The Lorentz-FitzGerald contraction applied to the Earth and its motion relative to the CMB

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Abstract

The $Lorentz - FitzGerald$ contraction is the physical phenomenon where an object becomes contracted along the axis of motion. We will test this hypothesis by observing the movement of the Earth relative to the CMB rest frame.

Keywords: *The L-F contraction, Michelson–Morley experiment*

1. Introduction

The $L-F$ contraction hypothesis is physics theory where a moving object shortens along the direction of its motion. Is is designed to explain the negative result of the $Michelson–Morley$ experiment. The $L-F$ contraction formula is given in the following way [1].

$$L = L_0 \sqrt{1 - \frac{v^2}{c^2}}$$

Where :

L: The contracted length along its direction of motion.
L_0: The rest length
v: The relative velocity between the observer and the moving object.
c: The speed of light in a vacuum.

$$L = L_0 \sqrt{1 - \frac{v^2}{c^2}} \approx L_0 \left(1 - \frac{v^2}{2\,c^2}\right) \tag{1}$$

$$\Delta L = L_0 - L = \frac{v^2\,L_0}{2\,c^2} \tag{2}$$

2. Earth's motion relative to the stationary coordinate system (K)

The Geocentric-Equatorial Coordinate System, Figure[1] has the origin O at the center of the Earth, the fundamental plane is the equator and the positive x points in the vernal equinox direction. The z points in the direction of the north pole. By the definition it is non-rotating coordinate system with the respect to the stars [2].

The position of the star is determined by two angles called right ascension and declination Figure[1]. The right ascension α is measured eastward in the plane of equator from the vernal equinox direction. The declination δ is measured northward from the equator to the line of sight, we would say that is an angle between the plane of equator and the direction of the starlight [2].

Our goal is to calculate the effect that the $L-F$ contraction has on the Earth, assuming that the Earth is moving at a velocity $\mathbf{v}_0$ relative to the stationary coordinate system (K).

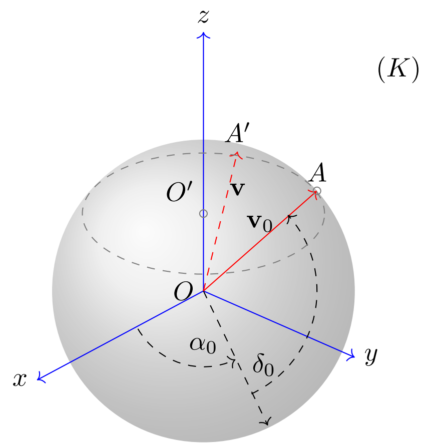

Figure 1: The Earth moves uniformly with velocity $\mathbf{v}_0$ relative to (K)

Let's denote by A the point on the Earth's surface so that $\mathbf{OA}$ has the same direction as the vector determined by the velocity $\mathbf{v}_0$. Let's mark with A' the point, which is on the same parallel as point A. Denote by $R \approx 6,371km$, the rest length of the Earth's radius (perpendicular to $\mathbf{v}_0$).

$$\varphi = \angle(\boldsymbol{OA}, \boldsymbol{OA'}) \tag{3}$$

$$\boldsymbol{\epsilon}_0 = \frac{\boldsymbol{OA}}{||\boldsymbol{OA}||} \tag{4}$$

$$\boldsymbol{\epsilon} = \frac{\boldsymbol{OA'}}{||\boldsymbol{OA'}||} \tag{5}$$

$$\boldsymbol{\epsilon}_0 = (\cos(\alpha_0)\, \cos(\delta_0), \sin(\alpha_0)\, \cos(\delta_0), \sin(\delta_0)) \tag{6}$$

$$\boldsymbol{\epsilon} = (\cos(\alpha)\, \cos(\delta_0), \sin(\alpha)\, \cos(\delta_0), \sin(\delta_0)) \tag{7}$$

$$\boldsymbol{v}_0 = v_0\, \boldsymbol{\epsilon}_0 \tag{8}$$

$$v = v_0\, \cos(\varphi) = v_0\, \boldsymbol{\epsilon}_0\, \boldsymbol{\epsilon} \tag{9}$$

$$\boldsymbol{v} = v\, \boldsymbol{\epsilon} \tag{10}$$

$$(\cos(\varphi) = \boldsymbol{\epsilon}_0\, \boldsymbol{\epsilon}) \Rightarrow \left(\cos^2(\varphi) = (\boldsymbol{\epsilon}_0\, \boldsymbol{\epsilon})^2\right) \tag{11}$$

$$OA \approx R\left(1 - \frac{v_0^2}{2\, c^2}\right) \tag{12}$$

$$OA' \approx R\left(1 - \frac{v_0^2\, \cos^2(\varphi)}{2\, c^2}\right) \tag{13}$$

$$\Delta R = OA' - OA = \frac{R\, v_0^2}{2\, c^2}\left(1 - \cos^2(\varphi)\right) = \frac{R\, v_0^2}{2\, c^2}\left(1 - (\boldsymbol{\epsilon}_0\, \boldsymbol{\epsilon})^2\right) \tag{14}$$

$$f(\alpha) = 1 - (\boldsymbol{\epsilon}_0\, \boldsymbol{\epsilon})^2 \tag{15}$$

Now we will find the maximum value of the function $f(\alpha)$.

$$\frac{df}{d\alpha} = -2\,(\boldsymbol{\epsilon}_0\,\boldsymbol{\epsilon})\frac{d\boldsymbol{\epsilon}}{d\alpha}\,\boldsymbol{\epsilon}_0 \tag{16}$$

$$\left(\frac{df}{d\alpha} = 0\right) \Rightarrow (\boldsymbol{\epsilon}_0\,\boldsymbol{\epsilon} = 0) \vee \left(\frac{d\boldsymbol{\epsilon}}{d\alpha}\,\boldsymbol{\epsilon}_0 = 0\right) \tag{17}$$

1^0

$$\boldsymbol{\epsilon}_0\,\boldsymbol{\epsilon} = 0 \tag{18}$$

$$\boldsymbol{\epsilon}_0\,\boldsymbol{\epsilon} = \cos(\alpha_0)\,\cos^2(\delta_0)\,\cos(\alpha) + \sin(\alpha_0)\,\cos^2(\delta_0)\,\sin(\alpha) + \sin^2(\delta_0) \tag{19}$$

$$\cos(\alpha_0)\,\cos^2(\delta_0)\,\cos(\alpha) + \sin(\alpha_0)\,\cos^2(\delta_0)\,\sin(\alpha) + \sin^2(\delta_0) = 0 \tag{20}$$

$$\cos(\alpha_0)\,\cos^2(\delta_0)\,\cos(\alpha) + \sin(\alpha_0)\,\cos^2(\delta_0)\,\sin(\alpha) = -\sin^2(\delta_0) \tag{21}$$

$$\cos(\alpha_0 - \alpha) = \cos(\alpha - \alpha_0) = -\frac{\sin^2(\delta_0)}{\cos^2(\delta_0)} = -\tan^2(\delta_0)\ \left(|\delta_0| \leqslant \frac{\pi}{4}\right) \tag{22}$$

$$\alpha_1 = \alpha_0 - \arccos\left(-\tan^2(\delta_0)\right) \tag{23}$$

$$\alpha_2 = \alpha_0 + \arccos\left(-\tan^2(\delta_0)\right) \tag{24}$$

$$\Delta R = \frac{R\,v_0^2}{2\,c^2} \tag{25}$$

2^0

$$\left(\frac{d\boldsymbol{\epsilon}}{d\alpha}\boldsymbol{\epsilon}_0 = 0\right) \bigwedge \left(|\delta_0| > \frac{\pi}{4}\right) \tag{26}$$

$$\frac{d\boldsymbol{\epsilon}}{d\alpha} = (-\sin(\alpha)\,\cos(\delta_0), \cos(\alpha)\,\cos(\delta_0), 0) \tag{27}$$

$$\frac{d\boldsymbol{\epsilon}}{d\alpha}\boldsymbol{\epsilon}_0 = -\cos(\alpha_0)\,\cos^2(\delta_0)\,\sin(\alpha) + \sin(\alpha_0)\,\cos^2(\delta_0)\,\cos(\alpha) \tag{28}$$

$$\left(\frac{d\boldsymbol{\epsilon}}{d\alpha}\boldsymbol{\epsilon}_0 = 0\right) \Rightarrow \left(\sin(\alpha_0)\,\cos^2(\delta_0)\,\cos(\alpha) - \cos(\alpha_0)\,\cos^2(\delta_0)\,\sin(\alpha) = 0\right) \tag{29}$$

$$(\cos(\delta_0) \neq 0) \Rightarrow (\sin(\alpha_0)\,\cos(\alpha) - \cos(\alpha_0)\,\sin(\alpha) = 0) \tag{30}$$

$$(\sin(\alpha_0 - \alpha) = 0) \Rightarrow (\alpha = \alpha_0 + \pi) \tag{31}$$

$$\boldsymbol{\epsilon} = (-\cos(\alpha_0)\,\cos(\delta_0), -\sin(\alpha_0)\,\cos(\delta_0), \sin(\delta_0)) \tag{32}$$

$$\boldsymbol{\epsilon}_0\,\boldsymbol{\epsilon} = -\cos^2(\delta_0)\left(\cos^2(\alpha_0) + \sin^2(\alpha_0)\right) + \sin^2(\delta_0) = -\cos(2\,\delta_0) \tag{33}$$

$$\Delta R = \frac{R\,v_0^2\,\sin^2(2\,\delta_0)}{2\,c^2} \tag{34}$$

3. Earth's motion relative to the (CMB)

Earth moves at about $370[km/sec]$ relative to the Cosmic Microwave Background (CMB), toward an apex located in the constellation Crater near Leo [3].

Galactic coordinates:
longitude $\ell \approx 264°$
latitude $b \approx 48°$
The Geocentric-Equatorial Coordinate:
$\alpha_0 = 168°$: Right Ascension
$\delta_0 = -7°$: Declination
$R \approx 6,371km$: The rest length of the Earth's radius
$v_0 = 370[km/sec]$: The relative velocity between the Earth and the (CMB)

$$|\delta_0| = 7^\circ < 45^\circ \tag{35}$$

$$\Delta R = \frac{{v_0}^2 \, R}{2 \, c^2} \tag{36}$$

$$\Delta R \approx 4.84 \, [m] \tag{37}$$

$$\alpha_1 = 168^\circ + 89.13^\circ = 257.13^\circ \tag{38}$$

$$\alpha_2 = 168^\circ - 89.13^\circ = 78.87^\circ \tag{39}$$

From equation (37) we can conclude that the length of the Earth's radius, which is determined by an arbitrary point on the parallel $7\,th$ South and the parallel $7\,th$ North changes by $4.84\,[m]$.

4. Conclusion

If equation (37) holds, then we would probably be able to observe (seismic for example) changes on the Earth's surface along the parallels $7\,th$ South and $7\,th$ North, which occur periodically every 6 hours. That would certainly support the validity of the $L - F$ contraction hypothesis. Otherwise if such changes cannot be observed, then we cannot reject the possibility that the $L - F$ contraction does not exist at all. In that case, we should consider looking alternative explanations for the $Michelson - Morley$ experiment(e.g., [4]).

5. Conflicts of Interest Statement

The author has no conflicts of interest to disclose.

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