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Measuring the Pecular Velocity of the System Without Going Beyond It

Svishch Vladimir

Kharkov National University of Aerospace named after Nikolay Zhukovsky, Kharkov Aviation Institute, Kharkov, Ukraine

Email address:
vladimir.svishh@rambler.ru

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Abstract: The proposed scheme for measuring the pecular velocity of the observer with respect to the relic radiation without leaving the observer's reference system is investigated. The stellar aberration phenomenon of the ground source using anisotropic matter is used to measure the velocity. A comparative analysis of relic radiation, stellar radiation, and ground-based sources has been carried out in order to use them for velocity measurements based on the stellar aberration of these sources. The principle of constancy of the velocity of light irrespective of the speed of the source and the observation device allows us to conclude that it is possible to use the radiation of terrestrial sources to measure the speed of the observer relative to the fossil emission, taking into account the difference of their wave fronts. The stellar aberration of the terrestrial source allows us to measure the velocity of the observer relative to the fossil radiation without leaving the observer's reference system. The use of an anisotropic medium eliminates the need to change the structure of the device in the measurement process. The expressions of the observer's velocity with respect to the relic radiation without leaving the observer's frame of reference are obtained depending on the parameters of the anisotropic medium used.

Keywords: Ground Source, Relic Radiation, Pecular Velocity, Light Aberration, Wavefront Curvature, Optical Crystal Axis, Refractive Index

1. Introduction

The problem of measuring the pecular velocity of the observer relative to the reference frame associated with the observable universe arose simultaneously with the hypothesis of the existence of the ether. Experiments to measure the pecular velocity since the creation of the Michelson interferometer in different variations continue to this day [1-5].

After Einstein's works on the theory of relativity and their development, the ether hypothesis proved to be superfluous [6, 7]. However, with the discovery of relic radiation a real possibility of a reference frame related to the observable Universe arose [8, 9]. And, naturally, the problem of measuring the peculiar velocity relative to the relic radiation was solved using the Doppler effect [10-15].

For the wide use of the reference system associated with the relic radiation, it is necessary, first of all, simple enough ways and devices to measure the velocity in it. The possibilities of measuring the velocity in such a reference system in a general form have been studied earlier [16-19].

The purpose of this work is to analyze in detail the method of measuring the observer's peculiar velocity based on stellar aberration using an anisotropic medium and to determine this velocity depending on the medium's parameters.

2. The Main Characteristics of the Radiation of the Observed Objects

Radiation from stars and other cosmic objects differs for a ground-based observer in the flat wave front due to their remoteness. This is essential for the observation of stellar aberration. When studying it, Einstein writes "Let some source of electrodynamic waves be located in the system K very far from the origin" [6]. Lorentz explicitly stipulates the condition "A section of a wave of such dimensions can be taken as a plane" in his study of aberration [20].

According to this parameter, the electromagnetic radiation of space objects, terrestrial sources, and relic radiation are significantly different.

Relict radiation surrounds us from all directions. The observer is as if in the center of the source, the radius R_r tends to 0 $R_r \to 0$. The curvature ρ_r of the wave front of the cosmic microwave radiation tends to infinity $-\infty$ $\rho_r = \frac{1}{R_r} \to -\infty$. Wavefront curvature ρ_c due to the remoteness $R_c \to \infty$ of space objects tends to 0 $\rho_c = \frac{1}{R_c} \to 0$.

Terrestrial sources are at a finite distance r from the observer, and therefore their wavefront at the inlet of the device has a finite curvature $\rho = \frac{1}{r}$.

The stellar aberration of terrestrial sources and relic radiation is not observable primarily because of the curvature of their wave fronts. The Doppler effect is observable and used when observing stars, quasars, other cosmic objects, terrestrial sources, and relic radiation. All these sources of electromagnetic radiation, taking into account the principle of constancy of the speed of light, from this point of view, are equivalent except for their wave fronts. When using the Doppler effect to measure the relative velocity of the source and the observer, the curvature of the source wavefront does not play a significant role. And to determine the stellar aberration of the source, the flat wavefront at the entrance of the instrument is an important parameter [17].

In addition, the Doppler effect measures the relative radial velocity of the source and the observer. This excludes the possibility of using it to measure the velocity of a closed system without going beyond its limits.

The possibility of determining the velocity of a closed system by determining the aberration of the source within this system is determined by the fact that it depends on the transverse velocity of the device relative to the light flux inside the device.

Based on the principle of constancy of the velocity of light regardless of the speed of the source and the observation device, the radiation of a terrestrial source is equivalent to relict radiation in terms of propagation in space. Relict radiation, radiation of space objects and terrestrial sources are equivalent except for their wave fronts.

Consequently, the velocity of the observer relative to the luminous flux of the terrestrial sources is equal to the velocity of the observer relative to the relict radiation.

3. Velocity Measurement Based on Stellar Aberration of Light with Using Anisotropic Matter

Longitudinal entrainment of light flux has been investigated in detail since the works of Fresnel. On the basis of the simplest (incorrect!) mechanical model about total entrainment of a part of ether by bodies he obtained the correct, experience-proven entrainment formula. [21 - 23].

This formula was perfectly confirmed by Fizeau's experience (1851) with moving water and repeated this experience by Michelson (1886) and Zeeman (1914) with increasing accuracy of measurements. Sommerfeld investigated aberration and crystal optics based on Lorentz transformations [20].

Fizeau's work on longitudinal entrainment of light flux by the medium was highly appreciated by A. Einstein "Fizeau's experiment is fundamental also for the special theory of relativity". [4, p.].

These researches and experiments referred to the longitudinal, in the direction of propagation, entrainment of the light flux and the transverse entrainment was not considered.

Fresnel at the same time (1818) investigated the influence of such transverse entrainment. He analyzed the effect of filling the telescope tube with water (an isotropic medium) on stellar aberration measurements and concluded that it had no effect on its magnitude.

"Although this experiment has not yet been made, I have no doubt that it will confirm this conclusion," he wrote to Arago in 1818.

Such an experiment was set by Erie in 1871, which confirmed the invariability of the stellar aberration angle. The analysis of such filling is carried out in detail in [22, 23].

A study of the effect of the entrainment of light flux by a uniaxial anisotropic medium on the measurement of stellar aberration along the unusual beam indicates a change in the angle of aberration along the unusual beam [18].

Let us consider in more detail the possibilities of measuring the velocity with respect to the relic radiation on the basis of stellar aberration of light using anisotropic matter.

Dependences of the refractive index on the direction of the ordinary and extraordinary light rays in a uniaxial negative crystal are shown in Figure 1.

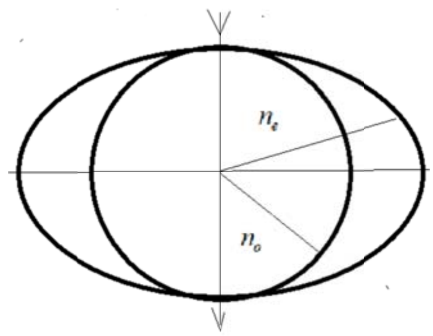

Figure 1. *Dependence of the refractive index of ordinary and extraordinary rays on their direction.*

If the refractive index n_o of the ordinary beam is equal in all directions (described by a sphere), the refractive index n_e of the unusual beam is described by an elipsoid of rotation with an axis coinciding with the optical axis of the crystal. The coefficient k_e of entrainment of the light flux of the unusual beam e perpendicular to the crystal axis will differ from the coefficient k_o of entrainment of the light flux of the ordinary beam o, but in the direction of the optical axis they are equal.

If the light flux is directed along the optical axis of the crystal $\varphi = 0$ and the velocity v_1 of the optical crystal is collinear to its axis or equal to zero, there is no lateral entrainment and therefore there is no deflection of the ordinary o and unusual e rays.

If the velocity v_1 of the optical crystal is perpendicular to its optical axis, there is no ordinary beam o deflection $\psi_o = 0$, but the unusual beam e will be deflected $\psi \neq 0$ (Figure 2).

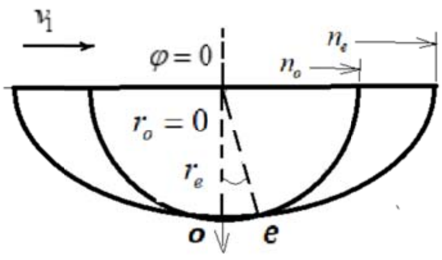

Figure 2. *Deviation of the extraordinary ray when the crystal moves perpendicular to its optical axis.*

Let the beam of light source 1 is directed along the optical axis of uniaxial negative crystal 2 with length L and refractive indices n_1 along the optical axis and n_2 across the optical axis. The angle of incidence of the beam is zero $\varphi = 0$ (Figure 3). On the other side of the crystal 2 there is a photodetector matrix 3.

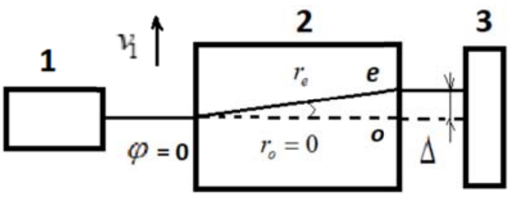

Figure 3. *Schematic of the channel of the device for determining the pecular velocity of the system.*

When there is no transverse velocity $v_1 = 0$ in the crystal 2, there is no splitting of the beam $\Delta = 0$ into ordinary o and extraordinary e, the light flux enters the original position on the matrix of photodetector 3.

At transverse velocity $v_1 \neq 0$ the ordinary light flux o is partially entrained by the crystal. The crystal for the ordinary beam o is isotropic, because the refractive indices n_1 along the crystal axis and n_2 across the crystal axis are equal $n_0 = n_1 = n_2$.

It would seem that the beam should deflect by the stellar aberration angle $\alpha_0 = \frac{V}{c}\sin\psi$ in accordance with the Fresnel study and the Erie experience [22]. However, the wave front of the ground source 1 hits the crystal 2 at an angle α_0, an aberration angle α_0 compensation occurs [17]. The ordinary beam o will not change the initial position.

For an unusual beam e the indices of refraction n_1 along the crystal axis and n_2 across the crystal axis are different $n_1 \neq n_2$. Therefore, the unusual beam will refract at an angle $r_1 = \frac{\alpha_0}{n_2} = \frac{1}{n_2}\frac{v_1}{c}$ and would be displaced on the photodetector matrix in the plane of the angle α_0 of incidence, that is, in the direction of velocity $v_1 = V\sin\psi$, taking into account the length L of the crystal and the smallness of the angles α_0, r_1, by Δ_1

$$\Delta_1 = L\frac{1}{n_2}\frac{v_1}{c} \tag{1}$$

In addition, this beam will experience a partial entrainment at a velocity v_2

$$v_2 = v_1\left(1 - \frac{1}{n_2^2}\right) \tag{2}$$

Along the axis of crystal 1 of length L the unusual beam e will propagate with the speed $\frac{c}{n_1}$ for time $t = L\frac{n_1}{c}$. During this time due to partial entrainment it will shift in addition to the displacement Δ_1 also in the direction of velocity v_1 by Δ_2

$$\Delta_2 = tv_2 = L\frac{v_1}{c}\frac{n_1}{n_2^2}\left(n_2^2 - 1\right) \tag{3}$$

The total shift Δ will be $\Delta = \Delta_1 + \Delta_2$

$$\Delta = L\frac{v_1}{c}\frac{1}{n_2}\left(1 + n_1 n_2 - \frac{n_1}{n_2}\right) \tag{4}$$

Hence the velocity $v_1 = V\sin\psi$ is

$$v_1 = \frac{\Delta}{L}c\frac{n_2^2}{n_2 - n_1 + n_1 n_2^2} \tag{5}$$

The effect of motion (second order $\frac{V^2}{c^2}$) determined by the Lorentz transformations may not be taken into account when measuring quantities of order $\frac{V}{c}$.

Since the radiation of source 1 in terms of propagation in space is equivalent to the fossil radiation, the velocity v_1 is equal to the speed of the observer relative to the fossil radiation in the direction v_1 at any point in space.

4. Conclusions

1. Consideration of characteristics of relic radiation, radiation of stars and terrestrial sources taking into account the principle of constancy of the velocity of light regardless of the speed of the source and observation device indicates the possibility of

measuring the speed of the observer relative to the relic radiation using the radiation of terrestrial sources.
2. The stellar aberration of the terrestrial source makes it possible to measure the observer's velocity relative to the fossil radiation without leaving the observer's reference frame, since the aberration is measured relative to the light flux inside the measuring device.
3. The use of an anisotropic medium makes it possible to measure the velocity of the observer without changing the structure of the device in the process of measurement.
4. The expressions for determining the observer's velocity depending on depending on the parameters of the anisotropic medium used.

ORCID

https://orcid.org/0000-0003-2903-5744

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