ABERRATION AND THE QUESTION OF EQUIVALENCE OF SOME ETHER THEORIES TO SPECIAL RELATIVITY

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In the last two decades, theories explaining the same experiments as well as special relativity does, were developed by using different synchronization procedures. All of them are ether-like theories. Most authors believe these theories to be equivalent to special relativity, but no general proof was ever given. By means of a gedanken experiment on light aberration, we produce strong evidence that this is the case for experiments made in inertial systems.

Key words: special relativity, ether, velocity of light, stellar aberration, synchronization.

1. INTRODUCTION

In his famous article of 1905, Einstein [1] gave a definition of time in a point B, in terms of the time of a distant point A in the same inertial system, by postulating that the "time" which light needs to go from A to B is the same as the "time" needed to go from B to A. He then showed that this synchronization procedure is consistent with his relativity principle.

More recently, Mansouri and Sexl [2] have constructed a set of transformations between inertial systems, based on other synchronizations, which depend on a parameter \( \varepsilon \). They showed that only the value of \( \varepsilon \) given by the Einstein's synchronization procedure is compatible with the principle of relativity and gives a one-way velocity of light constant in all inertial frames. In particular, the choice of the so-called absolute synchronization leads to an ether-like theory (theory of inertial transformations (TIT)) which has transformations...
different from the Lorentz ones, maintains absolute simultaneity, and has a one-way velocity of light different from \( c \). It was claimed by the authors, that this ether-like theory is kinematically equivalent to the Special Relativity Theory (SRT). This implies that it is impossible to measure the velocity of light is a convention, or that the synchronization procedure is a matter of choice. This is sometimes called Poincaré principle, but it is a conjecture that was really never proved.

Sjödin [3] developed waves and Maxwell equations for all synchronization procedures. He stated that we can only measure the “absolute” velocity of inertial systems by means of tachyons or waves travelling through the ether at a velocity different from \( c \). Since such things have never been observed and probably do not exist in nature, this idea has no practical consequences.

Selleri [4] developed the dynamical part of the TIT and the general transformations between inertial systems. He gave an argument based on the Sagnac effect claiming the logical inequivalence of the SRT and TIT. In fact, if there was only one different prediction between the TIT and the SRT, it would imply that the one-way velocity of light is measurable independently of conventions.

Aberration of light is a phenomenon in which only the one-way velocity of light come into play and in which, apparently, no clocks are used. Thus we think it is a good test for the equivalence of the SRT and the TIT. Sjödin and Podlaha [5] wrote an article on the subject but their earth was at rest always in the same inertial frame, thus an idealized solar system very different from the real one.

We develop here a gedanken experiment using aberration of light with two different inertial frames and conclude that the SRT leads to the same results as the TIT.

2. SYNCHRONIZATION AND MEASUREMENT OF VELOCITIES

Let \( K \) be an inertial frame having velocity \( v \) relative to the fundamental frame \( K_0 \) along the \( x_0 \)-axis in positive direction. Along the \( x \)-axis of \( K \), there are two points A and B with \( x_A < x_B \) and \( |x_B - x_A| = d \). In A there is one clock and in B there are two clocks.

We synchronize the first clock in B with the one in A by using Einstein’s procedure. It means that a light ray is sent from A at time \( t_A \) reflected in B at time \( \tilde{t}_B \) (where tilde stands for Einstein’s synchronization) and comes back to A at time \( t_A^* \). The definition of \( \tilde{t}_B \) is

\[
\tilde{t}_B = \frac{t_A^* + t_A}{2}.
\]  

One can easily verify that this definition is based on the assumption