

THE ORIGINAL LORENTZ EQUATIONS: THEIR CORRECT UNDERSTANDING AND VALIDITY

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ABSTRACT

Lorentz gave in 1904 his famous coordinate-transformation equations for relativistic correspondence. However, for the purposes of ideological propaganda - and for that purpose to deny Lorentz the origination of the theory -, those equations are often falsely alleged to be defective. An insinuation often adopted is based on concealing the correct import of those equations, which have to be understood in their proper context. The correct understanding of those equations demonstrates the falsity of the allegation.

INTRODUCTION

The famous ‘Lorentz Transformations’, upon which the ‘relativity theory’ is founded, were given by Lorentz in 1904, in his paper, “Electromagnetic Phenomena in a System Moving with any Velocity less than that of Light”, *Proc. Acad. Sci. Amst.* **6**, 809, (1904), as Equation Nos. (4) and (5). These equations were bestowed the title “Lorentz Transformations” by Poincare in his July, 1905 paper, “The Dynamics of the Electron”.

After the failure of various experiments to determine the absolute motion of the earth, Poincare had proposed in 1900 the “relativity postulate” that propounded the impossibility of such experimental determination as a general law of Nature.

To explain the failure of the experiments, Lorentz and Fitzgerald proposed a hypothesis that all bodies undergo a contraction in the direction of their motion. This alone would, however, not suffice to make ‘relativity postulate’ valid in all situations. Lorentz had been trying to modify that hypothesis suitably since mid-1890s.

In his above paper Poincare writes, “Lorentz has sought to extend and modify the hypothesis so as to make it fully compatible with the relativity postulate. **This he has succeeded in doing in his (above) paper**”.

Thus the formulation of the ‘relativity theory’ was essentially completed with the above paper of Lorentz. All theories, of course, receive subsequent developments, extensions, reformulations and amplifications, such as Euler, Lagrange, Laplace, and many others gave to the Newtonian theories. Similar has been the case with the Lorentz theory.

As narrated in the author’s popular science book, *The Great-Einstein-Sky-Ride*, more than twenty alternative derivations of the Lorentz Transformations are known. The author has given a completely new derivation with ballistic experiments, involving only the local measurements of transit durations and rotations of the projectiles, in the author’s science play *The Catherine Conspiracy: or The Honest Relativity*, and the author’s paper

“Ballistic Explorations for Relativity”,. for *Journal of New Energy*. This alternative derivation brings out a ‘Catherine Twist’ velocity-effect scarcely known as a necessary requirement for the relativity postulate. This little known effect provides a method for synchronization of clocks without any signals or transport of clocks.

A DENIGRATION OF LORENTZ

Lorentz’s theory, of course, implied absolute space, ether, absolute motion, etc. that were anathema to a dominant science establishment led by Mach. In fact Lorentz’s theory, with the non-equivalence of inertial states, further strengthened the case for absolute space.

An alternative derivation of the same transformation equations by Einstein, with its ‘politically correct’ language, came convenient to that sectarian establishment in their ideological war against Newton. Realising the propaganda potential of some rhetorical statements in Einstein’s paper, although they lacked any relevance or justification, the establishment promoted Einstein as the author and the originator of the ‘relativity theory’, with a view to using the theory, with a suitable philosophic gloss, in the propagation of their ideology. Some brilliant deductions and amplifications provided by Einstein considerably helped in this enterprise. The falsity of the propaganda, that has had an enviable success both in pedagogy and general literature, has been demonstrated extensively in the author’s popular science book *The Great Einstein-Sky-Ride*.

An essential strategy was to denigrate Lorentz, and to deny him the development of the theory, and therewith to discredit the views of Lorentz about the meaning and the substance of the theory.

A widely employed stratagem to this end is to insinuate that the Transformations as actually developed by Lorentz were erroneous – meaning he was there mistaken and wrong.

A typical instance of this class is discussed by the author in his above book *The Great Einstein-Sky-Ride* (page 182), illustrating the fraudulent deceit of the claim with the analogy of the ‘reduction of the field book’ procedure in land surveys.

While reproducing and introducing Lorentz’s 1904 paper, a noted author C. W. Kilmister, (*Special Theory of Relativity*, 1970, p.118), writes, “How far Lorentz was from a deeper understanding of the formula which he found can be seen by the equations (4) and (5) of his paper, where the relationship between the time and the old coordinates is slightly different from the one now considered.”

This clearly suggests that Lorentz did not, in fact, get his coordinate transformation equations exactly right, and the correct equations now used are named after him only by courtesy. The subtle suggestion is seen to have been widely swallowed.

We will now demonstrate that this allegation is completely baseless, and that the original Lorentz equations are faultless, and it is the same equations that are universally used even at this day.

THE VINDICATION OF LORENTZ

While understanding correctly the mathematical formulae we have to take into consideration the notation, the context, the contemporary conventions, etc. The same mathematical relationship can always be expressed in diverse ways, and all such diverse expressions are entirely equivalent, and all equally valid.

The original Lorentz equations, from Sec. 3 of his above paper, read,

$$\frac{c^2}{c^2 - v^2} = \beta^2 \dots (3)$$

$$x' = \beta l x, \quad y' = l y, \quad z' = l z \dots (4)$$

$$t' = \frac{l}{\beta} t - \beta l \frac{v}{c^2} x \dots (5)$$

As to the coefficient l , it is to be considered as a function of v , whose value is 1 for $v = 0$

Later, in Sec. 10, from considerations of the variation of mass, Lorentz deduces that l cannot depend on v , and the value of the constant must be unity, because we know already that, for $v = 0$, $l = 1$

In the following work we shall take l to be unity. It will be recognized that in the present usage $\beta = \frac{1}{\sqrt{1 - v^2/c^2}} = \gamma$. Therefore, adopting the present usage, Lorentz's

equations read,

$$x' = \frac{x}{\gamma}, \quad t' = \frac{t}{\gamma} - \gamma \frac{v}{c^2} x, \quad y' = y, \quad z' = z$$

The transformation rule for time is certainly “slightly different from the one now considered”, as Kilmister points out to us. But does it mean that it is erroneous, as Kilmister insinuates?

But what is the significance of these transformation rules? Are they the transformations between a moving system $\Sigma'(t', x', y', z')$ and a system $\Sigma(t, x, y, z)$ at rest?

It is patently and blatantly not so. The first rule, $x' = \frac{x}{\gamma}$, is decidedly not the relationship between two frames in relative motion in the x -direction. Such a thing would be absurd. It can only be a relationship between two frames at relative rest.

And here we have to take account of the contemporary convention and well-understood practice, which Lorentz adopts but does not have to explicate.

We take $\Sigma^*(t^*, x^*, y^*, z^*)$ as the frame at rest, and introduce an auxiliary Galilean frame $\Sigma(t = t^*, x = x^* - vt^*, y = y^*, z = z^*)$. The actual physical frame will be the one as resulting from the velocity-modifications of Σ , for which Lorentz, Abraham, Langevin, and others had different proposals.

What Lorentz's equations represent are the transformations from the auxiliary Galilean frame to the velocity-modified Lorentz frame. Abraham, Langevin, and others would have different corresponding transformation equations, to suit the velocity-modifications adopted by them.

Thus, the transformation from the frame at rest to the moving Lorentz frame is made in two stages: (1) From the frame Σ^* at rest to the auxiliary Galilean frame Σ , and (2) From the auxiliary Galilean frame Σ to the actual physical Lorentz frame Σ' . Lorentz's equations (4) and (5) represent only the second stage of the transformation.

Accordingly, the complete transformation from the frame Σ^* at rest to the moving Lorentz frame Σ' is given by,

$$x' = \gamma \cdot [x^* - v \cdot t^*] , \quad y' = y^* , \quad z' = z^*$$

$$t' = \frac{t^*}{\gamma} - \gamma \cdot \frac{v}{c^2} \cdot [x^* - v \cdot t^*] = \gamma \cdot \left[\frac{c^2 - v^2}{c^2} \cdot t^* - \frac{v \cdot x^*}{c^2} + \frac{v^2}{c^2} \cdot t^* \right] = \gamma \cdot \left[t^* - \frac{v \cdot x^*}{c^2} \right]$$

These are just the standard ‘Lorentz Transformation’ equations.

It is the ignorance – or, the deliberate ignoration – of the fact that the original Lorentz equations (4) and (5) represent only the second stage of the full transformation that leads to the questioning of the correctness of the original equations of Lorentz.

There is nothing wrong – absolutely nothing wrong – with the original Lorentz equations.
