



ETHER AND EQUIVALENCE OF INERTIAL FRAMES OF REFERENCE

Andrew Chubykalo ^{*1}, Augusto Espinoza ¹, Victor Kuligin ², Maria Korneva ²

¹ Unidad Académica de Física, Universidad Autónoma de Zacatecas, A.P. C-580, Zacatecas, México

² Physical Faculty Department of an Electronics, Voronezh State University, Russia



Abstract:

The paper discusses the problem of equality of Inertial frames of reference IFR. The hypothesis of a physical ether, whose properties do not depend on the choice of an inertial reference frame, is proposed. Based on the concept of the physical ether, it turns out the features of instantaneous action at a distance. It is shown that there is a class of transformations that preserves Maxwell's equations unchanged. The problem of choosing a transformation is posed. This choice should be based on experimental research.

Keywords: Ether; Action at A Distance; Waves; Equality of IRF.

Cite This Article: Andrew Chubykalo, Augusto Espinoza, Victor Kuligin, and Maria Korneva. (2019). "ETHER AND EQUIVALENCE OF INERTIAL FRAMES OF REFERENCE." *International Journal of Engineering Technologies and Management Research*, 6(7), 156-166. DOI: <https://doi.org/10.29121/ijetmr.v6.i7.2019.432>.

1. Introduction

The concept of equality of inertial reference frames and the concept of ether seem unrelated to each other. The content of these concepts was formed independently of each other. The way of forming the content of the term "ether" contains many mutually exclusive representations. The concept of "ether" is found already in the ancient philosophers. For example, Aristotle considered the ether to be all-pervading and filling the whole space. His idea: "Nature is afraid of emptiness" – has maintained its heuristic value for several centuries. Since then, this concept has been filled with scientists (Descartes, Jung and Fresnel, Navier, Stokes, Lorenz, and others) with various contents.

In parallel with the concept of "ether", the notion of the independence of natural phenomena from the observer's choice of reference frame developed. In 1870, K. Neumann introduced the idea of an inertial reference frame. Later in 1886, L. Lange introduced the concept of an inertial coordinate frame. The transition from one inertial frame to another was carried out using the Galilean transformation. It was Galileo who first suggested the equality of inertial reference frames. In the modern interpretation, the principle of relativity for classical theories says:

Since in kinetics of acceleration plays a role in Newtonian dynamics (see Newton's second law), if it is rather natural to assume that forces depend only on the relative position and velocities of physical bodies (and not their position relative to the abstract reference point), that all equations

of mechanics are written in the same way in any inertial reference frame - in other words, the laws of mechanics do not depend on which of the inertial reference frames we investigate, do not depend on the choice of any particular from the inertial reference frames.

With the advent of electrodynamics, the problem of the extension of the Galilean principle to the phenomena of electromagnetism arose. Poincaré was the first to propose to extend the principle of Galilean relativity to electromagnetic phenomena (1904). The apparent “incompatibility” of classical theories, based on instantaneous action at a distance, and optical light phenomena, based on the principle of propagation of electromagnetic waves at the speed of light, created a number of problems whose solution has not yet been found.

Scientists have proposed various models for the realization of equality of reference frames, using the notion of a special environment– the ether. We will list some models: a solid model, a crystal model, a hydrodynamic model, a gas-like model, and others. We will not consider them. Later we will note the main drawback of such models. In this article we will analyze the main problems and try to outline a way to solve the problem of equivalence of all inertial reference frames.

2. Ether, Classical Mechanics and Galileo Principle

We will consider relativistic representations in the next section. Here we present the main bases of the materialistic understanding of categories: space, time, matter in classical mechanics.

- 1) Time is **homogeneous**, no experiments can detect a change in the pace of time. Time is **the same** for all reference frames.
- 2) The space in any reference frame is **uniform and isotropic**. The unity of space and time for all reference frames is a necessary condition for the equality of inertial frames.
- 3) **The interaction** of material objects is **objective** and does not depend on the **subjective** choice of the reference frame by the observer.
- 4) In classical theories, **any speeds** of motion of material bodies and waves are possible.
- 5) Galilean transformation has **commutative** properties. The transition of an observer from one inertial reference frame to another does not affect the space-time relationship and does not affect the interaction of material objects.

In materialistic philosophy, there is no such term as “absolutely empty space”. Such an idea of “emptiness” is a mathematical abstraction. The whole space is filled with “physical ether.” Now we must describe the properties of **the physical ether** and show its fundamental difference from other models of “ethers.”

Let us start with the laws of mechanics for conservative frames

- 1) The equation of motion of a body is **invariant** with respect to the Galilean transformation. This means that the force acting on the body and the acceleration acquired by the body are also invariant with respect to the Galilean transformation.
- 2) The law of conservation of momentum is **invariant** with respect to the Galilean transformation.
- 3) The law of conservation of angular momentum is **invariant** with respect to the Galilean transformation.
- 4) The law of conservation of energy is **invariant** with respect to the Galilean transformation.

- 5) Here one should add the *invariance of the speed of light* in various inertial reference frames. This fact we will discuss specifically later.

If we take into account that the ether is a kind of *mediator* in the instantaneous interaction of charges, currents, gravitational masses, then the following properties of the physical ether appear:

- 1) The properties of the ether are the same in all inertial reference frames, i.e. are invariant. In any inertial reference frame, the physical ether has the same properties! This fact is the main difference between the model of the physical ether and all other models of the ether, similar to material media.
- 2) The main property of the physical ether is its lack of an absolute reference frame. Material models of “ethers” necessarily have an absolute frame of reference in which ether is stationary. This is their fundamental difference from the physical ether.
- 3) Ether has linear properties. Ether does not affect the fields, waves and their interaction with each other. However, it can act as an intermediary in the interaction of material objects and the propagation of oscillations. Interactions like “photon-photon” in the physical ether are impossible.
- 4) Physical ether does not resist the movement of neutral material bodies and does not possess viscosity.
- 5) Ether is an intermediary for instantaneous action at a distance (in the interaction of inertial charges). Ether transmits the effects of objects on each other, although it does not participate in the process of energy exchange and impulse exchange.
- 6) Electromagnetic waves are waves of ether oscillations in physical space. Since the properties of the physical ether do not depend on the choice of the inertial reference frame, the propagation velocity of these oscillations is unchanged. It is the same in any inertial reference frame.

We have described some properties of the physical ether. Now consider the role of the ether for the charge fields. We will consider the electric charge, although the qualitative picture will be similar when analyzing a gravitational charge.

3. Ether and Charge Field

The resting body creates an electrostatic field around itself. The field is a figurative physical *model* (reflection of a fragment of reality), which allows us to give a speculative idea and, based on *analogy*, present a picture of physical phenomena and processes. According to modern concepts of quasistatic electrodynamics, the electric charge is surrounded by *vacuum* (emptiness). It is impossible to imagine a carrier who would create something *material* in the surrounding vacuum charge, for example, a field.

Physical ether saves the situation. From the above point of view, the charge forms around itself from the ether (conditionally speaking) something like *an infinite continuous medium*. We call this medium the electric field of a fixed charge. The charge field is the excited state of the physical ether generated by the charge. The charge field has *energy and power* properties. It can affect other charges with some force and cause their acceleration. The ether here is only an *intermediary*.

Consider the charge field and give some definitions.

Definition 1. *The potential of the electric field* at a given point in space, created by an electric charge resting in this inertial reference frame, is the **energy** characteristic of the field at rest in charge. The potential is numerically equal to the work we need to do in order to move the trial (unit, positive, point) charge from infinity to a given point in space.

Definition 2. The electric field strength of a *fixed* charge at some point in space is a **force** characteristic of the field. It is numerically equal to the force that will act on the trial (unit, positive, point) charge **resting** at a given point in space.

Highlighted words reflect a very important point. The absence of the word “resting” in the old definitions led to contradictions and allowed relativists to make an erroneous conclusion about the inability of classical theories to explain magnetic phenomena.

The potential of the charge field and its intensity is the state of the ether excited by the charge. Each point of the material ether is excited by a charge, and the magnitude of this influence of the charge on the ether depends on the distance to the charge. We can **conditionally** consider the charge field (potential and intensity) as a certain *infinite medium* surrounding the charge (excited state of the ether).

The theory of electric potential often uses the concept of a *point* charge. This is a charged body, which under the conditions of the physical problem under consideration has a *negligibly small size*. Note that the charged body of “point size” has a finite inertial mass of rest and the value of electric charge.

In physics and in the theory of potential, there is a *law of charge conservation*. Point charge does not disappear and does not occur. It does not “crawl” in space under the action of pushing Coulomb forces. Coulomb forces are “balanced” by forces of non-electrostatic origin. These forces provide stability charge. If a charged point body moves with velocity \mathbf{v} , then $\text{div}\mathbf{v} = 0$. In addition, if a *point* charged body *rotates around its axis*, around it there is no rotation of the scalar potential ($\text{rot}\mathbf{v} = 0$) and, accordingly, there is no magnetic field.

This is evidence of an important fact. When a charge moves, its field moves only **progressively**, regardless of the nature and curvature of the trajectory. The field moves parallel to itself. This unusual property of motion of the charge field is precisely due to the properties of the physical ether surrounding the charge. Each point of the potential of a point charge in space always has the same **velocity vector** as the **charge**. In other words, all potential points have *the same velocity vector* at the same time regardless of the trajectory of the charge. The charge potential (= physical ether) does not perform a *rotational* motion relative to its center of mass.

Recall that the scalar potential of a charged body satisfies the Poisson equation:

$$\nabla^2\varphi = -\frac{\rho}{\varepsilon}. \quad (3.1P)$$

The continuity equation for scalar potential. Considering the scalar potential of a charge as some continuous *continuum*, we can use for the charge field the ratios obtained in continuum mechanics. For example, the continuity equation for a scalar potential has the standard form:

$$\frac{\partial \varphi}{\partial t} + \text{div} \mathbf{v} \varphi = 0. \quad (3.1)$$

This is the known equation of continuum mechanics. We can now introduce the vector potential \mathbf{A} . Let $\mathbf{A} = \varphi \mathbf{v} / c^2$, then we get a new form of the continuity equation:

$$\frac{1}{c^2} \frac{\partial \varphi}{\partial t} + \text{div} \mathbf{A} = 0. \quad (3.2)$$

In electrodynamics, this condition is usually called the Lorentz gauge condition. We recall that the potential of the field of a point charge always moves progressively, i.e. all potential φ points have *the same speed*. And we again return to the charge excited physical ether, as a conditional “medium”, and the laws of continuum mechanics.

The conservation equation for vector tubes [1]. In continuum mechanics there is a continuity equation for some arbitrary vector \mathbf{a} . The vector \mathbf{a} describes the infinite vector field created by the field source. This field has an instantaneous character, like a scalar potential.

The conservation equation for vector tubes is:

$$\frac{\partial \mathbf{a}}{\partial t} + \mathbf{v} \text{div} \mathbf{a} + \text{rot}[\mathbf{a} \times \mathbf{v}] = 0. \quad (3.3)$$

If we replace vector \mathbf{a} with the vector Coulomb field $\mathbf{E}_q = -\text{grad} \varphi$, then we can write:

$$\frac{\partial \text{grad} \varphi}{\partial t} + \mathbf{v} \text{div} \text{grad} \varphi + \text{rot}[\text{grad} \varphi \times \mathbf{v}] = \frac{\partial \text{grad} \varphi}{\partial t} + \mathbf{v} \nabla^2 \varphi + \text{rot}(\varphi \mathbf{v}) = 0. \quad (3.4)$$

External electric field (Faraday field)[2]. When a scalar potential moves with respect to a fixed observer, the observer will find an “additive” to the field strength. This additive is a *external electric field* of Faraday. The intensity of the external field is equal to:

$$\mathbf{E}_f = -\frac{\partial \mathbf{A}}{\partial t}. \quad (3.5)$$

This field is third-party because it cannot be expressed in the form of a potential gradient of the electrostatic field \mathbf{E}_q , i.e. the \mathbf{E}_f field *is not of electrostatic origin*. The external EMF is the result of the motion of the scalar potential field relative to the resting test charge in the observer’s reference frame. It is easy to show that the identity holds:

$$\text{rot} \mathbf{E}_f = -\mu \text{rot} \frac{\partial \mathbf{A}}{\partial t} = -\mu \frac{\partial \mathbf{H}}{\partial t}. \quad (3.6)$$

This identity is called the “Faraday’s Law.”

If Maxwell followed the laws of potential theory and continuum mechanics, he would write the following frame of equations:

$$\left. \begin{aligned} \operatorname{rot} \mathbf{H} &= \varepsilon \frac{\partial \mathbf{E}_q}{\partial t} + \mathbf{j} \\ \operatorname{rot} \mathbf{E}_f &= -\mu \frac{\partial \mathbf{H}}{\partial t} \\ \operatorname{div} \mathbf{E}_q &= -\frac{1}{\varepsilon} \Delta \varphi = \frac{\rho}{\varepsilon} \\ \operatorname{div} \mathbf{H} &= 0 \end{aligned} \right\}, \quad (3.7)$$

where $\mathbf{H} = \frac{1}{\mu} \operatorname{rot} \mathbf{A}$, $\mathbf{E}_q = -\operatorname{grad} \varphi$, $\mathbf{E}_f = -\frac{\partial \mathbf{A}}{\partial t}$, $\mathbf{j} = \rho \mathbf{v}$.

It is interesting to note the following circumstance. Maxwell believed that the electric field is *one*. If we remove the indices with electric fields and combine them, then the frame of equations (3.7) takes the standard form of writing Maxwell’s equations:

$$\left. \begin{aligned} \operatorname{rot} \mathbf{H} &= \varepsilon \frac{\partial \mathbf{E}}{\partial t} + \mathbf{j} \\ \operatorname{rot} \mathbf{E} &= -\mu \frac{\partial \mathbf{H}}{\partial t} \\ \operatorname{div} \mathbf{E} &= -\frac{1}{\varepsilon} \Delta \varphi = \frac{\rho}{\varepsilon} \\ \operatorname{div} \mathbf{H} &= 0 \end{aligned} \right\}, \quad (3.8)$$

where $\mathbf{H} = \frac{1}{\mu} \operatorname{rot} \mathbf{A}$, $\mathbf{E} = -\operatorname{grad} \varphi - \frac{\partial \mathbf{A}}{\partial t}$, $\mathbf{j} = \rho \mathbf{v}$. The frame of equations (3.8) perfectly describes quasistatic phenomena. All fields and potentials are instantaneous.

We will not analyze the relationship of equations (3.7) and (3.8). This is a special topic. We will give only a brief explanation concerning the Coulomb interaction of charges. The state of a physical ether excited by a charge is a mediator, as we said, with instantaneous action at a distance. The physical ether does not have inertia, all changes in free space occur instantly. Any new charge, being in the electric field of the first, instantly feels the effect of force. At the same time, the first charge experiences the same effect from the second. The mediator of interaction is not “*emptiness*”, as it is written in modern physics, but the state of the ether excited by charges. Due to the symmetry of the interaction, the ether does not change its energy. He conducts the interaction between the charges simultaneously in both directions.

Despite the negative attitude towards instantaneous action at a distance, *it is important for us to preserve instantaneous action and instantaneous potentials in physics:*

- 1) The problem of electromagnetic mass has a solution only within the framework of instantaneous action at a distance [3]. In the framework of retarded potentials, this problem is unsolvable [4].
- 2) Instant potentials allow us to explain magnetic phenomena without contradiction [4].
- 3) The nature of gravity is a quadratic effect of quasistatic electrodynamics [5].

4. Light and Physical Ether

Now we have to consider electromagnetic waves in the physical ether. In accordance with the Galilean-Poincaré principle, the laws of nature and their mathematical description should not depend on the choice of the inertial reference frame. We have made one step in this direction, recognizing the speed of light independent of the choice of the inertial reference frame. But this is only a formal step, recognizing that the propagation of electromagnetic waves and light is the propagation of oscillations of the physical ether. It remains to find the transformation law that would preserve the invariance of the Maxwell equations.

However, we ran ahead, postulating the constancy of the speed of light. Indeed, it follows from Maxwell's equations that a fixed source of waves can emit waves that run away from a source at the speed of light regardless of the direction of wave propagation. And what is the speed of propagation of light that an observer detects when a source of electromagnetic waves passes by? We will tell about it below.

Attempts to solve experimentally the problem of the dependence of the speed of light on the world material ether have been carried out repeatedly (Michelson, Morley, Miller, etc.). These results confirm the hypothesis of the constancy of light and reject the existence of the material ether. However, these experiments do not contradict the hypothesis of the physical ether.

Reminder for readers. Once again we will give the distinctive signs of the material ether and the physical ether:

- 1) The material ether is a certain material environment, which we endow with special properties. Such a medium-ether has an absolute reference frame. In other words, we can find a reference frame where this medium-like ether rests. The definition of a liquid or gas-like ether is somewhat more complicated. Here we can introduce local absolute reference frames for selected areas.
- 2) The physical ether, in contrast to the material medium-ether, does not have an absolute reference frame. The properties of such an ether are the same in any inertial reference frame. They do not depend on the choice of reference frame. We described the properties of the physical ether earlier.

Unfortunately, not all light phenomena have the correct explanation. There are phenomena that have not yet been noticed by experimenters and theorists. Consider one of these phenomena.

Let there be some continuous medium with a flat boundary. A ray of light falls on this border. In macroscopic electrodynamics, it is believed that the speed of light in the medium will decrease by $\sqrt{\epsilon}$ times (ϵ is the relative dielectric constant). In fact, this change in speed does not happen instantly. At the interface in the medium an intermediate region is formed, in which the light "slows

down” to a value of $c/\sqrt{\epsilon}$. At the same time, a reflected wave is formed in this region, which then goes into free space.

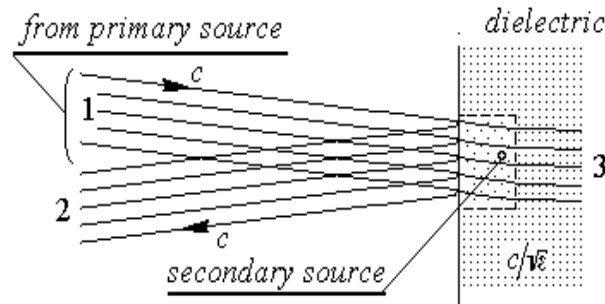


Figure 1: 1 – falling wave, 2 – reflected wave, 3 – transmitted wave.

Here you should pay attention to two phenomena. Firstly, the depth of the mentioned area depends on the density of the substance and its other characteristics. For example, in rarefied gases, it can be significant. Secondly, the region of the formation of the reflected wave (= emerging from the other side of the dielectric into space) becomes a “secondary source” for the reflected and transmitted waves. The light reflected from the medium has the value “c” relative to the secondary radiation source in free space. If the reflection point moves along the surface, its movement is simultaneously the movement of the secondary source. The reflected beam has a speed relative to the secondary source equal to “c”. Light propagating in the medium has a speed of $c/\sqrt{\epsilon}$ in this medium.

These circumstances were not taken into account by A. Einstein when creating the SRT.

5. Illusion and Reality

Let us consider one of the proofs of A. Einstein, illustrating the phenomenon of "time dilation" [6]. In Einstein’s thought experiment, a mirror is considered that moves along the x axis at a speed v , as shown in Figure 2. The observer sends a light pulse to the mirror perpendicular to the surface and receives a reflected signal. Knowing the distance to the mirror R_0 and the speed of the mirror v , the observer compares the signal passing time in the observer’s reference frame and in the reference frame associated with the mirror, and concludes that the time is “slowed down”. We do not stop at the detailed description of the experiment, since the content of the experiment is discussed in many textbooks (for example, [6]).

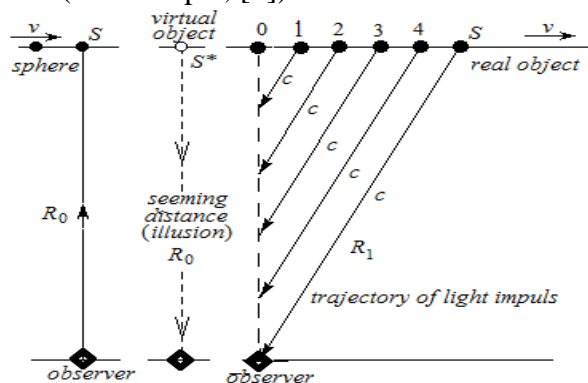


Figure 2:

Einstein used a mirror for “visualization”. The mirror creates the illusion of "correctness of reasoning." We will assume that a small reflecting light ball is moving. Now we will look at the physical process in detail.

The impulse of light before meeting the ball passed the distance R_0 . Then the light reflected from the ball, moving with speed v . Here we find an important point that A. Einstein did not notice. When a light impulse falls on a ball, this impulse is reflected from its surface. Now the ball becomes a “secondary source” of light. The impulse from a moving ball propagates in the form of a spherical light wave. The ball is the center of this expanding sphere at the speed of light. The sphere and its center (ball) move synchronously.

We will highlight the arrow in Fig. 2 a separate direction along which the pulse of reflected light propagates. The observer must meet precisely with this impulse. The ball moves and at the same time the sphere expands with the speed of light. The ball passes the points 1, 2, 3 Each point has its own sphere radius. When, finally, the expanding sphere reaches the observer, it “sees” the ball at point S^* , not at point S .

There is an incorrect expression: “As the light went from point S^* to the observer, the light source moved to point S .” In fact, due to the relative speed of movement, the eye (or optical device) perceives the moving wave front to be distorted, i.e. as if "turned at some angle" (aberration angle). The human eye, perceiving information from the front of a spherical wave, completes the picture, and the person sees the object at point S^* . Human gas sees an imaginary image (illusion) on the continuation of rays perpendicular to the wave front distorted by motion. In our earlier works, we also adhered to such a wrong explanation. It seems to the observer that light has traveled the distance R_0 . In fact, the light passed the distance R_1 . The angle between the segments R_0 and R_1 is called the aberration angle. In SRT it is known that the lengths of spatial segments are true scalars. The lengths do not depend on the choice of the inertial reference frame. Therefore, the time spent by the pulse on the passage of the "observer-ball-observer" section $T = (R_0 + R_1)/c$ is the same and does not depend on the choice of inertial reference frame. Time is the same for all inertial frames. We have no reason to accept Einstein's arguments as correct.

An explanation of some other SRT paradoxes can be found in [7]

The Speed of Light in the Medium and the Ether

Maxwell's equations and the requirement of equivalence of inertial reference frames seem incompatible within the framework of the Galilean transformation. Scientists needed to find a way out to eliminate the contradiction. Thus, the idea of a world ether, similar to the material medium, but possessing specific properties, arose. An indispensable element of such an ether or its fragment was an absolute reference frame associated with the entire ether or its fragment.

The introduction of the world ether, affecting the speed of propagation of an electromagnetic wave, was actually reduced to the search for the dependence of the speed of the light wave $c(v_e)$ on the speed of movement relative to the absolute reference frame (world ether). The unsuccessful results of the “ether wind” search with the help of experiments (Michelson, Morley, Kennedy, Miller, Lodge, Lordmeier, and others.). In our opinion, are natural. They confirm the absence of the world

ether as a material medium. However, these experiments do not reject the hypothesis of the existence of a physical ether.

The speed of light in the physical ether does not depend on the speed of the source or the speed of the observer. This hypothetical position is accepted by most physicists. However, it requires experimental confirmation. We can offer a simple experiment with the use of Korneva's binoculars. The essence of the experiment is shown in Figure 3:

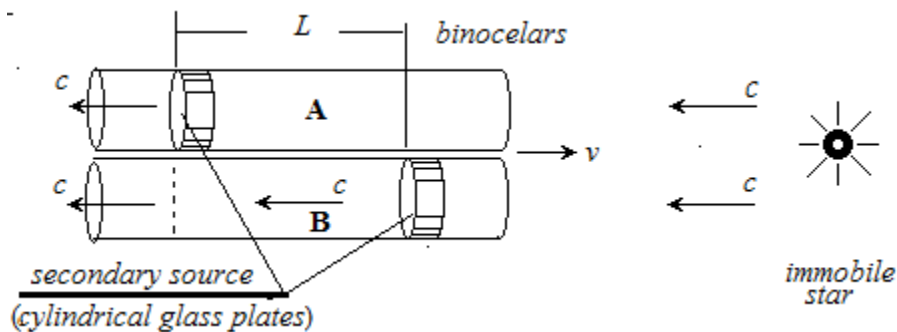


Рис. 3

Two hollow cylinders are arranged in parallel. Each cylinder has a round plate. If light passes through the cylinder, the last plane of the plate becomes a source of secondary radiation. Light from a secondary source has a speed of c . Let the binoculars approach a fixed star at a speed v . If the speed of light depends on the relative speed of the observer and the source, then the section L in the tube A light passes during the time $T_1/(c + v)$. In tube B, the speed of light is constant and the transit time is $T_2 = L/c$. At the binocular output, the rays will have a phase difference of

$$\Delta\varphi = 2\pi \frac{L v}{\lambda c}, \tag{6.1}$$

where λ – a wave length. If the observation is conducted from the ground or from a satellite, the relative velocity v changes direction by 180° . The change in the observed phase shift is easy to detect because the effect is of the order of v/c . We are confident in the negative result of this experiment. However, confidence is not yet true.

The Problem of Equality of Inertial Frames

So, the problem of equality of inertial reference frames does not yet have a solution. New circumstances require taking them into account. Studies have shown [4] that the wave equations are invariant with respect to a large group of transformations, which is related to the Lorentz transformations.

$$\begin{aligned} x &= x' \sqrt{1 + f(V/c)^2} - ct f(V/c), y = y', z = z', ct \\ &= ct' \sqrt{1 + f(V/c)^2} - x' f(V/c), \end{aligned} \tag{7.1}$$

where $f(V/c)$ is some odd function of V/c . In the particular case, we have the Lorentz transformation, if $f(V/c) = V/\sqrt{c^2 - V^2}$.

We see three solutions to the problem:

First option. The instantaneous potentials are transformed using the Galilean transformation. Wave fields are transformed by means of the parametric Galilean transformation [7].

The second option. The instantaneous potentials are transformed using the Galilean transformation. Wave fields must obey one of the transformations of the form (7.1).

The third option. Instantaneous potentials and wave fields obey one of the transformations of the form (7.1).

This question must be solved experimentally.

6. Conclusion

The problem of equality of inertial reference frames, as we found out, has not yet been completely resolved. We addressed issues related to the concept of the ether. In our opinion, the physical ether, whose properties do not depend on the choice of an inertial frame, deserves attention. With the introduction of the physical ether, the mechanism of instantaneous action at a distance begins to emerge. This interaction does not violate the principle of causality and reveals the mechanism of interaction of charges.

The second aspect of the problem of equality of inertial frames is associated with the confusion introduced by A. Einstein's special theory of relativity. Confusion caused by misinterpretation of physical phenomena.

The third aspect of the problem is to solve the problem of choosing the right option from those discussed above. We hope that experiments will be able to answer these important and complex questions.

References

- [1] Landau L and Lifshitz E 1986 Fluid Mechanics (2nd ed. Pergamon Press)
- [2] Tamm I 1979 Fundamentals of The Theory of Electricity (Mir Publisher, Moscow)
- [3] Kuligin V, Kuligina G and Korneva M 1996 The Electromagnetic Mass of a Charged Particle. *Apeiron* 3(1), 7
- [4] Chubykalo A and Kuligin V 2018 Unknown classical electrodynamics *Boson Journal of Modern Physics* 4(2) 384-425
- [5] Chubykalo A, Espinoza A and Kuligin V 2019 The postulate of the equivalence of masses or the law of their proportionality? *International journal of engineering sciences & research technology* 8(2) 129-137
- [6] Panofsky W and Phillips M 1990 Classical Electricity and Magnetism 2nd ed. (Dover Publ.)
- [7] Chubykalo A, Espinoza A, Kuligin V and Korneva M 2019 Why does the struggle around SRT continue to this day? *International Journal of Research – Granthaalayah* 7(1) 205-237

*Corresponding author.

E-mail address: achubykalo@ yahoo.com.mx