The notion “speed” and the Lorentz transformations

Sergey V. Shevchenko[1] and Vladimir V. Tokarevsky[2]
[1]Institute of Physics of NAS of Ukraine, Pr. Nauki, 46, Kiev-28, Ukraine, ret.

[2]Professor ret., Pr. Nauki, 46, Kiev-28, Ukraine

Abstract in the paper a few problems relating to the special relativity theory are considered, real SRT problems that arise from the self-inconsistence of the theory, and so limit its correct application; and imaginary, when at some “refuting of SRT” the notion “relatives speed” is erroneously applied, first of all the “*(c±V)*” problem.

Key words: special relativity theory, speed, spacetime, Lorentz transformations, Tangherlini transformations

The rather popular problem, which appears at discussions about the validity of the special relativity theory, relates to cases when the speed of light is measured in different inertial reference frames *K*, and K' that move relatively each other with a speed *V*, for the simplicity - with the parallel *X* and X' axes, and K' moves, let, in positive direction in the frame *K*.

1 “*(c±V)*” problem: “relative” and “relational” speeds

Then, as that is considered by Einstein in the well known 1905 year paper [1], if in a “stationary” frame, *K*, there are a pair of synchronized clocks that are in points x_1 and x_2 on a distance $L = x_2 - x_1$, then in the “stationary” frame the measured values of the one-way speed of light i.e. $c_1 = L/(t_2 - t_1)$ and $c_2 = L/(t_1 - t_2)$ are equal. However measured in this frame ways of light when the light is radiated and propagates in the frame K' between points x_1' and x_2' , $L' = x_2' - x_1'$ in these both cases are different: in the “ahead” case the light moves the distance $L_1' = L' + V\Delta t = [\Delta t = L'/c] = L'c/(c-V)$; in the “back” case the moving distance is $L_2' = L'c/(c+V)$. From that the observer in the *K* frame, if he measures the time intervals between time moments when light, moving “ahead” and “back”, is radiated in points x_1', x_2' and arrive to the points x_2', x_1', obtains that the real “relative” [relatively to the points x_2', x_1'] speeds of light are equal to $c_a = c - V$ and $c_b = c + V$ correspondingly. Further, that must be so in the K' frame, but from the relativity principle follows that for the observer in K', who, doesn’t know that the frame moves somewhere with some speed at all and so thinks that his frame is stationary, these speeds, which are “relative to x_2', x_1' point” also must be equal. At the solution of this puzzle Einstein chose the variant that the relativity principle dominates and indeed in all different relatively moving frames the speed of light is the same, obtaining by such way the Lorentz transformations.

Nonetheless this the SR postulate has no base besides the experimental outcomes (in those times – at EM interactions, including with the light), besides – in the [1] Einstein himself used the "*(c±V)*" formulae for the speed of light as they are true, when that contradicts with the postulate that the speed of light. Moreover, the postulate about the speed of light constancy seems as rather questionable since, in fact, means that the light is some magic essence that to hold this constancy causes, for example, clocks to change their thick rates; further, after Minkowski postulated absolute validity of the relativity principle, i.e. in the recent standard SR version, it causes even real spacetime transformations. All the last seems as rather strange and was and is a reason for seeking for corresponding flaws in the theory, including – the "*(c±V)*" problem above.

But in the reality that isn't so [relating to the "*(c±V)*" problem only, though]. The inferences above appear in such cases since, when considering of the Lorentz transformations and of the measured speeds above, two principally types of the speeds, including speeds of light, i.e. the "**relative**" speed, which is used in the transformations, and, let, the "**relational**" speed are mixed:

- the "***relative speed*" is the speed of a body relating to *other* body only provided** that **the second body is considered to be *at rest*** in this body's inertial reference frame; for example – motions of bodies inside a moving wagon are **relative to the wagon** and so, for example, relative to wagon's ends, **and just such speed is used in the Lorentz transformations**, and

- the "***relational speed***" that characterizes motion of ***systems*** of bodies in a frame, where all **system's** bodies **aren't at rest in this frame; this speed haven't practically relations to the Lorentz transformations,** including **relational** speeds $"(c \pm V)"$ in the frame *K*, for example when in the considered above case the moving in K system consists of the wagon's ends and the light.

Thus, correspondingly, it is senseless to seek for some errors in the transformations and, and further in the SR considering using the relational speeds.

The "relational" speeds indeed are applicable, but mostly when relative objects' motion in systems is considered, when that can impact on the whole system evolution. An example – if two objects move toward each other in a stationary frame with equal speeds *V*, then relational speed is equal $V + V = 2V$, that is one situation in the system, for example at the meeting of objects some interaction can happen; but if they move in opposite directions, e.g., after the meeting without interaction, the relational speed remains be 2V also, but this speed have quite other meaning in the system, in this case any interaction of the objects are impossible [in the case when there no fields, of course].

An example

By the way, it is possible that using of the relational speed isn't accompanied by some essential difference/contradictions with using of the relative speed, an example:

let a boy in a wagon at rest throw a ball orthogonally to the wagon's ceiling [let – along Y-axis] with a **real** speed v and make a short light flash to a mirror on the sailing, the ball and light will move orthogonally up and down [at zero gravity] with **real** speeds v and c; the one-way speeds of the ball and light "up" and "down" are equal, and are equal to the two-way speeds.

If the wagon moves along the X-axis with a speed V, then:

- the ball' moves in the plain (X,Y) with] the **real** speed [practically] $v_1 = (v^2 + V^2)^{1/2}$, the ball's trajectory is along sides of an isosceles triangle; and the ball's trajectory in the wagon remains be orthogonal when the ball's **real** relative [and **relational**] speeds **in the wagon** remain be [practically] v;

- as well as photons move in the plain (X,Y), but with the [unchanged] speed of light; and photons' trajectory is along sides of an other isosceles triangle, when photons' trajectories in the wagon remain be orthogonal; but, since photons move in the 3D space with the **real** standard speed of light only, their **real** relative [and relational] speeds in the wagon become be $v_p = (c^2 - V^2)^{1/2} = c(1 - v^2 / c^2)^{1/2}$.

At that the relative in the wagon values of the one-way "up" and "down" speeds of light remain be equal – and the corresponding relational speeds in the stationary system, where the wagon moves, are equal as well. Nonetheless the Lorentz transformations remain be true again, and, because of in moving wagon clocks tick slower in the factor $(1 - v^2 / c^2)^{1/2}$ above also, the **measured** in the wagon's reference frame **relative** the speed of light is again equal to c, when measured relational speed is lesser. It is evident that in this case there is no "direct" $"(c \pm V)"$ problem [though, of course there is $"(\vec{c} \pm \vec{V})"$], both, up and down speeds are equal and the "two-way" speed is equal to the "one-way" speeds independently on what coordinates transformations – Lorentz, Galileo, etc. between stationary and the wagon's frames are applied.

Besides according to the Lorentz transformations, if a pair of clocks in the wagon's ends were synchronized at rest, then the one-way arrivals of lights after a flash in the middle of wagons are evidently simultaneous, and the measured one-way speeds of light are equal to c in both, the stationary and the wagon's frames. However, after the wagon having a length L is accelerated up to a speed V, the **real** temporal intervals of the arrivals, which are measured by the stationary frame clocks will be different – the light hits in back/front clocks after elapsed intervals $\Delta t_b = L / 2(c+V)$ and $\Delta t_f = L / 2(c-V)$ Thus in the stationary frame measured relational one-way speeds of light are $(c \pm V)$, when the two-way speed is equal to c. But **measured** by the wagon's clocks intervals will be equal and the **measured** one-way and two-way speeds of light, as in the orthogonal way case above, again is equal to c.

2 The "Dingle problem" in the special relativity

Nonetheless here are a few nuances, first of all that relates to the notion "real" when some relations in the Matter's spacetime are considered. The core of the problem here is in that in the SR yet in the 1905 paper it was postulated that there is no the absolute Matter's spacetime and so all/every inertial reference frames are totally and completely equivalent. But from these postulates immediately, directly and unambiguously any number of evidently senseless logical and physical consequences follow, the most known – the "Dingle problem" in the SR

[from the frame total equivalence postulate follows that if there is, say a pair of relatively moving frames, then both observers in the frames must believe that in vis-à-vis's frame "time is dilated" and so the vis-à-vis ages slower then she/he, what is evident nonsense – that is possible only for one of the observers; or both can age equally, if both frames move in the absolute Matter's spacetime with equal absolute speeds].

The absolute spacetime and absolute frame

Correspondingly the use of the "proof by contradiction" results in the evident conclusion that the SR postulates above are incorrect, and so in the realty there exist both, the absolute Matter's spacetime and the absolute reference frames in this spacetime.

Moreover, as that is shown in [more seethe informational model [2] , [3], it is useful to read [4], though], Matter's spacetime is the absolute [5]4D Euclidian manifold, or [5]4D Euclidian "empty container", where all/every material objects/systems of objects and the system "Matter", as a whole because of the energy conservation law **uninterruptedly change their states**, i.e., the 3D spatial positions and/or their internal states. Thus every material object/system always moves in the 4D sub-spacetime with 4D speeds that have identical absolute values be equal to the standard speed of light, $\vec{c}$.

At that the changing of **only internal states** of having "rest mass" objects' **is accompanied always** by corresponding "the **coordinate time**" [further "τ"], intervals and is observed [for example observed as how clocks change their internal states] as the 1D motion in the coordinate time dimension. Since every change, i.e. a changing of a spatial positions or of internal states of the objects is accompanied always by "the true time" intervals also, all/every objects move also simultaneously in the 5-th, "true time", further "*t*" dimension with the speed of light.

Thus (1) - either the space or both times haven't some ***real*** **"own inherent" measures,** the emptiness hasn't measure, all measured spatial and temporal intervals are "relative" relating to material etalons, that correspond to fundamental properties just of Matter, not of the spacetime. And only because of everything in Matter changes with fundamentally stable and common for all/every objects "operation rate" there is the possibility to make etalons of the temporal and spatial intervals, and to characterize universally these changes

[besides, the objects move in the 4D sub-spacetime provided the "equal footing", in the space and in the times, if for the times the "*ct"* and *"cτ*" metrics are chosen. Thus all/every particles in Matter in their histories, if the histories include histories of all the particle's predecessors from the Beginning, when Matters as a whole started to evolve practically instantly, passed equal paths in the 4D sub-spacetime be equal to $\int ds = ct$, where $ds = (dx^2 + dy^2 + dz^2 + d\tau^2)^{1/2}$, t is the true time interval from the Beginning, let near 14 Billions of years. So every recent particle passed in the sub-spacetime near 14 Billions of light years]; and

(2) – in the spacetime there can be 3 different “absolute rest” frames, where the reference points/bodies can be as

(0,0,0,0,0) i.e. at rest relating to all dimensions; that is unreal case since everything in Matter changes always/moves somewhere;

$(ct,0,c_x,c_y,c_z)$; $(c_x^{\,2}+c_y^{\,2}+c_z^{\,2})^{1/2}=c$, i.e. at rest relating to the coordinate time, the reference body moves always in the space with the speed of light, an example is a frame where photons move, the frame hasn’t practical applications; and

$(ct,c\tau,0,0,0)$, i.e. the reference point/body is at 3D spatial rest moving only in the coordinate time. Just this frame is considered usually in physics as “the absolute frame” [and there were a number of attempts to observe the motion in this frame, starting seems from the Michelson and Morley experiment].

And, what is important in this case, **to define** an absolute frame **there is no necessity to point out some concrete point in the space and a reference body in this point**, which “is at rest in the space”**, the frames exist by definition;** and, for example, any body that moves in the coordinate time [with the speed of light] only, for example – some clock that has the maximal possible thick rate, automatically can be the reference body. So only one problem remains - how to find such a body or at least to measure its absolute spatial speed, and this problem is solvable – see [3].

Reality and unreality of physical description

The observed/measured motion in this frame is **absolute** and is **real.** All measured in any other frames material objects’ physical values, for example speeds, if they measured without known correspondence of the frames to an absolute frame **are unreal,** since don’t equal to the real ones.

However Matter is built/changes basing on a set of laws that are very symmetrical and so indeed, the relativity principle and the Lorentz transformations often work well, thus this “unreality” very often isn’t significant and application of the transformations, again - using “relative” speeds, not “relational” ones, results in adequate to the objective reality material/ physical outcomes/ inferences. As well as, say, the Minkowski formalism is adequate, though is based on rather fantastic postulate that real Matter’s spacetime is imaginary Minkowski space [further in the GR – imaginary pseudo Riemannian space].

That happens because of the rigid systems, when moving in the 3D space **really** rotate in the (cτ ,X) plain [“τ” here again is the coordinate time] so, that the rigid systems’ objects 4D coordinates always remain be in accordance with the Lorentz transformations. For example, if a system consists of one rigid rod having a length *L*, the clock on the rod’s front end, [and the rod’s front end itself, of course, also] always have lesser this time’s coordinate then the back clocks and the end; and, since clocks show just the coordinate time, the front end clock showings are lesser then the back end clock’s showings on the Voigt-Lorentz decrement $-VL/c^2$; as that Pythagoras prescribed, because **of the coordinate time axis is orthogonal to any 3D spatial line.**

And, besides, if a having rest mass body moves in the 3D space, the rate of its internal changing slows down, again as Pythagoras prescribed in $(1-v^2/c^2)^{1/2}$ times, thus, for example, moving clocks' thick rate slows down, unstable particles live longer etc.; simultaneously the spatial projection of a moving body becomes by lesser in the same factor – and all these facts compose the Lorentz transformation, to obtain the transformation is enough to know only the Pythagoras theorem. And to know – where, why and how the theorem should be applied, though, i.e. what is the Matter's spacetime.

But that above is true not always – as that is shown in the informational model the Lorentz transformations [and the SR] are completely adequate to the reality only if all physical processes proceed in the systems where the systems' objects are interact forming this system rigid enough. If a system consists of free objects, an application of the SR, which postulates that the Lorentz transformations in every inertial reference frame are applicable in whole Matter's spacetime and describe as real [fantastic] transformations of the space/time/spacetime, leads to illogical and/or unreal results.

3 Examples of inadequacy of the Lorentz transformations

"Classical" cases.

Well known examples – the "twin paradox", which is a complicated version of the Dingle problem and the "Bell paradox", where the space in the moving inertial reference frame doesn't want "to contract".

"The Wutke rod SR's problem"

Another interesting example of non-adequacy of the SR/Lorentz transformation to the reality was suggested by Andrew Wutke "The Wutke rod SR's problem" [5], when a rod having a length L moves freely in a frame with a speed V along the frame's X-axis being directed along this axis and, simultaneously, moves with some speed orthogonally to the X-axis, say, along Y-axis. Since the rod doesn't constitute with the frame a rigid system, its motion in the 4D sub-spacetime doesn't depend on the 4D motion of the frame, and its ends are rotated in the (cτ ,X) plain independently on the frame; for simplicity let the frame is the absolute.

Thus when the rod will cross the frames X-axis, it evidently crosses the axis remaining be in parallel with it, i.e., simultaneously by whole length, though having **real** length be contracted as $L(1-v^2/c^2)^{1/2}$. However, if the clocks on the rod's ends will be stopped at the meet with the axis, they show times that aren't equal, and according to the clocks showings the front end of the rod reached the axis earlier then the back end.

If V>>1 that means [and follows from the SR] that the rod, according to the data of its reference frame, stuck in the axis practically orthogonally, what, i.e. the data in the rod's frame, contradicts with experimental result.

At that the rod indeed moves practically be oriented orthogonally to the X-axis, but in the (cτ ,X) plain, what is, however, inessential at interactions in Matter; **all interactions in Matter happen only in the 3D space and in some true time**

moment, since all material objects are always simultaneously only in the space and in one true time point, thus the result above is as it is.

Analogously when twin-traveler returns to home, he is in the coordinate time earlier then the twin-homebody, i.e. both twins are in different points in the 4D sub-spacetime, but they can meet and talk about the journey.

4 Comparison of Lorentz and Tangherlini transformations

But physical situations, where studied systems are composed from free objects, very rarely are meet in practice. On Earth practically all systems are rigid because of the Earth gravity; in a huge number of experiments that "confirm" the validity of the SR rigid instruments are used, etc. And the relativity principle works well in such situations without problems, a seems interesting example:

Let there are two very bad boys, which were born exactly in one time moment at rest. When running from a sheriff they occur in a spaceship at rest in the spaceship's ends. But the sheriff arrived to the middle of the wagon, and made simultaneous shots by lasers in the boys; both boys are shot simultaneously in the rest frame and being **exactly equal ages**.

If the boys hid in the spaceship and the sheriff found them when the wagon moves with a large speed V already, then after that he shots simultaneously in the boys, real time intervals when the lasers' flashes hit in the boys in the stationary frame are different, Δt "ahead" is evidently larger then Δt "back" . But because of the front boy in the wagon is younger then the back end boy, they will be shot, though non-simultaneously in the rest frame, but when being again **exactly equal ages** – as that is in the "at rest" case; and so in accordance with the relativity principle in both frames both results **are real and identical**.

At that observer in the stationary frame, if he don't know how material objects move in the 4D sub-spacetime, will think that the front end boy was hit when was older then the back end boy, what isn't true in the reality.

The last example shows, besides, that rather popular "Tangherlini transformations" [6] aren't adequate to the reality. These transformations differ from the Lorentz transformations in that they don't contain the Voigt-Lorentz in/decrement above; thus all events in the stationary and moving frames are simultaneous. This simultaneity is provided in these transformations by

> "…the time transformation is obtained by synchronizing the clocks in the primed frame directly with those in the unprimed frame. This can be accomplished in a way that is capable of experimental implementation at present… Assume further that on a train passing with constant speed v in the positive x-direction, there is a row of clocks identical to those in the station, but unsynchronized, and that there are also transverse-oriented, electro-mechanical devices that enable clocks on the train to receive signals from clocks on the station. Then when clocks on the station read $t = 0$, this is communicated to the train's clocks as they pass by, setting them to zero (correcting for the transverse travel time), after which the clocks on the train are allowed to run freely at their own rate. Hence, in accordance with (2), they will run more slowly than clocks in the station, but at the same rate as clocks synchronized according to the LT…"

Indeed such synchronization of clocks in a moving frame, when clocks in moving frame are set according to the simultaneous showings of clocks in the stationary frame by some “communication”, for example using a radio channel, is possible. But at that the clocks in the ship will show, as that is for the stationary observer above, **unreal** age of the front boy at the light’s hit, and this unreality [and so the inadequacy of the Tangherlini transformations] is evidently non-avoidable, any communication can to set any clock’s showings, but cannot really make a human [here the front boy] be really older.

Thus an applicability of the Tangherlini transformations in physics seems as rather questionable, in contrast to the Lorentz transformations, which are based on fundamental properties of Matter and Matter’s spacetime: (i) – the “Cartesian” form of Matter’s [5]4D spacetime; (ii) - the fact that all/every material objects move in this spacetime with 4D speeds of light, moving simultaneously with the 1D speed of light in the true time; (iii) - equal footing in spatial and temporal dimensions at the 4D+1D motion of the material objects in Matter’s spacetime; and (iy) - the symmetry of the physical laws.

References

[1] Einstein, Albert. *Zur Elektrodynamik bewegter K¨orper*, Annalen Der Physik. 17:891, 1905

[2] Shevchenko, Sergey and Tokarevsky, Vladimir. *The Informational Conception and Basic Physics* e-print http://viXra.org/abs/1503.0077 DOI 10.5281/zenodo.16494

[3] Shevchenko, Sergey and Tokarevsky, Vladimir. *Measurement of the absolute speed is possible*? e-print http://viXra.org/abs/1311.0190 DOI 10.5281/zenodo.48709

[4] Shevchenko, Sergey and Tokarevsky, Vladimir. *The information as Absolute* e-print https://zenodo.org/record/268904#.WJnI0DhlSHv DOI 10.5281/zenodo.268904

[5] Andrew Wutke. *Is a rigid rod moving perpendicularly to x axis (in the standard Special Relativity axes convention) parallel to the moving system x’ axis?* Question of the ResearchGate thread https://www.researchgate.net/post/Is_a_rigid_rod_moving_perpendicularly_to_x_axis_in_the_standard_Special_Relativity_axes_convention_parallel_to_the_moving_system_x_axis

[6] Tangherlini, Frank R. *Galilean-like transformation allowed by general covariance and consistent with special Relativity*. Journal of Modern Physics, 2014, 5, 230-243