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EINSTEIN'S DEFINITION OF LENGTH CONTRADICTS INTERVAL INVARIANCE

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The special theory of relativity was 90 last year. However, it appears that many physicists don't understand its own essence. Among them are the contributors of such known journals as Phys. Rev. Lett., Phys. Lett. A, Amer. J. Phys., Phys. Scripta and others. As it turned out, they don't understand what is the 4-interval of a rod and don't know that the interval invariance means.

1. Below I make an attempt once again to explain in the most accessible form this important problem. Begin with the proof of an elementary theorem [1].

The theorem. *If an interval s is invariant, it does not depend on motion velocity.*

For clearness we suppose that $s = l^* f(\beta)$, where l^* is the constant, $f = (1-\beta^2)^a$ and βc is the velocity. We imply a moving rod (scale) as a material representative of the interval.

Necessity. It is obvious that the demand of the Lorentz invariance is observed if the equality

$$l^*(1-\beta^2)^a = l^*(1-\beta_1^2)^a \tag{1a}$$

is valid. But this is possible if $a = 0$ only (since $\beta \neq \beta_1$).

Sufficientness. Let $a = 0$. Then in two reference systems, where the rod moves with velocities βc and $\beta_1 c$, we have

$$s = l^*(1-\beta^2)^0 = l^* \text{ and } s_1 = l^*(1-\beta_1^2)^0 = l^*, \tag{1b}$$

i.e., the demand of interval invariance $s = s_1$ is really fulfilled.

So, the theorem is proved.

Let us consider the traditional (Einsteinian) definition of the moving rod length l_E from the viewpoint of the foregoing. Let for simplicity the rod be oriented and move along the x-axis of an S-system. In the framework of this definition it is characterized by two simultaneous events at its ends or a four-component quantity

$$l_E^n = (0, \Delta x, 0{,}0) = (0, l_E, 0{,}0). \tag{2}$$

Therefore the space-like interval answering this moving rod takes the form

$$s_E = \Delta x = l_E. \tag{3}$$

As is known, a direct consequence of the simultaneity demand of end-marks $\Delta t = 0$ (simultaneity of this pair of events) is the contraction formula

$$l_E = l^*(1-\beta^2)^{1/2}. \qquad (4)$$

Here l^* is the rod length at rest (proper length) and βc is its velocity (the velocity of the S^*-system relative to S).

From eq.(4) is follows that the interval s_E depends evidently on motion velocity

$$s_E = l^*(1-\beta^2)^{1/2}. \qquad (5)$$

As we proved above, such a dependence means that the traditional definition does not satisfy the Lorentz invariance demand [2].

In the framework of the concept of covariant (radar) length (see, e.g., [3]) instead of eq.(2) we have

$$l_r^i = (\beta l_r, l_r, 0,0), \qquad (6)$$

whence taking the elongation formula

$$l_r = l^*(1-\beta^2)^{-1/2} \qquad (7)$$

into account, interval constance

$$s_r = l^* \qquad (8)$$

(its coincidence with the length of the resting rod) is obvious. In other words, the four-component quantity l_r^i (in contrast to l_E^n) is a 4-vector.

2. For justice it should be mentioned that at first the discussed problem was indirectly considered still in the known «Lectures on Physical Foundations of Relativity Theory (1933—1934)» by L.Mandel'shtam [4]. We read there: «...the scale length measured in the rest system defines a space-like interval», i.e., $s = l^*$ in accordance with eq.(8).

Note also that the supporters of the orthodox viewpoint received last year a sensitive blow from East by publishing the book «Length Expansion» [5]. Both existing representations are considered there, and preference is given to «the hypothesis of length expansion». «The logical contradiction in the process of deriving the length contraction» is also stressed.

And the last remark. The considered problem is usually substituted for the question of observability of the length contraction. The right answer is: although the contracted length is in principle an observed quantity, it cannot serve as a characteristic of a moving rod because of its noncovariance. *The contracted length is not the length of a rod.* The «radar» length has this property only.

Thus, the traditional representation of the contraction of moving bodies contradicts the Lorentz invariance of an interval and must be removed. As a result, one of the main conclusions of relativity theory changes. It says now: longitudinal sizes of bodies increase in motion.

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