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APROPOS A. A. TYAPKIN'S PAPER: "EXPRESSION OF THE GENERAL PROPERTIES OF PHYSICAL PROCESSES IN THE SPACE-TIME METRIC OF THE SPECIAL THEORY OF RELATIVITY."

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THE author of the foregoing article believes that the true content of the special theory of relativity has not been completely analyzed up to the present and his article contains an exposition of the theory of relativity which is "free from the defects and gaps of the primary construction and exposition of the theory." However, it is in our view impossible to agree with this contention. One gets the impression, in reading the article, that the author either is not sufficiently well conversant with the literature, or is tendentious in his interpretation of it. In any case, the author could not clearly expound the logical structure of the special theory of relativity.

The factual aspect of the paper amounts essentially to the proof of the fact that Michelson's experiment can be described in the so-called Galilean coordinates. This assertion is quite obvious, since any phenomenon can be described in any coordinates. The results, which the author derives with the aid of an unwieldy analysis, can in fact be obtained simply. Let us consider two inertial systems: "stationary" L and "moving" L'. Then the coordinates x', y', z', and t', measured by means of a standard scale and a clock synchronized in the usual manner, are related to the coordinates x, y, z, and t in L through the Lorentz transformations. On the other hand, we can introduce the Galilean coordinates $\tilde{x}$, $\tilde{y}$, $\tilde{z}$, $\tilde{t}$ of the moving coordinate system, related to x, y, z, t by the usual Galilean transformations

$$\tilde{x} = x - vt,\ \tilde{y} = y,\ \tilde{z} = z,\ \tilde{t} = t.$$

And they are connected with the coordinates x', y', z', t' by the relations

$$\tilde{x} = x'\,[1 - (v^2/c^2)]^{1/2},\ \tilde{y} = y',\ \tilde{z} = z',$$
$$\tilde{t} = [t' + (x'v/c^2)]/[1 - (v^2/c^2)]^{1/2}.$$

If we assume $\tilde{t} = t$ and work in the coordinates $\tilde{x}$, $\tilde{y}$, $\tilde{z}$, then light propagating isotropically with velocity c in the stationary coordinate system will propagate anisotropically in the moving system; for example, for propagation along the x axis, we have

$$d\tilde{x}/d\tilde{t} = (dx/dt) - v,$$

i.e.,

$$d\tilde{x}/d\tilde{t} = \pm c - v$$

for dx/dt = ±c, and this is the primary assertion of the author.

It is obvious that the coordinate $\tilde{x}$ does not correspond to the coordinate x' determined by measurement with a standard scale in the moving system L'. As for the time $\tilde{t}$, not only does it not correspond to the usual synchronization in L', it does not at all agree with the time measured by the a clock which is at rest in L', because of the factor $1/[1 - (v^2/c^2)]^{1/2}$. In fact, the time $\tilde{t}$ is, of course, simply time measured in L. The use of such time was very reasonable from the point of view of prerelativistic physics, when the existence of a preferred system (L), which was at rest relative to the ether, was assumed. In reality, however, if the complete equivalence of L and L' is taken into account, then the introduction of such a common "time" cannot in any way be justified, although the coordinates $\tilde{x}$, $\tilde{y}$, $\tilde{z}$, and t may, of course, be used, just like any others.

It is well known that not only can Michelson's experiment be described in arbitrary coordinates, but the theory of relativity can, on the whole, be formulated in arbitrary non-Cartesian coordinates in the four-dimensional space-time, as has been done, for example, in Fock's book: "The Theory of Space, Time, and Gravitation." In particular, the description with the aid of the Galilean coordinates is considered in C. Møller's book: "The Theory of Relativity." It is necessary, however, to emphasize that in order to completely formulate the special theory of relativity in the Galilean coordinates, one should clearly introduce into the equation a metric tensor, since the interval in these coordinates has a non-Cartesian form:

$$ds^2 = (c^2 - v^2)\,d\tilde{t}^2 - v\,d\tilde{x}/d\tilde{t} - d\tilde{x}^2 - d\tilde{y}^2 - d\tilde{z}^2.$$

The author did not do this, having restricted himself to only a description of Michelson's experiment in Galilean coordinates. In consequence, in his article, devoted to the special theory of relativity, neither the theory of relativity, nor the principle of relativity, was mathematically formulated.

Touching upon the subject of the history of relativity, the author asserts that the role of Lorentz and Poincaré in the creation of the theory is underestimated, and that the authors of the theory of relativity are Lorentz, Poincaré and Einstein. These assertions do not seem valid to us. Lorentz's and Poincaré's contribution to the creation of the theory of relativity is well-known and is reflected in the generally accepted terminology: the Lorentz transformation, the Poincaré group. Lorentz's and Poincaré's papers are included in the well-known collection of classical papers on relativity: "The Principle of Relativity." Lorentz's and Poincaré's contribution is discussed in the popular Feynman lectures, which are known not only to students, but to schoolboys as well. The earlier works of Lorentz and Poincaré are discussed in more detailed works devoted to the history of the theory of relativity.

We must not forget, however, that for both Lorentz and Poincaré the question was the theory of electrons immersed in the ether, and that for both of them there existed a preferred coordinate system in which the ether was at rest. The relativity condition was for them the result of a cancellation, which prevented the detection of motion relative to the ether. Only Einstein repudiated the ether in his paper, considering all inertial systems as equivalent and the Fitzgerald contraction as a relative effect that can be observed in any inertial system. Therefore, Einstein is the only author of the theory of relativity in the true sense of the word, and this is how this question is usually dealt with (see, for example, M. Laue's book: "The History of Physics").

The elimination of the problem of the ether radically simplified the physical picture of the world and laid the foundations for the subsequent rapid development of theoretical physics. The principal conceptions of contemporary physics, and, in particular, of the relativistic theory of fields can thus be traced back precisely to Einstein's 1905 paper (see, for example, R. Feynman's lectures).

Thus, A. A. Tyapkin's primary assertion is that we can repudiate the convention about the isotropy of the velocity of light and adopt another convention which will allow the use of the Galilean rather than the Lorentz transformations. We then sacrifice the invariance of the description. Formally, it is mathematically possible, just as it is possible to use an oblique-angled coordinate system instead of the Cartesian system. However, from the point of view of physics, the loss of simplicity of the mathematical structure of the theory, the rejection of the group properties of the Lorentz transformations, and, thereby, the sacrifice of an adequite description of the symmetry properties of space-time, so complicates the picture that the corresponding formulation of the theory cannot be recognized as suitable for practical use. The situation here reminds us of the well-known relation between the Ptolemaic and Copernican systems.

Summarizing, we should say that contrary to A. A. Tyapkin's assertion, his paper does not contain new ideas which have not been discussed before in the literature. As for the treatment of the subject proposed by A. A. Tyapkin, it is unwieldy, incomplete, and only obscures the physical meaning of the relations considered. Furthermore, the article contains a number of objectionable assertions of lesser importance, the analysis of which would require too much space and is therefore hardly advisable.

Translated by A. K. Agyei