Potential-energy of the photon emitted by an atom: And the cosmological red-shift

Hasmukh K. Tank

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

Abstract

When an electron in an atom falls from higher orbit to a lower orbit a photon gets emitted. Since the electrostatic potential-energy of the electron is negative, because of the attractive force between the proton and the electron, the fall of electron makes its potential-energy more negative. So it is argued here that the energy of the emitted photon is a chunk of positive potential-energy; and since the photon is electrically neutral, it can feel only the gravitational force. Therefore it is proposed here that the photon emitted by an atom might be feeling a repulsive gravitational force; and so it always moves away from the emitting atom. As this photon moves away from the atom, its potential-energy goes on reducing. Then it is shown here that the loss of energy of the cosmologically red-shifted photon is indeed equal to ($G\ m_e\ m_p/\ e^2$) times the loss in electrostatic potential-energy of the electron at the same distance D.

Introduction

Cosmological red-shift was discovered by E.P. Hubble. He expressed the red-shift in terms of recessional velocities of galaxies. But he himself was of the opinion that expressing cosmological red-shift in terms of recessional-velocities is only a convention; not necessarily a cause. Einstein's general-relativity predicted expansion of not only space but also of time. And observation of time-dilation of super novae light-curves convinced majority of physicists that the cosmological red-shift is due to general-relativistic expansion of space-time. Some scientists tried to propose tired-light explanation for the red-shift; but they were rejected under the belief that 'tired-light-explanations' are not compatible with the observations of 'time-dilation of super novae light-curves. But recently this author showed that any mechanism which can cause cosmological red-shift will also cause time-dilation of super novae light-curves (Tank H. K. Advanced Studies in Theoretical Physics 2913). He also presented wave-theoretical insight into the special-relativistic 'length-contraction' (Tank H. K. 2013). He has noticed long back that the energy lost by the cosmologically red-shifted photons is strikingly proportional to the strength-ratio of gravitational and electric forces (Latest version of his write-ups: Tank H. K. 2014); but logical theoretical explanation for this correlation was lacking. Now, in this letter a theoretical explanation is also presented, that: When an electron in an atom falls from higher orbit to a lower orbit a photon gets emitted. Since the electrostatic potential-energy of the electron is negative, because of the attractive force between the proton and the electron, the fall of electron makes its potential-energy more negative. So it is argued here that the energy of the emitted photon is a chunk of positive potential-energy; and since the photon is electrically neutral, it can feel only the gravitational force. Therefore, it is proposed here that, the photon emitted by an atom might be feeling a repulsive gravitational force; and so it always moves away from the emitting atom. As this photon moves away from the atom, its potential-energy goes on reducing. Then it is shown here that the loss of energy of the cosmologically red-shifted photon is indeed equal to ($G\, m_e\, m_p / e^2$) times the loss in electrostatic potential-energy of the electron at the same distance *D*.

Also there is a question related to the current explanation of the cosmological red-shift: Assuming that the wavelength of the photon gets stretched due to expansion of inter-galactic-space; but the space within the galaxies is not expanding, as the galaxy is a gravitationally-bound structure. So at the edge of galaxies, including the edge of our milky-way galaxy, there must be a smooth and gradual transition from expanding intergalactic-space to un-expanded space within our galaxy. So the wavelength of a photon, which got stretched while passing through expanded space, should slowly start shrinking as it comes closer and closer to our milky-way galaxy; and shrink-back to its original wavelength in the un-expanded space within our galaxy. Some scientists had collected one hundred arguments against general relativity. Einstein's reply was that only one argument is sufficient for fall of my theory. The question raised here is one argument for the open-minded scientists to consider.

The Derivations:

The law of conservation of energy is the most trusted law of physics. Energies may get converted from kinetic to potential or from potential to kinetic, but energy is never lost. Let us consider here Feynman-diagram of an atom which emits a photon by its transition from more exited to less exited state. Since the electron feels attractive force from the proton, its potential-energy is negative; and when it falls from higher orbit to a lower orbit its potential-energy becomes more negative. So according to the law of conservation of energy the emitted photon should be viewed as a chunk of positive potential-energy. Since photon is electrically neutral particle, it can feel only the gravitational force. And since the energy possessed by it is positive potential-energy, it must feel repulsive gravitational force, and move away from the emitting atom. And as it moves away, its potential-energy goes on reducing. In the next paragraph we will see that cosmological red-shift is indeed equal to ($G\, m_e\, m_p / e^2$) times the loss in electrostatic potential-energy of the electron at the same distance *D*. [Cosmologists have been searching for repulsive-gravity. It seems that positive potential-energy of the photon emitted by an atom feels such repulsive gravity from its source atom.]

let us first define reduction in electrostatic potential-energy of an electron-proton-system z_e as:

$$z_e = [\, e^2 / r_e \,] - [\, e^2 / (\, r_e + D)] \,/\, [\, e^2 / (\, r_e + D)] \,,$$

where *e* is electric-charge, r_e is 'classical radius of electron' and *D* is 'luminosity distance'

i.e. $z_e = e^2\, [\, r_e + D - r_e \,]\, [\, r_e + D] \,/\, [\, r_e\, (\, r_e + D)\, e^2\,]$.

i.e. $z_e = D / r_e$. ……………………………………………………………(1)

From Dirac's Large-Number-Coincidence, we know, that:

$$(G\, m_e\, m_p / e^2\,) = (\, r_e / R_0\,) = (\, m_p / M_0\,)^{1/2} = 10^{-40} \,,$$

Where M_0 is total mass, and R_0 radius of the universe.

i.e. $z_e = 10^{40}$ (D / R_0). ……………………………………………………..(2)

Since $H_0 R_0 = c$, $z_c = H_0 D / c = D / R_0$ ……………………………………(3)

Comparing the expressions (1) and (3), we get:

$z_c = 10^{-40} z_e$. ……………………………………………………………..(3)

That is: ‘cosmological-red-shift, at a distance D is ($G\ m_e\ m_p /e^2$) times the reduction expected from the ‘electrostatic potential energy of an electron at that distance D.

(ii) Also, the linear part of the cosmological red-shift is:

$z_c = \Delta \lambda / \lambda_0 = H_0 D / c$...(4).

The right-hand-side of expression-4 can be written as:

$H_0 D / c = h H_0 / (h c / D)$.

Now, Steven Weinberg (1972) has found an interesting relation that:

$m_p^3 = h^2 H_0 / c G$, where, m_p is mass of a fundamental-particle, pi meson.
Alternatively, m_p^3 can be viewed as m_{proton} x m_{proton} x $m_{electron}$.

i.e. $G\ m_p^2 / (h / m_p\ c) = h H_0$ . ...(5).

So, from the expressions 4 and 5, we get:

$z_c = \Delta \lambda / \lambda_0 = [G\ m_p^2 / (h / m_p\ c)] / [h c / D]$. …………………...….............(6).

i.e. $z_c = \Delta \lambda / \lambda_0 = [G\ m_p^2 / h c] [D / (h / m_p c)]$,

where ($h / m_p c$) is a unit of distance, measured in terms of Compton-wavelength of pi-meson; and the constant [$G\ m_p^2 / h c$] denotes the strength-ratio of gravitational and electric forces.

Or, in terms of energy:

$z_c = h \Delta \nu / h \nu = [G\ m_p^2 / h c] [D / (h / m_p c)]$. ………………..……....(7).

That is, the reduction in energy of photon due to cosmological-red-shift is proportional to the strength-ratio of gravitational and electric forces.

(iii) When a massive particle losses its gravitational potential-energy its velocity reduces. But since velocity of light is always constant, a photon can lose its potential-energy by losing energy-of-mass, by keeping its acceleration constant, as can be seen from the following derivation:

We can express linear part of the cosmological red-shift z_c in terms of de-acceleration experienced by the photon (Tank 2011):

$$z_c = (f_0 - f) / f = H_0 D / c$$

i.e. $(h \Delta f / h f) = H_0 D / c$

i.e. $h \Delta f = (h f / c^2) (H_0 c) D$ …………………………………………..(8)

That is, the loss in energy of the photon is equal to its mass $(h f / c^2)$ times the deceleration $a = H_0 c$, times the distance D travelled by it. Where: H_0 is Hubble-parameter. And the value of constant deceleration a is: $a = H_0 c$, $a = 6.87 \times 10^{-10}$ meter/sec^2 , equal to the rate of said accelerated expansion of the universe!

Conclusion:

Our theoretical consideration predicted reduction of gravitational potential-energy of the photon emitted by an atom. And in the case of cosmological red-shift we do observe reduction of energy proportional to the strength-ratio of gravitational and electric forces. Also there is a q question against the current explanation of the cosmological red-shift. Therefore the new explanation proposed here should be paid open-minded attention.

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