Some limitations of the Big Bang Cosmology and Its Possible Alternative

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Date: 7th January, 2015

Abstract:

This letter begins with some questions which do not seem to have satisfactory explanations in the current Big-Bang Cosmology. Then it points out a paper [1] which shows that any mechanism which can cause 'cosmological red-shift' will also cause 'time-dilation of super-novae light-curves, so any alternative explanation of the cosmological red-shift' is not incompatible with the observations of super-novae light-curves. Rather, non-observation of time-dilation in the case of some super-novae needs further works. Then, based on the coincidences noticed by Nobel laureate physicists, and authentic text-books, a derivation is presented showing that every piece of matter and energy is expected to feel the 'cosmic gravitational force'. This derivation leads to a prediction that not only photons, but all other bodies are expected to feel this 'cosmic gravitational force' causing deceleration of their inertial-motion. It is shown that the so called 'Pioneer-anomaly' is very much expected based on this derivation.

1. Introduction:

Einstein's theory of relativity talks of 'contraction of length', 'dilation of time', and 'curvature' and expansion of space. 'Length' of an object is something physical and objective, so length can be measured using a foot-rule. But 'time' is not a physical entity; it is just a mental abstraction. We conventionally talk of 'time' by observing and comparing cyclically repeating physical processes. Does an hour-glass 'measure' 'time'? So talking about dilation of 'time', and measuring it using two atomic clocks at different heights, only means that physical processes within the atomic clocks get affected by gravity; and not dilation of 'time'. And since a decaying particle moving at high speed contains additional energy, namely 'kinetic energy', so it takes longer time to decay! Like this author, many scientists have been raising questions against the general-relativistic 'expanding model of the universe'; as can be found from the innumerable

peer-reviewed papers. According to Prof. Jayant Narlikar there is too much extrapolation of various formulae in the expanding model, which may not be correct. Another question, raised by some scientists is: Is energy conserved in GR? Some other scientists have gathered one hundred questions against relativity theory. Einstein's reply was: "One question is sufficient for fall of my theory". This author proposes to the open minded scientists to consider whether one of the questions raised here is not satisfactorily answerable by the general relativity theory? Moreover, the current model of cosmology predicts 'accelerated expansion' of the universe, demanding 'dark energy', but no trace of 'dark energy' is found so far. Therefore we need to consider the alternative explanation for the observations of 'cosmological red-shift' as proposed here.

2. Some questions regarding the expanding model of cosmology:

(i)

The general relativity theory predicts 'expansion of space' between the galaxies; but the space within the galaxy is not expanding, because galaxy is a gravitationally-bound-structure. The question raised here is: If so, then what happens at the edge of a galaxy whose external space is expanding but the space within is not expanding? Is there a smooth transition from expanding to non-expanding space? If expanding-space can stretch the wavelength of a cosmologically red-shifting photon, then less and less expanding space, at the boundary of the galaxy, should shrink the wavelength back to its original length, isn't it?

(ii)

According to general relativity the planets, like the earth, orbit around the Sun, because the space around the Sun has got curved; and the planets are in inertial-motion traveling along the geodesic path. Now the question raised here is: Inertial-motion of a body can be at any speed. Can the planets travel along the geodesic-path at any speed they like? Can they take a coffee-brake and then proceed further?

(iii)

According to general relativity there is a radial-distance at which rate of expansion of space is equal to the speed of light, so the wave-front of light beyond this radius is not able to enter the sphere of observable universe. This means that the speed of light is the same, 3×10^8 meters per

second. The question raised here is: Since the speed of light is the same in expanding as well as non-expanding space; and $f \,.\, \lambda = c$, i.e. the product of frequency (f) and wavelength (λ) is always equal to the speed of light (c); then the wavelength (λ) can increase only when frequency (f) gets reduced; and not because of expansion of space.

3. Alternative explanation for the 'cosmological red-shift':

Robert K. Adiar, in his book: "Concepts in Physics" [2] has presented a derivation that:

$M_0 \, c^2 - G \, M_0 \, M_0 \, / \, R_0 \; = 0$ Where M_0 is total mass of the universe, and R_0 is 'radius of the observable universe.

i.e. the gravitational potential energy of the universe is equal to total-mass of the universe.

i.e. $G \, M_0 \, M_0 \, / \, R_0 \; = \; M_0 \, c^2$ ……..….. (1)

i.e. $G \, M_0 \, M_0 \, / \, R_0 \; = \; M_0 \, c^2$ ……(2)

This expression helped this author to explain the recurrences of the large-number 10^{40} in astrophysics [3] as follows:

Since: $G \, M_0 \, M_0 \, / \, R_0 \; = \; M_0 \, c^2$

i.e. $G \, M_0 \, m_e \, / \, R_0 \; = \; m_e \; c^2 \; = \; e^2 \, / \, r_e$

i.e. $R_0 \; / \; r_e \; = \; e^2 / \, G \, M_0 \, m_e \; = \; (\, e^2 / \, G \, m_p \; m_e \,) \; (\, m_p / M_0 \,)$ ……..…(3)

Further derivation can be read from the ref [3].

i.e. $G \, M_0 \, m_e \, / \, R_0 \; = \; m_e \; c^2$ ……..…..(4)

i.e. $G \, M_0 \, m_e \, / \, R_0^2 \; = \; m_e \, (\, c^2 \, / \, R_0 \,)$…….....(5)

Since we know that radius of the universe R_0 is defined as a distance at which the recessional-velocity of the galaxies ($H_0 \, D$) attains the speed of light (c):

$H_0 \, R_0 = \; c$

i.e. $R_0 \; = \; (\, c \, / \, H_0 \,)$ ……..….(6)

Substituting (6) in (5):

$G M_0 m_e / R_0^2 = m_e (H_0 c)$…….....(7)

The expression-4 implies that mass of an electron is because of its 'cosmic gravitational potential energy'. Similarly mass, of every piece of 'matter' is because of its 'cosmic gravitational potential energy'. And the expression-7 implies that every piece of matter and energy feels a 'cosmic gravitational force' equal to its mass times the acceleration $H_0 c$.

Now, extending this expression (4) and (7) for the 'photons', we get:

$G M_0 (h f / c^2) / R_0 = (h f)$ ……..…..(8)

And $G M_0 (h f / c^2) / R_0^2 = (h f / c^2) (H_0 c)$…….……..…..(9)

When the photon moves a distance *D*, equal to the luminosity-distance of its source from us, the work done by the photon to overcome the 'cosmic gravitational force' is:

Work done = (Force) . (Distance)

i.e. Work done = $[G M_0 (h f / c^2) / R_0^2] D = (h f / c^2) (H_0 c) D$……..…..(10)

This is what we find in the case of 'cosmological red-shift', as follows:

The linear part of the 'cosmological red-shift' is expressed as:

Cosmological red-shift (z_c) = $(h f_0 - h f) / (h f) = H_0 D / c$

i.e. $(h f_0 - h f) = (h f / c^2) (H_0 c) D$ ……(11)

From the expressions (10) and (11) we find that the loss in energy of the cosmologically red-shifting photon ($h f_0 - h f$) is equal to the work done by the photon against the 'cosmic gravitational force' felt by it, i.e. $(h f / c^2) (H_0 c) D$.

After every unit distance the energy of the photon gets reduced. So the loss in energy of the photon goes on reducing with every subsequent unit distances. Thus 'cosmological red-shift' automatically becomes a non-linear function of distance, as observed in the case of distant galaxies.

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 [4]:

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

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

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

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

All these decelerations are of the same order of magnitude as $H_0\, c = 6.87 \times 10^{-10}$ m/s^2; and match strikingly with the 'critical-acceleration' a_0 of MOND; an extremely rare-probability coincidence. Matching of four different decelerations, 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. Slight differences in their values can be attributed to mundane effects like thermal radiation. Moreover, the extra-galactic photon experiences some gravitational blue-shift when it enters the gravitational-field of our milky-way galaxy. If we can send Hubble-like telescope out-side our milky-way galaxy then the value of $H_0\, c$ may be found very close to the decelerations of the above space-probes.

This value of acceleration ($H_0\, c$) also seems to play some role in the formations of structures of: nucleus-of-atom, globular-clusters, spiral-galaxies, galactic-clusters and the whole universe; as Sivaram C. has found interesting coincidences [5-8] that:

(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 $R_g = 100$ 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 = 30 kpc,

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

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

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

(v) Also, for the universe as a whole, with a density of 10^{-29} grams/ cm^3 and radius R= 10^{28} cm,

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

(vi) And the value of 'critical acceleration of MOND, $a_0 \sim 10^{-10}$ m / s^2

Alternatively we can consider the following derivation: (Can be removed based on learned referee's advice)

Let us assume that the 'cosmological-red-shift' is partly a gravitational-effect. The photon emitted by a supernova, and reaching us on earth, experiences some gravitational-pull from the mass within the sphere of radius *r* equal to the 'luminosity-distance' *D*. The change in gravitational-potential-energy of a photon of mass $m = (h f / c^2)$ will be:

$\Delta E = G (4/3) \pi \rho_c D^3 m / D$

Where:

ρ_c is average density of matter in the universe;

$\rho_c = 3 H_0^2 / (8 \pi G) = 9.6 \times 10^{-27}$ kg-m^{-3} ; [Ref.9]

i.e. $\Delta E = [G (4/3) \pi \{ 3 H_0^2 / (8 \pi G) \} D^3 (m)] / D$

i.e. $(\Delta E) = (1/2) (m) H_0^2 D^2$ ……..….(12)

Now, assuming this gravitational-potential-energy as the kinetic energy of body of mass *m*, as assumed in the case of expanding model of the universe:

$(1/2) m v^2 = (1/2) (m) H_0^2 D^2$ ……..…..(13)

i.e. $v = H_0 D$

We have been interpreting this velocity as the 'recessional-velocity' of the galaxies; whereas our derivation suggests that, the reduction in energy of the 'cosmologically red-shifting photon' can be because: the photon has to work against the gravitational-pull of the mass within the sphere of radius *D*.

The expressions-12 & 13 are correct as long as the 'luminosity-distance' *D* is smaller than $R_0/2$; that is, for the cosmological-red-shifts up to 0.5; but when $D > (R_0/2)$, a part of the sphere of radius *D* falls outside the sphere of the universe; so the mass contained in the sphere of radius *D* start deviating from the expression: $(4/3) \pi \rho_c D^3$. So we observe lesser red-shifts than expected

from the distant supernovae. Of course this second alternative cannot explain the Pioneer anomaly.

Conclusion:

We first pointed out some conceptual difficulties in the current Big Bang Model of cosmology; and proposed alternative interpretation of the 'cosmological red-shift'; that every piece of matter and energy experiences 'cosmic gravitational force'. Every moving object has to overcome this force to continue to move. Newton's first law is valid if there is only one particle in the universe. If there are two particles then there is gravitational interaction between them altering their inertial motion. Inter galactic photons have to overcome this 'cosmic gravitational force'; so they have to spend a part of their energy. This loss of energy manifests as the 'cosmological red-shift'. The so called Pioneer anomaly is a supportive evidence for this new interpretation of the 'cosmological red-shift'. The discussion of this paper is likely to help understanding MOND and the accelerated-expansion of the universe, as the values of those accelerations match strikingly with the 'cosmic gravitational acceleration' derived here.

References:

[1] Adiar R. K. "Concepts in Physics" Academic Press, New York (1969) pp 775

[2] Tank Hasmukh K., "Wave-theoretical insight into the relativistic length-contraction and time-dilation of super-nova light-curves" *Adv. Studies Theor. Phys.*, Vol. **7,** (2013), no. 20, 971–976 http://dx.doi.org/10.12988/astp.2013.39102

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

[4] Anderson, J.D., Laing, P.A., Lau, E.L., Liu, A.S., Nieto M. M., and Turyshev.S.G. "Indication, from Pioneer 10, 11, Galileo, and Ulysses Data, of an Apparent Anomalous, Weak, Long-Range Acceleration". *Phys. Rev. Letters.* **81** (1998) 2858-2861 [(Comment by Katz J.I.: *Phys. Rev. Lett.* **83**, 1892 (1999); Reply: *Phys. Rev. Lett.* **83**, 1893 (1999)].

5. Sivaram, C.: 1986, *Astrophys. Space Sci.* **125,** 189

6. Sivaram, C.: 1987, *Astrn. Astrophys.* **37,** 201; *Nature,* **327,** 108

7. Sivaram, C.: 1993, *Astron. Astrophys.* **275,** 37.

8 Sivaram, C. : 1994, *Astrophysics and Space science* **215,** 185-189

9. Spergel, D. N., et al. 2003, *Astrophysical Journal Supplement*, **148**, 175