Lorentz Contraction relative to Fresnel dragged reference frame explains Solid-State Michelson-Morley Experiment Null Result

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The formulas for the physical Fitzgerald-Lorentz contraction and the Lorentz mass increase are re-derived based on speed relative to the Fresnel dragged reference frame and on the isotropic speed of light in this reference frame. This derivation leads to length contraction and mass increase formulas which are similar to the current formulas but include the refractive index. The new formulas explain the essentially null result of the Solid-State Michelson-Morley experiment performed by J Shamir and R. Fox [1] and allow a sizeable mass (i.e. as opposed to isolated sub-atomic particles) to be accelerated somewhat beyond the speed of light with only a relatively small mass increase.

Keywords: Fitzgerald-Lorentz contraction, Lorentz mass increase, Fresnel dragged reference frame, isotropic, refractive index.

Introduction

The speed of electromagnetic radiation in a vacuum is reduced by over 30 % when it enters a transparent medium where it travels very close to the molecules comprising the medium. The Fizeau experiment with moving water confirmed Fresnel's drag formula and no experiments to date have conclusively proven that light is not dragged by a moving transparent medium. If we accept this viewpoint instead of Einstein's viewpoint it is possible to re-derive the Fitzgerald-Lorentz contraction and the Lorentz mass increase. Before proceeding, consider the fact that General Relativity Theory (GRT) allows that distant galaxies "drag" light when they are beyond the Hubble distance such that the light can not even start coming toward us until it distances itself from these galaxies. Although GRT considers space to expand, it appears easier, and perhaps no less correct, to consider fields to be moving through or expanding in space and exerting dominant control over the speed of light in a given region of space. We propose here that the inner region of matter dominates the inner space of that matter, and drags the reference frame where the speed of light is isotropic at a value of c/n as defined by Fresnel, where c is the speed of light in a vacuum and n is the refractive index of the material. Our proposal is strongly supported by the fact that both James Clerk Maxwell and current physics believe that the wave speed of electromagnetic radiation within a "stationary" medium, c/n, is well represented by the permittivity and permeability of the medium. For the above reasons, it is reasonable to re-derive the Lorentz contraction and mass increase formulas assuming that the Maxwell equations should be considered to hold in the dragged reference frame where the speed of light is isotropic, at a magnitude of c/n, while electromagnetic radiation moves within the medium. This derivation, depicted in Figure 1.0, leads to contraction and mass increase formulas which are similar to the Lorentz formulas except that they include the refractive index of the material. The new formulas explain the essentially null result of the Solid-State Michelson-Morley experiment performed by J Shamir and R. Fox [1] and allow a sizeable mass (i.e. as opposed to isolated sub-atomic particles) to be accelerated beyond the speed of light and close to v = nc with only a relatively small mass increase (i.e. a factor of about 3).

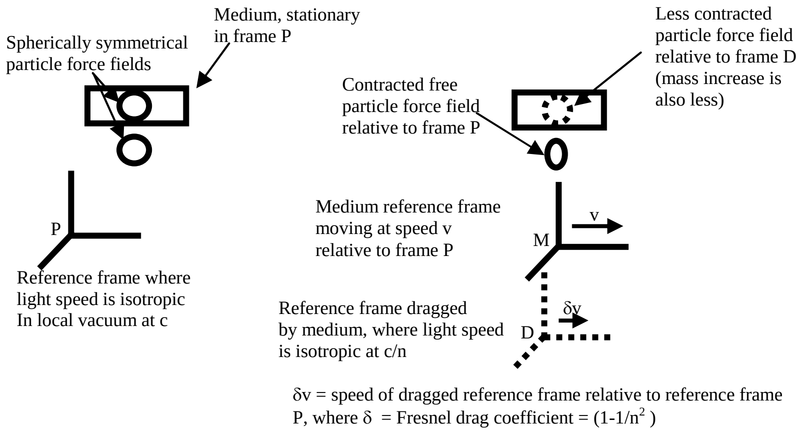
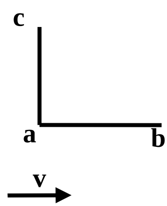


Figure 1.0 Lorentz Contraction and Mass Increase relative to dragged reference frame

Background

J. Shamir and R. Fox [1] and Reginald T Cahill [2] both report essentially null results for solid-state Michelson-Morley type experiments (i.e. experiments where both arms are made of a transparent material). Shamir and Fox conclude that the null result "enhances the experimental basis of special relativity".

Apparently both Shamir-Fox and Cahill considered Fresnel drag and a physical Fitzgerald-Lorentz contraction, leading to predictions of a non-null result for phase speeds. The contraction they considered, however, is determined relative to the space reference frame where the speed of light is isotropic with a value of c (as is commonly done) not relative to the dragged reference frame where the speed of light is isotropic with a value of c/n (as is done later in this paper). To see how they arrived at a predicted positive result, consider the experiment labelled as shown below,



where v is the velocity of the experiment relative to the reference frame where the speed of light is isotropic for our region of space, a-b is the arm of the experiment parallel to v (which experiences a physical contraction) and a-c is the arm of the experiment orthogonal to v (which does not experience a physical contraction). Light is split and travels path a-b-a and path a-c-a. Also,

c = speed of light in the isotropic reference frame
n = refractive index of the transparent medium arms
L = the length of both arms when stationary in the isotropic reference frame

The time for light to travel back and forth in the parallel arm is then given by;

$$t_{aba} = \frac{L\sqrt{1-\frac{v^2}{c^2}}}{\frac{c}{n}+(1-1/n^2)v-v} + \frac{L\sqrt{1-\frac{v^2}{c^2}}}{\frac{c}{n}-(1-1/n^2)v+v} \tag{1}$$

The time for light to travel back and forth in the orthogonal arm may be derived as follows. The phase speed of light within a transparent medium is considered to be isotropic relative to the dragged reference frame with a magnitude of c/n. The dragged reference frame moves at a speed of $(1-1/n^2)v$ relative to the preferred reference frame in which the speed of light within a vacuum is isotropic, and the transparent orthogonal arm of the experiment travels at a speed of v relative to this reference frame. Therefore, the experiment moves at a speed of $v_e = v-(1-1/n^2)v$ relative to the dragged reference frame. Since we know that the light must travel vertically up and down in the orthogonal arm, we can construct the following velocity vector diagrams for the upward and downward moving light,

where we seek the magnitude of v_m. For both diagrams we have;

$$c^2/n^2 = v_m{}^2 + v_e{}^2 \tag{2}$$

Substituting in for v_e and solving for v_m we have, for the orthogonal arm round trip time;

$$t_{aca} = \frac{2nL}{\sqrt{c^2 - (v/n)^2}} \tag{3}$$

The difference in the round-trip times given by equations (1) and (3) is not zero, and the difference in the difference, following a 90 degree rotation is twice this, ***so the prediction does not agree with the null results.*** But consider the additional possibility presented below.

Concepts Leading to Fitzgerald-Lorentz Contraction

The Fitzgeral-Lorentz contraction was developed by assuming that a preferred vacuum reference frame exists (i.e. the aether) where the speed of light is isotropic with a magnitude of c, and that a material body moving at speed v relative to this reference frame is contracted in a direction parallel to v such that the null result of the Michelson-Morley experiment is explained. It appears that Lorentz assumed that the electrical forces were states of stress and strain in the aether. From Maxwell's equations (assumed to hold in the preferred reference frame) it was possible to calculate the electromagnetic field surrounding a charged particle. When a calculation was done for a charge moving with velocity v through the preferred reference frame the force field was no longer spherically symmetric (as it was when stationary in the preferred reference frame). Its symmetry became that of an ellipse of revolution, having unchanged diameters in the directions orthogonal to the velocity, but shortened in the direction of motion in the ratio $\sqrt{1-(v^2/c^2)}$.

Contraction as a Function of Refractive Index

Suppose we now make the following additional assumption; that because of Fresnel drag, the Maxwell equations must be considered to hold in the dragged reference frame where the speed of light is actually isotropic, at a magnitude of c/n, while electromagnetic radiation moves within the medium. The speed of the experiment relative to the dragged reference frame was given earlier as v_e , so based on our plausible assumption, the parallel arm of the experiment is now shortened in the ratio $\sqrt{1-\frac{[v-(1-1/n^2)v]^2}{(c/n)^2}}$, which reduces to $\sqrt{1-\frac{v^2}{c^2n^2}}$. The contraction is now also a function of the refractive index of a given material and is given by

$$L_M = L_R\sqrt{1-\frac{v^2}{c^2n^2}} \tag{4}$$

where L_R is the length when stationary in the local space reference frame where the speed of light is isotropic and L_M is the length in the direction of motion when moving at speed v relative to this reference frame. This reasoning may be extended to non-transparent mediums as well. Our assumption is strongly supported by the fact that both James Clerk Maxwell and current physics consider that the speed of light within a "stationary" medium is well represented by the following equation

$$\frac{c}{n} = \frac{1}{\sqrt{\varepsilon\mu}} \tag{5}$$

where ε and μ are, respectively, the permittivity and permeability of a particular substance. Thus the wave speed of electromagnetic radiation within a medium may be considered to be controlled by the inner space of that medium.

When the ratio used in equation (1) is replaced by our new ratio, it can be shown that equation (1) is identically equal to equation (3) and therefore no fringe shift will be observed following a 90 degree rotation of the experiment.

Remaining Contraction Issues

We cannot, however, assume that the new contraction factor will allow us to always make accurate predictions. An objection to Fresnel's drag theory, prior to reinterpretation by Lorentz, was that different wavelengths of light have different refractive indices leading to different amounts of preferred reference frame dragging. Different amounts of dragging seemed to make no sense. If we consider the degree of frame dragging to be based on the field density near the "moving" matter (i.e. moving relative to the isotropic vacuum field), however, then the dragging between molecules would vary, being lowest when farthest from all surrounding molecules. As the transversely pulsating field of light moves through the changing fields of the vibrating molecules of the medium, it is possible that the average field density encountered by the light is a function of the frequency and wavelength of the light. This sets the stage to ask the question. In our new contraction formula, - how do we know what value of n to select ? There appears to be no reason why the value of n, which determines the effective (or average) dragged reference frame for light of a given wavelength traveling in the medium, needs to be the same as the value of n which determines the effective dragged reference frame for the electromagnetic force field surrounding charged particles within the medium. Perhaps this is the reason why Shamir and Fox did detect a small result corresponding to a speed of 6.64 km/s through the preferred reference frame for our region of space. Since this result is much less than the orbital speed of the earth around the sun they considered it too small to be meaningful.

The potential pitfalls of Michleson-Morley-Miller type experiments do not end with those described above. If the contraction factors for different materials are in fact slightly different, then the manner in which the arm lengths of the experiment are measured is critical since different measurement methods will result in different results.

Consider both arms to be made of the same transparent material and not restrained to be in tension or compression by some other material.

Let;

C_A = the contraction factor for the transparent arm material

C_M = the contraction factor for the measuring material

L = the desired length of both arms

L_P = the measured length of the parallel arm in the moving reference frame

L_O = the measured length of the orthogonal arm in the moving reference frame

Then we have the following possibilities;

A) Arms already perpendicular to each other when measured and C_A not equal to C_M.

- For this case we have $L_P = L\ C_M$ and $L_O = L$ and therefore $L_P/L_O = C_M$ (i.e. the arm ratio is determined by the measuring material)

B) Arms both parallel to motion when measured and C_A not equal to C_M.

- For this case we have $L_P = L\ C_M$ and $L_O = L\ C_M$, but when the orthogonal arm is moved into place it lengthens and becomes $L_O = L\ C_M / C_A$ and therefore $L_P / L_O = C_A$ (i.e. the arm ratio is determined by the arm material. Note: This is also true if both arms were originally orthogonal to the motion)

C) Arms initially in either position and C_A equal to C_M.

- For this case the length ratio in the final position is determined by the material common to both the arms and the measuring device.

Temperature differences can also affect results. There is no canceling effect because light travels in different arms of the experiment.

Concepts Leading to Lorentz Mass Increase

Lorentz extended his theory by considering the resistance an electron has to acceleration. As an electron is accelerated a steadily increasing magnetic field is produced. A changing magnetic field induces an electric field which opposes the electromotive force that produced the increasing magnetic field. This resistance to acceleration manifests itself as an increase in mass. Lorentz showed that this electromagnetic mass is a function of its velocity relative to the reference frame in which the speed of light is isotropic. Based on experiments, it appears that either all mass is electromagnetic in origin or that for unknown reasons, non-electromagnetic mass increases in the same ratio. Based on our earlier definitions then, the Lorentz formula for mass increase is given by;

$$M_M = \frac{M_R}{\sqrt{1-\frac{v^2}{c^2}}} \tag{6}$$

where M_R is the rest mass when stationary in the local space reference frame where the speed of light is isotropic and M_M is the mass when moving at speed v relative to this reference frame.

Mass Increase as a Function of Refractive Index

Using the same additional assumption specified earlier (i.e. that because of Fresnel drag, the Maxwell equations must be considered to hold in the dragged reference frame where the speed of light is isotropic at a magnitude of c/n) and knowing that the speed of the mass relative to the dragged reference frame is given by v_e, we are able to deduce the following new formula for mass increase.

$$M_M = \frac{M_R}{\sqrt{1-\frac{v^2}{c^2 n^2}}} \tag{7}$$

If this formula is correct, the mass increase of a sizeable body (i.e. as opposed to isolated sub-atomic particles) does not approach infinity as its speed approaches c relative to the local space reference frame where the speed of light is isotropic. Instead, it approaches infinity when its speed approaches nc (i.e. when $v = nc$). This means that we can achieve speeds which are above c, and in fact close to $v = nc$, with a relatively small mass increase. Calculations show, for example, that for $n = 1.5$ and $v = c$, M_M is only about 1.34 kg when M_R is 1 kg. Even at $v = 1.4c$, M_M still only increases to about 2.79 kg. For silicon, where $n = 4.24$, the mass could travel at 4c and still only increase by a factor of about 3. Recently, some super dense, supper cold liquids have achieved extremely high values of n. Since these liquids would nearly completely drag the preferred reference frame where the speed of light is isotropic, they should be able to move at many times the speed of light and not have their resistance to acceleration (i.e. mass) increase much.

Conclusion

A solid-state Michelson-Morley type experiment can easily hide the meaningful results required to determine one's motion through the preferred reference frame where the speed of light is isotropic in a vacuum.

It may be possible to accelerate a sizeable mass (i.e., as opposed to isolated sub-atomic particles) to speeds somewhat beyond the speed of light with only a relatively small mass increase.

References

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