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

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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 reference frame 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 spinning local frame of reference 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 Speed of Light · Dark Matter · Dark Energy · Multiverse

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1 Introduction

The theory of Special Relativity, written by Einstein in 1905, is formed by the following 2 postulates [1]:

Postulate 1 (principle of relativity).
The laws of physics are the same in all inertial frames of reference.
Postulate 2 (invariance of c).
The speed of light in free space has the same value c in all inertial frames of reference.

The Michelson-Morley experiment [2] was interpreted in such a way that there was no preferred frame of reference, thus no æther.

The experiment we are proposing here is to modernize the aforementioned experiment by physically moving it against the Earth's frame of reference. This frame will be defined by a graviton layer that is emitted by a large body, in our case the Earth, which will also have the same spin. Thus the failure to detect variation of the speed of light by the Michelson-Morley experiment can be explained by the fact both the reference frame and the Earth had the same spin. This reference frame is also characterized by the source of the strongest gravitational acceleration. Therefore this frame of reference is the planet Earth for all low orbit experiments that tested Special Relativity, the Sun for probes launched in the solar system, etc.

By sending a wavelength meter at a large velocity relative to the surface of the Earth, such as the one of the International Space Station, we hypothesize that there will be a measurable variance in the speed of light to detect with today's high-precision metrology [3].

The proposal is structured in the following way. In Section 2 we consider theoretical foundation of the Finite Theory which acknowledges time to be a non-negative variable within a space that is characterized by the euclidean geometry. We also demonstrate how the time dilation effects, the perihelion shift and the bending of light can be explained by only using laws of Newtonian mechanics and time dilation / contraction. Given we know the result of the measurement of the light bending in advance, we can "reverse engineer" the entire Universe to deduce all its characteristics, as is illustrated in Section 3. Our experimental proposition described in Section 4. Finally, in Section 5 we conclude this work.

2 Foundation of the Finite Theory

2.1 Hypotheses of the Finite Theory

Finite Theory is directly associating the time dilation effects with the superposed potentials of the predicted massless spin-2 gravitons that mediate gravitational fields.

Finite Theory also considers time to be a positive variable within a space that is characterized by the euclidean geometry, in contrast with General Relativity where the space-time is represented using the non euclidean geometry. No prediction made by General Relativity is in violation.

Definitions and hypotheses of the Finite Theory are as follows:

Definition 1
A 'local reference frame' moves coherently with the source of the local gravitational field where the latter is in turn defined to be the strongest gravitational acceleration. For example, if the observer and the observed object are nearby a planet then the local reference frame is set on the planet's surface, rotating with the same angular speed. Note that this can be a non-inertial frame.

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

Hypothesis 1
The speed of light in free space has value c for any observer at rest relative to the local reference frame. 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 local reference frame 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.

We'll consider consequences from these hypotheses in the sections below.

2.2 Time Dilation Effect

2.2.1 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

$$p_v = \frac{mv^2/2}{mc^2/2} \,. \tag{1}$$

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:

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

Here, $\Delta\tau_v$ is the time interval as measured in the proper reference frame of the moving observer and $\Delta\tau_0$ is the time interval as measured by a stationary observer. v is the speed of the moving observer as measured by the stationary one and $c = 2.998 \times 10^8$ m/s is the speed of light.

We immediately observe that the prediction of the Finite Theory (2) diverges from the special relativistic one

$$\frac{\Delta\tau_v}{\Delta\tau_0} = \sqrt{1 - \frac{v^2}{c^2}} \approx 1 - \frac{v^2}{2c^2} \,, \tag{3}$$

where the last equality is valid for small velocities $v \ll c$. Nevertheless, when the kinematical time dilation effect is combined with the gravitational one, Finite Theory predicts absolutely correct value of the time dilation cancellation altitude, as we will see in Section 2.5.2. In the following section, we will study the gravitational time dilation effect thoroughly.

2.2.2 Gravitational Time Dilation

The difference in the gravitational potentials will be directly proportional to the effects of the time dilation in the gravitational field. This effect is defined by the relation

$$\frac{\Delta\tau}{\Delta t} = \frac{1}{h}\left(h + \frac{M}{r}\right) = 1 + \frac{M}{hr} . \tag{4}$$

where, M is a mass of the large inertial body 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 the body. Δt is the interval of time measured by a distant observer, or at $r \to \infty$.

The time dilation effect as defined by General Relativity is a special case of (4) 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. Surely, we know that in the weak field limit of General Relativity, the time dilation effect in the gravitational field takes the following form (see, for example, [4]):

$$\frac{\Delta\tau}{\Delta t} = 1 - \frac{GM}{c^2 r} . \tag{5}$$

But according to the hypotheses of the Finite Theory, factor h in (4) is not a constant but is a variable that depends on the superposed gravitational potentials. For instance, in the solar system experiments where the gravitational potential of the Sun is the source of the strongest gravitational acceleration, we suppose $h = h_{solar}$. As we will see in the next subsection, the value of h_{solar} will be defined by the observation of the deflection angle of light grazing the Sun.

2.3 Bending of Light in the Gravitational Field

Because of the time dilation effect, the speed of light traveling through a gravitational field and away from a gravitational source will be different from the viewpoint of a distant observer.

According to (4), a distant observer notes that the light beam has the following velocity, which depends on its position in the gravitational field:

$$v = \frac{dr}{dt} = \frac{dr}{d\tau}\left(1 + \frac{M_{sun}}{h_{solar} r}\right) = c\left(1 + \frac{M_{sun}}{h_{solar} r}\right) . \tag{6}$$

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 are neglecting the effects of length contraction in the gravitational field, which results in the values of length interval dr for both local and distant observers to be equal.

A distant observers can interpret the slowdown of the light speed as the result of some non-null effective index of refraction:

$$n(r) \equiv \frac{c}{v} = \left(1 + \frac{M_{sun}}{h_{solar} r}\right)^{-1} \approx \left(1 - \frac{M_{sun}}{h_{solar} r}\right) . \tag{7}$$

The last approximated relation here is explained by the fact we suppose $|M_{sun}/h_{solar}| \ll r$. This condition is fulfilled for most of the real astrophysical objects, as we will later see.

The position dependent index of refraction causes the bending of light, which will be measured by distant observer. For the refractive index (7), the value of deflection angle is as follows:

$$\delta = -\frac{2M_{sun}}{h_{solar} r_{sun}}\,, \tag{8}$$

where r_{sun} is the radius of the source of gravity. This relation is a generalization of the result derived by Einstein himself. Details of the derivation can be found in [5].

Observed value of the deflection angle equals to (see [6], [7])

$$\delta_{obs} = \frac{4GM_{sun}}{c^2 r_{sun}} = 0.847 \times 10^{-5}\,\text{rad}\,, \tag{9}$$

Both General Relativity and Finite Theory can adjust the theoretical result (8) with the observed value (9), 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 [see Section 2.2.2], we have to introduce additional length contractions in the gravitational field, as is explained in [4].
2. In Finite Theory, we are using the observed value of the deflection angle to define h_{solar}:
$$h_{solar} = -\frac{c^2}{2G} = -0.675 \times 10^{27}\,\text{kg/m}\,. \tag{10}$$
It is important pointing out here that no additional length contraction in the gravitational field is required in this case.

In the following examinations, we accept the value (10) for all the others tests at the solar system scale. We also note that the aforementioned condition $|M_{sun}/h_{solar}| \ll r$ is confirmed due to that $|M_{sun}/h_{solar}| = 2GM/c^2 = R_s$ is the well known Schwarzschild radius. When we consider tests at the scale of the solar system, we can always suppose $r \gg R_s$.

2.4 Explanation of the Perihelion Shift

The bending of light and perihelion shift of planets at the solar system scale are the two definitive tests of General Relativity. As we have seen in the previous subsection, bending of light can be explained by the Finite Theory without any length contraction in the gravitational field. In this section, we'll also use the Finite Theory to explain the perihelion shift for all planets.

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

$$\frac{m\dot{r}^2}{2} + V(r) = \mathcal{E}\,, \tag{11}$$

where $V(r)$ is defined by

$$V(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\,. \tag{12}$$

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, [4]):

$$\frac{m\dot{r}^2}{2} + V_{eff}(r) = \mathcal{E}\,, \tag{13}$$

$$V_{eff}(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\left(1 - \frac{2GM}{c^2 r}\right)\,. \tag{14}$$

We note that this effective gravitational potential differs from Newton's potential (12) by the small factor $1-2GM/(c^2 r)$, which can be related to the parameter $h_{solar} = -c^2/2G$ that was in turn determined in (10):

$$1 - \frac{2GM}{c^2 r} = \frac{1}{h_{solar}}\left(h_{solar} + \frac{M}{r}\right) = 1 + \frac{M}{h_{solar} r}\,. \tag{15}$$

Thus, the effective gravitational potential of General Relativity can be written in the form

$$V_{eff}(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\left(1 - \frac{2GM}{c^2 r}\right)\,, \tag{16}$$

$$V_{eff}(r) = -\frac{GmM}{r} + \frac{\mathcal{L}^2}{2mr^2}\left(1 + \frac{M}{h_{solar} r}\right)\,. \tag{17}$$

As is demonstrated in [4], such correction to the gravitational potential leads to the perihelion shift of the elliptical orbit per unit revolution by the angle

$$\delta\varphi = \frac{6\pi GM}{c^2 a(1-e^2)}\,, \tag{18}$$

where a is the semi-major axis of the orbit and e is it's eccentricity. Again, by solving the parameter h_{solar} for the framework of the Finite Theory, this relation can be written in the form

$$\delta\varphi = \frac{6\pi GM}{c^2 a(1-e^2)} = -\frac{3\pi M}{a h_{solar}(1-e^2)}\,. \tag{19}$$

We know conclude (see [6], [7]) that the perihelion shift (19) agrees with observational evidence not only for the Mercury, but for all planets of the solar system. Thus, the perihelion shift can be successfully explained within a Newtonian framework if the correction (17) to the Newtonian potential energy is considered. The cause of such correction was discussed in [8]. This section has demonstrated that the additional term in (17) will appear as the result of the correction to the velocity because of the effects of the time dilation that also acts on planets.

2.5 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. Remarkably, Finite Theory and General Relativity give the same cancellation altitude though using completely different time dilation relations.

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

2.5.1 Time Dilation Cancellation Altitude in General Relativity

Let's consider the artificial satellite, rotating around the Earth with a radius of R_{orbit}. Because of the gravitational time dilation [see (5)], a stationary observer at altitude $R_{orbit} > R_{earth}$ should feel accelerated flow of time with respect to the stationary observer on the Earth (R_{earth} is the radius of the Earth):

$$\frac{\Delta\tau_{orbit}}{\Delta\tau_{earth}} = \frac{1+\frac{M}{hR_{orbit}}}{1+\frac{M}{hR_{earth}}}\,, \quad h=-\frac{c^2}{G} \tag{20}$$

But a satellite is not stationary, it rotates with a tangential velocity v, which leads to additional relativistic effect:

$$\frac{\Delta\tau_v}{\Delta\tau_{earth}} = \sqrt{1-\frac{v^2}{c^2}} \approx 1-\frac{v^2}{2c^2}\,. \tag{21}$$

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

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

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} = \frac{\left(1+\frac{M}{hR_{orbit}}\right)\left(1-\frac{v^2}{2c^2}\right)}{1+\frac{M}{hR_{earth}}}, \tag{22}$$

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1+\frac{M}{hR_{orbit}}-\frac{M}{hR_{earth}}-\frac{v^2}{2c^2}\,, \tag{23}$$

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

$$\frac{v^2}{c^2} = \frac{GM}{c^2R_{orbit}} = -\frac{M}{hR_{orbit}}\,. \tag{24}$$

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

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1+\frac{3M}{2hR_{orbit}}-\frac{M}{hR_{earth}} = 1, \tag{25}$$

$$R_{orbit} = \frac{3R_{earth}}{2}\,, \tag{26}$$

which corresponds to the altitude $H = R_{orbit} - R_{earth} = R_{earth}/2 \approx 3185$ km.

2.5.2 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 (4) and (10)]

$$\frac{\Delta\tau_{orbit}}{\Delta\tau_{earth}} = \frac{1 + \frac{M}{h_{solar} R_{orbit}}}{1 + \frac{M}{h_{solar} R_{earth}}}, \quad h_{solar} = -\frac{c^2}{2G}. \tag{27}$$

For the kinematical time dilation effect in Finite Theory we have (see the explanation in Section 2.2.1):

$$\frac{\Delta\tau_v}{\Delta\tau_{earth}} = 1 - \frac{v^2}{c^2}. \tag{28}$$

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 (27) and (28) we get

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} = \frac{\left(1 + \frac{M}{h_{solar} R_{orbit}}\right)\left(1 - \frac{v^2}{c^2}\right)}{1 + \frac{M}{h_{solar} R_{earth}}}, \tag{29}$$

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1 + \frac{M}{h_{solar} R_{orbit}} - \frac{M}{h_{solar} R_{earth}} - \frac{v^2}{c^2}, \tag{30}$$

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

$$\frac{v^2}{c^2} = \frac{GM}{c^2 R_{orbit}} = -\frac{M}{2h_{solar} R_{orbit}}. \tag{31}$$

Thus, we can write

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1 + \frac{3M}{2h_{solar} R_{orbit}} - \frac{M}{h_{solar} R_{earth}}. \tag{32}$$

Cancellation effect take place at altitudes where $\Delta\tau_{satellite} = \Delta\tau_{earth}$, which is fulfilled at the orbital radius $R_{orbit} = \frac{3R_{earth}}{2}$. Corresponding altitude $H = R_{orbit} - R_{earth} = R_{earth}/2 \approx 3185$ km absolutely coincides to the altitude derived in Section 2.5.1 in the frames of General Relativity.

3 Cosmological Implications

Based solely on the measurement of the light bending, we'll be able to "reverse engineer" the entire Universe to find out its main characteristics. We'll now illustrate how it can be done.

3.1 Parameters of the Invisible Universe

3.1.1 Fudge Factor of the Invisible Universe

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

$$|h_{visible}| = \frac{M_{visible}(3R_{visible}^2 - d^2)}{2R_{visible}^3}\,. \tag{33}$$

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 distance of the Milky Way in the visible Universe from its centre. In the following, we suppose $d = 0$ m. Therefore, we can deduce

$$h_{visible} = -\frac{3M_{visible}}{2R_{visible}} = -\,0.34 \times 10^{27}\ \mathrm{kg/m}\,. \tag{34}$$

As we can see, the value of $h_{visible}$ is not equal to the value $h_{solar} = -0.675 \times 10^{27}$ kg/m which was derived in Section 2.3. This can be explained by the presence of some invisible constituents encompassing the visible Universe. Thus, we can decompose

$$h_{solar} = h_{visible} + h_{invisible}\,. \tag{35}$$

Thus by solving $h_{invisible}$ we get

$$h_{invisible} = h_{solar} - h_{visible} = -\,0.335 \times 10^{27}\ \mathrm{kg/m}\,. \tag{36}$$

In the following section, we will use the resulting value of $h_{invisible}$ to solve the mass of the invisible Universe.

3.1.2 Mass of the Invisible Universe

Here we assume the invisible Universe follows the same inside-a-sphere distribution of matter as the visible one, thus

$$h_{invisible} = -\frac{3M_{invisible}}{2R_{invisible}}\,, \tag{37}$$

which results in

$$M_{invisible} = -\frac{2h_{invisible}R_{invisible}}{3} = 2.45 \times 10^{55}\ \mathrm{kg}\,. \tag{38}$$

To calculate the value of $M_{invisible}$, we have supposed $R_{invisible} = 1.1 \times 10^{29}$ m and used the result obtained in (36).

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

$$M_{invisible} = \frac{R_{invisible}(4R_{visible}M_{sun} - 3\delta r_{sun}M_{visible})}{3\delta r_{sun}R_{visible}}\,. \tag{39}$$

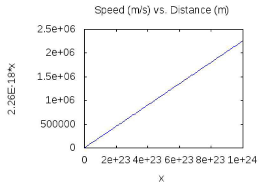

Fig. 1 Hubble's law

3.2 Approximation of the Center and Velocity of the Visible Universe

Dark energy is an energy filling all of space that has been hypothesized to expand the entire Universe but remains undetected. There are many problems arising from this idea but the main one is that in order to expand the Universe at an accelerated rate, the amount of energy required to overcome gravitational attraction would require an ever increasing sum of energy, which is in direct violation of the law of conservation.

3.2.1 Small Scales

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

$$v_{apparent} = H_0 \, x \,, \tag{40}$$

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's law is illustrated in Fig. 1.

On the other hand Finite Theory applied on the scale of the Universe is able to explain the behavior of the Universe without such energy. Indeed, if we consider the Universe to be the result of a Big Bang then all galaxies must have a certain speed and a specific direction. The latter is unimportant because the observed effect will always be the same regardless of the directions but if we try to represent the speed of the observed galaxies using Finite Theory where h is null because it is simplified, given it must not be encompassed by anything else, then we will have:

$$v_{apparent} = \frac{M_{visible}/|s_{visible}|}{M_{visible}/|x - s_{visible}|} \, v_{visible} \,. \tag{41}$$

where $s_{visible} = -\,1.33 \times 10^{26}$ m is a position of the center of the visible Universe, and $v_{visible} = c$.

After simplifying and subtracting the speed of the observer from his own observations, we will have the following relation. Note that the speed of the observer $v_{visible}$ needs to be subtracted because the observer himself is moving and is subject to the same speed of the visible Universe ($v_{visible}$):

$$v_{apparent} = \frac{v_{visible}|x - s_{visible}|}{|s_{visible}|} - v_{visible} \,. \tag{42}$$

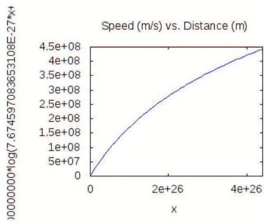

Fig. 2 Hubble's law at large scales

This means $s_{visible}$, or the position of the center of the Universe, is actually solvable by equaling (40) and (42):

$$H_0\, x = \frac{v_{visible}|x - s_{visible}|}{|s_{visible}|} - v_{visible}\,, \tag{43}$$

which results in

$$s_{visible} = -\frac{v_{visible}}{H_0}\,. \tag{44}$$

We'll note here that the speed of the visible Universe is the only variable that is found by a simple graphical best fit as we'll see in the next section for larger scales.

3.2.2 Larges Scales

For larger scales, the Hubble's law is no longer valid and the speed given a certain distance (cosmological redshift) is given by [9]:

$$v_{apparent} = c\log(1+z)\,. \tag{45}$$

As a first gross estimate, we can suppose the value of redshift z linearly depend on distance x: $z = x/|s_{visible}| = 7.6746 \times 10^{-27}\, x$. Consequently, we have

$$v_{apparent} = c\log(1 + 7.6746 \times 10^{-27}\, x)\,. \tag{46}$$

This dependence is illustrated in Fig. 2. By considering the visible Universe to be encompassed by a greater invisible Universe as found earlier, Finite Theory can easily represent the same curve. To do so we will simply add the scale factor of the invisible Universe $h_{invisible} = 3.34 \times 10^{26}$ kg/m:

$$v_{apparent} = \frac{v_{visible}\,(M_{visible}/|s_{visible}| + h_{invisible})}{M_{visible}/|x - s_{visible}| + h_{invisible}} - v_{visible}\,. \tag{47}$$

By using the aforementioned approximation [see (44)], we can replace $s_{visible}$:

$$v_{apparent} = \frac{v_{visible}\left(\frac{H_0 M_{visible}}{|v_{visible}|} + h_{invisible}\right)}{\frac{M_{visible}}{|x + v_{visible}/H_0|} + h_{invisible}} - v_{visible}\,. \tag{48}$$

By simply retrofitting $v_{visible}$ (to the maximum speed of c) and using the parameters of the visible Universe $M_{visible} = 10^{53}$ kg and $H_0 = 2.26 \times 10^{-18}$ s^{-1},

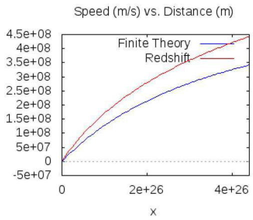

Fig. 3 Velocity-distance relation predicted by the Finite Theory

we'll get a curve that is the same as the one obtained by the observed cosmological redshift of the distant galaxies (see Fig. 3). It is important to mention here that we consider the visible Universe to be a point mass thus it remains an approximation but a more complex analysis will need to be put in place if we wish to obtain more precise results. It is therefore implied that using the mathematics of Finite Theory, it is possible to find a distance from the center and also the speed of the visible Universe. Unfortunately it still is impossible to deduce its direction given there is no external point of reference we can relate to.

4 Variance of c and Wavelength in a Graviton Layer: Experiment Proposal

Even if gravitons have not been directly detected and might not even be possible [10], we hypothesize to detect its presence indirectly by observing a variance in the wavelength of a photon and therefore a variance in c from the strongest graviton layer it is subject to. We are testing the absoluteness of the reference frames, as is demanded by the hypotheses of the Finite Theory.

Given gravity obeys the principle of superposition, we will isolate the local reference frame that roots the absoluteness of the kinetic time dilation amplitude using the gravitational acceleration strength:

$$a_{earth} = -\frac{GM_{earth}}{(x-i)^2}\,, \tag{49}$$

$$a_{sun} = -\frac{GM_{sun}}{(x-j)^2}\,, \tag{50}$$

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, $i = -6.371 \times 10^{6}$ m is a position of the center of the Earth and $j = 1.49597870691 \times 10^{11}$ m is a position of the Sun. The behavior of both accelerations is illustrated in Fig. 4.

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

$$x = \frac{(j-i)\sqrt{M_{earth} \times M_{sun}} + i \times M_{sun} - j \times M_{earth}}{M_{sun} - M_{earth}}, \tag{51}$$

$$x = 2.5245 \times 10^{8}\,\mathrm{m}\,. \tag{52}$$

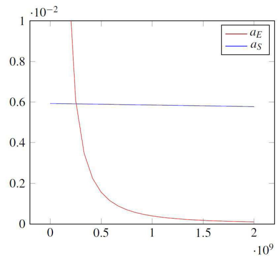

Fig. 4 Gravitational acceleration of the Earth and the Sun (m/s^2) vs. altitude (m)

The observer and the wavelength meter are both subject to time dilation relative to the surface of the Earth so both effects cancel out and as a result the observer sees a normally functioning wavelength meter. The wavelength is relative to the angular speed of the surface of the Earth so having an observer moving against it will alter what is measured. Furthermore the frequency (cycles per second) will be the same in all frames of reference. Thus the time dilation have no effect here and only the frames of reference are challenged.

By sending the experiment at a speed close to the speed of sound (we suppose the speed of the experiment to be 6125.22 m/s), it will be sufficient to detect a change in wavelength while energy is conserved:

$$E = \frac{h(c - v_1)}{\lambda_1} = \frac{h(c - v_2)}{\lambda_2} \,. \tag{53}$$

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

$$\lambda_2 = \frac{(c - v_2)\lambda_1}{c - v_1} = 6.49987 \times 10^{-7}\,\mathrm{m}\,. \tag{54}$$

Here, we have defined the light speed to be $c = 3 \times 10^8$ m/s.

As the frequency will be the same in all frames of reference and because the wavelength won't be, the resulting speed of light also won't be constant, relative to the observer in motion. For the stationary observer on the surface of the Earth, which observes the speed of light to be $c_1 = c = 3 \times 10^8$ m/s and a wavelength $\lambda_1 = 6.5 \times 10^{-7}$ m, we have

$$\nu_1 = \frac{c_1}{\lambda_1} = 4.615384615384615 \times 10^{14}\,\mathrm{s}^{-1}\,. \tag{55}$$

At this point we can find the new speed of the light beam in motion, which will be measured by an observer also in motion having velocity of $v_2 = 6125.22$ m/s:

$$c_2 = \lambda_2\nu_2 = \lambda_2\nu_1 = 2.9999399999999994 \times 10^8\,\mathrm{m/s}\,, \tag{56}$$

where we have merged the results (54) and (55).

For a wavelength meter with an accuracy of ± 1.5 pm then we will be able to confirm if the change in wavelength (and, correspondingly, the change of light speed) occurs. The predicted difference of $\lambda_1 - \lambda_2 = 1.3 \times 10^{-11}$ m is large enough to be measured.

5 Conclusion

As we have shown, Finite Theory is a viable candidate to be a new theory of gravity, which predicts a slightly different kinetic time dilation effects for particles traveling at high speeds, but an exact prediction for the bending of light and the perihelion shifts for planets in solar system (see Section 2). Moreover, Finite Theory allows to establish new properties of the invisible part of the Universe and explains some peculiar properties of late-time cosmological evolution (Section 3), which is based on two simple hypotheses.

Given the important findings we were able to deduce, we believe that Finite Theory deserves further theoretical and experimental investigation. The role of the experiment we have described in Section 4 is crucial for the recognition of the Finite Theory. It will possibly start new era in the gravitational physics and engineering.

References

1. A. Einstein, Annalen der Physik 10 **322**, 891 (1905). DOI 10.1002/andp.19053221004
2. A.A. Michelson, E.W. Morley, American Journal of Science **34**, 333 (1887)
3. Luna PHOENIX 1200, Tunable laser module & wavemeter (2018). URL http://lunainc.com/wp-content/uploads/2012/11/PHOENIX_1200HS_Data-Sheet_Rev07.pdf
4. Ta-Pei, *Relativity, Gravitation and Cosmology. A Basic Introduction* (Oxford University Press, 2005)
5. Ta-Pei, *Einstein's Physics. Atoms, Quanta, and Relativity Derived, Explained, and Appraised* (Oxford University Press, 2013)
6. C.M. Will, *Theory and Experiment in Gravitational Physics* (Cambridge University Press, 1993)
7. C.M. Will, Living Rev **17** (2014)
8. R. Wayne, The African Review of Physics **10**, 0026 (2005)
9. D. Xiaoming, The geometric characteristics of the universe (2018). URL http://www.survivor99.com/dxm/Deng01.pdf
10. T. Rothman, S. Boughn, (2006)