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Proposal for Wavelength Meter in Motion to Test the Invariance of Light Speed

Phil Bouchard

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Abstract A gravitational theory and an experiment proposal to prove its ground are being suggested here. An objective analysis of the classical and the modern physics was given followed by what really are flaws in the theory of Special Relativity as concluded by a simple thought experiment on length contraction and the removal of the unnecessary mass increase, because the effects of latter can be emulated by those of the time dilation. Thus, the work that is presented here will prove the entire universe can be represented mathematically by using time dilation and classical physics only. Basically, it extends General Relativity by predicting the perihelion shift, the light bending, and the mass of the invisible universe encompassing the visible one.

Regarding the experiment, a wavelength meter in motion aboard the International Space Station is proposed to test directly the invariance of light speed as postulated by the Special Relativity. The æther by its definition is a substance having a unique reference frame that fills the whole universe and serves as a medium for the propagation of light. If we extend the same idea by associating a 'comoving framework' to the center of a gravitational body with the same spin then we will have multiple graviton layers overlapping each other. Thus, the light speed will be relative to that comoving framework and to detect a change in light speed the observer will have to move against it. This can be done by sending a laser beam in the same direction of the moving apparatus and by measuring the difference in wavelength as we will further demonstrate.

Thus, this work will prove the importance of the experiment proposal with the aforementioned theoretical findings which will lead to alternative fields of study and technologies after it is proven to be valid.

Keywords Superluminal · Perihelion Shift · Light Bending · Rotation Curve · Gravitons

Fornux Inc.
20 Poirier St., Gatineau, Quebec, Canada, J8V 1A6, E-mail: phil@fornux.com

1 Foundation of the Finite Theory

1.1 Hypotheses of the Finite Theory

Finite Theory defines a new representation of the formulas derived from General Relativity based on the superposed potentials of the predicted massless spin-2 gravitons that mediate gravitational fields.

Additionally in contrast to General Relativity where the space-time is represented using the non-Euclidean geometry in order to keep the speed of light constant, Finite Theory considers time to be a positive variable within a space that is characterized by the Euclidean geometry.

Hypotheses of the Finite Theory are as follows:

Definition 1 A 'comoving framework' moves coherently with the source of the strongest neighbouring gravitational acceleration amplitude. For example, if the observer and the observed object are nearby a planet then the comoving framework is set on the planet's center, rotating with the same angular speed. Note that this can be a non-inertial frame.

Definition 2 A 'parent framework' is the source of the 2nd strongest gravitational acceleration amplitude. The source here is a collective noun and represents the conglomeration of its constituents.

Definition 3 An 'absolute framework' is a comoving framework that has no parent framework.

Definition 4 The kinetic energy is defined as $1/2mv^2$ (classical definition), with v being the speed of the object with respect to the observer.

Definition 5 A gravitational time dilation is directly proportional to the ratio of the superposed gravitational potentials of the observer and the observed object.

Hypothesis 1 The speed of light in free space has value c for any observer at rest relative to the comoving framework. However, observers in relative motion with respect to this frame will not measure the same value for c.

Hypothesis 2 The time dilation experienced by an object moving with respect to an observer at rest relative to the comoving framework is directly proportional to the ratio between the kinetic energy and the maximum kinetic energy of the object, where the latter is the case when its speed equals c.

Below, we'll consider consequences from these hypotheses to the time dilation effect.

1.2 Side by side comparison

Given from the gravitational time dilation of General Relativity:

$$t_o = \frac{\sqrt{1 - \frac{2Gm}{|i|c^2}}}{\sqrt{1 - \frac{2Gm}{(x+|i|)c^2}}} \times t_f \tag{1}$$

And from the gravitational time dilation of Finite Theory as later stipulated:

$$t_o = \frac{\frac{m}{|x-i|} + h}{\frac{m}{|i|} + h} \times t_f \tag{2}$$

If we equate the aforementionned equations by using a reference point infinitely far away and letting h include the effects of the entire universe:

$$\left(\frac{\frac{m}{r}+h}{h}\right)^{-1} = \frac{\sqrt{1-\frac{2Gm}{rc^2}}}{1} \tag{3}$$

$$\left(1+\frac{m}{rh}\right)^{-1} \approx 1-\frac{Gm}{rc^2} \tag{4}$$

$$\left(1+\frac{m}{rh}\right)^{-2} = 1-\frac{2Gm}{rc^2} \tag{5}$$

We will observe that General Relativity is making use of a constant in its equations:

$$h = \frac{c^2}{G} = 1.35 \times 10^{27}\, kg/m \tag{6}$$

1.3 Gravitational time contraction

Since in the candidate theory the acceleration is defined by gravitons pulling the body in the opposite direction of their velocity, the net effect of the gravitational acceleration already defines the flux. Unlike kinetic time dilation this is not an incident event but the residuum of the modus operandi by the acceleration vector magnitude.

In contrast to kinetic time dilation, gravitational time contraction will be used interdependently with the non-trivial ambient gravity field of the observer, or fractionalized.

1.3.1 Inverse square law

Different means of calculating the inner gravitational time dilation factor with no relation with the aforementioned procedure can also be used. It consists of calculating the intersection between a growing sphere held within the spherical body in question.

This is done by first calculating all sphere surfaces fitting inside the largest sphere not in intersection with the spherical body.

Now for the second part the spherical cap surface area resulting from the intersection of the two spheres will have to be considered only. This will cover the next section:

By summing both areas we will have:

$$f = \int \frac{2\pi r_2 \left(\frac{d_2^2 - r_2^2 + r_1^2}{2d_2} + r_2 - d_2\right)}{r_2^2} \mathrm{d}r_2 + \int \frac{4\pi r_2^2}{r_2^2} \mathrm{d}r_2 \tag{7}$$

$$f = \frac{\pi \left[d_2^2 \log\left(\frac{r_1+d_2}{r_1-d_2}\right) + r_1^2 \log\left(\frac{r_1-d_2}{r_1+d_2}\right) + 2d_2 r_1 - 4d_2^2\right]}{-d_2} + 4\pi\left(r_1 - d_2\right) \tag{8}$$

Where:

- r_1 is the spherical mass radius
- d_2 is the distance of the observer from the center

This results in exactly the same inner curve as the one found by Figure 11. Henceforth this confirms the validity of the equation.

1.3.2 Juxtaposition

As a means to compare previous formulation with the more common Newtonian gravitational acceleration , we will before all else find the corresponding mass with the volume of a sphere with the respective radius at a given mass density ϱ. Hence:

$$m = \frac{4\pi r^3 \rho}{3} \tag{9}$$

The general acceleration formula contains a discrepancy constant we will call B:

$$a = \frac{Bm}{r^2} \tag{10}$$

By solving the equation using the lowest factor found with Equation (8), the constant B turns out to be $3/2$ for a given mass density ϱ.

Here, the outer and inner acceleration factors can be converted by multiplying the mass squared to lay hold of the FT gravitational time dilation factor.

1.3.3 Inside a sphere

By putting Equation (8) into FT's context we will have to reduce the degree of the inverse radius down to 1:

$$f = \int \frac{2\pi r_2 \left(\frac{d_2^2 - r_2^2 + r_1^2}{2d_2} + r_2 - d_2 \right)}{r_2} \mathrm{d}r_2 + \int \frac{4\pi r_2^2}{r_2} \mathrm{d}r_2 \tag{11}$$

$$f = \frac{4\pi d_2 \left(3r_1 - 2d_2\right)}{3} + 2\pi \left(r_1 - d_2\right)^2 \tag{12}$$

Where:

- r_1 is the spherical mass radius
- d_2 is the distance of the clock from the center

Or more generically for a clock at a specific position inside one spherical mass, as seen from an observer positioned in a null environment:

$$t_o = -\Phi\left(r_s\right) \times t_f \tag{13}$$

$$t_o = \frac{2\pi \left(3r_s^2 - r^2\right)}{3} \rho \times t_f \tag{14}$$

$$t_o = \frac{m \left(3r_s^2 - r^2\right)}{2r_s^3} \times t_f \tag{15}$$

Where:

- r is the location of the clock
- r_s is the radius of the spherical mass
- m is the mass of the sphere

1.3.4 Outside a sphere

We can now estimate the amplitude of the gravitational potential by sampling anchored bodies at an infinitesimal position by consequently rationalizing the measurement with the amplitude derived from the location of the observer.

Since an inertial body being subject to a specific gravitational force is responsible for gravitational time dilation and that gravity is a superposable force, we will translate the same conditions of all gravitational potentials into the sum of all surrounding fields of an observed clock and the observer:

$$t_o = \frac{\Phi(r)}{\Phi(r_o)} \times t_f \tag{16}$$

$$t_o = \frac{\sum_{i=1}^{n} \frac{m_i}{|r_i - r|}}{\sum_{i=1}^{n} \frac{m_i}{|r_i - r_o|}} \times t_f \tag{17}$$

Where:

- r is the location of the observed clock
- r_i is the location of the center of mass i
- r_o is the location of the observer (typically 0)
- m_i is the mass i
- t_o is the observed time of two events from the clock
- t_f is the coordinate time between two events relative to the clock

1.4 Time dilation effect

1.4.1 Kinematical time dilation

We can represent time dilation using simpler techniques by interpolating dilation. Indeed if we rationalize the kinetic energy gained by the object in motion according to the maximum one it can experience at the speed of light then, due to the Hypothesis 2, we have

$$p_v = \frac{mv^2/2}{mc^2/2} \tag{18}$$

Since the time dilation percentage is the exact opposite of the speed ratio, we define general time dilation in direct relation to the proportion as follows:

$$\frac{\Delta\tau_v}{\Delta\tau_0} = 1 - p_v = 1 - \frac{v^2}{c^2} \tag{19}$$

Here, $\Delta\tau_v$ is the interval of time between some events measured in the proper reference of moving observer and $\Delta\tau_0$ is interval of time between the same events measured by the static observer. v is the relative velocity of moving observer measured by the static one and $c = 2.998 \times 10^8\ m/s$ is the speed of light.

We can note that the Finite Theory prediction (19) contradicts to the special relativistic result

$$\frac{\Delta\tau_v}{\Delta\tau_0} = \sqrt{1-\frac{v^2}{c^2}} \approx 1-\frac{v^2}{2c^2}\,, \tag{20}$$

where the last equality is valid for small velocities $v \ll c$. Nevertheless, as we will see in Sec. 1.7.2, when the kinematical time dilation effect is combined with the gravitational one, Finite Theory predicts absolutely correct value of the time dilation cancellation altitude, which is observed by GPS satellites. In the following, we will investigate the gravitational time dilation effect in more detail.

1.4.2 Gravitational time dilation

Effect of the time dilation in the gravitational field is a consequence of the difference in gravitational potentials. This effect is described by the relation

$$\frac{\Delta\tau}{\Delta t} = \frac{1}{h}\left(h+\frac{M}{r}\right) = 1+\frac{M}{hr} \tag{21}$$

where, M is a mass of the gravitating object and r is the distance from its centre. Under $\Delta\tau$ we mean the interval of local time at the point situated at distance r from the centre of the source of gravitation. Δt is the interval of time measured by the distant observer, situated at distance $r \to \infty$.

General relativistic time dilation effect is a particular case of (21) if $h = c^2/G$, where c is the speed of light and $G = 6.674\times 10^{-11}\, m^3 kg^{-1} s^{-2}$ is the gravitational constant. Indeed, we know that in the weak field limit of General Relativity, time dilation effect in the gravitational field takes the following form (see, for example, (Ta-Pei, 2005)):

$$\frac{\Delta\tau}{\Delta t} = \left(1+\frac{GM}{c^2 r}\right)^{-1} \approx 1-\frac{GM}{c^2 r} \tag{22}$$

But due to the hypotheses of the Finite Theory, factor h in (21) is not a universal constant but depend on the superposed gravitational potentials. For example, in solar system experiments, where the gravitational potential of the Sun is the source of the strongest gravitational acceleration, we suppose $h = h_{solar}$. The value of h_{solar} can be determined from the observation of the deflection angle of light in the gravitational field of the Sun, as we will demonstrate in the next subsection.

1.5 Bending of light in the gravitational field

Due to the time dilation effect, we expect to have different speed measurements of the same body by different observers. In particular, the speed of light traveling through the gravitational field will be different from the viewpoint of a local observer and from the viewpoint of a distant watcher.

According to (21), a distant observer notes that the light beam has a velocity, which depends on the position in the gravitational field:

$$v = \frac{dr}{dt} = \frac{dr}{d\tau}\left(1+\frac{m_{sun}}{h_{solar} r}\right) = c\left(1+\frac{m_{sun}}{h_{solar} r}\right) \tag{23}$$

In this relation, the local speed $v_{local} = dr/d\tau = c = 2.998 \times 10^8\, m/s$ is constant due to our hypothesis (Hypothesis 1). Also, we neglect the effect of length contraction in the gravitational field, which results in the equal values of length interval dr for both local and distant observers.

Distant observer can interpret the slow down of the light speed as the effect of some nonzero effective index of refraction:

$$n(r) \equiv \frac{c}{v} = \left(1 + \frac{m_{sun}}{h_{solar} r}\right)^{-1} \approx \left(1 - \frac{m_{sun}}{h_{solar} r}\right) \tag{24}$$

The last approximate relation here is due to the fact we suppose $|m_{sun}/h_{solar}| \ll r$. As we will see later, this condition is fulfilled for the majority of real astrophysical objects.

The position dependent index of refraction causes the bending of light, which will be measured by distant observer. For the refractive index (24), the value of deflection angle is as follows:

$$\delta = \frac{4 m_{sun}}{h_{solar} r_{sun}}\,, \tag{25}$$

where r_{sun} is the impact parameter, or the minimal distance from the light ray to the source of gravity. This relation is an obvious generalization of the result derived by Einstein. More detailed derivation can be found in (Ta-Pei, 2013).

Observed value of the deflection angle equals to (see (Will, 1993), (Will, 2014))

$$\delta_{obs} = \frac{4 G m_{sun}}{c^2 r_{sun}} = 0.847 \times 10^{-5}\,\text{rad} \tag{26}$$

Both General Relativity and Finite Theory can adjust the theoretical result (27) with the observed value (26), but in different ways:

1. To explain the experiment in General Relativity, which supposes $h_{solar} = h = c^2/G = 1.35 \times 10^{27}\, kg/m$, we have to introduce additional length contractions in the gravitational field, as is explained in (Ta-Pei, 2005).
2. In Finite Theory, we are decomposing the deflection angle into the time dilation and Newtonian acceleration constituents:

$$\delta = \frac{2 m_{sun}}{h_{solar} r_{sun}} + \frac{2 m_{sun}}{h_{solar} r_{sun}} = \frac{4 m_{sun}}{h_{solar} r_{sun}}\,, \tag{27}$$

No additional length contractions in the gravitational field is required in this case.

1.6 Explanation of the perihelion shift

The bending of light and perihelion shift of planets are the two classical tests of General Relativity. As we have seen in the previous subsection, bending of light can be naturally explained by the Finite Theory without length contractions in the gravitational field. In this section, we consider the possibility for the Finite Theory to explain the perihelion shift of planets.

As we know, the radial motion of a planets in the gravitational field of the Sun in Newton's gravity can be described by the relation

$$\frac{m\dot{r}^2}{2} + V(r) = \mathcal{E}\,, \tag{28}$$

where $V(r)$ is defined by

$$V(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2} \tag{29}$$

Here, m is a mass of planet, M — mass of the Sun, $\mathcal{E}$ — full non-relativistic energy of the planet, and $\mathcal{L}$ is the value of conserved angular momentum. Variable $r = |\mathbf{r}|$ is the distance to the Sun, which is supposed to be situated in the centre of coordinate system, and the dot means differentiation with respect to t. The second term in $V(r)$, in contrast to the attractive Newton's potential (first term), describes the action of repulsive centrifugal forces.

The general-relativistic investigation of the trajectory of a massive object in the spherically-symmetric gravitational field can also be described in terms of the effective gravitational potential (see, for example, (Ta-Pei, 2005)):

$$\frac{m\dot{r}^2}{2} + V_{eff}(r) = \mathcal{E}\,, \tag{30}$$

$$V_{eff}(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\left(1 - \frac{2GM}{c^2 r}\right) \tag{31}$$

Thus, the effective gravitational potential of General Relativity using the gravitational time dilation substitution (5), can be written in the form

$$V_{eff}(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\left(1 - \frac{2GM}{c^2 r}\right) \tag{32}$$

$$V_{eff}(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\left(1 + \frac{M}{h_{solar} r}\right)^{-2} \tag{33}$$

As is demonstrated in (Ta-Pei, 2005), such correction to the gravitational potential leads to the perihelion shift of the elliptical orbit per unit revolution by the angle

$$\delta\varphi = \frac{6\pi GM}{c^2 a(1 - e^2)}\,, \tag{34}$$

where a is the semi-major axis of the orbit and e is it's eccentricity.

We know (see (Will, 1993), (Will, 2014)) that the perihelion shift agrees with observational evidences not only for the Mercury, but for all planets of solar system. Thus, the perihelion shift can be successfully explained within a Newtonian mechanics if the correction (33) to the Newtonian potential energy is taken into account. This work has demonstrated that the additional term in (33) can appear as the result of the velocity-dependent correction that acts on planets in solar system.

1.7 GPS and time dilation cancellation altitude

The gravitational time dilation and the kinematical time dilation both play a role on GPS satellites. The former is affected by the altitude whereas the latter is affected by its speed. We will study here the correct altitude where both effects cancel out.

First, we consider time dilation cancellation altitude from the viewpoint of General Relativity.

1.7.1 Time dilation cancellation altitude in General Relativity

Consider the artificial satellite, rotating around the Earth on circular orbit with radius r_{orbit}. Due to the gravitational dilation of time [see (22)], static observer at altitude $r_{orbit} > r_{earth}$ should feel accelerated flow of time with respect to the static observer on the Earth (r_{earth} is the radius of the Earth):

$$\frac{\Delta\tau_{orbit}}{\Delta\tau_{earth}} = \sqrt{\frac{1-\frac{2Gm_{earth}}{c^2 r_{orbit}}}{1-\frac{2Gm_{earth}}{c^2 r_{earth}}}} \tag{35}$$

But satellite is not static, it rotates with linear velocity v, which leads to additional relativistic effect:

$$\frac{\Delta\tau_{v}}{\Delta\tau_{earth}} = \sqrt{1-\frac{v^2}{c^2}} \approx 1-\frac{v^2}{2c^2} \tag{36}$$

Here, we are using the low-velocity approximation ($v \ll c$), which is justified for real GPS satellites. As we can see, relativistic effect is opposed to the gravitational one, which makes it possible to find altitude, at which time dilation is cancelled.

Finale relation, which takes into account both effects, can be written in the form:

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} = \sqrt{\frac{1-\frac{2Gm_{earth}}{c^2 r_{orbit}}}{1-\frac{2Gm_{earth}}{c^2 r_{earth}}}}\left(1-\frac{v^2}{2c^2}\right) \approx 1+\frac{Gm_{earth}}{c^2 r_{orbit}}-\frac{Gm_{earth}}{c^2 r_{earth}}-\frac{v^2}{2c^2} \tag{37}$$

where the last approximate equality is valid in the Newtonian limit $r_{earth}, r_{orbit} \gg m_{earth}/h$. Also, under these conditions we can use the Newtonian relation for the velocity of satellite, rotating on the circular orbit $v^2 = Gm_{earth}/r_{orbit}$, which results in the relation

$$\frac{v^2}{c^2} = \frac{Gm_{earth}}{c^2 r_{orbit}} \tag{38}$$

Consequently, the radius of orbit, at which cancellation occurs, is found to be

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1-\frac{3Gm_{earth}}{2c^2 r_{orbit}}+\frac{Gm_{earth}}{c^2 r_{earth}} = 1 \quad \Rightarrow \quad r_{orbit} = \frac{3r_{earth}}{2} \tag{39}$$

which corresponds to the altitude $H = r_{orbit} - r_{earth} = r_{earth}/2 \approx 3185\,km$ (Ashby, 2002).

1.7.2 Time dilation cancellation altitude in Finite Theory

For the same artificial satellite, Finite Theory supposes the gravitational dilation of time for static observers to be defined by [see (21) and (6)]

$$\frac{\Delta\tau_{orbit}}{\Delta\tau_{earth}} = \frac{1 + \frac{m_{earth}}{h_{solar} r_{earth}}}{1 + \frac{m_{earth}}{h_{solar} r_{orbit}}}, \quad h_{solar} = \frac{c^2}{G} \tag{40}$$

You'll notice above that the radiuses are swapped when compared to its GR counterpart (3). For the kinematical time dilation effect in Finite Theory we have (see the explanation in Sec. 1.4.1):

$$\frac{\Delta\tau_v}{\Delta\tau_{earth}} = 1 - \frac{v^2}{c^2} \tag{41}$$

Though both kinematical and gravitational time dilation effects predicted by Finite Theory differ from those effects in General Relativity, combined effect to the artificial satellite appears to be the same in both theories. Indeed, combining (40) and (41) we get

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} = \frac{\left(1 + \frac{m_{earth}}{h_{solar} r_{earth}}\right)\left(1 - \frac{v^2}{c^2}\right)}{1 + \frac{m_{earth}}{h_{solar} r_{orbit}}} \tag{42}$$

For the orbital velocity of satellite we have $v^2 = Gm_{earth}/r_{orbit}$, which results in the relation

$$\frac{v^2}{c^2} = \frac{Gm_{earth}}{c^2 r_{orbit}} = \frac{m_{earth}}{h_{solar} r_{orbit}} \tag{43}$$

Thus, we can write

$$r_{orbit} = \frac{2h_{solar} r_{earth} + m_{earth}}{h_{solar}} \tag{44}$$

Cancellation effect take place at altitudes where $\Delta\tau_{satellite} = \Delta\tau_{earth}$. Corresponding altitude $H = r_{orbit} - r_{earth} = 6371\,km$ absolutely coincides with twice the altitude derived in Sec. 1.7.1 in the frames of General Relativity. In other words, this prediction can be upgraded into yet another experiment proposal.

1.8 Gravitational redshift

As we know, the relativistic Doppler shift is given by the following formula:

$$f_o = \sqrt{\frac{1 - \frac{v}{c}}{\frac{v}{c} + 1}} \times f_f \tag{45}$$

In contrast with the Finite Theory's kinetic Doppler shift as given by:

$$f_o = \frac{1}{\frac{v}{c} + 1} \times f_f \tag{46}$$

Which will result in the following divergent functions:

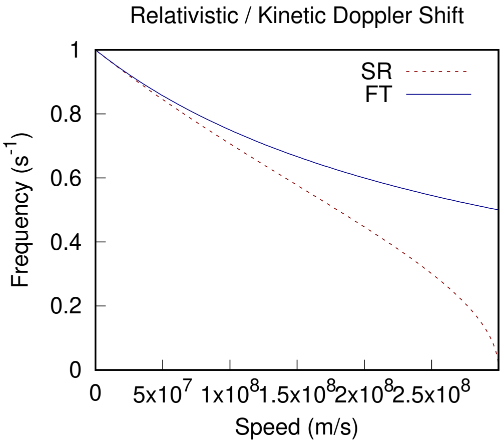

Fig. 1 Doppler Shift

Thus at low velocities both functions are equivalent but at high velocities they diverge. Unfortunately testing the gravitational redshift at high velocities is still a problem as of today so we'll have to restrict ourselves to testing low velocities.

In order to find the gravitational redshift and the relativistic Doppler shift cancelation point, we'll use the following formula:

$$\sqrt{\frac{\left(1-\frac{2G\,m_e}{c^2\,|p_e-d|}\right)\left(1-\frac{v}{c}\right)}{\left(1-\frac{2G\,m_e}{c^2\,|p_e|}\right)\left(\frac{v}{c}+1\right)}}=1 \tag{47}$$

Where:

- v is the relative velocity between the observer and the moving apparatus
- $c \;= 299792458\,m/s$
- $G \;= 6.67408\,m^3kg^{-1}s^{-2}$
- $d \;= 22.5\,m$ (elevation of the tower)
- $p_e \;= -6.371\times 10^6\,m$ (position of the center of the Earth)
- $m_e \;= 5.973\times 10^{24}\,kg$ (mass of the Earth)

Or:

$$v=\frac{Gcd\,m_e}{c^2\,|p_e|^2+(c^2d-2G\,m_e)\,|p_e|-Gd\,m_e} \tag{48}$$

$$v = 7.322\times 10^{-7}\,m/s \tag{49}$$

$$v/c = 2.442\times 10^{-15} \tag{50}$$

In terms of Finite Theory's gravitational redshift and the kinetic Doppler shift cancelation point, we'll use in turn the following formula:

$$\frac{\left(\frac{m_e}{|p_e|} + h_{solar}\right)\left(1 - \frac{v}{c}\right)}{\left(\frac{m_e}{|p_e - d|} + h_{solar}\right)\left(1 - \frac{v^2}{c^2}\right)} = 1 \tag{51}$$

Where:

- v is the relative velocity between the observer and the moving apparatus
- $c \; = 299792458\, m/s$
- $G \; = 6.67408\, m^3 kg^{-1} s^{-2}$
- $h_{solar} = c^2/G = 1.35 \times 10^{27} kg/m$
- $d \; = 22.5\, m$ (elevation of the tower)
- $p_e \; = -6.371 \times 10^6\, m$ (position of the center of the Earth)
- $m_e \; = 5.973 \times 10^{24}\, kg$ (mass of the Earth)

Or:

$$v = \frac{c\, m_e\, |p_e - d| - c\, m_e\, |p_e|}{h_{solar}\, |p_e|\, |p_e - d| + m_e\, |p_e|} \tag{52}$$

$$v = 7.322 \times 10^{-7}\, m/s \tag{53}$$

$$v/c = 2.442 \times 10^{-15} \tag{54}$$

We'll notice once again that by using completely different mathematics we obtain exactly the same factors which correspond to observations (Pound and Snider, 1964).

2 Cosmological implications

Herein are enumerated all consequences FT will lead to and highlights important differences from GR. Given we know the measurement of the light bending, we can "reverse engineer" the entire universe to find out all its characteristics. We'll now illustrate how it can be done.

At this level only complex computer research can be proposed to simulate a modeling of the universe under this umbrella in order to match its behavior with measurements such as the constant of Hubble's Law. Potentially, simulators can also be used to reverse time and estimate an early universe according to the current velocities of the superclusters, solve the scaling factor of the observed universe which will lead to an estimation of the real volume of the universe and solve local focal points of gravitational lenses.

2.1 Natural faster-than-light speed

One of the most practical and interesting goals of any research area in this field is to reach exoplanets. Unfortunately since GR disallows any probe or ship to travel faster than c we reach an impasse because one of the closest star named Alpha Centauri is about $4.36507\, ly$ or $4.01345\, m$ away from us. This means light rays will take $4.36507\, years$ to overtake that distance according to GR. The following section explores the consequences of FT on close distances such as the Moon that will follow the following principle:

$$t = \int \frac{\sum_{i=1}^{n} \frac{m_i}{|x-d_i|}}{\sum_{i=1}^{n} \frac{m_i}{|d_i|}} \times \frac{1}{c} dx \tag{55}$$

2.1.1 Moon

In order to estimate the distance of the Moon in conformance to FT, we will follow the henceforth equation that takes into account the adjoining most massive entity, or the influence of the scaling factor. We also know the time it takes for a laser to travel back and forth between the Moon and the surface of the Earth. Once again the scaling factor represents the average influence of all surrounding stars:

$$\begin{aligned} 1.25\,s = & \frac{m_s \log\left(|x_{ft} - r_m - p_s|\right) + m_e \log\left(|x_{ft} - r_m - p_e|\right)}{c\left(\frac{m_m}{|x_{ft}|} + \frac{m_s}{|p_s|} + \frac{m_e}{|p_e|} + h_{solar}\right)} \\ & + \frac{h_{solar}\,|x_{ft} - r_m| + m_m \log\left(|r_m|\right)}{c\left(\frac{m_m}{|x_{ft}|} + \frac{m_s}{|p_s|} + \frac{m_e}{|p_e|} + h_{solar}\right)} \\ & - \frac{m_m \log\left(|x_{ft}|\right) + m_s \log\left(|p_s|\right) + m_e \log\left(|p_e|\right)}{c\left(\frac{m_m}{|x_{ft}|} + \frac{m_s}{|p_s|} + \frac{m_e}{|p_e|} + h_{solar}\right)} \end{aligned} \tag{56}$$

And after numerical analysis we'll find that:

$$x_{ft} = 3.7647807986 \times 10^8\, m \tag{57}$$

Where:

- $c \;= 299792458\, m/s$
- $G \;= 6.67408\, m^3 kg^{-1} s^{-2}$
- $h_{solar} = c^2/G = 1.35 \times 10^{27}\, kg/m$
- $p_e \;= -6.371 \times 10^6\, m$ (position of the center of the Earth)
- $m_e \;= 5.973 \times 10^{24}\, kg$ (mass of the Earth)
- $r_m \;= 1.7375 \times 10^6\, m$ (radius of the Moon)
- $m_m \;= 7.348 \times 10^{22}\, kg$ (mass of the Moon)
- $p_s \;= 1.52 \times 10^{11}\, m$ (position of the center of the Sun)
- $m_s \;= 1.98892 \times 10^{30}\, kg$ (mass of the Sun)

If we compare with the distance predicted by GR:

$$x_{gr} = c \times 1.25 + r_m \tag{58}$$

$$x_{gr} = 3.764780725 \times 10^8\, m \tag{59}$$

Which is a difference of:

$$x_{ft} - x_{gr} = 7.36\, m \tag{60}$$

Indeed we just found a discrepency of $7\,m$ between the prediction of FT and GR at such a low scale.

2.2 Parameters of the invisible universe

2.2.1 Fudge factor of the invisible universe

An inside-the-sphere gravitational potential distribution formula of the entire visible universe predicts the following value of the parameter h:

$$h_{visible} = \frac{M_{visible}(3R^2_{visible} - d^2)}{2R^3_{visible}} \tag{61}$$

Here, $M_{visible} = 10^{53}\,kg$ is the mass of the entire visible universe, $R_{visible} = 4.4 \times 10^{26}\,m$ is it's radius, and d is the location of the Milky Way in the visible universe. In the following, we suppose $d = 0\,m$. Thus, we can calculate

$$h_{visible} = \frac{3M_{visible}}{2R_{visible}} = 0.34 \times 10^{27}\,kg/m \tag{62}$$

As we can see, the value of $h_{visible}$ does not coincides to the value $h_{solar} = 1.35 \times 10^{27}\,kg/m$ which was derived in Sec. 1.5. This can be explained by the presence of some invisible constituents of the universe. If so, we can decompose

$$h_{solar} = h_{visible} + h_{invisible} \tag{63}$$

Thus by solving $h_{invisible}$ we obtain

$$h_{invisible} = h_{solar} - h_{visible} = 1.01 \times 10^{27}\,kg/m \tag{64}$$

In the following we will use the obtained value of $h_{invisible}$ to determine the mass of the invisible universe.

2.2.2 Mass of the invisible universe

Since the invisible universe will follow the same inside-a-sphere distribution as the visible one, then

$$h_{invisible} = \frac{3M_{invisible}}{2R_{invisible}}\,, \tag{65}$$

which results in

$$M_{invisible} = \frac{2h_{invisible}R_{invisible}}{3} = 7.38 \times 10^{55}\,kg \tag{66}$$

That means the mass of the invisible universe is 738 times the mass of the visible universe. To calculate the value of $M_{invisible}$, we have supposed $R_{invisible} = 1.1 \times 10^{29}\,m$ and used the result obtained in (64).

To compute $M_{invisible}$ directly from the light bending δ we can also use the following relation:

$$M_{invisible} = \frac{R_{invisible}(4R_{visible}m_{sun} - 3\delta r_{sun}M_{visible})}{3\delta r_{sun}R_{visible}} \tag{67}$$

2.3 Galactic rotation curve

Altough we've been taking for granted classical physics was flawless we need to revert the last centuries of research in physics in order to admit the mistakes in the bedrock of physics. Indeed, the laws of Newton imply there is a parent framework from which rotating stars relates to in all cases. But what if we have a universe with only one black hole in it? The black hole will rotate relative to which comoving framework?

We can clearly see here that the black hole cannot rotate if it is the sole one in the universe. As a matter of fact, this singular black hole will be the one defining the absolute framework from which other stars will rotate around and their planets will rotate around each one of these stars, and so on. So the comoving frameworks simply are superposed with the most massive body defining the absolute one.

The best example we can use to prove this property is indeed the rotation curve because of the huge mass involved at the center of galaxies. If we take for example the formula of a standard rotation curve as given by the following (Pisani, 2014):

$$y_1 = \sqrt{\frac{i\, m_f m_{star}}{h \sqrt{\tan\left(\frac{\pi e_{max} i}{2 n_p}\right)}}} \tag{68}$$

$$i = \frac{2 n_p \operatorname{atan}\left(\frac{x^2}{h^2}\right)}{\pi e_{max}} \tag{69}$$

$$e_{max} = \frac{2 \operatorname{atan}\left(\frac{{r_{max}}^2}{h^2}\right)}{\pi} \tag{70}$$

$$m_t = \frac{4 r_{max} \operatorname{atan}\left(\frac{r_{max}}{r_0}\right)^2 {v_0}^2}{\pi^2} \tag{71}$$

$$m_{star} = \frac{m_t}{8 n_p} \tag{72}$$

Here $n_p = 200$ is the number of stars in the galaxy, $r_{max} = 20\, kpc$ is the maximum radius of the galaxy, $h = 4.5\, kpc$ is the radius of the bulge, $v_0 = 140\, km/s$ is the tangential velocity of the closest star and $r_0 = 1\, kpc$ is the position of the closest star. This will result in Figure 2.

Now let's define the dark matter contribution with:

$$y_2 = \sqrt{\frac{f_{dm}\left(m_t - f_m m_{star} n_p\right)\left(\frac{x}{r_{dm0}} - \operatorname{atan}\left(\frac{x}{r_{dm0}}\right)\right)}{\left(\frac{r_{max}}{r_{dm0}} - \operatorname{atan}\left(\frac{r_{max}}{r_{dm0}}\right)\right) x}} \tag{73}$$

Here $f_{dm} = 0.1$ is the dark matter mass scale, $f_m = 1$ is the matter mass scale and $r_{dm0} = 1\, kpc$ is the dark matter length scale.

By adding the dark matter contribution to the visible matter then we will have:

$$y_3 = \sqrt{{y_2}^2 + {y_1}^2} \tag{74}$$

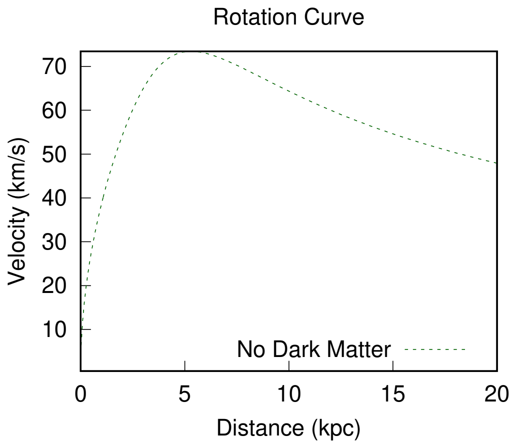

Fig. 2 Rotation Curve

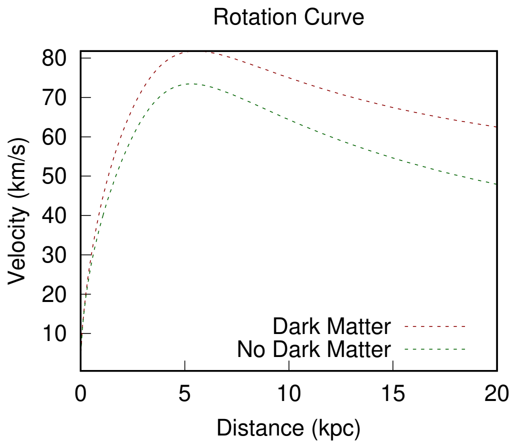

Fig. 3 Rotation Curve

Which will result in Figure 3.

Now to compute the Finite Theory rotation curve, all we have to do is to add a spin to the entire frame of reference:

$$y_4 = y_1 + \omega_{ft} x \tag{75}$$

Here $\omega_{ft} = 1.5\, s^{-1}$ is added angular velocity to the frame of reference. This will result in Figure 4.

The aforementioned graphic clearly demonstrates the veracity of Finite Theory in this scenario as well. In this demonstration there was some arbitrary factors being used but the general idea being proved remains the same.

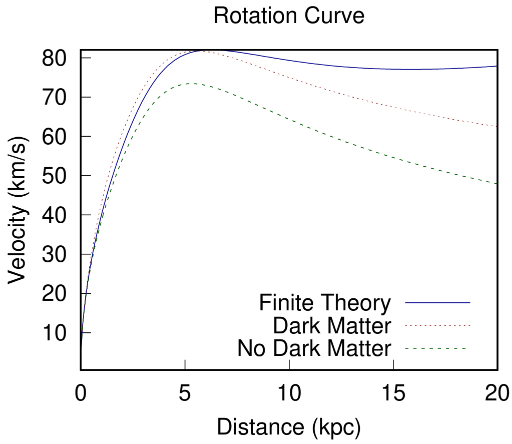

Fig. 4 Rotation Curve

2.4 Approximation of the center and velocity of the visible universe

Dark energy is a constant or scalar field filling all of space that has been hypothesized but remains undetected in laboratories. The problem is that in order to do so the amount of vacuum energy required to overcome gravitational attraction would require a constantly increasing total energy of the universe in violation of the law of conservation.

2.4.1 Small scales

The Hubble's law represents the rate of the expansion of the universe with the speed of the distant galaxies $v_{apparent}$ as seen from the Milky Way with:

$$v_{apparent} = H_0 \, x \,, \tag{76}$$

where $H_0 = 2.26 \times 10^{-18}$ s^{-1} is a Hubble's constant and x is a distance to the remote galaxy. Hubble law is illustrated in Fig. 5.

On the other hand Finite Theory applied on the scale of the universe proves that there is no need for such energy. Indeed if we consider the universe to be the result of a big bang then all galaxies must have a certain momentum. If we try to represent the speed of the observed galaxies using Finite Theory where h is null because the environment must not be encompassed by anything else then we will have:

$$v_{apparent} = \frac{M_{visible}/|s_{visible}|}{M_{visible}/|x - s_{visible}|} \, v_{visible} \tag{77}$$

where $s_{visible}$ is a position of the center of the visible universe, and $v_{visible} = c$.

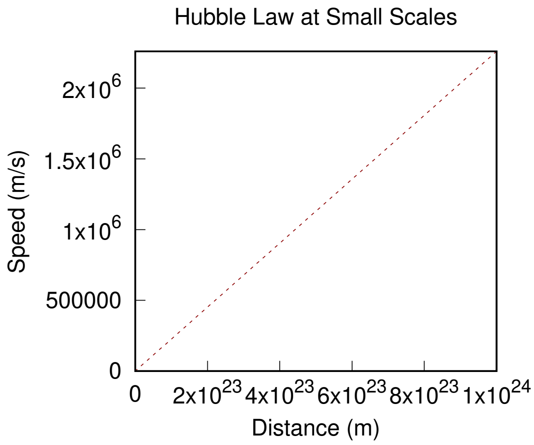

Fig. 5 Hubble law

After simplifying and subtracting the speed of the observer from his observations[1] we will have:

$$v_{apparent} = \frac{v_{visible}|x - s_{visible}|}{|s_{visible}|} - v_{visible} \tag{78}$$

This means $s_{visible}$, or the position of the center of the universe, is actually solvable by equaling (76) and (78):

$$H_0\, x = \frac{v_{visible}|x - s_{visible}|}{|s_{visible}|} - v_{visible}\,, \tag{79}$$

which results in

$$s_{visible} = -\frac{v_{visible}}{H_0} \tag{80}$$

$$s_{visible} = -1.33 \times 10^{26}\, m \tag{81}$$

Obviously the aforementioned speed is unidimensional and therefore has no velocity vector meaning there is no way to tell its direction given the isotropism of the visible universe.

3 Experiment proposal

Although gravitons have not been directly detected and might not even be possible (Rothman and Boughn, 2006), we hypothesize to detect its presence indirectly by observing a variance in both c and the wavelength of a photon from the graviton field it is traveling through. We reevaluate the absoluteness of the reference frames, as is demanded by the hypotheses of the Finite Theory.

[1] The speed of the observer $v_{visible}$ needs to be subtracted because the observer himself is moving and has the same speed of the visible universe ($v_{visible}$).

Since gravity obeys the principle of superposition, we will have to isolate which reference frame defines the absoluteness of the kinetic time dilation amplitude via the gravitational acceleration strength:

$$a_{earth} = -\frac{Gm_{earth}}{(x - p_e)^2}, \tag{82}$$

$$a_{sun} = -\frac{Gm_{sun}}{(x - p_s)^2}, \tag{83}$$

Here, $m_{earth} = 5.9736 \times 10^{24}\, kg$ is the mass of the Earth, $m_{sun} = 1.98892 \times 10^{30}\, kg$ is the mass of the Sun, $p_e = -6.371 \times 10^6\, m$ is a position of the center of the Earth and $p_s = 1.49597870691 \times 10^{11}\, m$ is a position of the Sun. The behavior of both accelerations is illustrated in Fig. 6.

Thus the reference frame for altitudes lower than the following is defined by the Earth:

$$x = \frac{(p_s - p_e)\sqrt{m_{earth} \times m_{sun}} + p_e \times m_{sun} - p_s \times m_{earth}}{m_{sun} - m_{earth}} = 2.5245 \times 10^8\, m \tag{84}$$

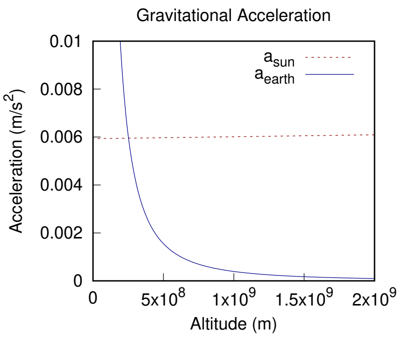

Fig. 6 Gravitational acceleration vs. Altitude

The observer is subject to time dilation relative to the surface of the Earth but the wavelength meter is also subject to the exact same amount of time dilation so both effect cancel out and what the observer sees is a normally functioning wavelength meter. The wavelength is relative to the spinning surface of the Earth so having an observer moving against it will change what is measured. Also the frequency (cycles per second) will be the same in all frames of reference. The hypothesis related to time dilation have no effect here and only the hypothesis related to the frames of reference play a role.

By sending the experiment at a speed in the vicinity of the speed of sound (in the following, we suppose the speed of the experimenter to be $6125.22\, m/s$), it should be sufficient to detect a change wavelength directly proportionally while energy is conserved:

$$E = \frac{h(c - v_1)}{\lambda_1} = \frac{h(c - v_2)}{\lambda_2} \tag{85}$$

Thus, if the stationary observer ($v_1 = 0\,m/s$) measures $\lambda_1 = 6.5 \times 10^{-7}\,m$, experimenter having velocity $v_2 = 6125.22\,m/s$ measures

$$\lambda_2 = \frac{(c - v_2)\lambda_1}{c - v_1} = 6.49987 \times 10^{-7}\,m \tag{86}$$

Here, we have accepted $c = 299792458\,m/s$ for the local value of the light speed.

As the frequency will be the same in all frames of reference, the speed of light won't be constant, relative to the moving observer. For the stationary observer, which measures speed of light $c_1 = c = 299792458\,m/s$ and wavelength $\lambda_1 = 6.5 \times 10^{-7}\,m$, we have

$$\nu_1 = \frac{c_1}{\lambda_1} = 4.6122 \times 10^{14}\,s^{-1} \tag{87}$$

Now we can find the new speed of the light beam in motion, which will be measured by an experimenter having velocity $v_2 = 6125.22\,m/s$:

$$c_2 = \lambda_2\nu_2 = \lambda_2\nu_1 = 2.9979 \times 10^{8}\,m/s\,, \tag{88}$$

where we have combined results (86) and (87).

For a wavelength meter having an accuracy of $\pm 1.5\,pm$ we should be able to confirm whether the change in wavelength (and, correspondingly, the change of light speed) occurs for the experiment in motion. The predicted difference of $\lambda_1 - \lambda_2 = 1.328 \times 10^{-11}\,m$ is large enough to be detected (HighFinesse, 2019).

4 Conclusion

As we have demonstrated in this proposal, Finite Theory is a viable candidate to the new theory of gravity, which can explain time dilation effects, bending of light and perihelion shifts for planets in solar system (see Sec. 1). Also, Finite Theory allows to establish new properties of the invisible part of the universe and explain some peculiar properties of late-time cosmological evolution (Sec. 2).

Though we still have some unresolved problems, we believe that results obtained to this moment are very promising, and Finite Theory deserves for further theoretical and experimental investigation. The role of the experiment we have described in Sec. 3 is crucial for the development of the Finite Theory. Possibly, it will start new era in the gravitational physics.

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