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

Phil Bouchard[1,*]

[1] *20 Poirier Gatineau, Quebec J8V 1A6 Canada*

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A wavelength meter in motion is proposed to test directly the invariance of c as postulated by the Special Relativity, which is the first time this experiment is attempted [1]. Until now it was assumed aether, if it was found, was a static substance having a unique reference frame from which entities were traveling through and therefore must not be present if tests proved otherwise. If we replace aether with graviton fields overlapping each other then we will have a reference frame that follows the rotation of the Earth. Thus to detect its presence, we will have to physically move against that rotating frame in order to detect a change in speed of light. This is done by sending a laser beam in the same direction of the velocity vector of the moving apparatus, capturing the difference in wavelength as we will demonstrate in this proposal.

*Electronic address: `pbouchard8@gmail.com`

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I. INTRODUCTION

In Einsteins 1905 paper on Special Relativity, two postulates form the basis of the theory [2]:

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.

It was assumed that the latter was already tested because of the Michelson-Morley experiment [3] and other replications favored the null hypothesis.

The aim of the experiment we propose here is to search for evidence of a variable speed of light. According to a recent study, it might be possible to predict all phenomena of the Universe based on the fact that gravity is a particle. In contrast with the previously assumed static aether from which the bodies are moving through, the graviton field will have the same spin of the emitting source. Therefore the failure to detect any movement by the Michelson-Morley experiment can be explained by the fact the reference frame simply had the same spin of the Earth. The reference frame simply follows the source of the strongest gravitational acceleration. This reference frame is the Earth for all low orbit experiments that tested Special Relativity, the Sun for solar system wide probes, and so on.

By sending the laser emitter and wavelength meter at a sufficiently large velocity compared to the inertial frame of Earth we hypothesize that a detectable variance in the speed of light will be seen, only now possible with recent advancements in high-precision metrology [4].

Our proposal is organized in the following way. In Sec. II we consider theoretical foundation of the Finite Theory which considers time to be a positive variable within a space that is characterized by the euclidean geometry. We demonstrate how the dime dilation effects, bending of light and perihelion shift can be explained by only using postulates of Finite Theory and laws of newtonian mechanics. Given we know the result of the measurement of the light bending in the gravitational field, we can “reverse engineer” the entire Universe to find out all its characteristics, as is illustrated in Sec. III. Our experimental proposition described in Sec. IV. Finally, in Sec. V we give some concluding remarks.

II. FOUNDATION OF THE FINITE THEORY

A. Postulates 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. No previous self-consistent results deriving from General Relativity are in violation.

Postulates of the Finite Theory are as follows:

Postulate 1 The local reference frame is defined to be the source of the strongest gravitational acceleration and following the associated spin of the emitting body.

Postulate 2 The speed of light is constant, relative to the local reference frame.

Postulate 3 The kinetic energy of body relative to its maxima induces dilation of time, relative to the local reference frame.

Postulate 4 A gravitational time dilation is the direct cause of the superposed gravitational potentials.

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

B. Time dilation effect

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 Postulate 3, 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 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 (2) contradicts to the special relativistic result

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

where the last equality is valid for small velocities $v \ll c$. Nevertheless, as we will see in Sec. II E 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.

2. Gravitational time dilation

Effect of the time dilation in the gravitational field is a consequence of Postulate 4 of the Finite Theory. This effect is described by the relation

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

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 (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. 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, [5]):

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

But due to the postulates of the Finite Theory, factor h in (4) 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.

C. 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 (4), a distant observer notes that the light beam has a velocity, which depends on the position in the gravitational field:

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

In this relation, the local speed $v_{local} = dr/d\tau = c = 2.998 \times 10^8$ m/s is constant due to our postulates (Postulate 1 and Postulate 2). 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:

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

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 (7), the value of deflection angle is as follows:

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

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 [6].

Observed value of the deflection angle equals to (see [7], [8])

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

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 Sec. II B 2], we have to introduce additional length contractions in the gravitational field, as is explained in [5].

2. In Finite Theory, we are using the observed value of the deflection angle to define h_{solar}:

$$h_{solar} = -\frac{c^2}{2G} = -0.675 \times 10^{27}\,\mathrm{kg/m}\,. \tag{10}$$

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

In the following considerations, we accept the value (10) for all the others Solar System tests. We also note that the above mentioned 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 processes inside solar system, we can always suppose $r \gg R_s$.

D. 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

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

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 $r = |\vec{r}|$ 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, [5]):

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

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

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

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

As is demonstrated in [5], such correction to the gravitational potential leads to the perihelion shift of the elliptical orbit per unit revolution by the angle

$$\delta\varphi = \frac{6\pi GM}{c^2 a(1-e^2)}\,, \tag{17}$$

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

$$\delta\varphi = \frac{6\pi GM}{c^2 a(1-e^2)} = -\,\frac{3\pi M}{a h_{solar}(1-e^2)}\,. \tag{18}$$

We know (see [7], [8]) that the perihelion shift (18) 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 (16) to the newtonian potential energy is taken into account. The cause of such correction was discussed in [9]. This work has demonstrated that the additional term in (16) can appear as the result of the velocity-dependent optomechanical counterforce that acts on planets in solar system.

E. GPS and time dilation cancellation amplitude

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 amplitude from the viewpoint of General Relativity.

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 (5)], 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):

$$\frac{\Delta\tau_{orbit}}{\Delta\tau_{earth}} = \frac{1+\frac{M}{hR_{orbit}}}{1+\frac{M}{hR_{earth}}}\,, \quad h = -\frac{c^2}{G} \tag{19}$$

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

$$\frac{\Delta\tau_{v}}{\Delta\tau_{earth}} = \sqrt{1-\frac{v^2}{c^2}} \approx 1-\frac{v^2}{2c^2}\,. \tag{20}$$

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:

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} = \frac{\left(1+\frac{M}{hR_{orbit}}\right)\left(1-\frac{v^2}{2c^2}\right)}{1+\frac{M}{hR_{earth}}} \approx 1+\frac{M}{hR_{orbit}}-\frac{M}{hR_{earth}}-\frac{v^2}{2c^2}\,, \tag{21}$$

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

$$\frac{v^2}{c^2} = \frac{GM}{c^2 R_{orbit}} = -\frac{M}{hR_{orbit}}\,. \tag{22}$$

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

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1 + \frac{3M}{2hR_{orbit}} - \frac{M}{hR_{earth}} = 1 \quad \Rightarrow \quad R_{orbit} = \frac{3R_{earth}}{2}\,, \tag{23}$$

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

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)]

$$\frac{\Delta\tau_{orbit}}{\Delta\tau_{earth}} = \frac{1 + \frac{M}{h_{solar}R_{orbit}}}{1 + \frac{M}{h_{solar}R_{earth}}}\,, \quad h_{solar} = -\frac{c^2}{2G}\,. \tag{24}$$

For the kinematical time dilation effect in Finite Theory we have (see the explanation in Sec. II B 1):

$$\frac{\Delta\tau_{v}}{\Delta\tau_{earth}} = 1 - \frac{v^2}{c^2}\,. \tag{25}$$

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 (24) and (25) we get

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} = \frac{\left(1 + \frac{M}{h_{solar}R_{orbit}}\right)\left(1 - \frac{v^2}{c^2}\right)}{1 + \frac{M}{h_{solar}R_{earth}}} \approx 1 + \frac{M}{h_{solar}R_{orbit}} - \frac{M}{h_{solar}R_{earth}} - \frac{v^2}{c^2}\,, \tag{26}$$

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

$$\frac{v^2}{c^2} = \frac{GM}{c^2 R_{orbit}} = -\frac{M}{2h_{solar}R_{orbit}}\,. \tag{27}$$

Thus, we can write

$$\frac{\Delta\tau_{satellite}}{\Delta\tau_{earth}} \approx 1 + \frac{3M}{2h_{solar}R_{orbit}} - \frac{M}{h_{solar}R_{earth}}\,. \tag{28}$$

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 Sec. II E 1 in the frames of General Relativity.

III. COSMOLOGICAL IMPLICATIONS

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.

A. Parameters of the invisible Universe

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:

$$|h_{visible}| = \frac{M_{visible}(3R^2_{visible} - d^2)}{2R^3_{visible}} \,. \tag{29}$$

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

$$h_{visible} = -\frac{3M_{visible}}{2R_{visible}} = -\,0.34 \times 10^{27}\,\text{kg/m}\,. \tag{30}$$

As we can see, the value of $h_{visible}$ does not coincides to the value $h_{solar} = -0.675 \times 10^{27}$ kg/m which was derived in Sec. II C. This can be explained by the presence of some invisible constituents of the Universe. If so, we can decompose

$$h_{solar} = h_{visible} + h_{invisible} \,. \tag{31}$$

Thus by solving $h_{invisible}$ we obtain

$$h_{invisible} = h_{solar} - h_{visible} = -\,0.335 \times 10^{27}\,\text{kg/m}\,. \tag{32}$$

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

2. Mass of the invisible Universe

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

$$h_{invisible} = -\frac{3M_{invisible}}{2R_{invisible}}\,, \tag{33}$$

which results in

$$M_{invisible} = -\frac{2h_{invisible}R_{invisible}}{3} = 2.45 \times 10^{55}\,\mathrm{kg}\,. \tag{34}$$

To calculate the value of $M_{invisible}$, we have supposed $R_{invisible} = 1.1 \times 10^{29}$ m and used the result obtained in (32).

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

$$M_{invisible} = \frac{R_{invisible}(4R_{visible}M_{sun} - 3\delta r_{sun}M_{visible})}{3\delta r_{sun}R_{visible}}\,. \tag{35}$$

3. Maximum light bending angle

If we consider the expansion of the Universe, radius of the visible part of the Universe will be a function of the cosmological time t:

$$R_{visible}(t) = R_{visible} + v_{edge}t + \frac{a_{edge}t^2}{2}\,, \tag{36}$$

where $R_{visible} = 4.4 \times 10^{26}$ m, v_{edge} is the initial speed of the edge of the visible Universe and a_{edge} is the rate of acceleration of the expansion of the visible Universe. It's not hard to see that $\lim_{t\to\infty} R_{visible}(t) = \infty$, which allows to define the maximum deflection angle of light near the Sun in an expanding Universe:

$$\delta_{max} = -\lim_{t\to\infty} \frac{2M_{sun}}{r_{sun}\left(\frac{3M_{visible}}{2R_{visible}(t)} + h_{invisible}\right)} = -\frac{2M_{sun}}{r_{sun}h_{invisible}} = 1.713 \times 10^{-5}\,\mathrm{rad} = 3.532''\,. \tag{37}$$

Here, for $h_{invisible}$ we are using the relation (32).

B. 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.

1. Small scales

The Hubbles 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:

$$v_{apparent} = H_0\, x\,, \tag{38}$$

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

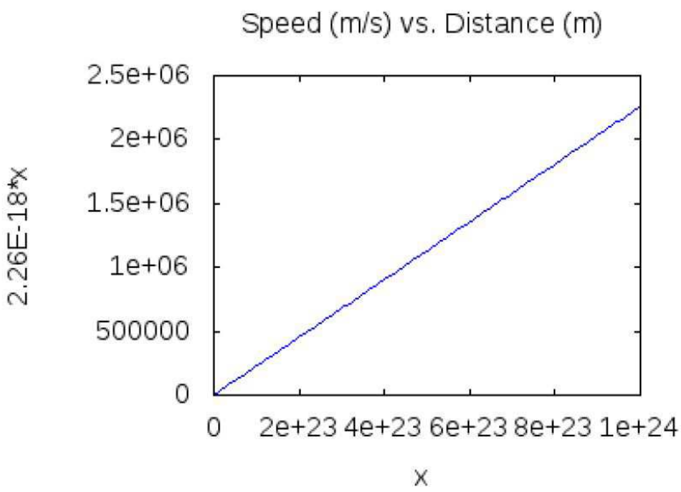

FIG. 1: Hubble law

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:

$$v_{apparent} = \frac{M_{visible}/|s_{visible}|}{M_{visible}/|x - s_{visible}|}\, v_{visible}\,. \tag{39}$$

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 observations[1] we will

[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 ($v_{visible}$).

have:

$$v_{apparent} = \frac{v_{visible}|x - s_{visible}|}{|s_{visible}|} - v_{visible} \,. \tag{40}$$

This means $s_{visible}$, or the position of the center of the Universe, is actually solvable by equaling (38) and (40):

$$H_0\, x = \frac{v_{visible}|x - s_{visible}|}{|s_{visible}|} - v_{visible} \,, \tag{41}$$

which results in

$$s_{visible} = -\frac{v_{visible}}{H_0} \,. \tag{42}$$

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

2. Larges scales

For larger scales, the Hubble's law breaks down and the velocity given a certain distance (cosmological redshift) is given by [10]:

$$v_{apparent} = c \log(1 + z) \,. \tag{43}$$

As a first gross estimate, we can suppose the value of redshift z linearly depend on distance x: $z = x/|s_{visible}| = 7.674597083653108 \times 10^{-27}\, x$. Consequently, we have

$$v_{apparent} = c \log(1 + 7.674597083653108 \times 10^{-27}\, x) \,. \tag{44}$$

Such dependence is illustrated in Fig. 2. Finite Theory easily accounts for such a curve by considering the visible Universe to be encompassed by a greater invisible Universe as found earlier. Hence we will simply add a scale factor of the invisible Universe $h_{invisible} = 3.34 \times 10^{26}$ kg/m:

$$v_{apparent} = \frac{v_{visible}\,(M_{visible}/|s_{visible}| + h_{invisible})}{M_{visible}/|x - s_{visible}| + h_{invisible}} - v_{visible} \,. \tag{45}$$

By using the aforementioned approximation [see (42)], we can replace $s_{visible}$:

$$v_{apparent} = \frac{v_{visible}\left(\frac{H_0 M_{visible}}{|v_{visible}|} + h_{invisible}\right)}{\frac{M_{visible}}{|x + v_{visible}/H_0|} + h_{invisible}} - v_{visible} \,. \tag{46}$$

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

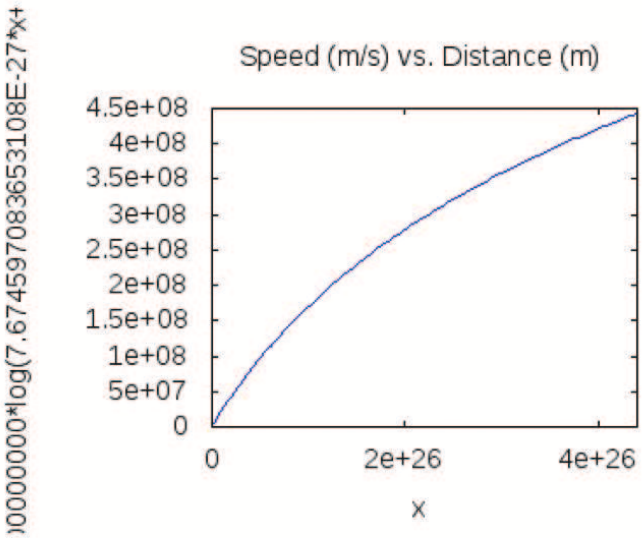

FIG. 2: Hubble law at large scales

that is very similar to the one obtained by the observed cosmological redshift of the distant galaxies (see Fig. 3). Needless to say that we consider here the visible Universe to be a point mass and a deeper analysis will need to be put in place to obtain more precise results. But it goes without saying that using the mathematics of Finite Theory, it is possible to find the center and the velocity of the visible Universe.

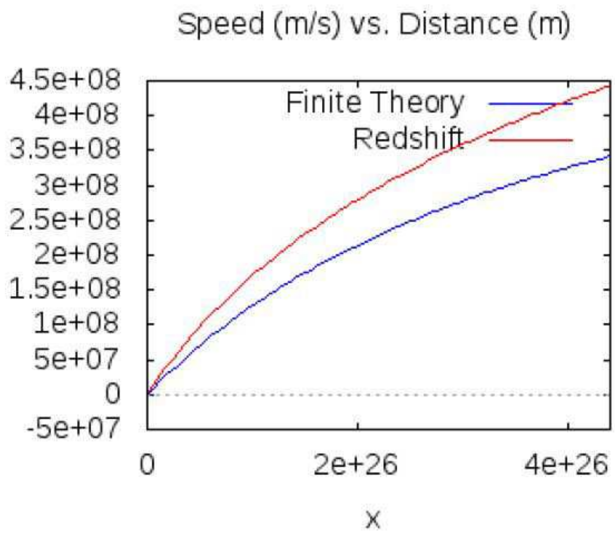

FIG. 3: Velocity-distance relation predicted by the Finite Theory

IV. VARIANCE OF C AND WAVELENGTH IN A GRAVITON FIELD: EXPERIMENT PROPOSAL

Although gravitons have not been directly detected and might not even be possible [11], 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 postulates of the Finite Theory.

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:

$$a_{earth} = -\frac{GM_{earth}}{(x-i)^2}\,, \tag{47}$$

$$a_{sun} = -\frac{GM_{sun}}{(x-j)^2}\,, \tag{48}$$

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:

$$x = \frac{(j-i)\sqrt{M_{earth} \times M_{sun}} + i \times M_{sun} - j \times M_{earth}}{M_{sun} - M_{earth}} = 2.5245 \times 10^{8}\,\mathrm{m}\,, \tag{49}$$

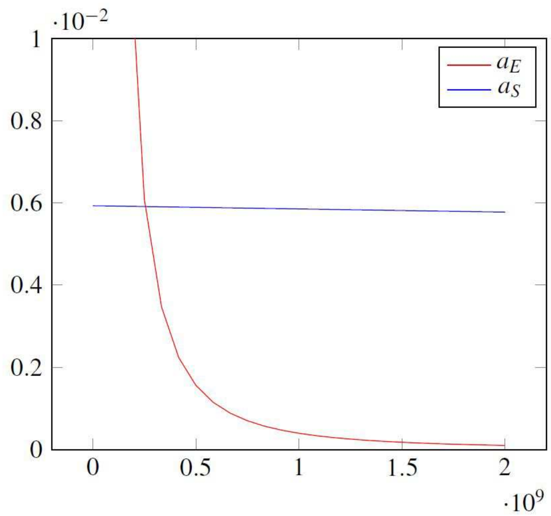

FIG. 4: Gravitational acceleration of the Earth and the Sun (m/s^2) vs. altitude (m)

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 postulates related to time dilation have no effect here and only the postulates 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:

$$E = \frac{h(c - v_1)}{\lambda_1} = \frac{h(c - v_2)}{\lambda_2} \,. \tag{50}$$

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

$$\lambda_2 = \frac{(c - v_2)\lambda_1}{c - v_1} = 6.49987 \times 10^{-7}\,\mathrm{m} \,. \tag{51}$$

Here, we have accepted $c = 3 \times 10^8$ 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 $c_1 = c = 3 \times 10^8$ m/s and wavelength $\lambda_1 = 6.5 \times 10^{-7}$ m, we have

$$\nu_1 = \frac{c_1}{\lambda_1} = 4.615384615384615 \times 10^{14}\,\mathrm{s}^{-1} \,. \tag{52}$$

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:

$$c_2 = \lambda_2 \nu_2 = \lambda_2 \nu_1 = 2.9999399999999994 \times 10^8\,\mathrm{m/s} \,, \tag{53}$$

where we have combined results (51) and (52).

For a wavelength meter having an accuracy of ± 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 $\lambda_1 - \lambda_2 = 1.3 \times 10^{-11}$ m is large enough to be detected.

V. 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. II). 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. III).

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. IV is crucial for the development of the Finite Theory. Possibly, it will start new era in the gravitational physics.

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