To measure the absolute speed is possible?

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Abstract One of popular problems, which are experimentally studied in physics in a long time, is the testing of the special relativity theory, first of all – measurements of isotropy and constancy of light speed; as well as attempts to determine so called "absolute speed", i.e. the Earth speed in the absolute spacetime (absolute reference frame), if this spacetime (ARF) exists. Corresponding experiments aimed at the measuring of proper speed of some reference frame in other one, including in the ARF, are considered in the paper.

Key words: informational physics, special relativity theory, spacetime, experimental testing

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1. Introduction

In [1 - 3] it was rigorously shown that Matter in our Universe – and Universe as a whole - are some informational systems (structures), which exist as uninterruptedly transforming [practically] infinitesimal sub-sets in absolutely infinite and fundamental set "Information". This informational conception allows to propose the physical model (more see [4], [5]), which, when basing practically only on Uncertainty principle, adequately depicts the motion and interactions of particles in the spacetime. In the model [subatomic] particles are some closed – loop algorithms that run on a "Matter's computer [6] hardware", which consists, in turn, of a closed chains of elementary logical gates – fundamental logical elements (FLE), which are some (distinct, though) analogues of C. F. von Weizsäcker's 1950-54 years "Urs" [7]. The FLE's sizes in both - in the space and in the "coordinate" time (see below) - directions are equal to Planck length, l_P, $l_P = (\frac{\hbar G}{c^3})^{1/2}$ ($\hbar$ is reduced Planck constant - the elementary physical action, G - gravitational constant, c- speed of light in the vacuum); the time of the FLE's "flip" is equal to Planck time, $\tau_P, \tau_P = \frac{l_P}{c}$.

Spacetime. The introducing of the Space and the Time notions in the model [8] is quite natural – they are some logical rules/ possibilities that allow (and define how to single out) to single out specific informational patterns / structures – i.e., For example, particles - in the main informational structure (i.e., - Matter) at that taking into account both - fixed and dynamical – characteristics of the structures. As possibilities Space and Time realize themselves as some 4D-Emptiness where a dense FLE lattice is placed – some analogue of “spin-network” [9], “causal set” [10], “Space-time points in causal space” [11], etc. Thus Space and Time are universal and “absolute”, so exist “forever”, since they exist also (“virtually”) before a beginning and after an end of any specific informational structure, including – of Matter in our Universe. After “materialization” at the Matter’s Beginning, Space and Time remain be absolute, revealing themselves as “the time” and “ the space” variables, when any element of Matter – a particle, a molecule, a star, etc. – have its own (individual, proper) space and time parameters in the absolute Euclidian 4D-spacetime.

The space is 3D Euclidian manifold, when the time is “two-faced” – it is simultaneously “absolute (or “true”) time” and “coordinate time”. Absolute time defines that for any change in Matter (e.g., for a FLE’s flip in any - “space” or “coordinate time” – direction) is necessary to spend the same “true time interval”. Thus the absolute time flows only in one [“positive”, as that is accepted in physics now] direction by definition. The “coordinate time” is necessary because of to do reversible operations, which are logically incorrect, if only the absolute time acts, is necessary to have corresponding rule “time” that allows and defines such operations. This time exists in our Matter and material objects can move in the coordinate time in both (direct and reversal, ±) directions – like along of a space direction, so this time constitute, with the space, Matter’s “space-[coordinate]time”, or further in the text - the “spacetime” (as well as below “time” as a rule is “coordinate time”).

The time axis in the spacetime is orthogonal to any spatial line, including, naturally, to 3 [e.g., Cartesian] spatial axes; what follows from the model’s premise that a FLE’ has 4 independent degrees of freedom and from the experimentally measured the “rest mass” and “relativistic mass” relation. The absolute time isn’t a coordinate in the model, though it can be fifth coordinate in a 5D spacetime, where all Matter’s objects move simultaneously with speed of light in positive direction.

2. Comparing of the SRT and the model

In this informational model Lorentz transformations can be obtained quite naturally, [4] if it is [rather reasonably] postulated that:

(1) The Matter exists and evolves in the [at least] 4D lattice of FLEs, at that every particle and every rigid system of particles (material body) moves through the lattice, and, because of the FLEs’ sizes are identical, through 4D spacetime, with identical speed that is equal to the light speed in the vacuum, *c*;

(2) The lattice – and the spacetime don’t depend on any Matter’s bodies motion, they are absolute and constitute by this way for Matter absolute coordinate system (ACS). Insofar as

the lattice is highly standardized for steps in any – time or space – direction (there is “equal footing”), there can be established “absolute reference frame” (ARF) which is at rest relating to the ACS and so it is inertial reference frame. There can be infinite number of equivalent ARFs and ACSs, as results of translations and/ or (spatial only) rotations of some ARF (ACS).

(3) Since all/ every particles always move relating to the ACS with the sped of light, the particle’s motion is characterized by the momentum, $\vec{P} = mc\vec{k}$, where *m* is some coefficient (the mass), $\vec{k}$ is 4D unit vector, at that particle is always oriented relating to the $\vec{k}$.

If a number of particles constitute a rigid body, this body becomes be oriented relating to its movement direction. An example – moving rod having the length *L* - is shown in the Fig.1.

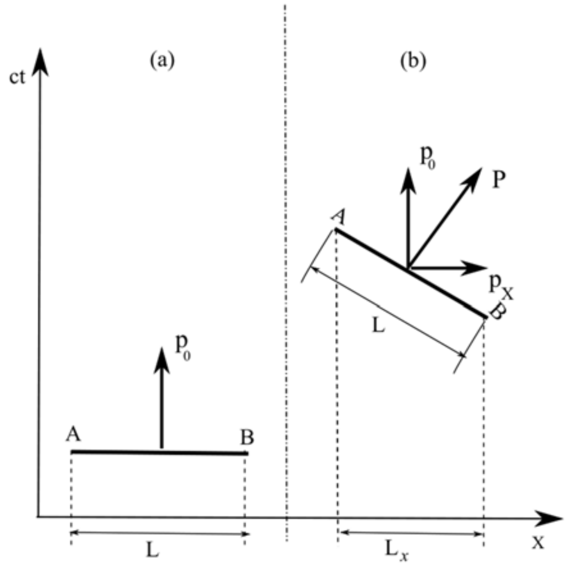

Fig.1. A rod having the length *L* moves in the spacetime: (a) – the rod is at rest (moves in the time only) in the ARF, (b) the rod moves also along X-axis with a speed *V*.

At rest (Fig. 1 (a)) the rod moves along temporal axis [with the speed of light] having the momentum $\vec{p}_0 = m_0 c\vec{i}_t$ that is perpendicular to the rod. If the rod was impacted with transmission to the rod a spatial momentum $\vec{p}_X = m\vec{V}$, it moves in the spacetime with the total momentum $\vec{P} = \vec{p}_0 + \vec{p}_X$, $\vec{P}$ is perpendicular to the rod.

From the Fig. 1 immediately follow the main equations of the special relativity theory (as well as of the Lorentz theory, though). Lorentz transformations:

- the first equation

$$x = vt + x'(1-\beta^2)^{1/2}, \qquad (1)$$

- and the second one:

$$t' = (1-\beta^2)^{1/2} t - \frac{Vx'}{c^2} \ , \qquad (2)$$

but with essential difference from the SRT – these equation aren't valid in whole [in the SRT - pseudoeuclidian] spacetime but are true for rigid mechanical systems (e.g., a system Earth + a satellite is rigid system also because of the gravity force) only. Moreover, the variables x', t' aren't some spacetime points; that are measured lengths (here - from the back of the rod) to some (here – the rod's) matter points, and clocks' readings in these points.

As well as from the postulates above follow main equations of the SRT dynamics. Since $P = mc$ and since *t*-axis is normal to any spatial direction (so the momentum of a particle at rest in the ACS remains be constant at any spatial motion) it can be easily obtained that

$$p_X = mV = \frac{m_0 V}{(1-\beta^2)^{1/2}} \ , \qquad (3)$$

and, for example, calculating the work of some force F at the spatial (an temporal impact results in the creation of new particles) acceleration of a body with rest mass m_0 on a way S (in the Eq. (4) below $p \equiv p_X$ for convenience),we obtain:

$$A = \int_{S_1}^{S_2} F(S) dS = \int_{p_0}^{p} \frac{p(1-\beta^2)^{1/2}}{m_0} dp = c\int_{p_0}^{p} \frac{pdp}{(p^2 + m_0{}^2 c^2)} dp = c\Delta P \, . \qquad (4)$$

Since at motion of a body the work of the force results in the change of the body's kinetic energy, from (4) we obtain

$$\Delta E = E - E_0 = cP - cp_0 \, , \qquad (5a)$$

or

$$E = cP = \frac{m_0 c^2}{(1-\beta^2)} \ , \qquad (5b)$$

and for a body at rest in an ARF

$$E_0 = cp_0 = m_0 c^2 \, . \qquad (5c)$$

3. Kinematical relations in moving rigid mechanical systems

The Voigt-Lorentz *t*- decrement [in (2)] for the rod's matter (including clocks) along the rod's length (the maximum is $-\frac{VL}{c^2}$), appears at the acceleration of the rod up to the speed

V and further remains be constant for any fragment of the rod at the uniform motion. So if (i) - one synchronizes a number of clocks along the rod before the acceleration, (ii) - after the acceleration up to some speed, e.g., the back end clock is transported slowly along the rod to the front end, so, that this clock constituted with the rod rigid system, - then the moving clock and stationary clocks along the rod readings will be identical, including the (moved) back end and front end clocks eventually. But if one accelerates also a pair of synchronized clocks, which were placed initially on the distance L (Fig.2 (a)), let to the same speed V (Fig.2 (b), independently, the free front clock reading will be identical to the both back ones, but will show later time then front end rod's clock; though all clocks are evidently in the same inertial reference frame.

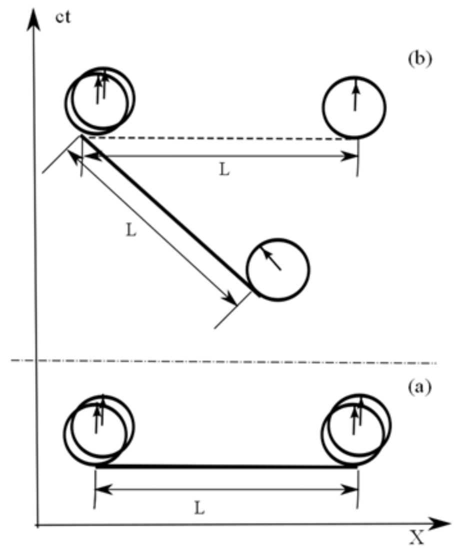

Fig. 2. Two pairs of synchronized clocks in the same reference frames. (a) at rest in an ARF, and (b) all clocks move with the same speed in the ARF, one pair constitutes the rigid body with accelerated rod; other pair moves independently on the rod.

Besides consider a simple kinematical problem.

Let in the middle point of moving rod a short light flash occurs. The rod's clocks readings at the flush are, if corresponding clock readings in an ARF is t: on back end clock: $t_A = t(1-\beta^2)^{1/2}$; on the middle point clock; $t_M = t_A - \frac{VL}{2c^2}$; on front end clock: $t_B = t_A - \frac{VL}{c^2}$.

Since photons move only in the space [4], the flash will be registered with some time increment, for example on back end clock, it is $\Delta t_A = \frac{L(1-\beta^2)}{2(V+c)}$. So observed in the rod's reference frame elapsed time is $\Delta t_{MA} = \frac{L}{2c}(1-\beta) + \frac{L}{2c}\beta = \frac{L}{2c}$, so measured by this way speed of light in the rod's IRF is equal to c.

Analogously the same result (measured speed of light is equal to c, i.e. to the speed of light in the ARF) can be easily obtained for the pair “middle point – front end” clocks; for the case, when the light moves from back end to front end (a mirror) and back, etc.

But if to measure speed of light the observer uses independent clocks, the measurement results in different cases will be different.

4. Measurement of proper speed of an IRF

From above follows the possibility of measurement at least of the proper speed of concrete reference frame [12], if in this frame an observer uses simultaneously a set of rigidly connected and independent clocks, see Fig.3.

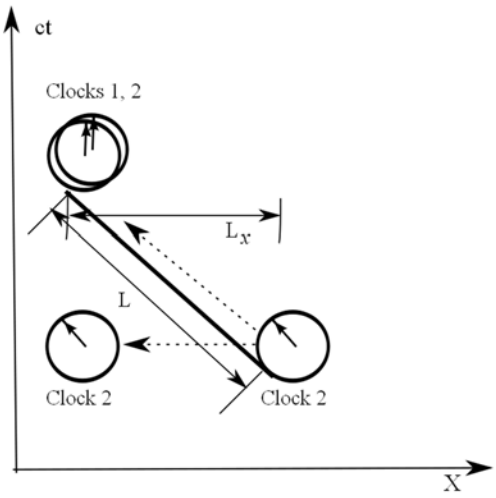

Fig. 3. A plot of clocks movements at measurement of the proper speed of a reference frame.

So, if there is a pair of synchronized clocks, and further one clock, let – the clock-2 telescopes slowly back and forth in any direction, the clocks' readings at the clocks rendezvous will be identical, independently on – the moved clock was rigidly mechanically connected by some rod with the fixed one (with clock-1) or the clock moves independently.

But the moved clocks' readings at the motion are different. When the independently moved clock readings are always identical to the fixed clock's ones, the connected [to the rod] clock obtains additional decrement (if the clock is moved along the speed $\vec{V}$ of the reference frame), $-\frac{Vx}{c^2}$, where x is the distance between the clocks, measured by the observer's rule.

Thus, if on some moving object, for example – on an Earth satellite, an observer can implement the scheme that is shown on the Fig. 3, then it can measure his proper speed. To do that, the observer should use two clocks and some rigid rod, let – with the length L.

Let one clock (clock-1) is fixed in the satellite and other clock (clock-2) is rigidly fixed on the rod's end, both clocks are synchronized. Then, if the rod is pushed along the satellite speed forward and back, after returning both clocks will have identical readings. However, if the clock-2 is pushed forward being rigidly coupled with the rod, but returns back independently, for example, by using own engine, the time decrement, which this clock obtained at pushing forward conserves and so the clocks' readings are different at their rendezvous on the decrement $-\frac{VL}{c^2}$.

Correspondingly from measured in this case the clock readings difference Δt_{12} and known rod's length the observer can determine the proper speed of his RF; in the case above – the orbital speed of the satellite, $V \approx \frac{\Delta t_{12} c^2}{L}$.

It is evident that such a procedure can be repeated any times with the accumulation of the decrements, so the requirements to the clocks' precision aren't too rigorous provided that they have adequate stability. If there were N repetitions, $V \approx \frac{\Delta t_S c^2}{NL}$; where $\Delta t_S = \sum_{i=1}^{N} \Delta t_i$.

5. Conclusion

From the consideration above follow a number of implications.

First of all from the informational model's approach, which is used here, follows, that if a system of measurement devices, i. e., rules and clocks constitute a rigid system (because of the Earth gravity it is possible to create rigid systems even between / with satellites, well known example is the GPS system), then outcomes of any experiment aimed at the measurement of the speed of light value or observation of some proper speed of this system will be in accordance with the special relativity; as well with the Lorentz theory, though, because of in this case the theories are experimentally indistinguishable. Measured values will be – the [standard] speed of light and null object's proper speed correspondingly. This inference is true independently of what experiment was executed – "tests of Lorentz invariance" at using interferometers, "round trip" or "one way" methods at measurements of the light speed value or its isotropy (see, e.g., [13]-[19] and refs therein); as well as of what clock synchronization is applied – "Einstein synchronization" or slow transport of synchronized clocks. If some deviations from the theories would be observed, than there will be, with a great probability, an artifact.

But if one creates at least partially free system, some possibilities occur. The described above experiment on Earth satellite seems as rather promising, since on stationary orbits Earth gravity in this cases is inessential, and so the measurement of a satellite orbital (proper in the Earth' reference frame) speed, rather probably, would be successful.

Nonetheless the Earth gravity makes impossible the measurement of the absolute speed, since the gravity always "has time" to correct the positions of clocks and rules in the 4D spacetime at the satellite orbital motion so that relating to the ARF the instruments always constitute rigid systems.

However principally the measurement of the absolute speed is possible. To do that is necessary to send corresponding cosmic probe in a point in space where resulting gravity force (not the gravity potential) is weak enough. Further an automaton could execute the set of measurements of the probe speed values in 4π directions by using the retractable rod and the pair of clocks, as that is described in the section 4 above.

There are no principal technical constraints for such experiment yet now. The mass of the probe would be, rather probably, not bigger then those that were lunched at other space missions. As well as seems that there aren't problems with the clocks – the measurement of time intervals with accuracy ~10^{-16} (see, e.g., [20], [21]) isn't now something exotic.

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