How Einstein and Minkowski missed real valued Lorentz transformations for v>c which are possible in 2D and in extended special relativity to 6D spacetime (three space three time) and its possible relation to the nature of spacetime and consciousness

Jan Pilotti B.Sc. mathematics, theoretical physics, M.D. Sweden pilotti.jan@telia.com

Abstract

Before Einstein's 1905 paper [1] physicists could, as e.g. Sommerfeld [2], discuss superluminal velocities. Nowadays almost everyone knows that Einstein's theory of special relativity (SR), seemingly, excludes superluminal velocities, i.e.$|v| > c$, as Einstein from energy velocity relation argued that it will take an infinite amount of energy to accelerate a body to v=c [1, p 63-64]. And even more impossible to $|v| > c$. Yet already in 1962 it was clarified [3] that acceleration is not the only means to get a velocity, as light has the velocity c and is not accelerated but "born" with v=c. So Einstein's SR does not exclude phenomena, as e.g. particles, "tachyons", with $|v| > c$. Feinberg and others describe possible features of tachyons [4] and possible ways to avoid seemingly causality violation [5]. There has also been experimental search for tachyons, the first in 1960-ties [6]. Yet no direct detection has succeeded even if some argues for indirect traces [7]. Often is used the old energy-velocity relation even for $|v| > c$ but assuming "tachyons " having imaginary rest mass gives measurable real valued energy [3,4,6]. Possible but perhaps a little ad hoc.

Another approach that seems more in the spirit of principle of relativity and more concerns the nature of spacetime is to examine the possibility of faster-than-light inertial frames and possible generalisation of the Lorentz transformation: if tachyons exists it is conceivable that a group of them with same constant velocity $|\overline{\boldsymbol{v}}| > c$ relative to an ordinary IS could be thought of as an inertial frame where these tachyons are at rest and have real coordinates. And if they shall exist also in our physical world they must have real coordinates in ordinary IS [8]. Parker [9] showed that this is possible for (x, t) but explicitly stated that his approach was not possible for (x, y, z, t).

Yet this has been done. Some allow imaginary numbers in the LT [10]. Another way is to add extra dimensions [8]. Cole [11] has shown how for four complex variables or six real variables the extra parameters are uncoupled for $|v| < c$ but coupled for $|v| > c$. Pavsic [17] also show how contraction from 6D to 4D involves imaginary numbers, see below.

Rindler's derivation of LT [12] gives $ds^2 = \pm\, ds'^2$ for 4D. As a heuristic argument the same derivation in 2D gives (as also stated in [9])

$$x^2 - c^2t^2 = \pm(x'^2 - c^2t'^2)\ (I)$$

The argument to just choose +, that (I) must remain valid as $v \to 0$, is not valid if looking for transformations for $|v| > c$.

+ sign in (*I*) gives ordinary LT for standard configuration

$$x' = \gamma(v)(x - vt) \qquad t' = \gamma(v)\left(t - \frac{vx}{c^2}\right) \qquad \gamma(v) = (1 - \frac{v^2}{c^2})^{-1/2} \qquad |v\,| < c$$

but $-$ sign in (*I*) gives "Generalised LT" (GLT)

$$x' = \gamma_G(v)(x - vt)\ \ t' = \gamma_G(v)\left(t - \frac{vx}{c^2}\right)\ but\ where\ \ \gamma_G(v) = (\frac{v^2}{c^2} - 1)^{-1/2} \qquad |v| > c\ (II)$$

For 4D

$$x^2 + y^2 + z^2 - c^2t^2 = \pm\left(x'^2 + y'^2 + z'^2 - c^2t'^2\right) \quad (III)$$

the choice of $-$ sign is not valid if only real valued transformations are allowed according to the law of inertia for quadratic forms [13] which states that the signature, the number of positive and negative terms must be the same on both sides i.e. +++ −. If allow imaginary number as [10] $-$ sign can be used in (*III*). Or if we add two parameters or dimensions with negative signs [8]. This seems also near the spirit of Minkowski ".. along a purely mathematical line of thought, to arrive at changed ideas of space and time" [14].

$$x^2 + y^2 + z^2 - c^2t^2 - c^2t_2^2 - c^2t_3^2 = \pm\left(x'^2 + y'^2 + z'^2 - c^2t'^2 - c^2t_2'^2 - c^2t_3'^2\right) \quad (IV)$$

Signature in VL is +++ −−− and using – sign in HL gives signature −−− +++, which yet is same signature as only the number of positive and negative terms counts.

+ sign in (*IV*) gives a possible GLT which are uncoupled i.e.

$$x' = \gamma(v)(x - vt) \quad t' = \gamma(v)\left(t - \frac{vx}{c^2}\right) \quad y' = y \quad z' = z \quad t_2' = t_2 \quad t_3' = t_3 \qquad \gamma(v) = (1 - \frac{v^2}{c^2})^{-1/2}$$

- sign in (*IV*) gives a possible GLT , which are necessarily coupled due to the $-$ sign,

$$x' = \gamma_G(v)(x - vt) \quad t' = \gamma_G(v)\left(t - \frac{vx}{c^2}\right) \quad y' = ct_2 \quad z' = ct_3 \quad t_2' = \frac{y}{c} \quad t_3' = \frac{z}{c} \quad \gamma_G(v) = (\frac{v^2}{c^2} - 1)^{-1/2}$$

As the coupled GLT clearly shows we can not think of superluminal IS just as ordinary IS going faster and faster, which is due to the singularity for v=c. Therefore the concept of standard configuration is not clear which is also seen in Cole's more detailed transformations involving ambiguity in signs [11].
As it is shown that with Rindler's derivation $ds^2 = \pm\, ds'^2$ and thus there is a choice but many derivations of LT does not give this choice it is interesting to examine why and especially for Einstein's original derivation 1905 [1] and Minkowski' s Address 1908 [14].
It will be shown how Einstein and Minkowski use arguments and a diagram which are seemingly self-evident but are valid only for $|v| < c$ and thus implicitly rule out $|v| > c$.
The problem about dimensionality of the world is still under debate [15]. Petkov has strong arguments for that the experimentally verified kinematic effects in relativity is possible only in a 4D block universe [16] or actually is possible only in a world of at least four-dimensions. Pavsic [17] show that when six-dimensional real spacetime is contracted to 4D transformations must be complex and interpret imaginary coordinates as that events observable to one observer is not observable to another observer, which is difficult to understand if the world is only 4D.
Petkov also writes "..- that the flow time is mind-dependent – outlined by Weyl should have been examined more rigorously." and ".. this idea appears to be self contradictory since Weyl assumed that consciousness (leaving aside the question of what consciousness itself is) *moves* in Minkowski spacetime where no motion is possible" [16 p. 150]. My intuition is that in a six dimensional spacetime with time and two extra "timelike" dimensions both the merits of 4D block universe and the fundamental experience of change can co-exist and that 6D spacetime is possibly related also to possibilities in QM and to consciousness, which is located in spacetime and not in the brain. [18].

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