Gravitational Index of Refraction

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Abstract

Henceforth the fact is admitted as an axiom that all bodies in the universe set up gravitationally the universe's optical medium, named *gravitational ether*, whose strength is the sum of all relative-velocity dependent gravitational potentials, from which we derive its *index of refraction*, that therefore is both nonuniform in space and changes in time as bodies move.

Keywords: gravitational ether; ether refraction index.

1 Introduction

Axiom (of universal gravitational ether) *Masses set up the universe's optical medium—gravitational ether—whose strength is the sum of all relative-velocity dependent gravitational potentials.*

2 The RVD gravitational potential

To infer the index of refraction of the universal gravitational ether, the RVD[1] gravitational potential is necessary. Therefore transcribe the Newton gravity law RVD completed from [5]. Let M and m be two point masses, and $\vec{r}$ the position vector of m with respect to M, i.e., $\vec{r}$ has its initial point at M and the terminal point at m. Newton's law of gravitation writes $\vec{F}_{\scriptscriptstyle N} = -GMm\vec{r}/r^3 = m\vec{g}_{\scriptscriptstyle N}$. *Newton's gravitational law* (empirically) *RVD completed* is

$$\vec{F} = \vec{F}_{\scriptscriptstyle N} + 3\vec{F}_{\scriptscriptstyle N}\frac{v^2}{c^2} - 6F_{\scriptscriptstyle N}\frac{\vec{v}^{\,3}}{c^3} = \vec{F}_{\scriptscriptstyle N}\left(1 + 3\frac{v^2}{c^2}\right) - 6F_{\scriptscriptstyle N}\frac{\vec{v}^{\,3}}{c^3}\,, \tag{1}$$

or using $\vec{g} = \vec{F}/m$ (*force per unit mass*, or *gravitational field strength*, or *gravitational acceleration*),

$$\vec{g} = \vec{g}_{\scriptscriptstyle N} + 3\vec{g}_{\scriptscriptstyle N}\frac{v^2}{c^2} - 6g_{\scriptscriptstyle N}\frac{\vec{v}^{\,3}}{c^3} = \vec{g}_{\scriptscriptstyle N}\left(1 + 3\frac{v^2}{c^2}\right) - 6g_{\scriptscriptstyle N}\frac{\vec{v}^{\,3}}{c^3}\,. \tag{1'}$$

By definition, the gravitational potential is a function U having the property $\vec{g} = \nabla U$, that is, $U = \int \vec{g}\, d\vec{r}$. From the second expression (1′) the *RVD completed*

[1] RVD stands for Relative-Velocity Dependence/Dependent, according to context.

gravitational potential is

$$U = U_{N}\left(1 + 3\frac{v^2}{c^2}\right) + 6U_{N}\frac{\vec{r}}{r}\frac{\vec{v}^{\,3}}{c^3}\,, \tag{2}$$

since $\nabla(\vec{r}/r^2) = 1/r^2$; $U_{N} = GM/r$ is the Newton gravitational potential.

3 Inferring the gravitational index of refraction

Consider electromagnetic waves, generically called *light*, traveling in the universe, hence in the gravitational ether. There is an optic filter according to which the gravitational potential for light (or for optics) does not contain the last term in (2), i.e.,

$$U_{optic} = U_{N}\left(1 + 3\frac{v^2}{c^2}\right), \tag{3}$$

because it is odd with respect to $\vec{v}$, namely the **Law of reversibility** states that *if the direction of a light beam is reversed, it will follow the same path (despite the number of times the beam is reflected or refracted).* One can add that *the time is the same when traveling to or from.*

Notice that the dimension of the gravitational potential is of a square velocity v^2. Extending Eq. (3) to the whole universe U_{optic} becomes the gravitational potential U_{optic_tot} of the whole universe an therefore gets the greatest square velocity, $U_{optic\_tot} = c^2$, at a point far from any mass (as source of gravitational potential), while at a point in the vicinity of some mass generating an optic gravitational potential U_{optic} , is $v^2 = c^2 - U_{optic}$, i.e.,

$$v^2 = c^2 - U_{N}\left(1 + 3\frac{v^2}{c^2}\right). \tag{4}$$

Dividing bot sides by c^2 and replacing $c/v = n$ where n is the index of refraction, Eq. (4) writes

$$\frac{1}{n^2} = 1 - \frac{U_{N}}{c^2}\left(1 + \frac{3}{n^2}\right), \tag{5}$$

whence $1/n^2 = [(1 - U_{N}/c^2]/(1 + 3U_{N}/c^2)$, whence finally

$$n = \sqrt{\frac{1 + 3U_{N}/c^2}{1 - U_{N}/c^2}}\,, \tag{5$'$}$$

the *gravitational index of refraction* resulted from the Newton gravitation law RVD completed.

The gravitational index of refraction resulted from the General Theory of Relativity (GTR) is

$$n_{GR} = 1 + 2\frac{GM}{c^2 r}\,, \tag{6}$$

which is the first approximation of n given by Eq. (5′). Indeed, since $U_{N}/c^2 << 1$ (for instance on the sun's surface $U_{N}/c^2 \approx 2.12249777567 \times 10^{-6}$), one can use the binomial series

$$(1 + \xi)^{\kappa} = 1 + \kappa\xi + \frac{\kappa(\kappa - 1)}{2!}\xi^2 + \frac{\kappa(\kappa - 1)(\kappa - 2)}{3!}\xi^3 + \ldots$$

from which, as enough approximation, we do not retain terms with ξ^k, $k \geq 2$. Thus with $\xi = U_N/c^2$, Eq. (5′) writes successively

$$n = \sqrt{(1+3\xi)(1-\xi)^{-1}} \approx \sqrt{(1+3\xi)(1+\xi)} \approx \sqrt{1+4\xi} \approx 1+2\xi\,,$$

hence just (6); for the first sign of $\approx$ we used $-\xi$ and -1 as ξ and κ of the binomial, while for the third $\approx$ we used 4ξ and $1/2$.

Both two competing formulas, (5′) and (6), give $1 + 4.245 \times 10^-6$ on the sun's surface; the difference appear scarcely at the 17th decimal $(n - n_{GR} \approx 1.9 \times 10^{-17})$, hence unreachable experimentally.

Discussion One should ascertain that the GTR now ends its over one century service, and passes to the science history museum.

Indeed, at its very proposal the GTR accounted for the only *Perihelion Advance* effect, which now is elegantly solved [5] with no supposition, and the tough question [6] waits for answer.

Subsequently GTR accounted for two effects, both pertaining to the above **Gravitational Index of Refraction**, namely: *Gravitational Deflection of Light* [2], and *Retardation of Light* [3] when traveling through gravitational ether having a relatively large index of refraction, specifically close to the sun.

The *Cosmological Red Shift* is now simply explained [7], replacing the fanciful *Big-Bang* scenario, although some of Einstein's contemporaries convinced him to add a repelling term in his equation of the gravitational field.

Other problems, like *Gravitational Waves*, and *Black Holes*, do not necessarily involve GTR, since the gravitational potential anyhow satisfies the D'Alembert waves equation, including with singularities. Detailed confrontation between GTR and experiment are given in [4].

References

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