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Superluminal Relativistic Phenomena in the Hypothesis of a Privileged Inertial System

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Abstract **– The Michelson-Morley experiment did not detect any ether wind. One of the possible explanations of this result was the contraction of the bodies along the direction of the ether wind. The hypothesis of the contraction of bodies in motion was incorporated in the special relativity theory of Einstein. However in this theory the existence of the ether is excluded and therefore the existence of the ether wind too. Time, space and even synchronicity become relative. However not all the scholars agree about these results, particularly on the isotropy of the light speed and on the relativity of synchronicity, due to logic reasons and phenomena such as the Sagnac effect. In this paper it is shown a simple explanation (essentially based on a geometric approach) of these phenomena in the light of the assumption of the existence of a privileged inertial system. The advanced hypothesis is that there is a spatial structure that is independent of the motion of bodies through it. It is shown that with this assumption apparently superluminal speeds are possible in inertial systems other than the privileged one, while in the latter the light speed is the maximum possible, due to a probable complementarity between the speed of the subatomic particles (and therefore the time of the bodies they constitute) and the motion of these bodies in space.**

Keywords **– Lorentz Factor, Michelson-Morley Experiment, Sagnac Effect, Special Relativity Theory, Superluminal Speeds.**

I. INTRODUCTION

The Michelson-Morley experiment [1] seemed a failure to its authors due to the fact that it did not detect any ether wind. One of the possible explanations of this result, that is the contraction of bodies along the direction of the ether wind, was furnished by Fitz Gerald [2] and it was formalized by Lorentz [3]. The Lorentz's transformations formulas were successively incorporated in the special relativity theory of Einstein [4]. However in this theory the existence of ether is excluded and then the existence of ether wind too. Time, space and even the synchronicity become relative.

Not all the scholars agree about these results, particularly on the isotropy of the light speed and on the relativity of synchronicity, due to logic reasons and phenomena such as the Sagnac effect. One of the most important opponents was Dingle [5] who highlighted the existence of paradoxes regarding the Relativity Theory. More recently Selleri [6] has proposed a model of relativity, defined as weak relativity, based on the existence of a privileged inertial system.

In our paper a similar model is proposed and it is shown that in this scenario apparently superluminal speeds are possible in inertial systems other than the privileged one.

II. EXPERIMENTAL RESULTS AND STRONG RELATIVITY PRINCIPLE

According to the special relativity time is slower for an observer who is in uniform motion with respect to an observer at rest in another inertial system. Moreover in this theory it is stressed that all inertial systems can be assumed as at rest with respect to other inertial systems because of space is a nil. It is important to note that the concept of space as a nil is not the definitive opinion of Einstein: he revised his thought about this topic [7].

Nevertheless the time slowdown of moving bodies has been proven by means of many experiments. The second postulate of the special relativity theory (the speed of light is a constant independent of the relative motion of the source), on the contrary, has been contested, due to the result of some experiments (Sagnac experiment, aberration of light). According to Selleri [6] the slowdown of time of moving bodies is not caused by acceleration but by the speed of the bodies with respect to a privileged inertial system S_0, in which "Space is homogeneous and isotropic and time homogeneous, at least from the point of view of observers at rest in S_0", and in which "the velocity of light is "*c*" in all directions". To reinforce this thesis the scholar observes that the decay time of muons that penetrate our atmosphere with rectilinear motion (therefore without acceleration) at a speed close to that of light (*0.9994 c*) is slowed down as the decay time of muons which rotate in an accumulation ring at the same speed and therefore subject to continuous accelerations.

Selleri reports the result of the well known experiment of Hafele and Keating [8] [9] too: four very precise clocks travelled around the Earth on board of two aircrafts, two towards East and two towards West. Other two clocks remained on the ground. The experiment showed that the time measured by the clocks boarded on the flight to the west was accelerated while the time measured by the clocks boarded on the flight to the east was slowed down with respect to the clocks remained on the Earth.

The result of the Hafele and Keating's experiment is very important: it demonstrates without doubt that the motion is not absolutely relative but it is to be referred at least to the universe as a whole and then the principle of strong relativity is wrong. In fact the clocks boarded on the flight to the east rotate around the centre of our planet and with respect to the universe faster than the clocks boarded on the flight to the west, due to the rotation of the earth to east. According to Selleri also the variation of the time speed of the clocks in the Hafele and Keating's experiment is caused by the speed. However the scholar admits that also the gravitational acceleration has an effect: the clocks on Earth are slower due to the greater gravity and this effect modifies the difference between their time speed and the time speed measured by clocks on board of planes (the slowdown of time measured by clocks moving east is reduced while the acceleration of time measured by the clocks moving west is increased). Here we want to underline that the effect of gravitational acceleration is not really different from the effect of speed for bodies (every point around a planet or star is characterized by an escape speed and if this speed is *c*, as in an event horizon, the local time stops): it causes in the body an effect like that caused by the speed with respect to a privileged inertial system, slowing down its time. After all matter is composed of atoms and these of particles but at any level of it we observe motion. It is not strange that every *bit* of matter/energy is associated to a fixed quantity of motion. This motion, insofar as it is expressed as a displacement in space, decreases within the particle thus slowing down the time rhythm of them.

III. Timing Between Inertial Systems

The relativity of space and time according to the special relativity can be shown by means of a simple and well known thought experiment.

In Figure 1A the observer O_1, the light source s_1 and the mirror m_1 are at rest in the inertial system S_1. A light pulse starts from s_1 and reaches m_1 and then it goes back to the source s_1. The light source s_2 and the mirror m_2 are instead moving to right with respect to O_1. The distance between s_2 and m_2 is equal to the distance between m_1 and s_1. The light pulse r_2 goes from s_2 to m_2 and then from m_2 to s_2. O_1 sees the light pulse r_2 travelling a longer path (in a longer period of time) than the path travelled by r_1. According to the strong relativity principle

every inertial system can be assumed as at rest. Therefore in Figure 1B s_2, m_2 and the observer O_2 are at rest in S_2. In this case s_1 and m_1 appear to O_2 moving to left and O_2 sees r_1 travelling a longer path (and in a longer period of time) than that travelled by r_2.

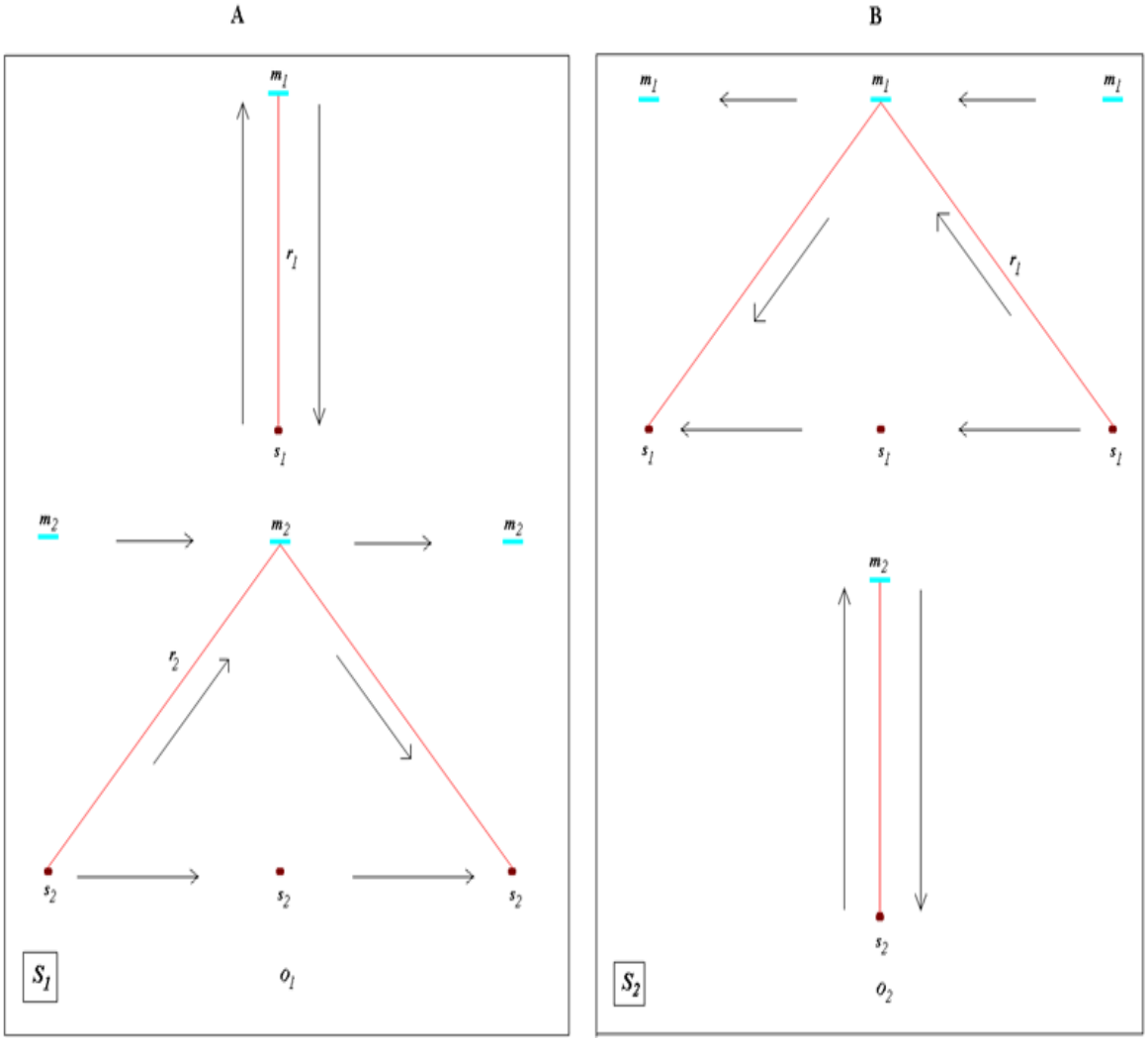

Fig. 1. In A the observer O_1, the light source s_1 and the mirror m_1 are at rest in S_1. A light pulse r_1 goes from s_1 to m_1 and then from m_1 to s_1. Another light pulse goes from the light source s_2 to the mirror m_2 and then from m_2 to s_2; s_2 and m_2 are moving to right with respect to O_1. The distance between s_2 and m_2 is equal to the distance between m_1 and s_1. O_1 sees the light pulse r_2 travelling a longer path (in a longer period of time) than the path travelled by r_1. In B s_2, m_2 and an observer O_2 are at rest in S_2. In this case s_1 and m_1 appear to O_2 moving to left. According to the strong relativity principle, O_2 sees r_1 travelling a longer path (and in a longer period of time) than that travelled by r_2.

However it is somewhat paradoxical that a time interval *A* is longer than a time interval *B* and at the same time the time interval *B* is longer than the time interval *A* and therefore the situation represented in Figure 1, even if interesting, is incorrect. However, as we will see below, this paradox can be easily solved.

Already in 1913 the Sagnac effect [6] questioned the constancy of the light speed in space. The relativistic explanations of the Sagnac effect, as asserted by Selleri [6], are not satisfactory.

However an even more important result is that of the Hafele and Keating's experiment. It demonstrates that time for a moving body can slow down with respect to a body at rest, but it can also accelerate and moreover the different situations can be compared at least in some cases (for example, in the Hafele and Keating's experiment this happened when the planes landed). If a clock c_1 went faster than a clock c_2, it is not possible the contrary (c_2

faster than c_1), and this implies that synchronicity is not relative [10] [11]. Therefore the scenario shown in Figure 1 (and then the principle of strong relativity) is not correct.

According to the Hafele and Keating's experiment by comparing two inertial systems time can slow down only in one of them with respect to the other. Therefore if time slows down in S_2 the light pulse r_1 makes more than *1* round trip in the time taken by the light pulse r_2 to make a round trip.

Following Selleri [6] we can assume that there is a privileged inertial system S_0 and we can speculate that it is composed of space quanta. As already mentioned above the motion of bodies through it reduces their internal movement and so their time slows down. However this does not imply that space and bodies at rest in S_0 are shortened in the direction of the motion of a body that is in motion with respect to S_0. This phenomenon could happen to that body in motion with respect to S_0 and it is even possible that an observer in motion with respect to S_0 sees S_0 and the bodies at rest in it shortened in the direction of their apparent motion, but this does not imply a real shortening of them.

However we will show that even applying the Lorentz's transformation to lengths (and this is the method used to ensure that the second postulate of relativity is always verified) superluminal speeds are possible in inertial systems other than S_0. On the side we have to note that Earth is not at rest in S_0: a reasonable estimate of its motion with respect to S_0 can be provided by the measure of its motion with respect to the cosmic background radiation rather than by the measure of its speed in the solar system, in the galaxy and so on.

In Figure 2 there is represented a situation similar to that of Figure 1 but taking into account the above.

In A it is shown the scenario from the viewpoint of the observer O_0, at rest in the privileged system S_0. The light source s_1 and the mirror m_1 are moving to right at the speed $v = (12 / 13)\ c$. A light pulse r_1 goes from s_1 to m_1 and then from m_1 to s_1. The speed of the light pulse, observed by O_0, at rest in the privileged inertial system S_0, is c. Therefore if in S_0 there are a light source sm_0 (which can also reflect the light) and a mirror m_0 and if the distance sm_0 - m_0 is equal to the distance $s_1 - m_1$, a light pulse r_0 goes up and down several times in the time taken by r_1 to go from s_1 to m_1 and vice versa (more precisely in this case r_0 will cover the distance sm_0 - m_0 *5.2* times, that is it will cover *2.6* round trips).

In B an observer O_1 is at rest in the inertial system S_1. In the upper quadrant of B it is shown the apparent motion of the system S_0: r_0 is seen by O_1 going up and down and to left at an apparent superluminal speed, but it is only apparently a superluminal speed, because the time of O_1 is slowed down. The distance covered by s_0 and m_0 to left, measured in S_1, is shorter than the distance covered by s_1 and m_1 to right in S_0, due to the Lorentz-Fitz Gerald contraction ($L_1 = L_0\ [1 - (12 / 13)^2 / c^2]^{0.5}$ where $c = 1$, L_0 is the distance covered by s_1 and m_1 in S_0, L_1 is the distance apparently covered by sm_0 and m_0 in S_1).

Increasing the speed of the system S_1 (for $v \rightarrow c$) the number (say it n) of round trips that r_0 makes during a round trip of r_1 inS_1 grows tending to infinity. Taking into account the Lorentz's transformation the length of a single round trip of r_0, observed by O_1, tends to the length of the round trip of r_1 (observed by O_1) or, that is the same, to the length of a single round trip of r_0 observed by O_0 (due to the fact that as the speed v of S_1 grows the trajectories of r_0 tends to an orthogonal to the motion trajectory). However as the speed of S_1 increases the light appears to O_1 faster and faster, and this due to the fact that only one space dimension is influenced by Lorentz's transformations.

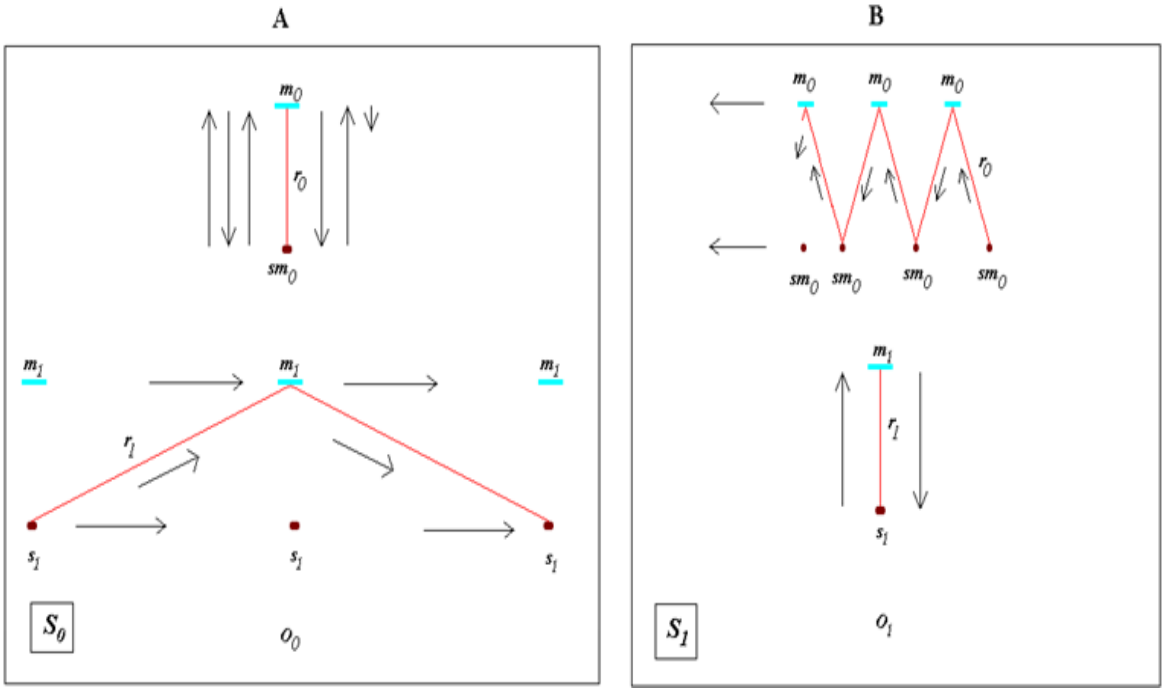

Fig. 2. In A the observer O_0 is at rest in the privileged inertial system S_0. In the time taken by a light pulse r_1 to go from s_1 to m_1 (which are moving to right at the speed of $(12 / 13)\ c$) and vice versa, the light pulse r_0 goes from sm_0 (which is a light source but also a mirror) to m_0 and vice versa several times. The length of the r_0 path is 2.6 times the length of the path of r_1 in S_1 (side B, lower quadrant). In B an observer O_1 is at rest in S_1. His time is slowed down and then while he sees r_1 to go up and down one time, he sees r_0 going to left but also going up and down 2.6 times. Due to the Lorentz factor, the space apparently covered by s_0 and m_0 from the point of view of O_1 is reduced, but only for the direction of motion. The path of r_0 observed by O_1 is more than 2.6 times the path of r_1 and its speed appears superluminal to O_1.

IV. Conclusion

There is a privileged inertial system (S_0). The existence of this privileged system is suggested by different variations of time speed in clocks in motion with different speed with respect to the centre of Earth and the universe as a whole.

The bodies, being composed by particles with an internal motion, could have a certain and fixed quantity of motion. Therefore when they are in motion in the space or are being pushed their internal motion diminish or, that is the same, their time slows down.

In inertial systems other than S_0 superluminal signals could be observed.

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