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The Big Bang Universe, the Speed of Light and the Principle of Energy Conservation

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The Big Bang theory states that the observable U*niverse* began 13.8 *Gy* ago, in an enormous and swift expansion. General relativity claims that this expansion is an expansion of space (or better space-time) itself and still is (uniformly?) occurring. According to this theory, the wavelength of light coming from nearby or distant galaxies[1] increases or shows cosmological redshift (or simply redshift).

Let us denote with λ (or ν) the wavelength (or frequency) of light emitted by the (nearby or distant) galaxy source (or generated by the same source on the Earth) and λ_G (or ν_G) the wavelength (or frequency) of light measured by an Earth observer. As we noted above, if $\lambda_G > \lambda$ (or $\nu > \nu_G$), then the galaxy's light is redshifted.

The redshift of a galaxy z_G in cosmology is characterized by the relative difference between the observed wavelength λ and emitted wavelength λ_G of light (or, in general, electromagnetic radiation) sourced by nearby or distant galaxies. This is mathematically expressed by the following equation

$$z = (\lambda - \lambda_G)/\lambda_G$$

or

$$\lambda/\lambda_G = 1 + z \quad \ldots (1).$$

The vast majority of nearby and distant galaxies[2] show redshift in their spectra.

In contrast to the Big Bang model, the ultraviolet surface brightness data of galaxies, over a very wide redshift range, imply that the observable Universe is the non-expanding (Euclidean) Universe (NEEU) [2, and references therein]. A detailed analysis of the gamma-ray burst sources performed by Sanejouand [3] supports this view, suggesting that the Universe has been Euclidean and static over the last 12 *Gy*. To explain redshift, Premović [4] hypothesized that the speed of light emitted by nearby/distant galaxies in NEEU is superluminal.

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[1] We define nearby galaxies as those galaxies whose redshift z is from 0.001 to 0.1 (or $0.001 \le z \le 0.1$) and distant galaxies as those having $z > 0.1$. Of course, there is no sharp boundary between nearby and distant galaxies [1].

[2] Almost all nearby and distant galaxies are redshifted; they are moving away from the Earth. There are about 100 galaxies that have blueshifts and are heading towards the Earth. Most of these are Local Group (dwarf) galaxies.

In the cosmological literature, the speed of light during the lifetime of the Universe is a more recent issue. For the interested reader, we would recommend the reviews of this issue by Magueijo [5] and Farrell and Dunning-Davies [6]. This is not the place to deal with these issues. Instead, we would only note here that Sanejouand [3] hypothesized that the speed of light decreased by about 2-3 × 10^{-5} $km\ sec^{-1}\ y^{-1}$ during the cosmological history of the Universe.

We here hypothesize that the cosmological redshift of nearby and distant galaxies is caused by their superluminal speed of light in the past, i.e., the speed of light of these galaxies was greater than the current speed of light c (≈ 3 × 10^8 m sec^{-1}).

The Principle of conservation of energy is one of the fundamental laws of physics that is not violated by any known process. For example, in quantum physics, energy is conserved. In contrast, one of the problems that the Big Bang Universe is facing is the apparent violation of this law by the cosmological expansion.

Let us assume that a nearby or distant galaxy is moving from the Earth, emitting light toward the Earth's observer who measures it. Assume that the frequency of this light is ν and its photon energy, according to Planck's equation, is $E = h\nu$, where h is Planck's constant (6.63×10^{-34} $J\ sec$). On the other hand, an observer moving with a nearby or distant galaxy would measure a higher frequency ν_G and calculate higher photon energy, $E_G = h\nu_G$. The number of photons in the light emitted by the galaxy must equal the number of photons that reach the Earth or

$$\mathcal{N}_G = \mathcal{N}$$

where $\mathcal{N}_G$ or $\mathcal{N}$ can be approximated as a very large natural number if it is larger than or equal to say 10^4 [7].[3]

The Principle of energy conservation is one of the fundamental laws of physics that is not violated by any known process. Following this law, the total energy of the light emitted by the galaxy, E, must be equal to the total energy that reaches the newborn Earth, EG, or

$$\mathcal{N}_G h\nu_G = \mathcal{N} h\nu \quad \ldots (2).$$

We know that $1/\nu_G = \lambda_G/c$ *and* $1/\nu = \lambda/c$. Taking this into account and dividing eqn. (2) with the speed of light c, we get after a bit of algebra that $\mathcal{N}\lambda_G = \mathcal{N}_G\lambda$. As we noted above, $\mathcal{N}_G = \mathcal{N}$, so $\lambda = \lambda_G$, $\nu = \nu_G$, or $h\nu = h\nu_G$. However, as we noted above, $\lambda_G < \lambda$, or $\nu_G > \nu$, or $h\nu_G > h\nu$. During the Universe's expansion, light emitted by the galaxy would lose energy. This loss would cause its wavelength to rise or result in a cosmological redshift. This is one of the major stumbling blocks to the modern theory of cosmological redshift based on the expansion of the Universe.

As we noted above, the Principle of energy conservation states that the total energy of the light emitted by the galaxy at G must be equal to the total energy that reaches the Earth E_G, or

[3] Each large rational number (say ≥ 10000) can be approximated with a corresponding natural number since the approximation error is small (< 0.01 %). In the case of nearby or distant galaxies, we are dealing with an extremely large rational number of the periods; therefore, the approximation error is extremely small – i.e. completely negligible [7].

$$E_G = \mathcal{N} h\nu_G = E = \mathcal{N} h\nu$$

or

$$\nu_G = \nu \quad \ldots (2)$$

Suppose now that $\nu_G = c_G/\lambda_G$, where c_G is *the* speed of light emitted by the galaxy and we know that $\nu = c/\lambda$, where c is the speed of light reaching the Earth. Taking this into account and after a bit of algebra, we have

$$\lambda/\lambda_G = c/c_G \quad \ldots (3).$$

If $c_G < c$, then $\lambda_G < \lambda$ as it is observed experimentally. Therefore, E (= $h\nu$) = E_G (= $h\nu_G$). In other words, during the Universe's expansion, light emitted by the galaxy would not lose energy if its speed is lower than the speed of this light measured on the Earth. By this postulation, we can overcome the above-mentioned stumbling block. Moreover, the wavelength of the emitted light would rise when it reaches the Earth, giving a cosmological redshift.

Combining eqns. (1) and (3), we write

$$\lambda/\lambda_G = c/c_G = 1 + z.$$

In our communication [8], we proposed that when the light was emitted from the galaxy with z = 136, the speed of this light was $1/137^{th}$ of its present speed *c*.[4,5] This speed, c_{min}, represents the minimum possible speed of light in the past Universe. In the equation form,

$$c_{min} = c/137 = c/(1 + z) = c/(1 + 136).$$

We also proposed the following formula for this speed

$$c_{min} = \alpha c = c/137$$

where $\alpha = 1/137$ is the fine structure constant. Applied here we get

$$c/c_G(\min) = 137 = \lambda/\lambda_G(\min).$$

According to the current concordance cosmology of a flat Universe (with a matter density $\Omega_m \approx 0.25$, a cosmological constant $\Omega_\Lambda \approx 0.75$ and a Hubble constant $H_0 = 72\ km\ sec^{-1}\ (Mpc)^{-1}$), $c_G(\min) = c/137$ (or z =136) corresponds to a Universe of the age of about 11 My or roughly 0.1 % of current cosmological time and with a radius about 0.1 % of its current radius [8].

References

[1] P. I. Premović, *Nearby and distant galaxies: a brief note*. The General Science Journal.

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[4] It can be easily calculated that $\alpha c = c_{min} \approx 2.2 \times 10^6\ m\ sec^{-1}$.

[5] From the frame of reference of the galaxy, the speed of light on Earth is *c*/137.

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