

Is the expansion of universe accelerating or the Photons decelerating?

Hasmukh K. Tank

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

E-mail: tank.hasmukh@rediffmail.com

Abstract

Astronomical observations of the cosmological red-shift are currently interpreted in terms of ‘expansion of universe’ and ‘accelerated-expansion of the universe’, at the rate of $H_0 c$; here H_0 is Hubble’s constant, and c is the speed of light. Whereas a straight-forward derivation presented here suggests that: rather it is the photon which is decelerating, at the rate of $H_0 c$. Such a deceleration of photons can be caused by virtual electrons, positrons and pi-mesons, contained in the extra galactic quantum vacuum, because: they do have gravitational-acceleration of the same order as $H_0 c$ at their “surfaces”; or by decay of a photon into a lighter photon and a particle of mass $h H_0 / c^2$. Tired-light interpretations of the cosmological red-shift were so far considered as not compatible with the observations of ‘time-dilation of super-novae light-curves’; so in a paper titled: “Wave-theoretical insight into the relativistic ‘length-contraction’ and ‘time-dilation of super-novae light-curves’” (Tank, Hasmukh K. 2013), it has been already shown that any mechanism which can cause ‘cosmological red-shift’ will also cause ‘time-dilation of super-novae light-curves’. Therefore, we now need not to remain confined to the Big-Bang model of cosmology.

Keywords: Cosmology; Cosmological Red-Shift; Accelerated Expansion of the Universe; Steady-State-Cosmology.

1. Introduction

E.P. Hubble’s observations of ‘cosmological red-shift’, and subsequent observations till today, are currently interpreted in terms of ‘expansion of the universe’ and accelerated-expansion of the universe at the rate $H_0 c$. Whereas a straight-forward derivation presented here suggests that: rather it is the photon which is decelerating, at the rate of $H_0 c$. Tired-light interpretations of a cosmological red-shift were so far considered as not compatible with the observations of ‘time-dilation of super-novae light-curves’; so in a paper titled: “Wave-theoretical insight into the relativistic ‘length-contraction’ and ‘time-dilation of super-novae light-curves’” (Tank, Hasmukh K. 2013) it has been already shown that any mechanism which can cause ‘cosmological red-shift’ will also cause ‘time-dilation of super-novae light-curves’. Therefore, we now need not to remain confined to the Big Bang model of cosmology.

Martin Lopez-Corredoira (2014) applied Alcock- Paczynski cosmological test to six candidate cosmological models; and reached a conclusion that only two of them, namely lambda-CDM and static universe with tired light interpretation of the cosmological red-shift, fit the data.

Cosmologists have accepted the ‘space-expansion- interpretation’ of the ‘cosmological red-shift’, as it matches with Einstein’s General Theory of Relativity (GR), which predicted ‘expansion of space’. This author has been arguing that ‘expansion of space’ of GR is a ‘mathematical terminology’ not a physical phenomenon; because: as per GR, if the space between the galaxies is expanding, but the space within the galaxy is not doing so, as a galaxy is a gravitationally-bound structure, then what happens at the boundary of the galaxy? Such uneven expansion of glass would break

the glass, and may tear off the space, if expansion-of-space were a physically-real phenomenon. Recently, Ling Jun Wang, (2014) in an article, “On the Flatness of Space-time” has rigorously proven that curvature and expansion of space-time are mathematical entities, not the physically real curvature or expansion of space. So, the static universe with tired-light explanation has remained the only candidate. In this paper ‘cosmological red-shift’ is explained in terms of deceleration of photons caused by virtual electrons and pi-mesons contained in the extra galactic quantum vacuum. And, as supportive evidence, it is shown here that virtual electrons and pi-mesons do have gravitational-acceleration of the order $H_0 c$ at their “surfaces.” As a further supportive evidence for this proposal, it is shown that even the space-probes Pioneer-10, Pioneer-11, Galileo and Ulysses too, did decelerate at the same rate $H_0 c$ (Anderson J.D. at all 1998).

2. The derivations

- i) It is currently believed that the expansion of the universe is getting accelerated at the rate $H_0 c$. The following derivation suggests that rather it is the cosmologically red-shifting photon, which is decelerating at the same rate. The linear part of the cosmological red-shift is expressed as:

$$z_c = h \Delta f / h f = H_0 D / c$$

That is, the loss in energy of the photon, at a distance D , is:

$$h \Delta f = (h f / c^2) (H_0 c) D \quad (1)$$

That is, the loss in energy of the photon at a distance D is equal to its “mass” times the acceleration ($H_0 c$) times the distance D . Whether the expansion of the universe is accelerating, is still a hypothesis; whereas the cosmologically red-shifting photon is decelerating at the same rate ($H_0 c$), as found here, is an experimentally observed fact.

The mechanisms, which can cause such a deceleration of the photons, can be explained as follows:

- a) The inter-galactic space is not a void extension of nothingness. As per quantum mechanics, pairs of virtual particle-and-antiparticles keep on coming in existence for small durations of time permitted by ‘Heisenberg’s uncertainty principle’. There are many pairs of virtual particles always present in the path of inter-galactic photons. The gravitational-acceleration at the “surface” of these particles is of the order of $H_0 c$ as shown below: So all these virtual particles, bit by bit, keep on causing ‘gravitational red-shift’ in the inter-galactic photons.

Gravitational acceleration at the “surface” of the electron:

$$a_e = G m_e / (e^2 / 2 m_e c^2)^2 = H_0 c \quad (2)$$

Gravitational acceleration at the surface of the pi-meson can also be derived from Steven Weinberg’s formula, that:

$$m_{pi} = [h^2 H_0 / c G]^{1/3}$$

$$\text{i.e. } G m_{pi} / (h / m_{pi} c)^2 = H_0 c \quad (3)$$

Even the accelerations at the “surface” of the nucleus-of-atom, the globular-clusters, the spiral-galaxies, and the galactic-clusters too, are of the order of $H_0 c$ as Siveram C. (1994) has numerically found:

- i) For a typical atomic nucleus of mass m_n , ($A = 150$)

$$a = G m_n / r_n^2 \sim 1.0 \times 10^{-10} \text{ m / s}^2$$

- ii) For a globular cluster of mass 10^6 solar-masses and radius $R_g = 100 \text{ pc}$,

$$a = G M_g / R_g^2 \sim 10^{-10} \text{ m / s}^2$$

- iii) For a spiral galaxy of mass $M_{gal} = 10^{12}$ solar-masses and radius $R_{gal} = 30 \text{ kpc}$,

$$a = G M_{gal} / R_{gal}^2 \sim 0.8 \times 10^{-10} \text{ m / s}^2$$

- iv) For a typical cluster of galaxies, $M_c = 10^{16}$ solar-masses and radius $R_c = 3 \text{ Mpc}$,

$$a = G M_c / R_c^2 \sim 10^{-10} \text{ m / s}^2$$

- v) Also, for the observable-universe as a whole, with a density of $10^{-29} \text{ grams / cm}^3$ and radius $R_0 = 10^{28} \text{ cm}$,

$$a = H_0 c = 6.87 \times 10^{-10} \text{ m/s}^2$$

- vi) And the value of ‘critical acceleration of MOND,

$$a_0 \sim 10^{-10} \text{ m / s}^2$$

- ii) As a supportive evidence for the above theory, let us look at the values of decelerations experienced by Pioneer-10, Pioneer-11, Galileo and Ulysses space-probes, (Anderson J.D. et al. 1998):

$$1) \text{ For Pioneer-10, } a = (8.09 \pm 0.2) \times 10^{-10} \text{ m / s}^2$$

$$2) \text{ For Pioneer-11, } a = (8.56 \pm 0.15) \times 10^{-10} \text{ m / s}^2$$

$$3) \text{ For Ulysses, } a = (12 \pm 3) \times 10^{-10} \text{ m / s}^2$$

$$4) \text{ For Galileo, } a = (8.0 \pm 3) \times 10^{-10} \text{ m / s}^2$$

All these decelerations are of the same order of magnitude as $H_0 c = 6.87 \times 10^{-10} \text{ m/s}^2$; and match strikingly with the ‘critical-acceleration’ a_0 of MOND; an extremely rare-probability coincidence. Matching of four different decelerations of the space-probes, in spite of the differences in their mass, velocities and directions, is itself a striking coincidence; and its matching with the deceleration experienced by the ‘cosmologically red-shifting photon’ cannot be ignored by a scientific mind as a coincidence. So the atoms contained in the space-probes got decelerated due to the bit-by-bit decelerations caused by the virtual particles. This mechanism is testable in the laboratory. Or:

- b) By decay of a photon into a lighter photon and a particle of mass $h H_0 / c^2$, at every wavelength traveled by the photon. Experimental detection of a new particle of such a small mass may be difficult but not impossible for the physicists. One of the ways of predicting a new particle is to calculate the missing energy, by applying the law of conservation of energy. The photon does loose a chunk of energy $h H_0$ while traveling every distance equal to its wavelength. This method suggests that a particle of mass $h H_0 / c^2$ is likely to exist, based on the following argument: The strength ratio of electric forces and strong forces is $\sim e^2 / h c$, and we do find particles of the similar mass-ratio, namely, the mass-ratio of the electron and the pi-meson: $(m_e / m_{pi}) \sim (e^2 / h c)$. Similarly, we can expect the particles with a mass-ratio: $(h H_0 / c^2) / m_e = [(G m_e m_{proton}) / (e^2)]$. Interestingly the ratio $(h H_0 / c^2) / m_e$ is indeed equal to the ratio $[(G m_e m_{proton}) / (e^2)]$! Therefore, our expectation of a particle of mass: $(h H_0 / c^2)$ is quite reasonable.

3. Summary

The straight-forward derivation presented here suggests that: the extra-galactic photons are decelerating at the rate $H_0 c$ is an experimentally-observed fact. The gravitational acceleration at the “surface” of the virtual electrons, virtual positrons and virtual pi-mesons is also of the same order of magnitude as $H_0 c$, so the gravitational field of the virtual particles bit-by-bit can keep on causing ‘gravitational red-shift’ in the extra-galactic photons. This reduction in the energy of the photons can explain the observation of ‘cosmological red-shift’. This mechanism is testable in the laboratory. Possible alternative mechanism proposed here is: decay of the photon into a lighter photon and a new particle of mass: $(h H_0 / c^2)$.

References

- [1] Tank Hasmukh K., (2013) "Wave-theoretical insight into the relativistic length-contraction and time-dilation of super-nova light-curves" *Adv. Studies Theor. Phys.*, Vol. 7, no. 20, 971-976 <http://dx.doi.org/10.12988/astp.2013.39102>.
- [2] Martin Lopez-Corredoira (2014) "Alcock-Paczynski Cosmological test" *Astrophysical Journal* Vol. 781(2) DOI:10.1088/0004-637X/781/2/96 <http://dx.doi.org/10.1088/0004-637X/781/2/96>.
- [3] Ling Jun Wang, (2014) "On the Flatness of Spacetime" *Physics Essays*, Volume 27, No. 3.
- [4] Anderson, J. D., Laing, P. A., Lau, E. L., Liu, A. S., Nieto M. M., and Turyshev, S. G. (1998) "Indication, from Pioneer 10, 11, Galileo and Ulysses Data, of an Apparent Anomalous, Weak, Long-Range Acceleration". *Phys. Rev. Letters*. 81 2858-2861 [(Comment by Katz J.L.: *Phys. Rev. Lett.* 83, 1892 (1999); Reply: *Phys. Rev. Lett.* 83, 1893 (1999)]. <http://dx.doi.org/10.1103/PhysRevLett.81.2858>.
- [5] Sivaram, C. (1994) *Astrophysics and Space science* 215, 185-189 <http://dx.doi.org/10.1007/BF00660076>.