On the Speed of Gravity and Energy of Photons

Hasmukh K. Tank

Indian Space Research Organization, 22/693 Krishna Dahm-2, Ahmedabad 380015 India

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Abstract:

Accepting Einstein's theory, that the changes in gravitational field can propagate at the speed of light, it is proposed here that: before an electron in an atom emits a photon, the energy ($h\ f_0$) of the photon was a part of total energy of the atom; contributing to establishing the gravitational-field around the atom. As soon an electron in that atom emits a photon of energy $h\ f_0$, and the photon starts moving away from the atom, the gravitational-field around the atom partly reduces, proportional to the photon's energy $h\ f_0$, and this wave of 'reduced gravitational field' propagates radially outwards at the speed of light. And a part of energy of the photon gets spent in "filling" the 'gravitational potential-well' produced by its energy when it was a part of energy of the atom. From the Gauss's law for gravity we find that the energy spent by the photon to "fill" the 'gravitational potential-well' during its inter galactic journey manifests as the 'cosmological red-shift'.

Introduction:

Newton's gravity was 'instantaneous action at a distance". Laplace (1805) was the first to think of finite speed of gravity. Many scientists predicted different speeds of gravity to explain the perihelion advance of Mercury. Ultimately, Einstein's proposal, that the speed of gravitational-waves too should be equal to the speed of light, got widely accepted, as it could successfully explain the perihelion advance of Mercury. Accepting Einstein's theory, that the changes in gravitational field can propagate at the speed of light, it is proposed here that: before an electron in an atom emited a photon, the energy ($h f_0$) of the photon was a part of total energy of the atom; contributing to establishing the gravitational-field around the atom. As soon an electron in that atom emits a photon of energy $h f_0$, and the photon starts moving away from the atom, the gravitational-field around the atom reduces proportional to the energy $h f_0$, and this wave of 'reduced gravitational field' propagates radially outwards at the speed of light. And a part of energy of the photon gets spent in "filling" the 'gravitational potential-well' produced by its energy, when it was a part of energy of the atom. From the Gauss's law for gravity we find here that the energy spent by the photon to "fill" the 'gravitational potential-well' during its inter galactic journey manifests as the 'cosmological red-shift'.

The Derivation:

The integral form of Gauss's law for gravity: (Taken from Wikipedia page Gauss's Law)

$$\oiint_{\partial V} \mathbf{g} \cdot d\mathbf{A} = -4\pi G M$$

Where:

$\oiint_{\partial V}$, (also written $\oint_{\partial V}$), denotes a surface integral over a closed surface,

∂V is any closed surface, (the *boundary* of a closed volume V),

$d\mathbf{A}$ is a vector, whose magnitude is the area of an infinitesimal piece of the surface ∂V, and whose direction is the outward-pointing surface normal. $\mathbf{g}$ is the gravitational field, G is the universal gravitational constant, and M is the total mass enclosed within the surface ∂V. The left-hand side of this equation is the flux of the gravitational field, which is always negative (or zero), and never positive. i.e.:

$$\oint_{\partial V} \mathbf{g} \cdot d\mathbf{A} = -4\pi GM.$$

In our case, the volume V is a sphere of radius D . The total gravitational-charge, i.e. mass lost by the photon is $[(h f_0 - h f) / c^2]$. It is reasonable to expect the gravitational field to be spherically symmetric. By making this assumption, **g** takes the following form:

$$\mathbf{g}(\mathbf{r}) = g(r)\mathbf{e_r}$$

(i.e., the direction of **g** is parallel to the direction of **r**, and the magnitude of **g** depends only on the magnitude, not direction, of **r**). Plugging this in, and using the fact that ∂V is a spherical surface with constant radius D and area $4 \pi D^2$:

$$g(d)(4 \pi D^2) = -4 \pi G m_e$$

And the force, $F_g = [G m_e (h f / c^2)] / (D^2)$ …………………..(2)

And the gravitational potential-energy $E_g = [G m_e (h f / c^2) / (D)]$ ………(3)

Now, based on the inverse square-law of propagation of energy, the total gravitational potential energy contained within the sphere of radius D can be derived as:

Total gravitational potential-energy:

$E_{g\,(\text{total})} = [G m_e (h f / c^2) / (D)]. [(4 \pi D^2) / (4 \pi r_e^2)]$,

where $(4 \pi r_e^2)$ is the surface-area of the electron.

Now, equating this energy with the energy lost by the photon, $(h f_0 - h f)$:

$$[G m_e (h f / c^2) / (D)]. [(4 \pi D^2) / (4 \pi r_e^2)] = (h f_0 - h f)$$

i.e. $[G m_e / r_e^2)] (h f / c^2) D = (h f_0 - h f)$ …………………………(4)

Now, Sivaram C. [1] has numerically shown that:

$[\ G\ M_{gal}\ /\ R_{gal}^{2}\ ] = [\ G\ M_{globu}\ /\ R_{globu}^{2}] = [\ G\ m_e\ /\ r_e^{2}\ ] = a_0$ of MOND $= H_0\, c$,

Where H_0 is Hubble's constant, and c is speed of light, and 'a_0 of MOND' stands for the critical-acceleration of Milgom's Modified Newtonian Dynamics. So we can write the expression-4 as:

$$(\ H_0\ c\ )\ D\ (\ h\, f\ /\ c^2\ ) = (\ h\, f_0 - h\, f\ )$$

i.e. $(\ h\, f_0\ -\ h\, f\ )\ /\ (\ h\, f\ ) = (\ H_0\ D\ /\ c\ )$ ……………………………..(5)

We know that the expression-5 is a well known expression for the 'cosmological red-shift'.

Conclusion:

This derivation leads us to a new possibility: that the 'cosmological red-shift' seems to be due to the reason that the photon emitted from the atom has to "fill" the 'gravitational potential-well' produced proportional to its energy, when it was a part of the atom.

References:

[1] Sivaram, C. (1994) *Astrophysics and Space science* 215, 185-189