An Axiom-free Relativizing of Newtonian Physics

Predicts the Gravitational Redshift as Good as General Relativity

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Abstract

Of the most important predictions of General Relativity theory, are its success in predicting the light bending near massive celestial objects, and the gravitational redshift, suffered by light emitted from such objects. In a recent article we showed that an axiom-free relativizing of Newtonian Physics, termed Information Relativity theory, predicts, at least as good as General Relativity, the degree of solar light bending observed during all investigated Solar eclipses. Here we demonstrate that the theory also matches the predictions of General Relativity for the gravitational redshift.

Keywords: Gravitational redshift, General Relativity theory, Spacetime, Gravity, Newtonian physics, Information Relativity theory.

Introduction

Gravitational redshift of light caused by massive celestial objects is one of the most important theoretical results of the equivalence principle and General Relativity theory. Together with the prediction of gravitational light bending [1-3], it constitutes an important tool in modern observational astronomy. For light emitted from the Sun, the gravitational redshift, originally calculated by Albert Einstein [4] is equal to $\frac{\Delta\lambda}{\lambda} = 2.1 \times 10^{-6}$, which corresponds to a predicted decrease in velocity of 634 m/s. This prediction was confirmed by numerous experiments using various measurement methods (see, e.g., [5-8]). For example, based on measurement of the difference in wavelength between the infrared oxygen triplet in emission just of the Sun's limb, Lopresto et al. [8] detected a velocity of 627 m/s, which is about 0.99 of Einstein's prediction.

In this short article we demonstrate that our recently proposed axiom-free modification of Newtonian physics, termed information relativity theory (see, e.g., [9, 10]), predicts the gravitational redshift as good as General relativity, without any reference, whatsoever, to the notion of spacetime. The only modification we make on Newton's mechanics amounts to accounting for the time that takes any information carrier, including light, to travel from one point in configuration space to another. In previous articles, we demonstrated that Information Relativity theory, although formulated only in terms of physical observables, with no reference to the notion of spacetime manifolds, time curvature, light cones, etc., is successful in reproducing, with high level of precision, the predictions of general relativity concerning the deflection of light near massive celestial objects [11], and the Schwarzschild radius of black holes [12].

Information Relativity prediction of the gravitational redshift

Information relativity theory preserves the Newtonian framework of gravity, but relativizes it, as force majeure of the fact that information flow between two points in configuration space is not instantaneous, as assumed by Newton, but is rather delayed by the time it takes the information carrier (e.g., light) to travel between the two points.

To derive the theory's term for gravitational redshift, consider the example of light emitted from the Sun towards an observer on Earth. Define $\beta_S = \frac{v_S}{c}$, and $\beta = \frac{v(r)}{c}$, where v_S is the velocity of the emitted Sun's light at its rim, and $v(r)$ is the velocity of the emitted light at distance r from the Sun's center.

Information Relativity theory (see ref. 2, section 9), prescribes that $\beta(r)$ is given by:

$$\beta(r) = \beta_S - \frac{1-e^{\frac{GM_\odot}{c^2}\left(\frac{1}{R_\odot}-\frac{1}{r}\right)}}{1+e^{\frac{GM_\odot}{c^2}\left(\frac{1}{R_\odot}-\frac{1}{r}\right)}} = \beta_S - \frac{1-e^{\frac{R_{Sch}}{2}\left(\frac{1}{R_\odot}-\frac{1}{r}\right)}}{1+e^{\frac{R_{Sch}}{2}\left(\frac{1}{R_\odot}-\frac{1}{r}\right)}}, \quad r \geq R_\odot \qquad (1)$$

Where $R_\odot$ is the Sun's radius ($\approx$ 695,700 km), c is the velocity of light in vacuum (299 792 458 m/s), $M_\odot$ is the Sun's mass (≈1.989 × 10^30 kg), G is the gravitational constant (6.67408 × 10^{-11} m^3 kg^{-1} s^{-2}), and R_{Sch} is the Sun's Schwarzschild's radius equaling:

$$R_{Sch} = \frac{2\,GM_\odot}{c^2} \approx 2.954\ \ km \qquad (2)$$

For convenience, define $\hat{r} = \frac{r}{R_\odot}$ (i.e., the distance from the Sun measured in solar radii), This enables us to rewrite eq. 1 as:

$$\beta\,(\hat{r}) = \beta_S + \frac{1-e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{r}})}}{1+e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{r}})}} \quad , \hat{r}\ \geq 1 \qquad (3)$$

Or:

$$\Delta\beta\,(\hat{r}) = \beta(\hat{r}) - \beta_S = \frac{1-e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{r}})}}{1+e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{r}})}}\ ,\ \hat{r}\ \geq 1 \qquad (4)$$

For an observer on earth, at distance $\hat{r} = \hat{h} \approx 214.9$, we have

$$\Delta\beta\,(\hat{r} = \hat{h}) = \beta(\hat{r} = \hat{h}) - \beta_S = \frac{1-e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{h}})}}{1+e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{h}})}} \approx \frac{1-(1+\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{h}}))}{1+(1+\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{h}}))}$$

$$= \frac{-\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{h}})}{2+\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{h}})} = -\frac{\frac{R_{Sch}}{2R_\odot}(\hat{h}-1)}{2\,\hat{h}+\frac{R_{Sch}}{2R_\odot}(\hat{h}-1)} \qquad (5)$$

Substituting $\hat{h} = 214.9$, $R_\odot = 695{,}700$ km , and $R_{Sch} = 2.954\ \ km$, we get:

$$\Delta\beta = \beta_E - \beta_S = -\frac{\frac{2.954}{2x\,695{,}700}(214.9-1)}{2x\,214.9+\frac{2.954}{2x\,695{,}700}(214.9-1)} \approx -1.053361 \times 10^{-6} \qquad (6)$$

Which corresponds to:

$$\Delta v = v_E - v_S = (\beta_E - \beta_S)\,c \approx -1.053361 \times 10^{-6} \times 299\,792\,458 \text{ m/s} \approx -315.79 \text{ m/s} \qquad (7)$$

At very far distances from the Sun ($\hat{r} \rightarrow\infty$), from Eq. 3 we have:

$$\beta\,(\infty) = \lim_{\hat{r}\rightarrow\infty}\beta\,(\hat{r}) = \beta_S + \lim_{\hat{r}\rightarrow\infty}\frac{1-e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{r}})}}{1+e^{\frac{R_{Sch}}{2R_\odot}(1-\frac{1}{\hat{r}})}} = \beta_S + \frac{1-e^{\frac{R_{Sch}}{2R_\odot}}}{1+e^{\frac{R_{Sch}}{2R_\odot}}} \qquad (8)$$

Or:

$$\beta_S - \beta\ (\infty) = -\frac{1-e^{\frac{R_{Sch}}{2R_\odot}}}{1+e^{\frac{R_{Sch}}{2R_\odot}}} \approx -\frac{1-(1+\frac{R_{Sch}}{2R_\odot})}{1+(1+\frac{R_{Sch}}{2R_\odot})} = \frac{\frac{R_{Sch}}{2R_\odot})}{2+\frac{R_{Sch}}{2R_\odot}} = \frac{R_{Sch}}{4R_\odot + R_{Sch}} = \frac{1}{4}\ \frac{R_{Sch}}{R_\odot} \qquad (9)$$

Substituting $R_\odot$= 695,700 km , and R_{Sch} = 2.954 *km*, we get:

$$\beta_S - \beta_\infty = \frac{1}{4}\frac{2.954\ km}{695{,}700\ \text{km}} \approx 1.061521 \times 10^{-6} \qquad (10)$$

Assuming $\beta_\infty \approx 1$, we have

$$v_S - v_\infty = v_S - c = (\beta_S - 1)\ c = 1.061521 \times 10^{-6} \times 299\ 792\ 458\ \text{m/s} = 318.24\ \text{m/s} \qquad (11)$$

Thus the decrease in Solar light velocity upon arrival to an observer on Earth is:

$$\Delta v = 315.79 + 318.24 = 634.03\ \text{m/sec} \approx \mathbf{634\ m/sec} \qquad (12)$$

Which is almost equal to the velocity predicted by General Relativity (634 m/s), with relative difference equaling $\frac{634-636}{636}$ x 100 ≈ - 0.3 %, or ≈ 3/1000!

The relationship between velocity and redshift according to Information Relativity theory (see e.g., [9, 11]) is given by:

$$z = \frac{\Delta\lambda}{\lambda} = \frac{\lambda_{obs} - \lambda_{em}}{\lambda_{em}} = \frac{\beta}{1-\beta} \qquad (13)$$

Thus, the redshift corresponding to a velocity decrease of 634.03 m/s is equal to:

$$\frac{\Delta\lambda}{\lambda} = \frac{\Delta\beta}{1-\Delta\beta} = \frac{\frac{\Delta v}{c}}{1-\frac{\Delta v}{c}} = \frac{\Delta v}{c-\Delta v} = \frac{634.03}{299\ 792\ 458 - 634.03} \approx 2.1149 \times 10^{-6} \approx 2.12 \times 10^{-6} \qquad (14)$$

Which is almost equal the prediction calculated by Einstein using the equivalence principle. The relative difference between the two predictions is equal to

$\frac{2.12-2.1}{2.1}$ x 100 ≈ 0.95% (less than 1%).

Concluding remarks

We have shown that a simple, axiom-free modification of Newton's physics predicts the observed solar redshift as good as General Relativity. In previous articles [11, 12] we also demonstrated that Information Relativity theory is equally successful in reproducing General Relativity's predictions of starlight bending, and the Schwarzschild radius of black holes (without the troubling singularity).

The fact that our simple modified Newtonian model is as successful as General Relativity theory, in deriving good predictions of the above mentioned, points to the hastiness of the physics community in abandoning the Newton's gravity, in favor of Einstein's spacetime.

References:

[1] Dyson, F. W., Eddington, A. S. and Davidson, C. (1920). Relativity and the Eclipse Observations of May, 1919, *Nature* 106, 786–787.

[2] Allen Brune Jr., R., Cobb, C.L., De-Witt, B.S., De-Witt-Morette, C., Evans, D.S., Floyd, J.E., Jones, B.F., Lazenby, R.V., Marin, M., Matzner, R.A., Mikesell, A.H., Mikesell, M.R., Mitchell, R., Ryan, M.P., Smith, H.J., Sy, A. and Thompson, C.D. (1976). Gravitational Deflection of Light: Solar Eclipse of 30 June 1973 I. Description of Procedures and Final Results. *Astronomical Journal*, 81, 452.

[3] Uzan, J-P. (2010). Tests of general relativity on astrophysical scales. *General Relativity and Gravitation*, 42 (9), 2219-2246.

[4] Einstein, A. (1911). On the influence of gravitation on the propagation of light. *Annalen der Physik*, 35, 98-108.

[5] Hentsche, K. (1996). Measurements of Gravitational Redshift between 1959 and 1971. *Annals of Science*, 53, 269-295

[6] Cacciani, A. Briguglio, R., Massa, F., Rapex, P. (2006). Precise measurement of the solar gravitational red shift. *Periodic, Quasi-Periodic and Chaotic Motions in Celestial Mechanics: Theory and Applications*, 425-437.

[7] Wilhelm, K., Dwivedi, B. N. (2014). On the gravitational redshift. *New Astronomy*, 31, 8–13.

[8] Lopresto, J.C., Schrader, C., Pierce, A.K. (1991). Solar gravitational redshift from the infrared oxygen triplet. *The Astrophysical Journal*, 376, p. 757.

[9] Suleiman, R. (2017). Information Relativity: The Special and General Theory. DOI: 10.13140/RG.2.2.36312.29442.

[10] Suleiman, R. (2016). Information relativity theory solves the twin paradox symmetrically, *Physics Essays*, 29, 304-308.

[11] Suleiman, R. (2017). Outside spacetime: An axiom-free relativizing of Newtonian Physics predicts the degree of solar light bending, as good as General Relativity. DOI: 10.13140/RG.2.2.13522.66245.

[12] Suleiman, R. (2014). Black Holes have no Interior Singularities. http://vixra.org/pdf/1406.0084v4.pdf.

[13] Suleiman, R. (2013). The dark side revealed: a complete relativity theory predicts the content of the universe. *Progress in physics*, 4, 34-40.