the general science journal

Special Relativity of the Big Bang Universe based on the Doppler Effect

Pavle I. Premović
Laboratory for Geochemistry, Cosmochemistry and Astrochemistry,
University of Niš, P.O. Box 224, 18000 Niš, Serbia

Many cosmologists consider that the Big Bang hypothesis is the best theory we have to explain the birth and existence of the Universe. According to this theory, the Universe was formed approximately 13.8 billion years ago when it expands from a point, known as a singularity. The Universe has been expanding ever since and is still occurring.[1] From this singularity all energy and matter of this Universe came into being.

The Big Bang model of the Universe says that nearby or distant galaxies[2] are (apparently) at rest in space. Change of distance between the Earth and these galaxies are not due to their motion through space but space between the Earth and them is expanding. As a consequence, light emitted by nearby or distant galaxies are redshifted.

In contrast, some cosmologists in the past and at present consider that nearby or distant galaxies are moving from each other and, of course, also away from the Earth. So, the measured redshift of their light by Earth's observer is caused by their speed relative to the Earth: υ_G. This speed is defined by a formula of non-relativistic Doppler shift[3] for light

$$\upsilon_G = cz_G \quad \dots (1),$$

in which z_G is redshift of light coming from a nearby or distant galaxy to the Earth and c (= 2.99792×10^8 m sec^{-1}) is the speed of light. This equation is valid for $z_G << 1$. A good approximation for $\upsilon_G = cz_G << c$ is $\upsilon_G = cz_G \leq 0.1c$ or briefly $z_G \leq 0.1$ [2]. So, the above eqn. is valid for nearby galaxies.

One of the concepts of Special relativity (SR) is length contraction which depends upon the second postulate of SR that the speed of light c is the same in all inertial frames of reference [1].

We suppose (very roughly) that a nearby or distant galaxy is rod-shaped traveling with a radial speed υ_G away and relative to Earth's observer, Fig. 1a. Denote with L_0 the rest length of this (rod-shaped) galaxy which is measured by a galaxy's observer and the moving length with L which is measured by Earth's observer. SR states that the moving length L is shorter than the rest

[1] A period just after the Big Bang called inflation.
[2] We define nearby galaxies as those whose redshift z_G is from 0.001 to 0.1 (or $0.001 \leq z_G \leq 0.1$) and with distant galaxies having $z_G > 0.1$ [1, 2]. Of course, there is no sharp boundary between nearby and distant galaxies.
[3] The low velocity limit of the relativistic Doppler effect.

length L_0. In other words, these two lengths are related to each other by the SR formula for length contraction

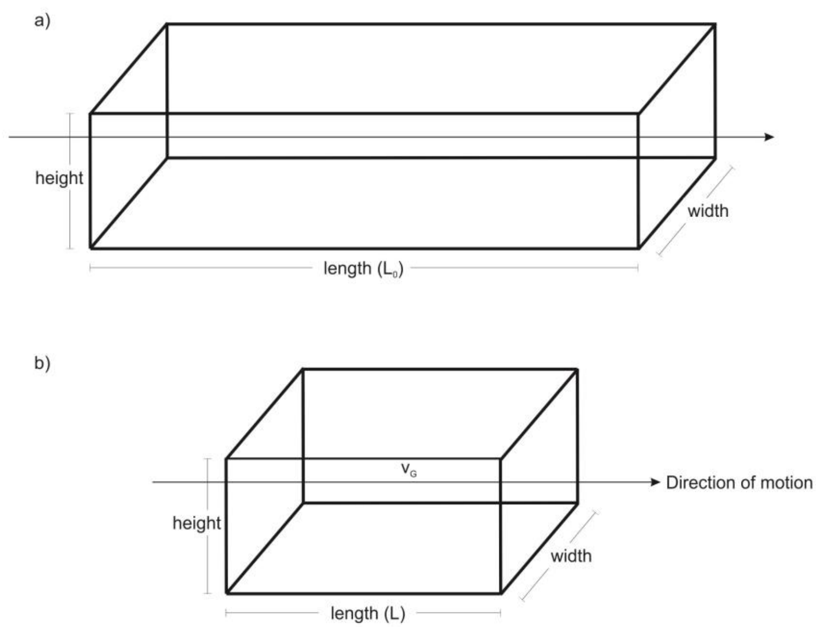

Fig. 1. The rod-shaped nearby or distant galaxy:
a) at the rest ($\upsilon_G = 0$) and b) moving with $\upsilon_G/c = 0.87$, $z_G \approx 3.8$ and $L_0/L = 0.5$.

$$L = L_0\sqrt{(1 - \upsilon_G^2/c^2)} \quad \ldots (2).$$

Of course, length contraction of nearby and distant galaxies is observable by Earth's observer. According to this equation, the magnitude of this contraction in the direction of motion depends to their speed υ_G. Presumably, its height and width would remain the same during length contraction. In the case of nearby galaxies $\upsilon_G \leq 0.1c$ and they would contract by ≤ 5 %.

Eqn. (1) is not valid for distant galaxies (redshift $z_G > 0.1$). For example, distant galaxies with redshift $z_G > 1$ their recessional speed would be greater than the speed of light c and Earth's observer would be able to see farther than the Hubble length c/H_0, in which H_0 is Hubble's constant. This is so-called the "horizon problem" of the Hubble law (see https://www.loop-doctor.nl/hubble-and-humason-measured-redshift).

In this case cosmologists rely on formula for relativistic Doppler shift

$$z_G = [\sqrt{(1 + \upsilon_G/c)/(1 - \upsilon_G/c)}] - 1.$$

According to this equation, distant (rod-shaped) galaxies with $\upsilon_G = 0.87c$ would have redshift $z_G \approx 3.8$ and they would contract by about 50%, Fig. 1b. Distant (rod-shaped) galaxies with $\upsilon_G \geq 0.9995c$ would have redshift z_G about 40 and would be contracted about 99 %. In other words, the “Doppler” world of galaxies with $z_G \geq 40$ would appear almost two-dimensional to Earth’s observer.[4]

References

[1] P. I. Premović, *Distant galaxies in the non-expanding (Euclidean) Universe: the light speed redshift.* General Science Journal, May 2020.
[2]] P. I. Premović, *Nearby and distant Galaxies: a brief note*. General Science Journal, October 2020.

[4] The SR contraction of distant galaxies (or their two-dimensional appearance) can be seen by Earth’s observer at rest because their diameter (or dimension, in general) is extremely much smaller than a distance between these galaxies and the Earth. So, the light emitted from galaxy’s different points would reach this observer at the same instant of time (read: Terrell effect).