On the Speed of Gravity, Energy of Photon and the Cosmological Red-Shift

Hasmukh K. Tank

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

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Abstract:

Accepting Einstein's General Relativity 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 derivation presented here 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 emitted 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 derivation presented here 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'.

The Derivation:

When an electron in an atom jumps from higher orbit to a lower orbit, the electrostatic potential-energy of the electron becomes more negative; and a photon of energy $h f_0$, equal to the difference in the potential-energy, gets emitted. Since we intend to consider here the gravitational potential-well produced by the energy of the photon, and "filling" of this potential-well from the energy of the photon, let us express this energy $h f_0$ in the form of gravitational potential-energy, as follows:

$$[G M_x (h f_0 / c^2) / R_x] = h f_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here: M_x and R_x are presently unknown mass and radius for us.

Expression-1 describes the gravitational potential-energy at the point-of-emission of the photon. As the photon moves away from this point, by a distance D, the gravitational potential-energy of the photon reduces to the left-hand-side of

expression-2, and energy of the photon accordingly reduces to hf. The difference of energy gets spent in "filling" the gravitational potential-well within the spherical shell of radius D, up to which the gravitational-wave could reach at the speed of light.

$$[G\,M_x\,(\,h\,f_0\,/\,c^2\,)\,/\,(\,R_x+D)] = h\,f \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

Since the gravitational-force is 10^{-40} times weaker than the electric-force, the distance R_x is expected to be 10^{40} times the reduction in radial-distance of the electron in orbit. So the conversion of electrostatic potential-energy into gravitational potential-energy is expected to obey the following relation:

Electric-force . Distance $[\,r_2-r_1] = $ [Gravitational-force]$[\,10^{40}\,(r_2-r_1)]$

i.e. $[(e^2/\,r_1^2)-(e^2/\,r_2^2)]\,.\,[\,r_2-r_1] = $ [Gravitational-force]$[\,10^{40}\,(r_2-r_1)]$

i.e. $R_x = [\,10^{40}\,(r_2-r_1)]$

Now, it will be more convenient to find the ratio, as shown in expression-3, as we intend to discover whether it is equal to the well-known ratio of the 'cosmological red-shift'. So let us find the ratio:

$$[\{G\,M_x\,(\,h\,f_0\,/\,c^2\,)\,/\,R_x\}-\{G\,M_x\,(\,h\,f_0\,/\,c^2\,)\,/\,(\,R_x+D)\}]\,/\,[G\,M_x\,(\,h\,f_0\,/\,c^2\,)\,/\,(\,R_x+D)] = (h\,f_0\,-\,h\,f\,)\,/\,(h\,f\,) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(3)$$

i.e. $(\,R_x+D-R_x\,)\,(R_x+D\,)\,/\,(\,R_x\,)\,(\,R_x+D\,) = (h\,f_0\,-\,h\,f\,)\,/\,(h\,f\,) \quad \dots..(4)$

i.e. $(\,D\,/\,R_x\,) = (h\,f_0\,-\,h\,f\,)\,/\,(h\,f\,) \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.(5)$

Comparing this expression-5 with the experimentally-found expression for the 'cosmological red-shift', as per our hypothesis proposed in the introduction, that: "The energy spent by the photon to "fill" the 'gravitational potential-well', during its inter-galactic journey, manifests as the 'cosmological red-shift'."

$$(h f_0 - h f) / (h f) = H_0 \, D / c \quad \text{..(6)}$$

From the comparison of expressions- 5 with expression-6 we get the value of the un-known radius as:

$$(H_0 \, D / c) = (D / R_x) \quad \text{...(7)}$$

i.e. $R_x = c / H_0 = R_0$ where R_0 is currently believed to be the 'radius-of-the-observable-universe', whereas according to our hypothesis R_x is just a distance required to express 'electrostatic potential-energy', released in the form of a photon, to express the same energy in the form of 'gravitational potential-energy'. From the known value of R_0 one can find out the value of M_x as which will be equal to the 'Total-mass-of-the-universe'. And we can re-write the expression-1 as:

$$[G \, M_0 \, (h f_0 / c^2) / R_0] = h f_0 \quad \text{..(8)}$$

Replacing $(h f_0 / c^2)$ with the mass of the electron m_e ; and the energy $h f_0$ with the energy of the electron, $m_e \, c^2$:

$$[G \, M_0 \, m_e / R_0] = m_e \, c^2$$

i.e. $[G \, M_0 \, m_e / R_0] = e^2 / r_e$

Where: e is electric-charge, and r_e is classical-radius-of-the-electron. And from this expression we arrive at P. A. M. Dirac's most familiar Large-Number-Coincidence (LNC), and its explanation by Tank [1], that:

$$R_0 / r_e = [G \, M_0 \, m_e / e^2] = [G \, m_p \, m_e / e^2] \; [M_0 / m_p]$$

i.e. $[R_0 / r_e] [e^2 / G \, m_p \, m_e] = [M_0 / m_p] \quad \text{...............................(9)}$

The Large Number Coincidence (LNC), that the ratio $[R_0 / r_e] = [e^2 / (G \, m_e \, m_p)$ actually implied that the 'cosmological red-shift' is due to the process of

conversion of electrostatic potential-energy into gravitational potential-energy, as discussed here.

From the above discussion we find that M_0 is not the total-mass of the universe; rather it is an 'equivalent-theoretical-mass' needed to express electrostatic potential-energy in terms of 'gravitational potential-energy'; and similarly, R_0 need not be interpreted as the 'radius-of-the-universe'; rather R_0 is the radial-distance required while expressing 'electrostatic potential-energy' in terms of 'gravitational potential-energy'. I hope, the reader is able to appreciate this subtle difference.

Summary:

We first expressed the electrostatic potential-energy $h f_0$, released by an electron while jumping from higher-orbit to a lower-orbit, in terms of gravitational potential-energy of the photon. Then, based on our hypothesis, that the part of energy of the photon gets spent in "filling" the 'gravitational potential-well' produced by the energy $h f_0$, we formed an expression similar to the expression for the 'cosmological red-shift'. From comparison of our expression with the experimentally-established expression for the 'cosmological red-shift' we obtained the un-known mass M_x and un-known radius R_x; and found that they are currently believed to the 'total-mass-of-the-universe' and 'radius-of-the-universe' respectively. Then, based on our hypothesis, that: part of energy of the photon gets spent in "filling" the 'gravitational potential-well' produced by the energy $h f_0$, we arrived at a conclusion that "total-mass-of-the-universe" M_0 and "radius-of-the-universe" R_0 are not the 'quantities of the real physical world'; rather they are 'equivalent-theoretical-mass' and 'equivalent-radius' required to express 'electrostatic potential-energy' $h f_0$ in terms of 'gravitational potential-energy'.

Therefore, it is not necessary that 'observable-mass-of-the-universe' should match with M_0 .

References:

[1] Tank, Hasmukh K. (1997) "Explanation for the recurrences of Large-Number 10^{40} in astrophysics" *Proce. Indian Natnl, Sci. Academy- **63,** A* No. 6 pp 469-474 *www.new1.dli.ernet.in/data1/upload/insa/INSA_2/20005975_469.pdf*