An Astronomical Test for the Second Postulate of the Special Theory of Relativity

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A conceptual and critical analysis of the Special Theory of Relativity is made, mainly of its 2nd postulate, enumerating the reasons that still justify making a test to prove its validity. Textual quotations from Einstein as well as other renowned scientists are used, all of them enhancing the author's position. Particular use is made of two papers from Prof. J.G. Fox: "Experimental Evidence for the Second Postulate of Special Relativity" and "Evidence Against Emission Theories," both published during the 1960s in the *American Journal of Physics*. The outline of an alternate theory that could adequately explain phenomena currently explained only by relativity are given. Finally, an astronomical method is proposed, based on systematic observations of the stellar aberration phenomenon, in order to test in a direct way the referred postulate. It is concluded that, considering the importance of the subject, the proposed test is justified regardless of the result.

Keywords: Special Relativity, Stellar Aberration, 2nd Postulate, Einstein, Emission Theory, Ether

1. Introduction

Since their postulation a century ago, the formulas derived from Special Theory of Relativity (STR) have continued to demonstrate their effectiveness for the calculation of the magnitudes involved in dynamic phenomena of high velocities. The experimental results have so accurately fitted with those predicted by these formulas that it might appear extemporaneous and even ridiculous to propose the convenience of a new test for this famous theory. But my position is that this concordance does not imply the validity of its postulates but only their consequences, and hence provides a necessary but not a sufficient condition to constitute proof. Also, I am convinced that many scientists still hope for the appearance of an experiment that definitely proves the validity of the second postulate.

The reasons for this, which I develop below, are most likely as follows:

1) The basic postulate of STR is intrinsically illogical.
2) The empirical facts that supported the basic postulate at the time of its postulation are today questionable.
3) There is, to date, no unquestionable direct experimental proof .
4) It is possible to develop a theory, on a more logical basis, leading to similar formulas to those derived from the Relativity Theory.

1) *The basic postulate of STR is intrinsically illogical:* To say that light velocity, for a definite inertial system, is independent of the movement of the luminescent source, as the 2nd postulate says, leads immediately to the idea of an environment specific to the referred system, in which light propagates with its characteristic velocity for that environment, c. But the 1^{st} postulate warn us about the validity of all physical laws for all inertial systems, and, therefore, it demands this velocity c to be the same for any other inertial system, which is to

say that this velocity should remain the same both for the observer's movement and for the movement of the source. In other words, this constancy should be valid for any relative movement between the observer and the luminescent source.

This constancy of *c*, which is the core of the STR and hence referred to as its *basic postulate*, leads to the so called "Lorentz Transformations," which relate the different parameters to be measured from two inertial systems K and K′ with uniform velocity *v* between them. Most certainly, this postulate has seemed illogical for more than one student of science who happened to broach STR for the first time, like an annoying reef in the ocean of logic and common sense in which he was navigating in the study of science or, more precisely, in the study of the so-called Classical Physics. To accept this conclusion, or this imposition, leads one to imagine a luminescent environment able to adapt to the relative movement between a luminescent source and its observer, in such a way that whatever the sense and the magnitude of this movement, the velocity measured by the observer for the light reaching him will always be the same. Alternatively, one must imagine that the source itself adapts to different observers with different relative movements, emitting light in such a way that each of them register the same arrival velocity for it. Whatever the mechanism imagined for this process, it is not possible to frame it in any logical or natural pattern.

And as illogical as is the constancy of *c*, just as questionable are the concepts of simultaneity and synchronism Einstein deploys for the development of his formulas. The simultaneity of two or more events must be a definition, such as the position of a given point in space, with complete independence from the method used to determine it. In STR, it is defined through the observed coincidence of the signals emitted by the events, applying to light because it is the fastest signal available. When we annotate, for instance, the beginning of a solar surface eruption in an astronomical register, we know that the event actually took place approximately 8.3 minutes before, and we say *approximately* because we do not know the exact value of light velocity nor the distance to the sun. That is to say that in distant events, the simultaneity can only be given by definition or by inference of its occurrence. This is also valid for establishing the magnitude of any measurable parameter: we know it in proportion to the accuracy of the instrument we use for carrying out its measurement. In STR, when the parameter to be measured is time, we face the famous paradox of clocks, so difficult to assimilate, and so severely questioned, for example, by Dingle [1].

2) *The empirical facts that supported the basic postulate at the time of its postulation are today questionable:* In his classical work "On the electrodynamics of moving objects" (*Annalen der Physik* 17, 891-1905), in the first part of the introduction, Einstein says:

> *It is well known that if we attempt to apply Maxwell's electrodynamics, as conceived at the present time, to moving bodies, we are led to asymmetry which does not agree with observed phenomena....*

Later, he continues in part 2:

> *Examples of a similar kind such as the unsuccessful attempt to substantiate the motion of the earth relative to the 'light-medium' lead us to the supposition that not only in mechanics, but also in electrodynamics, no properties of observed facts correspond to a concept of absolute rest;…[2]*

We see that in his original 1905 work, Einstein makes just an oblique mention about which many consider the crucial proof of STR: the Michelson-Morley experiment [3]. Would he be making reference only to the Airy test in which the Greenwich Observatory's telescope was filled with water intending to obtain a bigger stellar aberration angle, assuming the prevailing concept of ether with which the famous phenomenon discovered by Bradley was being explained? Most probably, if we refer to what Einstein himself confessed to R.S. Shankland during an interview in February, 1950. I quote:

> *When I asked him how he had learned of the Michelson-Morley experiment, he told me that he had become aware of it through the writings of H. A. Lorentz,[*] but only after 1905 had it come to his attention! 'Otherwise', he said, 'I would have mentioned it in my paper'.[†] He continued to*

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[*] H. A. Lorentz, *Arch. Néerl*. **2**, 168 (1887), and many later references.

[†] A. Einstein, *Ann. Physik* **17**, 891 (1905); also in English translation (Dover Publications, New York). My colleague, Professor L. L. Foldy makes the following comment: Although Einstein may have been unaware of the Michelson-Morley experiment in 1905, he does make reference in the second paragraph of his 1905 paper to "unsuccessful attempts to discover any motion of the earth relatively to the 'light medium'." It is not clear whether Einstein is here referring to v/c or $(v/c)^2$ experiments, particularly since in the next sentence he goes on to say "They suggest rather that, as has been shown to the first order of small quantities, the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good." There is an implication, but by no means a certainty, that the first reference is to second-order experiments such as the Michelson-Morley experiment, and suggests the possibility that Einstein was aware of the negative results of such experiments if not with the experiments themselves. Einstein derives the Lorentz-Fitzgerald Contraction but says nothing about whether there is experimental confirmation. The whole paper is rather strange in the respect that Einstein reveals very little about what he knows to be experimentally verified and in that he makes no *specific* references to the work of others. The paper in fact presents an enigma in that it is very difficult to see how much of the special theory of relativity is a pure mental construct and how much is an inference

> *say the experimental results which had influenced him most were the observations on stellar aberration‡ and Fizeau's measurements§ on the speed of light in moving water. 'They were enough', he said. [4] (I, II, III, IV are Shankland's notes).*

Let us see what Einstein says in this regard during a conference about the STR in London, 1921:

> *Considering that I am going to explain the theory of relativity, I must say that this theory does not have its origin in speculation. It was discovered while trying to fit as accurately as possible the theory of Physics to observed facts...The law of the constancy of light in vacuum, confirmed by the development of electrodynamics and optics, together with the well known Michelson's experiment for explaining the equivalence of all inertial systems (principle of restricted relativity), caused, first of all, the concept of time to be relativized... [5]*

Let us also see a more specific reference on this topic in Einstein's own words, in his book "The Meaning of Relativity," in the Special Relativity chapter:

> *But all experiments have shown that electro-magnetic and optical phenomena, relatively to the earth as the body of*

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from experimental results (or a theoretical formulation of such results) of which Einstein had knowledge. See also G. Holton, *Am. J. Phys*. 28, 627 (1960).

‡ J. Bradley, *Phil. Trans. Roy. Soc*. (London) **35**, 637 (1728); G. B. Airy, Proc. Roy. Soc. (London) **20**, 35 (1871); **21**, 121 (1873).

§ H. L. Fizeau, *Compt. Rend*. **33**, 349 (1851); *Ann. Chem. Phys*. **57**, 385 (1859).

> *reference, are not influenced by the translational velocity of the earth. The most important of these experiments are those of Michelson and Morley, which I shall assume are known. The validity of the principle of special relativity can therefore hardly be doubted.*
>
> *On the other hand, the Maxwell-Lorentz equations have proved their validity in the treatment of optical problems in moving bodies. No other theory has satisfactorily explained the facts of aberration, the propagation of light in moving bodies (Fizeau), and phenomena observed in double stars (De Sitter). The consequence of the Maxwell-Lorentz equations that in a vacuum light is propagated with the velocity c, at least with respect to a definite inertial system K, must therefore be regarded as proved. According to the principle of special relativity, we must also assume the truth of this principle for every other inertial system. [6].*

So, despite their absence in his original work, we have here, mentioned in detail, the experimental facts that, according to Einstein, support his postulate of the constancy of c:

A. The Michelson-Morley experiment. [3].
B. The Stellar Aberration phenomenon. [7], [8].
C. The Fizeau experiment on light velocity in moving water. [9].
D. De Sitter's argument about the observed facts, or rather the un-observed ones, with apparent orbits of double stars. [10].

Let us now see, case by case, how each of these justify my claim number 2) at the head of this section.

A) *The Michelson-Morley experiment:* This is the most surprising case, and it is difficult to understand how it is still conceptualized as the *crucial experiment* that led to the STR. Let us consider my reasons:

a) The luminescent source and the observer were both in the same reference system (the Earth), not having, therefore, any relative movement between them. The experiment with a more valid basis was, in all respects, Tomaschek's, carried out long after, using instead a star as the luminescent source [11]. In point 3), we shall see how even today, the validity of Tomaschek's experiment is lessened.

b) The original experiment (considering the various repetitions made afterwards), was carried out in an environment containing air, not in a vacuum as is stipulated in the 2nd postulate on the constancy of *c*.

c) The most immediate and natural conclusion of this experiment's result is that light accompanies the source's movement, at least in an environment containing air. (It is valid to point out that the statement of this experiment is similar to Fizeau's for moving water, considering the objective of evaluating the effect of ether's movement on light's movement. The difference is that instead of water, the so called ether was *used*, and that instead of forcing water to circulate in the system with a still source and observer, source and observer were made to c*irculate* in an hypothetical still ether).

B) *The Stellar Aberration phenomenon*: The stellar aberration is developed in a special chapter, as an introduction to the proposed test, *leitmotiv* of the present work. Let us say here that it could be taken as an experimental fact to support the STR only in the case of Airy's test, due to the null variations in its value between an empty telescope and one filled with water. Anyway, as we shall see, it is the most remarkable piece of evidence against the STR, since it makes evident the Earth's movement by its interaction with the light of an extraterrestrial luminescent source.

C) The Fizeau experiment about light's velocity in moving water: This experiment considers how a given moving element (water in this case) interferes with light velocity, and it is not a direct proof of the 2nd postulate, but only of its consequences, as it is essentially the Theorem of Velocity Addition for the STR; that is to say, one of the cases in which the formulas developed from the STR are verified experimentally. Let us remark that also in this experiment, the luminescent source and the observer remain in the same reference system, as we saw in A). Curiously, or as a paradox (as is the case in the previous item), the fact that the movement of water produces a variation in the interference fringes of the interferometer opposes the 2nd postulate (qualitatively speaking); this is so because, according to the electromagnetic theory of light dispersion, water's electrons become emissive luminescent sources, and any variation in the fringes only appears when water is moving, that is, when the source moves with respect to the observer.

D) *De Sitter's argument about the observed facts, or rather the unobserved ones, with apparent orbits of double stars*: This argument was made after the STR's publication, so that Einstein could not use it at the time. It is widely developed by Fox in his works to be mentioned in point 3). Let us only say here the following. De Sitter's argument is that, for the case of close binary stars with significantly high radial velocities, if one assumes that the light emission velocity is added to that of the orbital velocity, then we would have the paradox of seeing each star in two different places of its orbit at the same time. However, O. Struve has demonstrated that there is evidence in stellar systems with proximate stars of the existence of a gas cover surrounding the whole system [12]. This gas cover would be thick enough to remove the difference between the original velocities of light of their components. In the case of visual binaries, with very much separated components, the effect of velocity addition would result in deformations or eccentricities in the apparent orbits. These eccentricities are observed, but we ignore whether they are real or due to the mentioned effect. It is worth quoting Fox again in his conclusion on this topic:

> *... Thus it cannot be argued that the data on binary stars provide support for the emission theory. However it does seem, contrary to what has been believed for several decades, that the data on binary stars do not offer any evidence against the emission theory. [13].*

From this brief analysis of the facts commonly considered to have led to the statement of the STR, we could ask how this statement could be made and subsequently accepted. My opinion is that the scientific world at the time was imbued, including Einstein himself, by the idea of an absolutely still environment whose vibration transmitted electromagnetic waves in general and light in particular… that is to say, the famous ether. The three first cases strongly opposed this idea, leaving only the fourth to endorse it, although it came later. The bafflement produced among those endorsing the ether theory (all round the world actually), was enormous, and several hypotheses were proposed to provide explanations, like Lorentz's and Fitzgerald's length contraction ones, and Fresnel's ether dragging. And in such a context Einstein stated that of his own, the constancy of c, with all the ad-hoc development of the STR. These explanations maintain the idea of an absolute ether, like the electronic theory and equations of Maxwell and Lorentz, and the STR itself involves the luminescent ether, but with the addition of its versatility to maintain c constant to any observer, with independence of its relative movement with respect to the luminescent source. And this despite what Einstein expressed in his theory, and after, that the idea of the ether should be abolished due to lack of experimental support.

Why was the possibility of light having the velocity of the source added to its own not taken as an explanation of the negative results mentioned? Was there, by chance, an experimental fact besides De Sitter's argument to reject this idea? The settling of the ether theory seems to be the only answer. Of course, the other answer is that Einstein's genius conceived the explanation of the constancy of *c* beyond the validity of the experimental facts at the time.

3) *There is, to date, no unquestionable direct experimental proof:* With no notice of any conclusive experiment in this sense over the last 40 years (and please be aware that I am always referring to the 2nd postulate), I shall directly refer here to J.G.Fox's work "Experimental Evidence for the Second Postulate of Special Relativity" [14]. From this work I quote the initial abstract:

"It is pointed out that the extinction theorem of dispersion theory, for which an elementary derivation is given, shows that an incident light wave is extinguished at the surface of a dielectric. This may mean that information about the velocity of light from a moving source would be lost if the light passed through intervening transparent, stationary material before it was measured. All past laboratory measurements to verify the constancy of the velocity of light from moving light sources and mirrors and from extraterrestrial sources were made only after the light had passed through stationary material. Double stars, especially close binary pairs, are surrounded by a common envelope of gas which may contain enough matter to extinguish the direct light from the stars. Thus de Sitter's proof of the constancy of the velocity of light may not be conclusive. It is concluded that there may not exist any sure experimental evidence for the second postulate of special relativity."

J.G. Fox further analyzes, soon after in his work “Evidence Against Emission Theories” [13], how different experimental results from various optical and electronic phenomena can be interpreted under the Emitting Ritz Theory [15] point of view considering the Extinction Theorem. He concludes that there are not totally conclusive experimental events for either accepting or rejecting the theory. Due to the position of the Ritz Theory being so opposite to the STR regarding light velocity, this conclusion certainly applies to the 2nd postulate as well.

4) *It is possible to develop a theory, on a more logical basis, leading to similar formulas to those derived from the STR.*: In the first section of the last quoted paper [13] there is a summary of Ritz’s electromagnetic theory [15] in which it is considered as the only sensible attempt at an emissive theory, which is one that considers the propagation of the electromagnetic waves as being linked to the movement of the emissive source. This theory was actually just sketched as an example of a possible way to oppose, on a relativistic basis in the Galilean sense, the invariance concept of the Maxwell-Lorentz electromagnetic theory. Unfortunately, he could never take it to a more generalized expression including optical phenomena, since he died a year and a half after its statement.

Without considering the nature or the constitution of the force fields, and without seeking to encompass Ritz’s emissive model, although perhaps it does, I am proposing the following outlines for a theory we could name “Of the moving fields”:

I) Every material particle produces in its surrounding space one or more force fields, that propagate with a velocity which is characteristic of the originating field and of the environment in which it propagates.

II) The field produced depends on the nature of the particle, and expresses itself by the force acting over other material particle. This force will depend on:

1) The nature and the distance of the second particle.
2) Its velocity relative to that of the field.

III) The field always follows the movement of the particle that produces it, in an absolute manner in vacuum, and proportionally or null in a material environment, according to the permeability of that environment.

IV) All the previous statements are valid in all inertial systems, which is to say that there does not exist any preferred system for them.

These hypotheses do not attempt to be exhaustive, but instead constitute the outlines of a theory able to explain dynamic and electromagnetic phenomena in a general way that is an alternative to the STR (though note that the last hypothesis is the same as the 1st postulate of the STR). To do this in a quantitative way requires mathematical and experimental development for each particular field, so as to provide the mathematical expression for the relationship between common parameters. Most probably these expressions will contain coefficients of the β^n type, where β is the relative velocity between the particle and the field (v and c, expressed as $c \pm v$ or as v/c, *etc.*), and "n" is a rational number of any sign, particular to each case. As an example of this theory's consequences, let us say that the force that an electrical field exerts over a moving particle, electrically charged, would diminish as it increases its velocity in the direction of the propagation of the field, due to the decrease of the relative velocity between particle and field. The same would happen with the mass of a particle moving in the same direction of the propagation of the corresponding gravity field. In both cases, the opposite consideration is also valid, that is to say, an increase of its magnitudes when the movement of the particle is contrary to the propagation of the field. But this analysis will only be valid if it is valid to talk of the *relative* velocity of a particle with regard to a force field, because if only *c* exists for this velocity, then the STR is valid, and its formulas would be the ones to be considered.

After exposing the reasons that, to my understanding, justify the effort of performing a new test for the STR, I will now proceed to describe such a test, making first a brief review of the phenomenon in which it is based.

2. Stellar Aberration

The Stellar Aberration phenomenon, observed and explained by Bradley [7], was the first concrete evidence of Earth's movement around the Sun, giving definite support to the Copernican heliocentric theory. It may now be useful for confirming or rejecting the STR's 2nd postulate. Its measurement offered as well a method to calculate light velocity, confirming at the time the former value found by Römer, derived also from astronomical observations, in that case the delays of the eclipses of one of Jupiter's satellites.

We all know the figure used for an easy understanding of this phenomenon: that of the rain and the pedestrian with an umbrella, and of how he will have to adjust the inclination of the umbrella as he walks faster, even without wind and with the consequently vertical rainfall.

But how does the aberration happen? In the correct interpretation of this phenomenon lies the clue to be able to judge the validity of the 2nd postulate. Bradley was not concerned about the nature of light to describe it, although he seemed to accept Newton's corpuscular theory for it [16]. Even though he did not write it down, it is accepted that he found its explanation (he was in fact investigating the stellar parallaxes when he discovered it) as he was sailing along the Thames, and he observed how the position of the ship's weathercock varied according to its velocity and that of the wind [17], [18]. He compared then the star's light to the wind, and the Earth to the ship, and reasoned that, just as the weathercock pointed towards the resulting direction of the wind, the telescope should point towards the resulting direction of light.

The phenomenon of an altered direction of light resulting from its movement relative to the Earth points out that there has been a vectorial addition, or *composition*. Thus the light's movement *has not remained constant* when the luminescent source (the star) is observed from Earth. This fact constitutes by itself one more piece of evidence of the 2nd postulate's invalidity. Let us nevertheless review in detail, the geometrical aspects of this phenomenon.

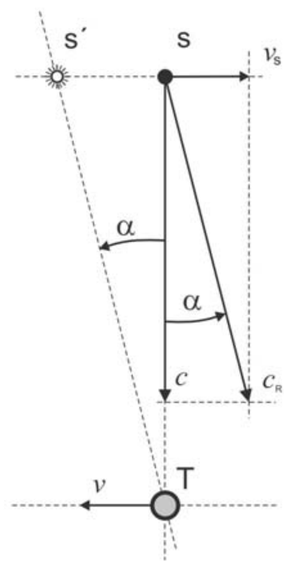

Figure 1

In Figure 1, S is the real position of a star, T, the position of the Earth, and vectors $\vec{v}$ and $\vec{c}$ represent the velocities corresponding to the earth and the star light, respectively.

Mentally returning to the image of the rain and the pedestrian with the umbrella, $\vec{v}$ corresponds to the pedestrian's velocity, and $\vec{c}$ represents the velocity of the rain, falling vertically due to the absence of wind; the clouds keep still with regard to the road. In Figure 1, we are simplifying, and apart from not keeping an accurate scale, we chose a position for S to achieve a perpendicular motion of T relative to the direction of S ($\vec{v} \perp \vec{c}$). If we transfer $\vec{v}$ to S in a direction opposite to the Earth's movement, we shall have the apparent motion of S ($\vec{v}_S$) relative to the Earth, just like that of the cloud to the pedestrian in the example. Vectors $\vec{c}$ and $\vec{v}_S$ compose (i.e. vectorially add) to give $\vec{c}_R$ and, as we know, a telescope on the Earth wanting to focus star S, would have to do so in the TS′ direction, parallel to $\vec{c}_R$, which forms an angle α with respect to TS called the *aberration angle*, with S′ being the apparent resulting position of the star considered.

The case in Figure 1 corresponds to the situation of T_1 shown in Figure 2, in which the star S is in the ecliptic plane, and the Earth is aligned with the Sun and the star. As the year goes by, the position of S′ will oscillate around a line, the maximum amplitude for this oscillation being $S'_1S'_3 = 2\alpha$, corresponding to the difference in the positions for the observations from T_1 and T_3, measured with a 6 month difference. From T_1 to T_2 and from T_3 to T_4, the aberration will decrease to the point of completely disappearing at the positions T_2 and T_4, for which vector $\vec{c}_R$ coincides with $\vec{c}$. Here its modulus will be $|\vec{c}_R| = c - v$ or $|\vec{c}_R| = c+v$, this difference being verifiable experimentally by the Doppler effect.

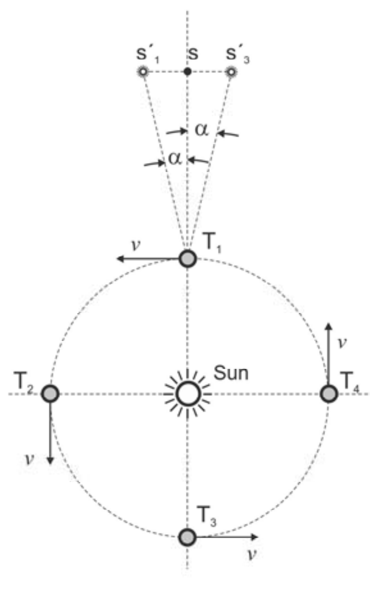

Figure 2

Is it logical to suppose, as the STR demands for this case, that in the vectorial addition of the two vectors, the resulting vector's modulus keeps the value of one of them even though its direction did vary with respect to it? What parallelogram should we build in Figure 1 for $\vec{c}_R$ to be equal to $\vec{c}$ without a null value for $\vec{v}_S$? This would be equivalent to saying that in the TS′S triangle, in the same Figure, the hypotenuse TS′ is equal to the TS cathetus, even though S′S is not 0. Although $\left|\vec{c}_R\right| = \sqrt{\left(c^2 + v^2\right)}$ could not be measured in a valid way (due to the difficulties expressed in point 3 of the Introduction), Bradley measured the value of α, and any astronomer can do it nowadays. And if α is a reality, there is no geometry that cannot make real that $\left|\vec{c}_R\right| = \sqrt{\left(c^2 + v^2\right)} > c$. (When we say that $\left|\vec{c}_R\right| = c_R$ could not be measured yet, we are making reference to a method different from the Doppler effect, which, as we know, reveals the variation of frequencies under both classical and relativistic settings).

The described case is an extreme. The other extreme is for a star visually close to any of the poles of the celestial sphere. Here, S′ will describe a circumference of ratio α around S, which is to say that we shall always have the same value for the aberration, but its direction will constantly change.

The biggest difference in the apparent positions will appear in a 6 month period, whatever the time chosen for the observations. Obviously, for any other position of the chosen heavenly body, this will describe an ellipse with respect to its real position whose major semi axis will be α with the minor being $\alpha\sin(\varphi)$, where φ is the declination of the heavenly body with respect to the ecliptic.

And where does the described velocity composition occur? If we consider the light dispersion, or *reemission*, from the electronic theory of light propagation in a material medium, this composition will occur in the first contact of the stellar light with the upper layers of the atmosphere, where enough matter can be found so as to extinguish any variation of the velocity of this light according to the Extinction Length Theorem [19], [20]. This also implies that, after this composition, the light will maintain its direction as well as its normal velocity value for air. In the absence of an atmosphere, (the Hubble satellite telescope, for example), the point of inflection will be at the objective for the same reason as for the wave extinction and reemission theory, with the star acting as a luminescent source fixed in the objective. This explains the Airy test's failure, in 1871, when he filled the Greenwich Observatory telescope with water, expecting to obtain a bigger value for the aberration after the decrease in light propagation velocity inside the telescope. The idea of that test is a consequence of the explanation given at that time for the aberration, resulting from a scientific community dominated by the concept of an absolute ether: during the time elapsed for the passage of light between the objective and the ocular, the Earth walks a certain distance that causes the ocular to lose focus. This movement would occur along the telescope's length, giving the light ray trajectory an inclination bigger than would be expected if the Earth, and therefore the telescope, had been still. If light moves slower (which in fact happens in water), the aberration should consequently have been bigger. But this did not happen, proving that reasoning with the ether was wrong or, rather, that the idea of a still ether was wrong. If any doubt still remained, soon after that, in the 1880 decade, the experiment carried out by Michelson and Morley with its rotary interferometer, definitely sealed this idea. (Actually, it was not strictly so, and even nowadays an attempt appears every now and then to explain the M-M experiment's failure, trying to save the idea of the ether [21], [22]).

On the other hand, as we know, the STR explains the aberration by a simple application of Lorentz's transformations to the angle formed by the direction of the Earth's movement on one side and the line of sight to Earth from a heavenly body on the other. The K and K′ systems are, then, analogous to the heavenly body and the earth that move in relation to one another with the earth's velocity v. If θ is the referred angle for the heavenly body's system K, and θ' is the corresponding angle to the earth's K′ system, then the aberration will be the difference between both angles: $\alpha = \theta' - \theta$. The relation between these angles, applying Lorentz's transformations, is given by the following expression:

$$\tan \Theta' = \tan \Theta \times \frac{(1-\beta^2)^{½}}{(1-\beta \sec \Theta)}, \quad \text{where } \beta = v/\mathrm{c}\ . \tag{0.1}$$

Ignoring the second order infinitesimals, β^2, and processing, we obtain:

$$\tan (\Theta' - \Theta) = \tan \alpha \cong b \cdot \sin \Theta, \tag{0.2}$$

Giving, for $\theta = 90^{\mathrm{o}}$, its maximum value:

$$\tan \alpha \cong \beta = v/\mathrm{c} \tag{0.3}$$

3. The Astronomical Test

Now, let us see what would happen if the light from our star S would come with a value different to that considered as constant, c, lets say c' (smaller), or c'' (bigger).

We can see in Figure 1 that, due to the composition of $\vec{c}$ with $\vec{v}$, the angle α is such that $\tan(\alpha) = v/c$, the same expression as (0.3). Due to the practically circular shape of the Earth's orbit, we can have v as a constant. Now, in Figure 1 and in the relation (0.3), with v

constant, if c varies then so must C_R and, obviously, α. And here is the marrow of our work. Due to the interpretation we give to the aberration (similar to Bradley's), although we cannot measure an eventual variation of C_R due to the difficulties already expressed regarding light reemission in the air and in the lenses of any instrument we use, we would indeed be able to register the variation of α. Let us note that in the relativistic formulas for aberration, c cannot appear as a variable because it is considered a constant, so that the radial velocity of a star cannot influence the aberration, in those formulas, because it cannot influence c.*

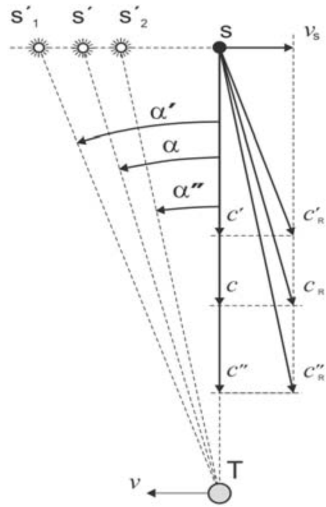

Figure 3

To *see* how this c variation would quantitatively influence the aberration, let us work with the parameters which participate in this phenomenon. We shall simplify its values to make clear the concept of the magnitudes: in Figure 3, we have represented again the case of

* Here we come again to a relativistic paradox: In its aberration interpretation and, consequently, in the formula (0.3), v is the relative velocity between the heavenly body and the earth. Consequently the radial velocity would intervene, with a direct first order incidence in its value. This fact had been underlined by several authors, remarking the practical inconsistency of the relativistic approach to this phenomenon, considering that alterations of such a magnitude do not actually occur. The present article's author recently came to know about these questions due to the contributions of Doctors J. Guala-Valverde, from "Julio Palacios Foundation," and T. E. Phipps, from Urbana, Illinois (USA). To them, my acknowledgments. [28], [29], [30], [31].

Figure 1, but adding the vectors $\vec{c}'$ of a smaller modulus than $\vec{c}$, and $\vec{c}''$, of bigger modulus. Let us suppose that c = 300,000 km/sec, and v = 30 km/sec. We shall have that tan(α) = v/c = 1/10,000. For very small angles, expressed in radians, the value of its tangent is practically equal to the angle's. We can say, expressing it now in degrees, that:

$$\alpha = \frac{30}{300,000} \times \frac{360^0}{2\pi} \cong \frac{30}{300,000} \times \frac{360 \times 60 \times 60''}{6.2832} \cong 20.626'' \quad (1.1)$$

(We know that the real value nowadays accepted for α is 20.48"). Let us see which values could be expected for α if c would suffer a 300 km/sec decrease, c', or an increment of 60 km/sec, c'':

$$\alpha' = \frac{30}{299,700} \times \frac{360^0}{2\pi} \cong 20.647'' \quad (1.2)$$

$$\alpha'' = \frac{30}{300,060} \times \frac{360^0}{2\pi} \cong 20.622'' \quad (1.3)$$

Well, these could be the cases for stars with radial velocities of +300 km/sec, and –60 km/sec, as the light coming from them would appear increased or diminished by these values. If we could select an adequate sector of the celestial sphere containing these stars, visually close, and observe it in regular periods during a year or more, we would register little apparent variations of their relative positions provided that c would be variable, produced by the different aberrations corresponding to each one.

Figure 4 shows this case, in which A and B are the real positions of two stars, with real separation δ (in arc seconds), and radial velocities +300 and –60 km/sec respectively, and A_2, A_4, A_6,.....,B_2, B_4, B_6..., the successive apparent positions in observations carried out every 2 months from A_0 and B_0, each describing a different aberration

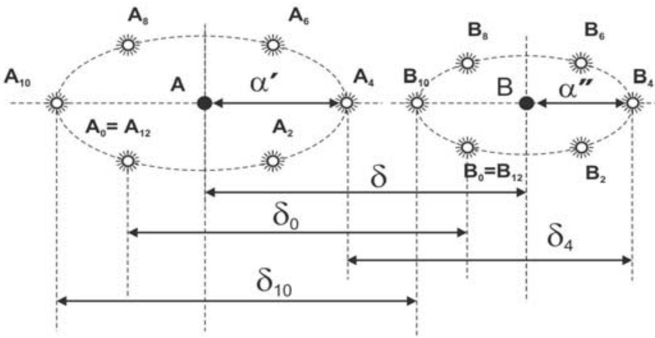

Figure 4

ellipse due to differences in the angles α' and α''. The apparent separations δ_0 , δ_2 , δ_4 ... will vary their value with each observation, $\Delta\delta$, and in the case of the figure, the biggest variation will appear between the observations at month 4 and month 10. It can be easily demonstrated, by algebraic addition of segments, that

$$\Delta\delta_{\max} = \delta_{10} - \delta_4 = 2(\alpha' - \alpha''). \tag{1.4}$$

This value, for our example, is

$$2(20.647'' - 20.622'') = 2\times 0.025'' \cong 0.05''. \tag{1.5}$$

This example was carried out with credible parameters, and shows a result that, although it may appear too insignificant to be considered as a definitive result, is one that at the present date can be registered within the precision of current astrometric methods. Obviously, the conclusion will only come after the statistical analysis of the results obtained, choosing adequately the sectors of the celestial sphere to be observed and programming an adequate number of observations. In this sense, the distant galaxy clusters are the ones with the biggest radial velocities, but I cannot guarantee whether they would be good references for our purpose due to definition, shine, *etc.* However, if that would be the case, then for example the cluster Ursa Major II, with a radial velocity of +41 000 km/sec, would have $c' = 259\,000$ km/sec and $\alpha' = v/c' \cong 23.892$." For this case, $\Delta\delta_{max} = 2\,(\alpha' - \alpha) = 2\,(23.892" - 20.626") = 6.532,"$ α being the aberration of a star visually close that can be taken as a reference. The value to be obtained for the apparent difference in positions would obviously constitute a *prima facie* measurable result.

I consider it superfluous to point out that, even though we have approximated the velocity values, the orders of magnitude of the results are exactly equal to those which would be obtained using exact values.

Let us conclude that there are stars with radial velocities near 500 km/sec and bright enough to be correctly observed. Certainly the ideal case would come from a double visual star, whose components have significant opposite radial velocities, in which case the apparent positions of each star would vary in a perceptible first order manner under the STR, and in a minimum but measurable one according to our reasoning in this test.

In any case, it will be task of astronomers to choose the most convenient cases to establish an observation program that could give a definitive result. And it is even possible that some observatory has graphic registers of observations, carried out for other purposes, which could be used for the present proposal.

4. Conclusion

I am aware that all the statements of the Introduction may be arguable, especially after a century of Relativity, and so, the reader can ignore them and point his attention to the test, that, whatever his position with respect the STR, is direct and convenient. In fact, the proposed test manages to avoid the inconvenience, which appeared to be inevitable, of making a measurement of c with the light going through a dielectric, as expressed by Fox in his work in reference 14. This is so because it is precisely in the dielectric where the composition of velocities (that of the light with that of the dielectric) and hence the breakage in the light's direction takes place, generating the aberration phenomenon. That is to say that here the dielectric (the atmosphere or the lens of a spatial telescope) is not a "perturbing" element but a "necessary" one to be able to make the measurement, in this case, of the aberration angle α.

In any event, the ideas expressed in this work may appear to be only a desperate attempt to save the logical structures of basic Science, just as they were constructed until the appearance of the STR. The almost perfect agreement between the experimental results and those predicted by the formulas derived from it, the simplicity of its expression, and the absence of other theories developing similar formulas, will likely make the reader presume that the STR will successfully pass the proposed test. In this case, there would be no doubt about its validity or about Einstein's exceptional genius to conceive or foresee a hypothesis that, contrary to what was expressed by him on several opportunities, lacked (as pointed out in this analysis) decisive experimental fundament or correct interpretation of the experimental facts. But if the STR does not pass, then the scientific world will have to immediately develop another model leading to similar formulas to those provided by the STR, but on a logical and verifiable basis which will allow us to get a better understanding of the way our universe *works*. A humble collaboration in this sense would be the one proposed in the present work.

As a manner of certain support to all I have presented here, I shall quote excerpts of the already referenced R.S. Shankland and H. Dingle publications respectively, and the final paragraphs of the conclusions of the likewise referenced works of J.G. Fox. These last works have been the basis and the stimulus for the present article.

> *...Einstein told me that Michelson did not like the relativity theory. He told Einstein this and he also heard it from others. Einstein laughed and added, 'You know we were very good friends!' Michelson said to Einstein that he was a little sorry that his own work had started this 'monster'... [23].*

> *...But, whatever may be the right solution, electromagnetic theory is so intimately involved in the whole of sub-atomic physics that the entire subject must be submitted to revision if the special relativity theory is disproved, and the importance of this is so great that a clear settlement of the question, before kinematical velocities not negligible compared with that of light become possible, is imperative. This demands a genuine effort to examine the matter with a completely unprejudiced mind. The general impression which these replies give"* (Prof. Dingle is referring to those he received after publishing his previous article in which he pointed out a contradiction in the STR [24]) *"is that the obstacle to the acceptance of my arguments are mainly psychological: my communication has been read, not to see if what I say is right, but to see where it is wrong. If my critics could only manage to conceive the possibility that it might be right, I think they would at once see that it is; it is so very simple. [25].*

> *...Nevertheless if one balances the overwhelming odds against such an experiment yielding anything new against*

> *the overwhelming importance of the point to be tested, he may conclude that the experiment should be performed. [26].*

> *...There are numerous indirect verifications of special relativity. After all, we have a very satisfactory body of theory. Even when extrapolated very far, relativistic electromagnetism yields excellent agreement with experiment even in the field of quantum electrodynamics. The dramatic success of Dirac's equation needs no elaboration. This general kind of evidence in support of special relativity seems overwhelming in its scope and variety. This is the reason for the widely held belief that no other theory could account for all these phenomena. However, it should be realized that these successes are not actually evidence against the Ritz theory. What is needed is the demonstration that the theory is in contradiction with experiment or that it is not self-consistent. It is with this in mind that the relation of the theory to experiment has been examined here. [27].*

Finally, let us remember how all the laws of Astronomy could be perfectly explained five centuries ago with the geocentric theory of Ptolemy, and how Copernicus did the same but considering more logical the sun to be the centre of the planet's movements. Consider also how both theories coexisted for decades until the works of Galileo, Kepler and Newton came, supporting the heliocentric theory. Finally, recall how it was precisely the explanation of the stellar aberration by Bradley that gave the most conclusive verification of it.

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