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The Redshift and Age of Nearby and Distant Galaxies

Pavle I. Premović,
Laboratory for Geochemistry, Cosmochemistry&Astrochemistry,
University of Niš, pavleipremovic@yahoo.com, Niš, Serbia

"No one would claim that the problems in cosmology have been resolved, but the evidence is consistent with an evolving, but non- expanding universe, which had no beginning in time and no Big Bang". Eric Lerner

Abstract

An equation is derived that correlates the natural logarithm of the age of distant galaxies in the Big Bang Universe with the redshift of the light they emit. This equation is based on published data for their age. A simple analysis of the equation implies that the Big Bang Universe may be old as low as 4.7 Gy. That age is comparable to the age of the Sun and its planetary system and it is about three times younger than the age (about 13.8 Gy) of the Big Bang Universe adopted by the vast majority of cosmologists. This and other issues are briefly discussed.

Keywords: cosmology, galaxy, redshift, age, Earth

Introduction

According to the Big Bang theory, the age of the Universe is about 13.8 billion years. This theory states that cosmological redshift (or more commonly just redshift), denoted here as z_G, is the result of the Universe expansion during the flight of the light from nearby/distant galaxies[1] to the Earth.

In contrast, Lerner [3, and references therein] reported that the ultraviolet surface brightness data of nearby/distant galaxies, over a very wide redshift range, support the non-expanding (Euclidean) Universe (NEEU). Moreover, Sanejouand [4] performed a detailed analysis of the gamma-ray burst sources. This analysis indicates that the observable Universe has been Euclidean and static over the last 12 Gy. The Big Bang Universe is finite in space and time. In contrast, NEEU is unlimited in both space and time.

[1] 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]. Of course, there is no sharp boundary between nearby and distant galaxies.

The age-dating of nearby/distant galaxies is an important topic in the study of galaxy evolution. To determine their accurate age is exceedingly difficult.

For our purpose, we select sixteen distant galaxies (with $z_G > 1$) and one nearby galaxy (with $z_G < 0.1$), Table 1. This selection is based on an emerging consensus among cosmologists (or a current consensus among cosmologists but open for further evaluation, of course).

Table 1. Selected galaxies.

Name of galaxy	Redshift z_G	Age (A_G)*	$\ln A_G$*	References
GN-z11	11.09	0.4[0.3]	− 0.9[−1.2]	[5]
MACS0647-JD	10.7	0.5[0.5]	− 0.8[− 0.7]	[6]
GRB 090423[1]	8.26	0.6[0.6]	− 0.5[− 0.5]	[7]
EGS-zs8-1	7.73	0.7[0.7]	− 0.4[− 0.4]	[8]
z8 GND 5296	7.51	0.7[0.7]	− 0.4[− 0.4]	[9]
ULAS[2] 1120+0641	7.085	0.8[0.8]	− 0.2[− 0.2]	[10]
IOK-1	6.96	0.8[0.8]	− 0.2[− 0.2]	[11]
Cosmos Redshift 7	6.60	0.7[0.9]	− 0.4[− 0.1]	[12]
Abel 383**	6.027	0.8[1.0]	− 0.2[0]	[13]
APM 08279+5255[2]	3.91	2.1[1.8]	0.7[0.6]	[14], [15]
zf-COSMOS-20115	3.72	1.7[1.9]	0.5[0.6]	[16]
QSO B1422-231	3.62	1.4[1.9]	0.4[0.6]	[17]
A1689B11	2.54	2.6[2.5]	1[0.9]	[18]
53W091	1.55	3.5[3.2]	1.3[1.2]	[19]
53W069	1.43	4.0[3.3]	1.4[1.2]	[20]
3C 65	1.175	4[3.5]	1.4[1.3]	[21]
NGC 6872	0.01594	5[4.7]	1.6[1.55]	[22]

*In the square brackets are A_G (Gy) and $\ln A_G$ calculated using eqn. (1); **multiply imaged by the cluster Abell 383; [1]gamma ray burst (GRB) host; and [2]quasar (a type of active galaxy).

Age of distant galaxies

Table 1 contains the name of selected galaxies, their redshift z_G and published age A_G (hereinafter $A_G = 0$ corresponds to the currently accepted age of Big Bang Universe ≈ 13.8 Gy). It appears that the ages of these galaxies were calculated assuming the flat model of the Universe[2], with the matter density parameter $\Omega_M = 0.3$ and the "dark energy" density parameter

[2] It is worth noting here, that an analysis of major cosmological data by Valentino, Melchiorri, Silk [23] favors a closeduniverse although other evidence suggests the Universe is flat.

$\Omega_\Lambda = 0.7$, and $H_0 = 70$ km sec^{-1} (Mpc)$^{-1}$. These ages can be calculated using the calculator of Wright [24].

To find a relationship between the age of these galaxies, A_G, and their redshift z_G, we plot their age vs. their redshift, Fig 1. This graph implies that the age of these galaxies can be approximately expressed as a (natural) exponential function [$f(x) = e^x$] of their redshift.[3] For this reason, we plot the natural logarithm $\ln A_G$ *vs*. z_G, Fig. 2. The graph shows an approximate linear dependence of $\ln A_G$ on z_G, confirming the approximate (natural) exponential dependence of A_G on z_G. Using the regression method, we obtained the following linear function for the above graph

$$\ln A_G = -\,0.25 z_G + 1.55 \quad \ldots (1).$$

In Table 1 are also given the age of selected galaxies A_G and $\ln A_G$ calculated using eqn. (1).

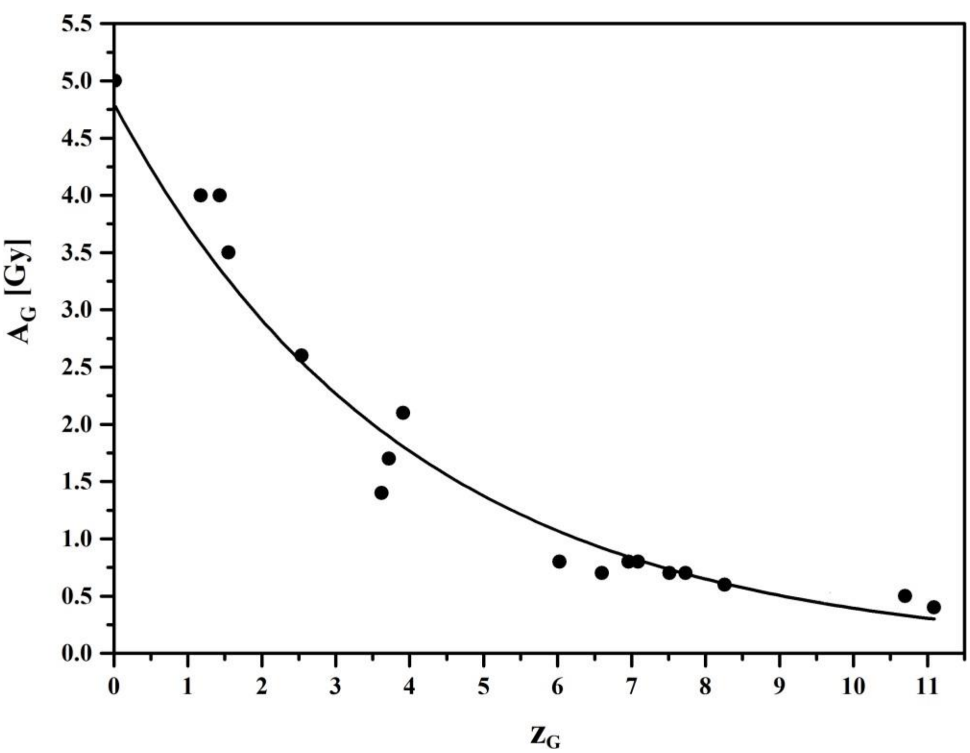

Fig. 1. Galaxy's age A_G *vs*. their redshift z_G for selected galaxies.

After the conversion of this equation into the (natural) exponential form we have

$$A_G = e^{0.25 z_G - 1.55}.$$

[3] The mathematical reason for this exponential dependence for the calculated ages of distant galaxies on their redshift is beyond the scope of this paper.

The dimension of the left side of this expression is T but its right side is dimensionless.[4] Hence, eqn. (2) is dimensionally incorrect. The simplest way to make this equation dimensionally correct is to multiply its right side by the constant α equals or close to 1 and expressed in time unit of A_G (e.g. Gy)

$$A_G = e^{-0.25z_G + 1.55} \times \alpha.$$

Since lnα is equal or close to 0 the natural logarithmic form of this equation is identical to the initial eqn. (1).

To estimate possible uncertainty in determining A_G we employed eqn. (1) to the galaxy APM 08279+5255 with redshift $z_{APM} = 3.91$ and age $A_{APM} = 2.1$ Gy, Table 1. A simple calculation based on this equation shows that the age of this galaxy should be about 1.8 Gy. The difference between the experimental (2.1 Gy) and the calculated one (1.8 Gy) is (about) 0.3 Gy or the percentage difference is about 15 %.

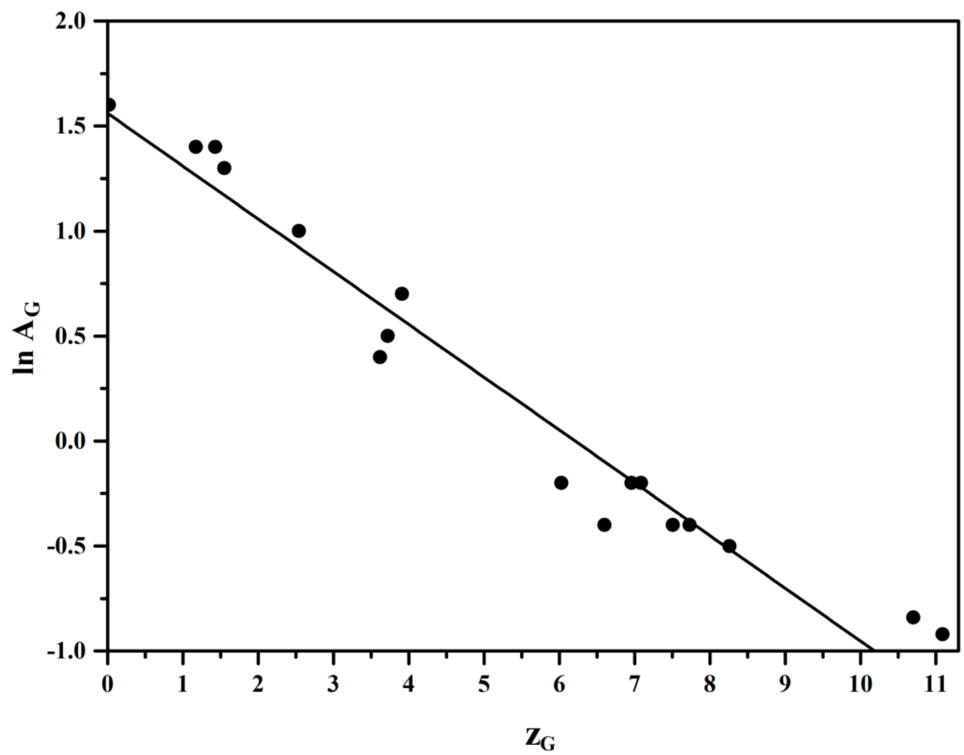

Fig. 2. Natural logarithm of galaxy's age lnA_G *vs*. their redshift z_G for selected galaxies.

Let us denote with $A_G(X)$ the age of unknown distant galaxy X and with $A_G(S)$ the age of the galaxy's age standard with known corresponding redshifts $z_G(X)$ and $z_G(S)$. Introducing these two

[4] Just to remind the reader that T is a symbol for basic dimension-time.

ages into eqn. (1) we get two equations $\ln A_G(X) = -0.25z_G(X) + 1.55$ and $\ln A_G(S) = -0.25z_G(S) + 1.55$. Subtracting these two equations yields

$$\ln A_G(X) - \ln A_G(S) = -0.25[z_G(X) - z_G(S)].$$

For convenience, we write

$$\ln A_G(X) = \ln A_G(S) - 0.25[z_G(X) - z_G(S)] \quad \ldots (2).$$

This equation can be used to determine the age of distant galaxies of unknown age but with a known redshift. For this purpose, we need a reliable age standard for galaxies. The author prefers the galaxy APM 08279+5255.

Let us attribute $\ln A_G(S)$ to the APM 08279+5255 with $z_{APM} = 3.91$ and $\ln A_G(X)$ to the galaxy GN-z11 with $z_{GN} = 11.09$ (Table 1). Inserting these two redshift values into eqn. (2) we get that the age of GN-z11 is about 0.11 Gy. As expected, this value is in a rather reasonable agreement with the value (0.4 Gy) given in Table 1. A similar calculation for 3C 65 indicates that its age is about 4 Gy which is equal to the value in Table 1.

Arp's peculiar galaxies

In 1966 Harald Arp, a famous American astronomer published his Atlas of Peculiar Galaxies in which he presented 338 images of rather peculiar galaxies. He later published many papers,articles and books. His work is updated in his last book, "Catalogue of Discordant Redshift Associations". In all of his publications, Arp argued that many quasars with high-redshift are somehow linked to nearby low-redshift active galaxies. He hypothesized that these quasars are ejected from these galaxies and exhibit intrinsic redshifts. This is a controversial view which does not accord with the current cosmological thinking. Most cosmologists reject Arp's interpretation arguing that his observations could be explained by perspective effects. In this work, we will only consider briefly one of Arp's classic cases.

Arp discovered that five quasars around the distant central Seyfert galaxy, NGC 3516 with redshift $z = 0.009$. Chu et al. [23] reported redshift measurements of these quasars and found that they are distributed along the minor axis of the galaxy, Fig. 3. Since $z_G = 0.009 \approx 0$ this implies that the age of NGC 3516 within the Big Bang Universe (or NEEU) is probably ≥ 4.7 Gy. The redshifts of quasars are: 0.33, 0.69, 0.93, 1.40 and 2.10. Using this equation we estimated the quasar's ages: 4.5 Gy, 4.1 Gy, 3.7 Gy, 3.3 Gy and 2.7 Gy. Therefore, it appears that the central galaxy NGC 3516 is formed after these quasars. In other words, NGC 3516 did not "deliver the five baby quasars". Of course, this is true if eqn. (1) is valid.

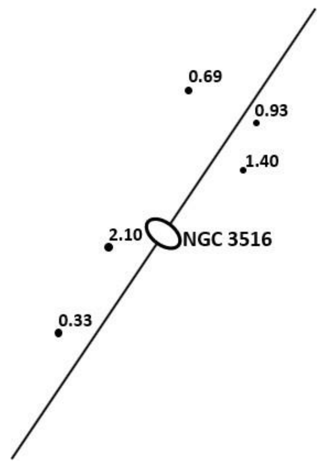

Fig. 3. The five quasars related to the central galaxy NGC 3516. Redshifts are written to the upper right of each quasar. The redshift of NGC 3516 is z = 0.009, see also [25].

Age of Universe and Earth

A simple analysis of eqn. (1) shows that if $z_G = 0$. $A_G = 4.7$ Gy ($\ln A_G = 1.55$). This implies that the age of the observable Universe is about 4.7 Gy which is approximately the same as the age of the Sun and its planetary system. This value is about three times less than the generally accepted value (about 13.8 Gy) by astronomers for the Big Bang Universe. If this is true then no galaxy can be older than about 4.7 Gy. Indeed, most distant galaxies are between 0.2 Gy and 3.8 Gy old. This corresponds to their A_G between 0.2 Gy and 3.8 Gy.[5] However, this hypothesis is odd given that, as noted above, a vast majority of cosmologists believe that the age of the Big Bang Universe is about 13.8 Gy. We tentatively propose eqn. (1) is not valid for nearby galaxies of this universe. The dependence of A_G on z_G has probably another (defined or undefined) mathematical form so that for $z_G = 0$, $A_G \approx 13.8$ Gy. However, it appears that the observable Universe is looking younger every day [26, 27]. Therefore, it is necessary to consider carefully the possibility that the observable Universe is much younger.

The age of the Sun and its planets in NEEU would be also about 4.7 Gy. In addition, a recent study implies the galactic crashes influenced the Milky Way, and found that one of them coincided with the birth of our Sun around 4.7 billion years ago [28]. This kind of crash could occur in the Big Bang Universe and in NEEU as well. Therefore, it is conceivable that Sun and its planetary system in NEEU could begin to form about 4.7 Gy.

[5] We name the period after it the "galaxy-barren epoch". The question now is why no or few galaxies were created in this epoch which has been going on for 10 Gy?

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