Comment on “Criticism to the Twin´s Paradox” by Luís Dias Ferreira

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In a recent paper “Criticism to the Twin´s Paradox” Luís Dias Ferreira consider the Twin Paradox conundrum affirming that “the so-called “twin´s paradox” is consider an important issue in special relativity theory because implies a profound understanding of space time structure. And yet, since its original formulation in 1911 by Paul Langevin, numerous alleged explanations for this disturbing paradox have been produced; as it seems, unsuccessfully. This remains a subject for heated debate. Why?” In this comment we refer our previous answer to this issue that is not referred in the paper.

Dias Ferreira in his “Criticism to the Twin´s Paradox” [1] gives his answer to the paradox,

> “Because in all those explanations one tries to reconcile the irreconcilable, this is, what seems to be a logical conclusion (based on the phenomenon of time dilation) with what is simply unacceptable: how can it be a difference in aging from twins without breaking the fundamental equivalency between frames of coordinates?”

Our answer [2-23] is that there is no Twin Paradox because the relation of time dilation is not the relation between rhythms (proper times) and the Principle of Relativity is not a fundamental equivalence between frames of coordinates. Several works, some very recent, point out the importance of this discussion about the foundations of Relativity, Quantum Mechanics, Cosmology and Biophysics [24-93].

The analysis of the “paradoxes” [17, 18] of a physical theory is an important matter, since it questions and assigns physical meaning to the statements of the theory. Following Richard Feynman,

> *A paradox is a situation which gives one answer when analysed one way, and a different answer when analysed another way, so that we are left in somewhat of a quandary as to actually what should happen. Of course, in physics there are never any real paradoxes because there is only one correct answer; at least we believe that nature will act in only one way (and that is the right way, naturally). So, in physics a paradox is only a confusion in our own understanding* (R. P. Feynman, R. B. Leighton, and M. Sands vol. II, 17-5 The Feynman Lectures on Physics (AddisonWesley Publishing Company, 1979), 13th ed.).

The famous twin paradox emerges in the standard interpretation of special relativity, which says that each twin ages slower than the other during any part of the to-and-fro trips, but when they meet one of them is older. This is of course not possible if “ageing slower” refers exclusively to rhythms of clocks along the trip and nothing else happens. Although the twin paradox is addressed and “solved” in any introductory course on special relativity, it was at the origin of more than 25,000 articles in the literature (Grandou, T. Rubin, J. L. I J T P. Vol.

48 Issue 1, p101 (2009)) since it was launched by Langevin in 1911, and new publications arise regularly (the references given are therefore merely indicative [17, 18]). Therefore, one can only suspect that "perhaps the last word on the twin paradox has yet to be said (Sastry, G. P. Am. J. Phys. 55, 943 (1987))".

In our previous works, we have shown that the null result of the Michelson-Morley-Miller experiments in vacuum is deeply connected with the notion of time. The same is true for the postulate of constancy of the two-way speed of light in vacuum in all frames independently of the state of motion of the emitting body. The argumentation formerly given is very general and must be true not only within Special Relativity and its "equivalence" of all inertial frames, but as well as in Lorentz-Poincare scenario of a preferred reference frame. In this works we address the foundations of Special Relativity particularly the question of the constancy of the one-way speed of light and of the differences and similarities between both scenarios. Although they seems manifestly differ in philosophy, it is debated why and how the assumption of a "special system of reference experimentally inaccessible" is indeed compatible with Einstein's Special Relativity, as beautifully outlined and discussed by Bell in "How to teach Special Relativity" [Speakable and Unspeakable in Quantum Mechanics (Cambridge University Press, Cambridge, 1988)]. This rather trivial statement is still astonishing nowadays to a big majority of scientists. The purpose of our works is to bring such assertion into perspective, widening the somewhat narrow view of Special Relativity often presented in textbooks and scientific papers [2-23].

In this previous works a broad approach of the Theory of Relativity has been formulated. The standard interpretation of the theory can be explained. It is a result of considering that the existence of a frame where the one-way speed of light is isotropic independent of the source, named Einstein's frame (EF), is superfluous. Only the relative movement between two frames must be considered. This cannot be so. There is an indeterminacy of the theory [The Principle of Relativity and the Indeterminacy of Special relativity, EJP (2007) [14]]. This can be demonstrated considering a third frame where the speed of light is isotropic and analysing the relative movement [14]. The twin paradox is analysed as an example well known of one the difficulties of the standard interpretation. The twin paradox has never been solved and cannot be solved with that interpretation. The paradox is not specifically with the twins in relative movement but with the standard interpretation [17, 18]. In section I of [18] it is considered the Twin Paradox in a one-way trip. Considered in a one-way trip the paradox allegedly emerge because the standard interpretation affirm that both twin are being younger. This affirmation is the result of the time dilation expression that standard Special Relativity consider the relation between the rhythms. It is shown that the relations of rhythms is given by another expression that relates the proper times [18]. This expression is obtained calculating the rhythms of every twin in relation to EF and relating them. In relation to the EF the time dilation expression is the relation between the rhythms of every twin in relation of the rhythm of the EF. This clearly show that the problem is not well formulated by the standard interpretation. The relation of rhythms is only dependent of the speed of the twins in relation to the EF and cannot be expressed in function of the relative speed defined by the standard interpretation. Therefore, this relation of rhythms does not depend of the frame considered. It is the same for both frames. The results must be the same and it is. Does not depend on the point of view. In section II of [18] we formulate the two-way formulation of the paradox. This correspond to consider that one of the twins return. The standard interpretation considers legitimate to calculate, using the standard equation, the total ageing of both twins without considering acceleration in a first calculation in the frame of the twin that stays at home. Therefore, in that calculation there is no acceleration associated to the change of the frame. However, the returning twin must accelerate. This show that this calculation must be an approximation, and this is what has been accepted. For a long trip the effect of changing speed does not have a significant effect in the calculation and can be ruled out. Or we can consider that the "returning twin" is another twin with the same age of the twin that must return, moving in returning opposing direction (Lord Halsbury argument [18]). This is a way to avoid the acceleration and consider only inertial frames. Therefore, in a second calculation for the frames of the returning twin it must give the same result of the first calculation. It is shown that it does, as expected. Therefore, the affirmation that Special Relativity cannot be applied because the acceleration, or, because the frames are different [17, 18], is ruled out. If we apply the relation between the rhythms we obtain the same result. It does not depend of the frame contrary to the standard explanation [17, 18]. In section III of [18] the distance between the twins for the several frames are equated and shows an answer v1that is dependent of the two frames consider. It is not only a problem of relative movement between two frames. This problem of the determination of the distance (Grøn, Ø. Eur. J. Phys. 27, 885 (2006)) is intimately related with the problem of simultaneity since we are considering the ageing of the twins at a given distance at the same time. If we have a rod moving we know for sure that the extremities of the rod are simultaneous at two points of another frame. The difficulty to solve the paradox with the standard interpretation is only a result to attribute a wrong physical interpretation to a mathematical equation that does not have the meaning of relation between rhythms. And Special Theory of Relativity is a result of assuming the existence of a frame where the one-way speed of light is isotropic independently of the speed of the source and can solve the twin paradox. If we consider the frame of the returning twin, twin 2, we obtain the same relations for the to and fro frames. This is what equations (11) and (12) expose [18]. And also expose why it is not possible to obtain consistently from twin 2 frame the relation between rhythms with expression (13) [18], the standard dilation equation, allegedly the relation of rhythms. It is because (13) is not the relation between rhythms. It is not because we cannot apply the expression (see appendix of [18]). The expression can be applied and give the relation between the proper times to the variation of Lorentz times. And we can convert these equations to the relation between rhythms. Without any paradox. Of course, the knowledge of Einstein's speed is not enough to solve the problem, and this is why standard Special Relativity does not explicitly can solve the paradox. We know the distance to twin 3 in the frame of twin 1 but we don't know the distance in the frame of twin 2 only with the knowledge of Einstein speed [18]. We need to know v_1. This is why never standard special relativity can solve the paradox [see ref. 1, 2-10, 12, 18, 19, 20-24 of [18]].

Einstein was right: "We cannot solve our problems with the same thinking we used to create them"(https://en.wikiquote.org/wiki/Talk:Albert_Einstein)

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