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The Age of the "Megamaser" Galaxies in the Big Bang Universe (very slightly corrected)

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The Big Bang theory is widely regarding as the leading explanation for the origin of the Universe. According to this theory, all the matter and energy in the current Universe was emerged from a singularity. The Universe then expanded rapidly over to the present version and this expansion of space itself (or better of space-time itself) is still occurring.
Hubble's law states that the recession speed v_G of distant galaxies is proportional to their distance D_G from the Earth. This law can be expressed as follows

$$v_G = cz_G = H_0D_G \ldots (1)$$

where c (= 2.99792×10^5 km s^{-1}) is the speed of light, z_G is galaxy's redshift and H_0 (= 72 km sec^{-1} $(Mpc)^{-1}$ = 7×10^{-11} y^{-1}) is the Hubble constant. According to cosmology, H_0 represents the constant rate of cosmic expansion. The above formula is valid for distant galaxies with $z_G \leq 0.1$. For $z_G > 0.1$ this law is no longer relevant and furthermore depends on the particular cosmological model.

Most cosmologists consider that when the Big Bang occurred, time began. The time scale for the age of the Universe and its galaxies is set by the Hubble time $1/H_0$. For a Hubble constant H_0 of 72 km sec^{-1} $(Mpc)^{-1}$, as given by current measurements, the Hubble time $1/H_0$ is around 13.65 Gy. However, the true value of the Hubble constant is still debatable and its estimate varies between 50 km sec^{-1} $(Mpc)^{-1}$ to 100 km sec^{-1} $(Mpc)^{-1}$. Thus, the Hubble time varies between 10-20 Gy and hence the beginning or zero time of the Universe.

The best estimate of the age of the Earth (and the rest of the Solar system) is 4.55 ± 0.05 Gyr**.** (This value is derived from several different lines of evidence). Therefore, it appears that Earth's formation is a more reliable zero-time standard then the Hubble zero-time for both the expanding and the non-expanding Universe. In other words, the birth of the Earth can be considered as "coordinated astronomical time"[1] (CAT) for each of the universes. This would imply that each of them is "geocentric in time".

Most of distant galaxies were formed before Earth's creation. For this type of galaxies, we will use the term before the Earth and label it BE. This is in rough analogy to the historical term before Christ or BC. For example, the galaxy APM 08279+5255 was formed about 2.5[2] Gy BE The age of this galaxy (~ 2.1 Gy) was determined by measuring the Fe/O ratio [1].

[1] In rough analogy with the world standard "zero" time: coordinated universal time (UTC).
[2] In previous version is 2.1 Gy instead 2.5 Gy. Please, accept the author's apology.

A much smaller number of distant galaxies were formed after the birth of the Earth. For this type of galaxy, we will use the term after the Earth and label it AE. In rough analogy to the historical term after the death of Christ or AD.

In what follows, we will only consider the galaxies whose peculiar motion is insignificant.

In the further text we will consider only galaxies which are formed during BE. Fig. 1 E and G represent the relative position of the Earth and galaxy G when the Earth is born. Let us denote with D the distance between these two astronomical objects at that time. After Earth's formation and to the present, the galaxy G moves away from it at a recession speed v_G for an additional distance of $4.55v_G$.[3]

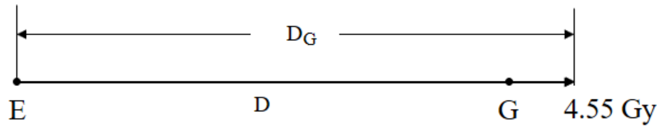

Fig. 1. Relative positions of the Earth and galaxy G and their distances.

In present time, we measure the total distance D_G between the Earth and the galaxy G which can be expressed with a simple formula

$$D_G = D + 4.55v_G$$

where D_G and D are expressed in Gly, the unit of 4.55 is Gy and v_G is the recession speed of the galaxy G. For convinience this equation can be written as

$$D = D_G - 4.55v_G \quad \ldots (2).$$

Denote with z the redshift of galaxy at the distance D from the Earth. Elementary physics and Hubble's law [eqn. (1)] imply that this galaxy travels the distance $4.55v_G$ with an average recession speed $v_G = (cz_G + cz)/2$. Of course, this formula is valid only for z_G and z lower than or equal to 0.1 (or ≤ 0.1). A bit of algebra applied to eqn. (1) yields $z = z_G(D/D_G)$. After simple mathematical manipulation, we can write eqn. (2) in the following form

$$D = D_G(2D_G - 4.55cz_G)/ (2D_G + 4.55cz_G) \quad \ldots (3).$$

Of course, if galaxies are formed during BE then

$$D_G - D = 4.55c(z_G + z)/2.$$

Substituting z with z_GD/D_G and plugging the value of c (= 299792 km sec^{-1}), and after a bit of algebra, we get

$$D = D_G - 2.275z_G(1 + D/D_G) \quad \ldots (4).$$

As one of the direct distance measurement methods, the "megamaser" method has demonstrated its capability for precise distance measurement of distant galaxies, i. e. galaxies beyond our Local Group. But it appears this method is suitable for very few distant galaxies -

[3] Fig. 1 would be drawn by the observer Adam created when Earth was created.

“megamaser” galaxies. For the present case we select five of these galaxies whose redshift z_G and distance D_G from the Earth (determined by the megamaser method) is known, Table 1. The peculiar motion of these galaxies is negligible.

Table 1. “Megamaser” galaxies.

Name of galaxy	Redshift[S] z_G	D_G [Mly] Megamaser	D [Mly][1]
NGC 1052	0.004930	65 [2]	50
UGC 3789	0.010679	162 [3]	120
NGC 6323	0.02592	349 [4]	250
NGC 5765B	0.02754	411[5]	300
NGC 6264	0.03384	447 [6]	320

[S]From Simbad (Astronomical database, Centre de données astronomiques de Strasbourg, Université de Strasbourg) and [1]calculated using eqn. (3).

Plugging into eqn. (3) D_G and z_G, given in Table 1, we calculated the distance D of these galaxies to the just born Earth, Table 1.

A simple calculation shows that the average value of D/D_G of selected galaxies is about 0.72. Since z_G of these galaxies is much smaller than 0.72 (Table 1) eqn. (4) can be can be approximate to

$$D = D_G - 2.275z_G(1 + D/D_G) = D_G - 1.72_G \times 2.275z = 1.7 \text{ Gly} - 3.9z_G.$$

Since z_G of the selected galaxies is much smaller than 0.1 (Table 1) then the minimum D should be ~ 1.3 Gly[4]. In contrast, the calculated D for the “megamaser“ galaxies is < 0.350 Gly therefore they are formed after the Earth, or during AE.

Of course, the above approach can be applied to any galaxy with $z_G \leq 0.1$ if we know its distance D_G from the Earth.

References

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[4] In previous version is erroneously typed D = 1.3 Gy. Please, accept author’s apology.