away! It is happened instantly, quantum! Thus, we can see that, all these points at which this an instantaneous change occurs are quantum points (dots, cells) of space! This space itself, formed from zero quantum points (dots, cells), will continue to be called as the zero-quantum hyperspace, where time is zero!

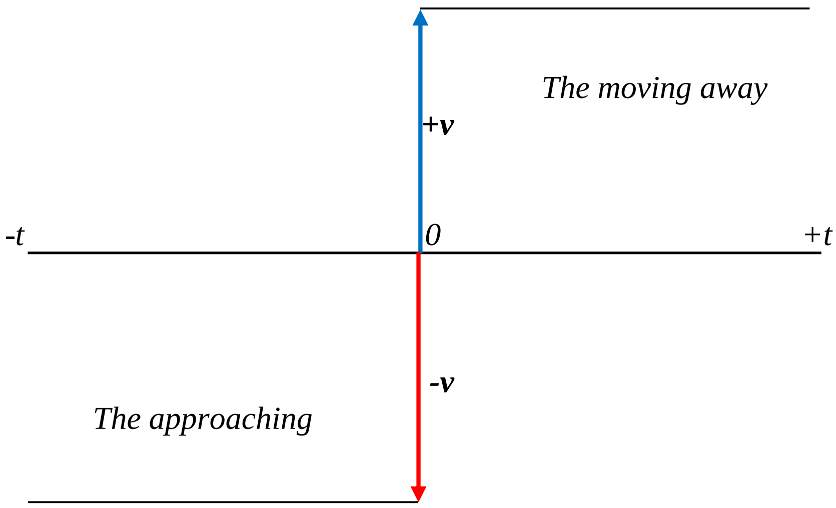

Figure 6. Illustration of an instant reverse in a relative motion and in the direction of relative velocity in the moment of two approaching points coincident.

On the other hand, note the obvious fact (see Figure 5 again) that, for example, the pairs of points (1, 4'), (2, 4'), (3, 4'), (3, 5'), (2.5 ') are approaching, and the pairs of points (1, 2'), (2, 3'), (1, 5'), (1, 6') are moving away from each other! It obvious that the number of the pairs of each class points that are moving away and which are approaching are equal to infinity! Thus, when the reference frames (coordinate systems) K and K' move relative to each other, there always be observed three sets of points: 1- instantly coinciding; 2 - approaching; 3 - moving away relative to each other!

Here the question is arising: What is indeed the velocity of propagation of interaction? Usually in modern physics it takes that the velocity (rate, speed) of interaction is constant and it equals to the speed of light, because the such kind of assumption has been made by the famous scholar A. Einstein! His authority still so high, and of cause, it is difficult for us quickly to change our imagination about Universe Building! But in fact, as shown above, the velocity of light is not the speed of propagation of interaction, but it is the velocity of an information transfer (or it is the velocity of propagation of information) between moments in the time of two events in the space! Also, for example, it is interesting to know what is the speed of magnetic and electrical interaction, and what is the speed of gravitational interaction? It is clearly obvious here that the velocity of interaction is not equal to the velocity of propagation of light and electromagnetic waves, and the propagation rates of various kinds of radiation! And now attention! We should understand the simplest fact that before quantum of light or a

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front electromagnetic wave start to move, the electric and the magnetic fields as result of interaction between some points (cells or dots) of a physical space should be set! Therefore, the spread of fields in space goes quicker than the motion of quantum of light or electromagnetic waves in them! Probably, its similar takes place in spread of a gravity field! Any way, we can suppose that the velocity of spread velocity of interaction in many times is quicker than velocity of light! Based on the examples already discussed above (see Fig. 4. and references [1-16]), a simple conclusion follows: The interaction of all physical objects and fields occurs through the basic hyperspace, at points with zero time! This is true for all without exception quantum phase spaces and subspaces and times!

Also, for example, according to the law of conservation of energy, the equation for the birth of a quantum (photon) of light through a zero-time hyperspace can be written, as

$$m_p C^2 = m_{p0} V_H^2 \tag{34}$$

where m_p - photon mass in physical space, C – velocity (speed) of light (velocity of photon) in physical space, m_{p0} - photon rest mass, V_H – speed (velocity) of propagation of interaction between physical objects and all kind fields in physical spaces through the zero-time hyperspace. Since the rest mass of the photon usually takes equal zero, it follows that the speed of propagation of interaction is equal to infinity, namely $V_H = \infty$.

Ladies and Gentlemen, we all live in only one of many quantum physical spaces and times! Our physical space is 3-dimentional quantum phase space with 1-variety time! It is a simultaneous second-order phase space! That's it!

6. Multidimensional space and multivariate time

Obviously, the position of any point in the n-dimensional space can be determined by vectors such as: $R_{0i} = 0$ is zero-dimensional space vector; $R_{1i} = R_{0i} + x_{1i}$ is one-dimensional space vector; $R_{2i}^2 = x_{1i}^2 + x_{2i}^2 = R_{1i}^2 + x_{2i}^2$ is two-dimensional space vector; $R_{3i}^2 = x_{1i}^2 + x_{2i}^2 + x_{3i}^2 = R_{2i}^2 + x_{3i}^2$ is three-dimensional second order space vector; $R_{4i}^2 = x_{1i}^2 + x_{2i}^2 + x_{3i}^2 + x_{4i}^2 = R_{3i}^2 + x_{4i}^2$ is four-dimensional space vector. Finally, the general expression for the multidimensional second order space vector can be written, as

$$R_{ni}^2 = x_{1i}^2 + x_{2i}^2 + x_{3i}^2 + x_{4i}^2 + \cdots + x_{(n-1)i}^2 + x_{ni}^2 = R_{(n-1)i}^2 + x_{ni}^2 \tag{35}$$

Where: $n = 1,2,3,4 \dots n-1,\ n,\ n+1$; x_{ni} is the position of any point in the linear or nonlinear coordinate system!

Notice: If even any force field or power interaction between two subjects of space does not propagate along a straight line, but along a curved line, then space in itself does not have curvature! Anything in an empty space can have a curvature into itself, for example, as the field has already been said, but not the space itself! Space is linear, and force field and motion can be nonlinear or rectilinear! But also, it must be understood that straight-line uniform movement (the motion with a constant velocity) is possible only if no forces act on a moving body!

Also, it is obvious that the position of any point in eigen multivariate time is determined by vectors such as:

$T_{0i} = t_{0i} = 0$ is the specific zero-variate time vector; $T_{1i} = t_{0i} + t_{1i} = T_{0i} + t_{1i} = t_{1i}$ is the univariate time vector; $T_{2i}^2 = t_{1i}^2 + t_{2i}^2 = T_{1i}^2 + t_{2i}^2$ is the two-variate time vector ; $T_{3i}^2 = t_{1i}^2 +$

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$t_{2i}^2 + t_{3i}^2 = T_{2i}^2 + t_{3i}^2$ is the three-variate time vector; $T_{4i}^2 = t_{1i}^2 + t_{2i}^2 + t_{3i}^2 + t_{4i}^2 = T_{3i}^2 + t_{4i}^2$ is the four variate time vector. Finally, the general expression for the 2-nd order multivariate time vector can be written, as

$$T_{ni}^2 = t_{1i}^2 + t_{2i}^2 + t_{3i}^2 + t_{4i}^2 + \cdots + t_{(n-1)i}^2 + t_{ni}^2 = T_{(n-1)i}^2 + t_{ni}^2, \quad (36)$$

where t_{ni} is the position of any point in eigen multivariate time in linear or nonlinear time coordinates!

The real physical space that we can feel and observe with the help of our sense (feelings) organs is three-dimensional space with the univariate time directs in one direction only!

Further finally here in general case, the vector of multidimensional space of the *k*-th degree of order could be written as

$$R_{ni}^k = x_{1i}^k + x_{2i}^k + x_{3i}^k + x_{4i}^k + \cdots + x_{(n-1)i}^k + x_{ni}^k = R_{(n-1)i}^k + x_{ni}^k \ , \quad (37)$$

where $\kappa = 1, 2, 3, \ldots. n$ is the exponent or degree of order (index) of the space.

In general, *j*-th order multivariate time vector of any *i*-th moment in time could be written as

$$T_{ni}^j = t_{1i}^j + t_{2i}^j + t_{3i}^j + t_{4i}^j + \cdots + t_{(n-1)i}^j + t_{ni}^j = T_{(n-1)i}^j + t_{ni}^j \ , \quad (38)$$

Thus, it is obvious that spaces with exponent $k = 2$ are in reality actually 2-nd degree a plane matrix spaces or matrices!

6. Quantum-phase physical spaces and subspaces

Our physical three-dimensional, visually visible part of the universe has the shape of an ellipsoid and it is in a multilinear empty space that is much larger than the universe! There are many different universes in space! There is no ban on their quantity, diversity and quality! In addition, depending on the phase shift of the quantum interaction in time, there may be many phase time spaces, which can be described by the universal multivariate time vector, as follows:

$$T_{pi}^j = q(T_{ni}^j \pm \varphi_i) \quad (39)$$

Where: T_{ni}^j is the multivariate vector of any one *i*-th moment in time; j is the order of multivariate time vector, see (38); q is the function of time intensity; $\varphi_i = kt_0$ is a phase of interaction quantum in time, where t_0 is a quantum shift time between parallel phase spaces, $k = 0, 1, 2, 3, ..$

But, only one case corresponds to our quantum-phase physical space, when $n = 1$, $k = 0$, $q = 1$ and $j = 1$.

7. Basic Conclusions:

1. It has been proved that the time in any physical space is not dependent on velocity of motion!
2. The time and the passage of time in the same physical space are the same in all inertial and non-inertial reference systems! The transmission rate (speed, velocity) of light or electromagnetic information is constant in the same physical space! Thus, it is clear that $t_1, t_2, t_3, t_4, t_5, t_6, t_7 \ldots..$ these are the moments of the time of one common physical time, and

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it is obvious that, these are not different times (the passage of times) in different moving relative to each other reference frames (or coordinate systems)!

3. It obvious that the number of points that are moving away and which are approaching equal to infinite! Thus, when the reference frames (coordinate systems) K and K' are moving relative to each other, there will always be three sets of points: 1- instantly coinciding; 2 - approaching; 3 - moving away relative to each other!

4. The interaction, for example gravitational interaction, of all physical objects and fields occurs through the basic hyperspace, at points with zero time!

5. The speed (rate, velocity) of propagation of interaction between physical objects and all kinds of fields in physical spaces through the zero-time hyperspace is equal to infinity, namely $V_H = \infty$.

6. Our physical three-dimensional, visually visible part of the universe has the shape of an ellipsoid and it is in a multilinear empty space that is much larger than the universe! There are many different universes in space!

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