Gravitational Index of Refraction

D.H.W. Reffer
ICPE, Splai Unirii, 313, Sector 3, Bucharest, Romania
dhwreffer@gmail.com

Abstract

Henceforth the fact is admitted as an axiom that all bodies in the universe set up gravitationally the universal optical medium, named gravitational ether, whose strength—from which we derive its index of refraction—is the sum of all relative-velocity dependent gravitational potentials, hence both nonuniform in space and changing in time as bodies move. Besides, Einstein's $\mathscr{E} = mc^2$ is of gravitational cosmological nature, including pure Newtonian.

Keywords: gravitational ether; ether refraction index; Special Theory if Relativity; General Theory of Relativity; Relative-Velocity Dependent Interaction

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 *relative-velocity dependent* 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 $\vec{F}_N = -GMm\vec{r}/r^3 = m\vec{g}_N$. *Newton's gravitational law (empirically) RVD completed* is

$$\vec{F} = \vec{F}_N + 3\vec{F}_N\frac{v^2}{c^2} - 6F_N\frac{\vec{v}^3}{c^3} = \vec{F}_N\left(1+3\frac{v^2}{c^2}\right) - 6F_N\frac{\vec{v}^3}{c^3}\,, \tag{1}$$

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

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

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 gravita-*

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

tional 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.

2.1 Einstein's formula $\mathscr{E} = mc^2$ is a gravitational truth

Though this is not the main subject herein, we treat it to use the opportunity of handling the gravitational potential.

It is thought that Einstein famous formula (in the title), is pure relativistic, but this myth disappear on showing in simple cosmological terms that it is of gravitational nature, and quite Newtonian.

Let m an $\mathscr{E}_p$ be the mass and potential energy respectively of a particle in a gravitational field of potential U—either pure Newtonian or RVD completed—that is, $\mathscr{E}_p/m = U$. Since the dimension of U is that of a square velocity, v^2, on extending U to the entire universe, and **far** away from any masses ($U_N \approx 0$), it gets the greatest value, $U_{univ} = c^2$, hence $\mathscr{E}_{p_{univFar}}/m = c^2$, i.e.,

$$\mathscr{E}_{p_{univFar}} = mc^2, \tag{3}$$

and if there is some mass in relative **vicinity**, setting up a gravitational potential U, then

$$\mathscr{E}_{p_{univVicin}} = mc^2 + U. \tag{4}$$

This reasoning does not invoke the RVD completion of U, thus being valid in the Newton approximation too—this raising two questions: why was not Einstein's formula noticed before the theory of relativity? and why its gravitational nature was never noticed?

Note that the famous formula is inferred in relation to the potential energy, while in the special theory of relativity, in relation to the kinetic energy.

In words, the above two formulas express like this: the gravitational potential energy with respect to masses in the whole universe is given by formula (3), far from any mass, which is in agreement with the Einsteinian alias of *rest energy*, and by formula (4) near to some mass generating an U 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.,

$$U_{optic} = U_N\left(1+3\frac{v^2}{c^2}\right), \tag{5}$$

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*.

As already mentioned in subsection 2.1, the dimension of the gravitational potential is of a square velocity v^2. On extending Eq. (5) to the whole universe, U_{optic} becomes the gravitational potential $U_{opticUniv}$ of the whole universe and therefore gets the greatest square velocity, $U_{opticUniv} = c^2$, 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} the speed of light is smaller, $v^2 = c^2 - U_{optic}$, i.e.,

$$v^2 = c^2 - U_N\left(1 + 3\frac{v^2}{c^2}\right). \tag{6}$$

Dividing bot sides by c^2 and replacing $c/v = n$ where n is the index of refraction, Eq. (6) writes

$$\frac{1}{n^2} = 1 - \frac{U_N}{c^2}\left(1 + \frac{3}{n^2}\right), \tag{7}$$

whence $1/n^2 = [(1 - U_N/c^2]/(1 + 3U_N/c^2)$, whence finally

$$n = \sqrt{\frac{1 + 3U_N/c^2}{1 - U_N/c^2}}, \tag{7'}$$

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

As known, the gravitational index of refraction from the General Theory of Relativity (GTR) [1] is

$$n_{GR} = 1 + 2\frac{GM}{c^2 r}, \tag{8}$$

which is the first approximation of n given by Eq. (7′). 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

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

from which, as enough approximation, we do not retain terms with ξ^k, $k \geq 2$. Thus with $\xi = U_N/c^2$, Eq. (7′) 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 (8); 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, (7′) and (8), give $1 + 4.245 \times 10^-6$ on the sun's surface; the difference is unreachable experimentally.

Discussion One should ascertain that the GTR [1] now ends its more than one century service, and passes to the science history museum.

Indeed, at its very proposal 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 *Hubble 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 is given in [4].

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