Stellar Aberration and Einstein's Relativity

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Adapted from: Physics Essays, Vol. 9, No: 1 P. 96-99, 1996.
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Abstract

Stellar aberration is explained by the relative motion between a star and an observer on earth. Based on the principle of invariance, Einstein's relativity predicts that absolute motion does not exist. Consequently, there should be no difference between a star having a velocity with respect to an observer and an observer having a velocity with respect to a star. In the case of stellar aberration, this prediction appears contrary to observations. It is shown that the description of stellar aberration, in terms of relative transverse velocity between the star and an observer on earth should be corrected, because it is an erroneous interpretation of Einstein's relativity.

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1. Introduction.

The exact position where a star appears in the sky does not only depends on the coordinates of the source observed, but also on the observer's relative velocity. The observer velocity is responsible for a phenomenon called "Bradley aberration" or "Stellar aberration". Stellar aberration is a well known phenomenon among astronomers. It was discovered by the astronomer James Bradley [1] in 1727. It is claimed to be caused by the relative transverse motion between the earth and the star emitting the photons.

Some authors [2-5] have shown that this prediction is not fully compatible with observations. There is no available explanation for the fact that, while the observational data on stellar aberration are compatible with a moving earth, the symmetric description, when the star (and not the observer) possesses the relative transverse motion, does not apparently lead to observations compatible with predictions.

2. Radial Velocities.

Each component of relative motion between a source and a detector is discussed here separately. In the case of radial motion, it is well known that the relative motion between the source and the detector produces a change in wavelengths, explained by the "Doppler effect". There is then no change of direction of the photons. The radial velocity is compatible with the difference of radial velocities between the star and the detector. According to Einstein's relativity, the condition of invariance implies that there exists no absolute velocity of the source or of the detector. Observations have shown that in the case of radial motion, data are in full agreement with Einstein's predictions.

3. Transverse Velocities.

In the case of transverse motion between the two objects, another effect called "Aberration of Light" is predicted and observed. Following Einstein's relativity, a symmetrical situation is expected whether the source or the detector possesses the transverse velocity. Just as with the Doppler effect, the Einstein's principle of relativity also means that only the relative motion is relevant.

However, it has been demonstrated [2-5] that some observations are not compatible with those predictions. The seriousness of the problem has even been overlooked. Of course, the absence of a

suitable explanation leaves the phenomenon of aberration of light without any rational solution. It has been claimed that the observed results, which depend on whether the earth or the star is moving, are experimental proofs of the failure of Einstein's principle. Let us examine that problem.

4. Description of the phenomenon.

One knows that the earth completes a full circumference around the Sun every year. Consequently, since the Earth-Sun radius (R_e) is well known, it is easy to determine the earth tangential velocity (V_t) required to complete the circumference in twelve months (T seconds). We have:

$$2\pi R_e = V_t\, T. \qquad 1$$

Equation 1 predicts that the average translational velocity V of the earth around the Sun is 29.79 Km/s. Of course, the earth velocity vector changes continuously in direction and completes a full cycle during a one year period while the earth circles the Sun.

On Figure 1, an observer on Earth detects the photons emitted by a stationary star S, located in a direction perpendicular to the Earth velocity V_t. The star is located at such a large distance from the earth that the parallax caused by the orbit diameter around the Sun is completely negligible. Only the transverse velocity matters here.

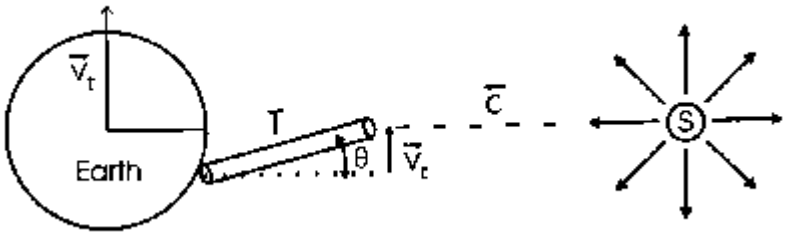

Figure 1

The stationary star S is emitting photons in all directions. The Earth and the telescope are moving upward at a velocity V. The telescope must make an angle* q *with respect to the real direction of the coming photons in order to collect them at its focus.

We read in astronomy textbooks, that the relative velocity between photons (at velocity c) and the Earth (V_t), explains why a telescope "T" on Earth (see Fig. 1) must be pointing at the angle q , with respect to the Earth-star direction, to be able to point out at the star. Figure 1 shows that while the photons move in straight line toward the Earth, they will always remain in the axis of an inclined telescope, since it is moving sideways with the Earth. The angle q is equal to:

$$\text{Tan}\,\theta = \frac{V_t}{c}. \qquad 2$$

Equation 2 gives q equals 20.5 arc-s. This is in perfect agreement with the value of aberration observed so many times since Bradley in 1727. During the year, the observed direction of the stars makes one oscillation with an amplitude of 20.5 arc-s., as expected from the Earth motion around the Sun. The value of 20.5 arc-s. is called the constant of stellar aberration.

5. Apparent Lack of Symmetry.

A serious problem is revealed when one reads the description of that phenomenon. Scientific papers and textbooks on relativity [6] state or imply that stellar aberration is determined by the "relative velocity" between the light source and the detector. It has been clearly shown experimentally that it is not so. Many convincing arguments have been pointed out by H. Ives [2], Eisner [3], and Phipps [4], and Hayden [5], and several others to show that when the source (instead of the detector) is moving, the aberration no longer exists. Observations show clearly that, in contradiction with special relativity, stellar aberration does not depend on the relative motion between the source and the detector but exists only when the detector is moving. Textbooks explain the results solely when the observer is moving. There is no known explanation for the case when the source is moving.

That lack of symmetry, between the cases whether the source or the detector is moving is shown clearly [5] on the basis of the separation of binary stars. One can reliably determine the motion of individual stars of a binary system from their spectrum from the periodic Doppler shifting of the spectral lines of the star components. Therefore, stars of a binary system acquire sufficient relative transverse velocity to produce an important aberration. Such an aberration is not observed. Some papers report non realistic hypotheses to explain aberration when the star is moving. The explanation goes from the claim that we do not observe reality or the "Umbrella Analogy" mentioned by Eddington and some others.

6. Mechanism of Aberration.

Let us consider on figure 2, a stellar source S and a detector located on Earth. Source S emits photons in all directions at velocity c. In physics, photons are conceived as being particles and are represented as bullets ejected from the surface of the emitter S with a velocity c. After a short interval of time after emission, the photons emitted at one instant form a sphere around the star as shown (dotted circle) on figure 2. Let us consider now that the star S (instead of the Earth) has a transverse upward velocity as shown in figure 2.

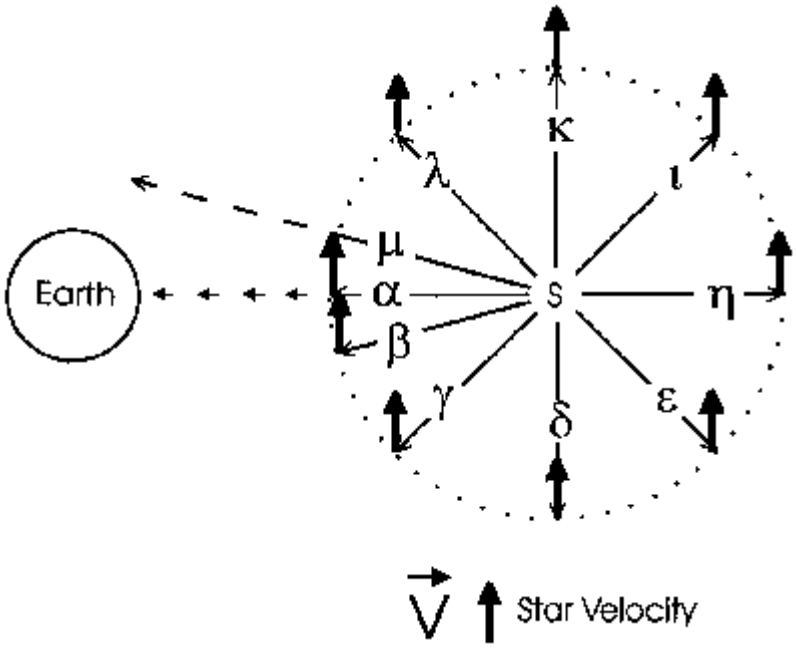

Figure 2

In this case, the star is moving upward with respect to the Earth. Photons emitted from the new direction* b *are now reaching the Earth.

We know that the resulting velocity U of the emitted bullets (photons) is the relativistic sum of the star velocity V and the speed of light c. From figure 2, we see that V is perpendicular to the direction of light going to earth. The general velocity composition formula giving the sum of V and c, as given by Møller [6] is:

$$U = \frac{[1-(v/c)^2]^{1/2}c + (\{1-[1-(v/c)^2]^{1/2}\}(c \bullet V)/v^2 - 1)V}{1-(c \bullet V)/c^2} \qquad 3$$

Since the direction of V is perpendicular to c, we have $(c \cdot V) = 0$. This yields:

$$U = [1-(v/c)^2]^{1/2}c - V \qquad 4$$

whence, we obtain:

$$|U|^2 = |c|^2 \qquad 5$$

Equation 4 gives that the final velocity of light is still rigorously c but the direction has changed by the angle d , where:

$$\delta = \mathrm{Tan}(V/c). \qquad 6$$

Consequently, those photons will then no longer reach the Earth.

Let us consider now, (fig. 2) the photons (or bullets) emitted from S in direction a , when the star is originally at rest (V=0). The bullets emitted in that direction are labeled a , so that one can recognize their direction. Other bullets, emitted in other directions are labeled b , g , d , e , h , i , k and l with respect to the star S.

When the star is moving upward at a velocity V, particles labeled a will no longer reach the detector on Earth as calculated above. They will have a new direction at an angle d , labeled m , and will miss the Earth. However, the other beam of particles originally pointing in direction b is now deviated by an angle d in the direction of a , because the downward component of b is equal to the upward component of V. Therefore angle d given to ray b , just compensates for the upward velocity V. Therefore the photons take direction of a .

Consequently, those photons do not have any transverse velocity component since the velocity V of the star cancels exactly the velocity component of light emitted in direction b in the opposite direction. Therefore, these photons will reach the Earth without producing any stellar aberration. It is well known in mathematics that a vector, made of the sum of two original vectors loses all information about the individual components that formed the final vector. There is absolutely no possibility for the source at that location, to send particles in such a way that they would arrive with a transverse velocity at the earth location, since it is impossible for any particle (photon) with a transverse velocity to reach the earth. Consequently, any transverse velocity V of the source S is completely undetectable.

7. Compatibility with Einstein's Theory?

This result must be examined in terms of relative motion. It is stated in relativity that there exists no absolute velocity. Only the relative velocity between two objects has a physical meaning. How can this be compatible with the above description of stellar aberration? This apparent paradox is solved when one considers more carefully what those two objects are. In the case described above, the aberration of light clearly involves the relative motion between the bullets (photons) and the detector. It does not involve the relative motion of the system that has fired the bullets (called source). In fact the star, from which the particles are emitted is no more than the support from which the particle (bullets) originated. Erroneously, the relative velocity between the star and the earth has been considered while one should consider the relative velocity between the incoming particles (bullets or photons) and the earth. Using that last consideration we find at last that the principle of relative motion described by Einstein can be applied in this case.

The error of interpretation discussed here is exactly similar to the situation that appears when a hunter is firing at his prey. Nobody ever claimed to be able to calculate the transverse velocity of a running hunter from the knowledge of the direction of the bullet moving toward the prey. The angle of penetration of the bullet into the prey depends on the relative velocity between the prey and the bullet and not the velocity relative to the hunter. If the hunter is running forward, he must point his gun with an angle having a backward component to reach his target.

One must conclude that it was an error to claim that the aberration of light is caused by the relative transverse velocity between the star and the Earth. One should say that it is the result of the relative transverse velocity between the Earth and the coming photons. Consequently, in this particular case, Einstein's principle of relativity can be applied.

8. Case for Other Models for Light.

It can be seen quite easily that the explanation given above about the aberration of light can be applied to the wave model of light just as well as to the model of photons. The consequences are quite identical. No aberration of light is expected when the emitter (instead of the wave) has a transverse velocity. One can also ask the question: "Can we find a similar interpretation for the aberration when light is described according to modern physics? One must recall that modern physics finds its interpretation with the use of the Copenhagen interpretation. The Copenhagen interpretation implies that photons cannot exist independently of the observer and are created at the moment of detection. Consequently, the explanations given here cannot be applied directly. In fact the question does not make sense since in modern physics, it is claimed that explanations do not necessarily have to be compatible with causality. This is stated clearly

by Heisenberg himself when he writes: "The law of causality is no longer applied in quantum theory". When we do not accept the principle of causality it does not make sense to look for the cause of stellar aberration.

However, without changing the mathematics of modern physics, (but without using the Copenhagen Interpretation of Modern Physics), it is possible to show that physical phenomena can be described in a causal way. This has been shown in more details recently. It can be shown that, using a causal description of modern physics, the phenomenon of stellar aberration of light" is explained classically.

Acknowledgment.

The author wishes to acknowledge the financial assistance of the National Science and Engineering Research Council of Canada, and exchange of correspondence with Dr. T. E. Phipps.

Important Note on Relativity

Stellar aberration is a correction, which is absolutely needed, in order to get a logical system of coordinates for stars and galaxies, which is valid at any time all year round and even at any epoch. Without stellar aberration, it is impossible to establish a coherent system of coordinates in the universe. Stellar aberration takes into account the velocity of the observer due to the Earth rotation and also its translation around the Sun.

There are now extremely accurate tables of coordinates of astronomical objects, reporting the accurate observations of very large telescopes on Earth and even in space. A higher accuracy is even obtained using interferometric methods. It seems there is almost no limit in the accuracy that can be achieved.

However, all these “highly accurate” coordinates have been calculated without involving any correcting factor due to the proper motion of the observed object (star or galaxy). This procedure is clearly at fault with Einstein principle of relativity who claims that it is only due to the relative velocity. These tables are calculated without taking into account the relative velocity between the Earth and the galactic object. Only the Earth velocity of rotation and translation around the Sun is taken into account. In the case of orbiting telescopes, the stellar aberration due to the velocity of the satellite is also taken into account. Fortunately, it is obvious that all scientists “forget” to apply Einstein’s relativity principle here. The generally accepted procedure is not compatible with the Einstein’s principle of relativity. Consequently, we are forced to conclude that Einstein’s principle of relativity is in error. That accepted system of coordinates (which actually, is with respect to the Sun) is “in fact” considered, as an ABSOLUTE system of coordinate.

There is also another important question that must be raised. Does this system of coordinates give the “real” position of stars? Considering that the real relative velocity between the observer and the star is already not taken into account (contrary to Einstein’s principle), is it logical to use these Sun’s coordinates? We know that star aberration calculation described above corresponds to using Sun’s coordinates. Does that system (of coordinates) lead to coherent results? The answer is NO, not completely. Let me give an example.

Let us assume that we make astronomical observations during several millennia. During these millennia, the solar system moves at velocity V around the center of our galaxy. After many millennia, we will find that very remote galaxies in the universe will “appear” to make oscillations, for each rotation of our sun around our galaxy. Therefore our system of coordinates, based on the Sun’s frame, must be corrected, due to this new (galactic) star aberration, due to the velocity of the sun around our galaxy. Sooner or later, due to the extreme accuracy in the measurements of coordinates, we will have to take into account that other correction due to the rotation of our galaxy. There will be no other choice, if we wish to remain coherent. There is also one more minor correction, originating from the perturbation of our sun inside our local galaxy, due to the interaction with neighboring stars.

The ultimate correction of star aberration involves the absolute velocity of our sun in the universe. That absolute velocity has already been determined. We have seen in the paper: “Big Bang Cosmology Meets an Astronomical Death” that the dipole of the 3K cosmic radiation is due to the proper motion of our

sun in the universe. Of course, the cosmic radiation is due to the emission of the Planck radiation of interstellar gases in the universe, which is at 3K as explained in the paper: "The Origin of the 3 K Radiation" and also in the paper: "The 3 K Microwave Background and the Olbers Paradox"

The asymmetry (dipole) of that Planck radiation is due to the absolute proper motion of our sun in the universe. This shows that it is now possible to determine that absolute frame of reference in our universe. There exists no other system of coordinates capable of giving coherent data.

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References

[1] J. Bradley "*Account of a New Discovered Motion of the Fixed Stars*" Phil. Trans. 35 p. 637 (1728).
[2] H. E. Yves "*Extrapolation from the Michelson-Morley Experiment*" J. Opt. Soc. Am. 40, pp. 185-190 (1950)
Also - P. Marmet, "The Overlooked Phenomena in the Michelson-Morley Experiment"
[3] E. Eisner, "*Aberration of Light from Binary Stars - a Paradox?*" Am. J. Phys. 35, pp.817-819 (1967)
[4] T. E. Phipps "*Relativity and Aberration*," Am. J. Phys., 57, pp., 549-550 (1989) also Phipps T. E., Jr., "*Stellar Aberration from the standpoint of the Radiation Convection Hypothesis.*" Phys. Essays 4, 368, (1991)
[5] H. C. Hayden, *Stellar Aberration,*" Galilean Electrodynamics, 4. pp. 89-92 (1993)
[6] C. Moller, *The Theory of Relativity*, (Oxford 1972)
[7] W. Heisenberg, "*Physics and Philosophy, the Revolution in Modern Science*" New York, Harper and Row, (1966) p. 88
[8] P. Marmet, "*Absurdities in Modern Physics: A Solution*" Les Éditions du Nordir, Simard Hall, 165 Waller, Ottawa, K1N 6N5, Canada (1993).

Résumé

Le phénomène d'aberration stellaire est expliqué par la vitesse relative transversale entre l'étoile et l'observateur sur terre. Ceci est en conformité avec le principe d'invariance d'Einstein. Ainsi, il ne doit y avoir aucune différence entre une étoile ayant une vitesse par rapport à un observateur et un observateur se déplaçant par rapport a une étoile. Il est observé que dans le cas de l'aberration stellaire, certains résultats semblent incompatibles avec ce principe d'Einstein. On démontre ici que la description de l'aberration stellaire en terme de vitesse relative transversale entre les étoiles et la terre devrait être corrigée à cause qu'elle est une interprétation erronée de la relativité d'Einstein.

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