Special Aether or Special Relativity?

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Abstract—The advent of elegant theories, such as special relativity and quantum mechanics, ushered modern physics into an era marked by fantasized contemplation of phenomena, a trend that even persists today. In principle, every phenomenon is physical and can be comprehended mechanistically, given access to the necessary information. In a previous study, we explored the discussion on the equivalence of quantum mechanics with Fick's second law as its classical analogous for Brownian particles which reveals that there should be underlying particles that govern the motion of subatomic particles in quantum mechanics. In this context, we delve into how the description of a special aether medium in space enables the system to adhere to Galilean relativity instead of special relativity, which assumes the absence of aether. Given this, we emphasize that space and time are absolute; rather, it is indeed the velocity that is relative to the initial frame of reference.

Keywords—Relativity, Time, Space, Aether, Light

I. Introduction

With the knowledge of light and magnetic field interaction in the so-called Faraday's rotation experiment and the equality of speed of light with electromagnetic radiation, Maxwell drew that light is an electromagnetic wave.[1] He found that the speed of light in a vacuum is always constant c from any inertial frame of reference. This conflicts with Newtonian mechanics as Galilean relativity shows the total speed of light should be equal to the sum of the speed of light and the speed of the moving object from which the light is emitted. On the other hand, Einstein developed a theory of special relativity to maintain the constant speed of light in any inertial frame of reference. He accomplished this using Lorentz transformation (instead of Galilean transformation) where Pythagorean theory in two dimensions is embedded in the calculation of the speed of light.[2] However, here we argue that rather than the speed of light, it is indeed the traveling time and space that are independent of the frame of reference as it is postulated by Newtonian mechanics.[3]

We propose that light is transferred through a physical property in space, maintaining the traditional hypothesis that space is filled with minute particles known as aether.[4] Our further speculation suggests that light might be the oscillation of these particles, and their communication speed between neighboring particles collectively leads to the speed of causality. With this assumption, we deduce that the constant causality speed is an inherent property of the aether. Due to the aether's constant speed of causality, the speed of light can be unaffected by the velocity of the reference frame, though this doesn't universally apply. The speed of light remains constant, regardless of the frame of reference, only if we assert that aether is carried by an independently moving entity separated from the reference frames of our interest. The speed of light would differ between any two frames if their respective aether that is carrying light has different velocities. In such cases, the Galilean transformation can be used to calculate the total speed of light, which can differ from the speed of causality. Before delving further into this, let's briefly explain special relativity to the best of our ability.

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II. Results and Discussion

Imagine that we shine a light in the longitudinal direction (x-direction) from a longitudinally moving frame of reference with coordinates of (t' and x') and a velocity of v in the x-direction relative to a stationary frame of reference with coordinates of (t and x). From the moving frame, the prime frame, the light that is emitted from the stationary frame travels with a speed of $c - v$, while from the stationary frame of reference, the light emitted from the prime frame travels with a speed of $c+v$. However, according to Maxwellian mechanics, light travels the same distance in any frame of reference at a given time. Therefore, to maintain the speed of light constant c, from the moving frame of reference we inevitably write:

$$ct' = \gamma(ct - vt), \tag{1}$$

where γ is called the Lorentz factor that adjusts time and length to equalize the light speed measured from different frames of reference. As all the laws of physics should be valid regardless of the frame of reference, therefore symmetrical, from the stationary frame of reference we write:

$$ct = \gamma(ct' + vt'). \tag{2}$$

By substituting Eq. 1 in Eq. 2, we receive:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1}. \tag{3}$$

The same equation emerges for γ if we had imagined the light travels transversely to either frame of reference. Because, from the prime perspective, we would have

$$(ct')^2 = \gamma^2((ct)^2 - (vt)^2), \tag{4}$$

and from the stationary perspective, we have:

$$(ct)^2 = \gamma^2((ct')^2 - (vt')^2). \tag{5}$$

By substituting Eq. 5 into Eq. 4, we again receive Eq. 3.

This is thought to be the case in Michelson–Morley's light interference experiments. This experiment was devised to prove the existence of an aether medium in space. It was hypothesized if the aether moves with a velocity v relative to the Earth then the transverse and longitudinal lights have different traveling times for light.[5] Furthermore, the rotation of the device would lead to the change in interference pattern owing to the uneven friction for longitudinally and transversely traveling light caused by aether acting as an impedance on the light path. Now, please assume that the Michelson-Morley interferometer device has an equal transverse and longitudinal length of x from the splitter, and it is moving against the aether longitudinally with a velocity of v relative to that of the aether. Then from the stationary frame of reference, longitudinal light traverses the $x - vt_{long}$ length in the forward path and the $x + vt_{long}$ length in the backward path to the splitter, making it a total of $2x$ traveling. Therefore, the time that the light takes to travel from the splitter to the mirror and go back to the splitter is:

$$t_{long} = \frac{x}{c-v} + \frac{x}{c+v} = \frac{2x}{c}\frac{1}{1-\frac{v^2}{c^2}}. \tag{6}$$

On the other hand, the aether moving in a longitudinal direction causes an angle in the transversely passing light pathway such that we have $x = \sqrt{x_{trans}^2 - (v^2 t_{trans}^2)}$. Therefore, the time that takes transverse light to move from the splitter to the mirror and then come back to the splitter is:

$$t_{trans} = \frac{2x}{c}\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{7}$$

By comparing Eqs. 6 and 7, we see that $t_{long} \neq t_{trans}$. If an aether exists, the time that it takes for the light to go through longitudinal and transverse pathways must be different, and the rotation of the device would change the interference pattern. However, Michelson and Morley detected the same interference pattern regardless of the angle of the apparatus and the time of the year the measurement took place. Therefore, the experiment failed to prove the presence of aether.

In an effort to equalize the longitudinal and transverse time, $t_{long} = t_{trans}$, it was proposed that the longitudinal pathway undergoes contraction, represented as $x_{long} = x/\gamma$. This contraction was thought to result from the frictional force on the light applied by the aether due to its opposing motion with a specific relative velocity of v. Nevertheless, setting aside the aether hypothesis, Einstein normalized the time by formulating special relativity as discussed earlier. In this theory, time dilation and length contraction emerge to synchronize the speed of light. Thus, from the stationary frame of reference, as previously demonstrated in Eq. 2, expressions for time and length are given by

$$t = \frac{t' + \frac{v}{c}t'}{\sqrt{1-\frac{v^2}{c^2}}}, \quad x = \frac{x' + vt'}{\sqrt{1-\frac{v^2}{c^2}}}, \tag{8}$$

and from the moving frame of reference, using Eq. 1, the time and length become:

$$t' = \frac{t - \frac{v}{c}t}{\sqrt{1-\frac{v^2}{c^2}}}, \quad x' = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}}. \tag{9}$$

Special relativity was strongly supported by the scientific community considering the null results of the Michelson-Morley experiments, in which the existence of aether was not proven. On the other hand, if we adhere to special relativity, we can justify the constant speed of light without the need for aether.[6] However, we argue that when the aether is undergoing different motions, it varies the speed of light. Furthermore, if the aether that is attributed to a frame of reference moves with a different velocity than the aether of another frame of reference, the respective speed of light will not be the same. Consequently, the total speed of light cannot remain constant; instead, it is the causality speed that is invariant to the frame of reference and is an inherent property of space. The constant causality speed leads to the constancy of light speed when the aether motions of the frames are the same. Bearing this in mind, we demonstrate that the special implementation of the aether medium into space disputes the principles of special relativity. Even though there is no way to prove the presence of underlying degrees of freedom, it is still intuitive to think that the universe functions mechanically despite this mindset.

We assume that light is either carried or created by underlying degrees of freedom that communicate with the speed of causality. We think degrees of freedom that compose aether near the surface of the earth are rotating with, presumably, a similar velocity of v as the one of the earth around the sun. For the sake of simplicity, we consider the system constituted of the Earth rotating around a stationary Sun. In this system, we think that even though the causality speed is expected to be the same from any frame of reference, the speed of light is variant and follows the Galilean transformation. We elaborate our conjecture with the example of the Michelson-Morley experiment. In this experiment, from the stationary frame of reference, the light in a transverse pathway moving in two directions, and the total speed of light (c_{tot}) and total length based on Galilean transformation using Pythagorean theorem simply are:

$$c_{\text{tot}}^2 = c^2 + v^2, \quad x_{\text{tot}}^2 = x^2 + (vt')^2, \tag{10}$$

which makes transverse time to be:

$$t^2 = \frac{x_{\text{tot}}^2}{c_{\text{tot}}^2} = \frac{x^2 + (vt')^2}{c^2 + v^2} = t'^2 \quad \Rightarrow \quad t = t', \tag{11}$$

whereas, from the moving frame of reference, the aether speed is zero ($v = 0$) and the above equations become:

$$\begin{cases} c'_{\text{tot}} = c \\ x'_{\text{tot}} = x \end{cases} \quad \Rightarrow \quad t' = t. \tag{12}$$

We see that from both stationary and moving frames of reference, the time that takes the light to travel through the transverse pathway is equal because the moving frame of reference measures a shorter length and slower speed of light than the stationary frame of reference. But for the longitudinal path from the stationary frame of reference according to the Galilean transformation, we have:

$$c_{\text{tot}} = c + v, \quad x_{\text{tot}} = x + vt', \tag{13}$$

therefore the traveling time in this direction from the stationary frame of reference is:

$$t = \frac{x_{\text{tot}}}{c_{\text{tot}}} = \frac{x + vt'}{c + v} = t', \tag{14}$$

and from the moving frame of reference, the aether motion relative to the earth is again zero ($v = 0$). Therefore, from the moving frame of reference for the longitudinal pathway, we again receive Eq. 12.

We showed the traveling time of light that travels through two different directions in Michelson-Morley's experiment is not affected by the frame of reference. In Michelson and Morley's experiment, the only transitional motion that we take into account is the rotation of the Earth around the sun. Therefore, in such a system, the stationary frame can be interpreted as the absolute frame of reference, since the system is motionless. However, the solar system including the sun and its planets such as Earth where the light is emitted undergo different dimensions of motion. As we do not have complete knowledge about the universe, it is impossible to find the absolute speed of light from the absolute frame of reference. Nonetheless, to calculate the absolute speed of light from an absolute frame of reference using Galilean transformation in classical mechanics, we must consider all the motions that the emitting object is undergoing.

Thus far, we have been able to justify the results of Michelson-Morley's experiment with a special implementation of aether into space without adjusting time and space. The aether and earth were moving with the same velocity of v and a relative velocity of zero from each other. Further, we showed that the speed of light is equal to the causality speed of c from the moving frame of reference with the relative velocity of aether to the frame of reference being zero. When the aether within a system moves faster or slower than its surrounding, then we need the relative speed of the aether to the interested frame of reference to calculate the total speed of light from that frame. For instance, imagine an isolated system that can carry the aether independently from its surrounding. Then, the total speed of emitted light within this system from the frame of reference moving along with the same speed remains the causality speed of c, but from a stationary frame of reference, for instance, outside the system, the speed of light and the aether speed within the system add up to provide the total speed of light.

The same principle is followed for a stationary system whose underlying degrees of freedom somehow move with a relative velocity to the stationary frame of reference in the same direction that the light is emitted through the system. But we should remember that it is the interaction of matter and the aether that can lead to the motion of the aether. Therefore, for the aether to move relative to a stationary frame, the constituent matter within the system must move. We think that the light itself that is also caused or created by these underlying particles interacts with matter in the same way. Consequently, the light velocity decreased by interaction with the medium, and the decrease of the speed of light alleviated with the moving matter. To understand the effect of the aether's velocity on the speed of light and its interaction with matter, we discuss Fizeau's experiment in which light is emitted through water. We know that the speed of light reduces (c') upon the collision of light with the water molecules inversely proportional to a specific property of water called refractive index of n. If the water molecules are stationary, then the reduced speed of light (c') is as follows:

$$c' = \frac{c}{n}. \tag{15}$$

This could be because water molecules with their surrounding aether medium interact with the underlying degrees of freedom that constitute light. As a result, water forms a sort of rigidity in the motion of nearby hidden particles to a degree measured as the refractive index. This means that the water increases the viscosity of the aether medium for the passage of light. Now further imagine that the water moves with a velocity of v in the same direction as the emitted light, with the same principle, now these underlying degrees of freedom are dragged by water molecules depending again on its refractive index of n. Therefore, the light that collides with the moving water molecules experiences less resistance in passage through the moving water than when the water is still. In this scenario, the length and time of traveling light from a stationary frame of reference using Galilean transformation follows:

$$t = t' + \frac{v}{c}t', \quad x = x' + vt', \tag{16}$$

using Eq. 16, we can derive the speed of light to be

$$\frac{x}{t} = \frac{\frac{x'}{t'} + v}{1 + \frac{v}{c^2}\frac{x'}{t'}}. \tag{17}$$

From Eq. 17, it is realized that for the $v = 0$ the speed of light in both frames of references is equal, and for this case, it is $\frac{c}{n}$. But for the velocity of v, we receive:

$$\frac{x}{t} = \frac{c}{n}\left(\frac{1 + \frac{nv}{c}}{1 + \frac{v}{nc}}\right). \tag{18}$$

Eq. 18 is approximately equal to Fizeau's equation:

$$\frac{x}{t} \approx \frac{c}{n} + v\Big(1 - \frac{1}{n^2}\Big). \tag{19}$$

However, if the water moves in the opposite direction as the light motion, the sign of the second term changes to negative.

$$\frac{x}{t} \approx \frac{c}{n} - v\Big(1 - \frac{1}{n^2}\Big), \tag{20}$$

which means the speed of light once is decreased due to interaction with the medium and second, it is decreased even more as the opposite force is applied by the aether against the light particles. But what if the light transversely is emitted to the longitudinally moving water? It will be carried with the moving water longitudinally while transversely passing through it. The squared length and time of traveling light from the stationary frame of reference under this two-dimensional motion across the medium can be calculated again using the Pythagorean theorem as follows:

$$t^2 = t'^2 + (\frac{v}{c}t')^2, \quad x^2 = x'^2 + vt'^2. \tag{21}$$

From Eq. 21, the squared speed of light will be:

$$(\frac{x}{t})^2 = (\frac{c}{n})^2 \left(\frac{1 + (\frac{nv}{c})^2}{1 + (\frac{v}{nc})^2} \right). \tag{22}$$

The Eq. 22 can be written as:

$$(\frac{x}{t})^2 \approx (\frac{c}{n})^2 + v^2 \Big(1 - \frac{1}{n^4} \Big). \tag{23}$$

We simply think that the velocity of light follows classical Galilean relativity rather than special relativity. Special relativity is just an elegant form of mathematics to justify the constant speed of light invariant to the frame of reference if an aether medium is neglected. However, in our model, we conjectured that it is time, space, and causality speed that are invariant. We show that the presence of a special aether explains why the traveling time is equal in two directions in the Michelson-Morley experiment, and how Fizeau's experiment works out.

Without considering the presence of particles either carrying light or the idea that light is the oscillation of particles constituting the aether, how else can we offer a physical explanation for the nature of light and its behavior? Additionally, the existence of a medium within and around matter may serve as a justification for the bending of light when it passes near a massive object. The stiffness of the medium within and around the matter, coupled with its rotation around the matter due to the spin of the matter around its axis, could guide light to circumnavigate the massive body. In the framework of general relativity, this circumnavigation is interpreted as a consequence of the curvature of spacetime.

Now let's forget about the light, if a particle moves with a velocity of u° concerning the moving frame in the same direction, from the stationary frame of reference the velocity of the particle obeys the Eq. 24

$$\frac{x}{t} = \frac{u^\circ + v}{1 + \frac{u^\circ v}{c^2}}. \tag{24}$$

The same particle with a velocity of u°, this time with respect to the stationary of reference, from the moving frame of reference has a velocity of:

$$\frac{x'}{t'} = \frac{u^\circ - v}{1 - \frac{u^\circ v}{c^2}}. \tag{25}$$

Eq. 25 is derived by dividing x' by t' in Eq. 16, and then substituting the velocity of the particle u° into the equation.

We also know that the momentum of the particle should be equal within these two frames of reference. From the stationary frame of reference, the particle momentum in the moving frame of reference is:

$$p' = m'(\frac{x'}{t'} + v). \tag{26}$$

From the moving frame of reference, the particle momentum in the stationary frame of reference is:

$$p = m(\frac{x}{t} - v). \tag{27}$$

To maintain the conservation of momentum, we write:

$$m'(\frac{x'}{t'} + v) = m(\frac{x}{t} - v). \tag{28}$$

Substituting the Eqs. 24 and 25 respectively in 28 and 27, and rearranging the equation, we write down:

$$\frac{m'}{m} = \frac{1 - \frac{uv}{c^2}}{1 + \frac{uv}{c^2}}. \tag{29}$$

Knowing

$$\frac{1 - \frac{uv}{c^2}}{1 + \frac{uv}{c^2}} = \frac{\sqrt{1 - \frac{u^2}{c^2}}}{\sqrt{1 - \frac{u'^2}{c^2}}}, \tag{30}$$

we substitute Eq. 30 into Eq. 29 to write:

$$\frac{m'}{m} = \frac{\sqrt{1 - \frac{u^2}{c^2}}}{\sqrt{1 - \frac{u'^2}{c^2}}}. \tag{31}$$

Now, take this problem to the moving frame of reference where the particle is at rest with a velocity of $u = 0$ and a mass of $m = m_\circ$ from the perspective of the moving frame and with a velocity of $u = v$ and mass of $m' = m$ from the stationary frame of reference. Under these circumstances, we derive the relativistic mass:

$$m = \frac{m_\circ}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{32}$$

This equation shows that the mass of a moving object increases. Also, we note that by expanding Eq. 32, we receive:

$$m = m_\circ + \frac{1}{2} m_\circ \frac{v^2}{c^2}. \tag{33}$$

By multiplying the Eq. 34 with c^2, we derive the relativistic mass-energy equivalence[7] relation as follows

$$mc^2 = m_\circ c^2 + \frac{1}{2} m_\circ v^2, \tag{34}$$

which shows the particle at rest has an energy of $E = m_\circ c^2$, and the sum of it with $\frac{1}{2} m_\circ v^2$ —-the measure of so-called kinetic energy—- is the total energy of the particle. This is an indication that the particle is forced to stay at rest position by unknown underlying degrees of freedom.

We believe that these degrees of freedom surrounding the ordinary particles and moving with them are the underlying cause of the formation of force.[8] The degrees of freedom rotate around the spinning body and apply force on the nearby bodies. As a result, a large spinning body in a system causes the significantly smaller bodies near them to rotate along the way around the larger body. In the same way, as the Earth rotates around the sun, the Moon rotates around the Earth, and the electron orbits the atom. The special implementation of aether into space can further explain how the movement of the magnet can generate current in the conductor. The magnetic field is the flux of the underlying particles through the highly synchronized spinning ordinary particles. When we pass it near by conductor, the flux of underlying particles applies force on electrons and results in a current in the conductor. Similarly, the current in the conductor applies force on nearby underlying particles and synchronizes the spins within the agent. Furthermore, the electrical current in the conductor generates a flux of the underlying particles through the magnet known as a magnetic field upon passing the conductor near the magnet.

III. Conclusions

The special implementation of aether explains the speed of light under different circumstances. We showed instead of normalizing time and space using special relativity, we can use the absolute definition of time and space in justification of the speed of light in the presence of aether.

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