Nonconservation of Charge and Energy as Consequences of Contracted Length Noncovariance

V.N. Strel'tsov
Laboratory of High Energies
Joint Institute for Nuclear Research
Dubna, Moscow Region, 141980 Russia

Additional arguments against the traditional representation of the contraction of longitudinal sizes of moving bodies are presented. It is shown that the use of noncovariant contracted length leads to violation of the laws of electric charge and energy conservation.

"Although the totality of events exists with respect to a certain definite inertial system, this totality is no longer independent of the choice of inertial system. Four-dimensional continuum does not disintegrate objectively into sections, among which the sections containing all simultaneous events would be."

Einstein [1]

Introduction

Recently new and, one might say, the most convincing proofs of contracted length noncovariance have been obtained. It has been shown that the traditional (Einsteinian) definition of moving rod length[2] contradicts the Lorentz invariance of interval [3,4]. As is known, this definition in fact pierces through all space correlations of relativity theory. The generally accepted approach based upon this definition following Born [5] is named Einstein's theory of relativity (ETR). An alternative approach (radar formulation) is based upon the other "radar definition" of length [6,7]. Its consequence is the increase (and not contraction) of the longitudinal sizes of moving bodies.

Earlier considerations that the traditional condition of simultaneity ($\Delta t = 0$) of two events (endpoints of a moving rod) contradicts the principle of relativity [6]*, as it depends on the reference system, have already been said. As it is easy to be convinced, this statement is also contained in the first sentence of the given quotation [1]. What is more, the sense of the second sentence is that simultaneous events cannot objectively present the rod in different systems which are different sections of a four-dimensional contin-

* In this connection, see also [8].

uum. Hitherto, these "physical arguments", however, are disregarded as the first proof of interval (corresponding to contracted length) noninvariance [9].

The relativistic interval is the main invariant of relativity theory, and so it is also named the fundamental invariant. By definition, the interval is the quantity which does not change when transitting from one inertial reference system to another. Since this transition is related to changing motion velocity, the interval invariance must mean its independence of velocity, *i.e.* constancy.

In accordance with the Einsteinian definition, the four-component quantity in Minkowski space

$$l_n^c = \{c\Delta t, \Delta x, 0, 0\} = \{0, l_c, 0, 0\} \quad (1)$$

corresponds to the rod oriented and moving along the x axis. Taking into account the contraction formula

$$l_c = l^*(1 - b^2)^{1/2}, \quad (2)$$

where l^* is the rod length at rest and bc is its velocity, we have the corresponding interval

$$s_c = l^*(1 - b^2)^{1/2}. \quad (3)$$

Based on (3), we conclude that the traditional definition of moving rod length does not satisfy the Lorentz invariance requirement. The latter result can be obtained in another way, taking into account that we have

$$s_c^* = l^*$$

when passing ($b \to 0$) to the rest system of the rod. The comparison of (3) and (4) tells us directly about the noninvariance of "contracted interval." In other words, the four-component quantity l_c^n is not a 4-vector [9,10].

Thus, we are obliged to refuse the generally accepted representation of the contraction of longitudinal sizes in motion as it contradicts the very substance of relativity theory. But these new, one would think, indisputable "mathematical arguments" do not meet a proper understanding. We hope that the "physical considerations" presented below turn out to be more convincing.

Violation of the law of charge conservation

Let us consider the element of a linear conductor (at rest in the S^*-system and directed along the x^* axis) carrying a current of density $j_*^I = -j_-^*$. The densities of electrons r_-^* and rest ions r_+^* are equal, and the total density is $r^* = 0$. Thus, from the point of view of the S-system the wire is neutral.

$$\Delta q^* = r^* \, \Delta V^* = 0, \quad (5)$$

where Δq^* is the charge, and ΔV^*, the volume of the considered element of the conductor.

Now let us transit to a system (S) where conduction electrons are at rest $j_- = 0$. Based on the transformation formulae for components j^i, for the total density in the S-system, we obtain

$$r = r_- + r_+ = -r_-^* b^2 g, \tag{6}$$

where bc is the velocity of the conductor in the S-system, $g = (1 - b^2)^{-1/2}$.

Using the volume contraction formula $\Delta V = \Delta V^* g^{-1}$ corresponding to (2), we conclude that from the viewpoint of the S-system, the wire has a positive charge (see, *e.g.*, [5])

$$\Delta q = -r_-^* b^2 \Delta \mathrm{V}^* . \tag{7}$$

Thus, it is evident that in the framework of the ERT the invariance of an electric charge is violated. What is more, this result may be interpreted otherwise. A neutral current-carrying conductor acquires a charge (without removing electrons to the outside) as a result of motion. In other words, the use of the noncovariant quantity has led us to the violation of the law of charge conservation.

In the framework of the radar formulation [11]

$$\Delta q = j^i \Delta V_i , \tag{8}$$

where the 4-vector of a volume element

$$\Delta V_i = (\Delta V^* g, -b\Delta V^* g, 0, 0). \tag{9}$$

As a result, $\Delta q = 0$, *i.e.*, the demand of charge Lorentz invariance is really fulfilled, and, consequently, the charge is conserved.

Violation of the law of energy conservation

The electrostatic energy of a plane-parallel capacitor whose plates are normal to the x^*-axis is equal to

$$E^* = e^* V^* = \frac{(\mathsf{E}_x^*)^2}{8Gp} s l^* ,$$

where e^* is the energy density of an electric field E_x^*, s is the area of the plates, l^* is the gap between them. Since E_x^* (and, consequently, e^*) and s are not transformed when passing to the moving S-system, the formula for energy of a moving capacitor is practically defined by l. If, in accordance with ETR, we take contraction length l_c, then evidently we come to a contradiction with the known relativistic formula $E = E^* g$. What is more, in this case the energy of a moving capacitor is smaller than its energy at rest. Though, as known, in order to set a capacitor in motion, it is necessary to expend some energy (it is transferred to the capacitor).

Thus, in the framework of ERT we also have a contradiction with the law of energy conservation, resulting again from the use of noncovariant contracted length.

A similar difficulty does not arise [7] if l is given by the radar length l_r, obeying the elongation formula $l_r = l^* g$.

Let us observe that while calculating the energy of the gravitational field, even the use of the covariant expression (9) for a volume element does not remove the indicated difficulty. The fact is that in this case, the energy density of the field is given by the component of the energy-momentum pseudotensor (see *e.g.*, [12]). The noncovariance of the known expression for the equivalence of mass and energy should also be noted. If even in one reference system (at $c = 1$), the corresponding values are equal, in all other systems this equality is violated as the mass (being a scalar) remains constant, but the energy changes (like the component of a 4-vector).

Conclusion

As it follows from the presented results, the generally accepted idea of the contraction of moving bodies contradicts the laws of electric charge and energy conservation. Therefore we are obliged to retract it, replacing it by the concept of covariant radar length according to which longitudinal sizes increase. Thus, as one can say after 90 years, one of the main conclusions of relativity theory must be abandoned.

References

[1] Einstein, A., *On the Special and the General Theory of Relativity*, London, 15th ed., 1952, Appendix V.

[2] *Idem*., *Ann. Phys*., 1905, 17, p. 891.

[3] Khvastunov, M.S., Strel'tsov, V.N., *Izv. Vuzov. Fizika*, 1995, No. 2, p. 125.

[4] Strel'tsov, V.N., *JINR Commun*. D2-94-446, Dubna, 1994.

[5] Born, M., *Einstein's Theory of Relativity*, NY, Dover, 1962, p. 283.

[6] Strel'tsov, V.N., *Found. Phys*. 1976, 6, p. 293.

[7] *Idem*., *Hadronic J*., 1990, 13, p. 345.

[8] Fermi, E., *Z. Phys*. 1922, 23, p. 340.

[9] Strel'tsov, V.N., *JINR Commun*. P2-84, 843, Dubna, 1984.

[10] *Idem*., *Hadronic J*., 1994, 17, p. 105.

[11] *Ibid*., p. 73.

[12] Einstein, A., *Ann. Phys*., 1916, 49, p. 769.