

Big Bang revisited

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Abstract

An alternative interpretation of the data plotted in a Hubble-Lemaitre graph is presented. Also, an attempt is made to suggest a different origin of the cosmic background radiation.

1. Introduction

During a talk for a March 1949 BBC Radio broadcast, the English astronomer Fred Hoyle, an advocate of the "steady state" cosmological model, coined ironically the term "Big Bang". However, the "Big Bang" is generally accepted as a valid theory attempting to describe the evolution of the Universe.

A distinction should be made between the observable Universe and the actual Universe. The former depicts a virtual reality since the obtained pieces of information are not concurrent. The latter is unattainable since no information can be transmitted instantaneously (disregarding quantum entanglement). The term "known Universe" is probably associated with the observable one.

2. Expansion of the Universe

The two pillars of the Big Bang cosmological model are the Hubble-Lemaitre law and the cosmic microwave radiation background. In comparing an ordinary explosion with the expansion of the universe, the error lies in comparing the kinematics of Newtonian mechanics (with an infinite speed of light) with those of a universe obeying the laws of relativity with a limited value of the speed of light. The red shift observations are not a snapshot of a universe as it is now but for each particular star (or galaxy) reveals how the expansion rate (redshift velocity) was at the time the light started its journey to the observer. The observed red shift for a galaxy, e.g., 10 million light years away, is not as it is now but as it was 10 million years ago. We cannot know its value now by direct observation. We cannot even know if that particular star or galaxy still exists. Stars are born from the cosmic dust and eventually meet their final destiny, ranging from white dwarfs to supernova. Galaxies can merge and may even disappear in a black hole. As a result, the plot of the observed red shifts vs distance, the latter deduced from the cosmic ladder (Cepheid variables, parallax e.tc.) is misleading. As a general rule, a plot of various points which are not concurrent is meaningless unless the x axis is time. As a result, a more informative way is to plot the observed red shifts vs past time to which they actually belong.

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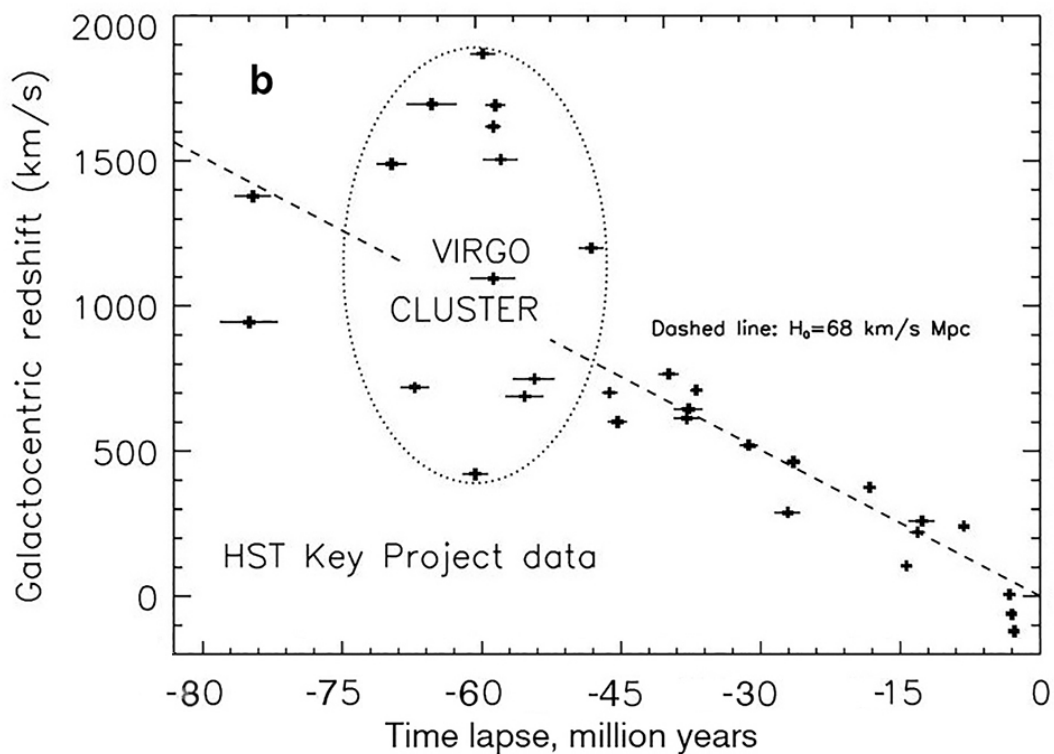
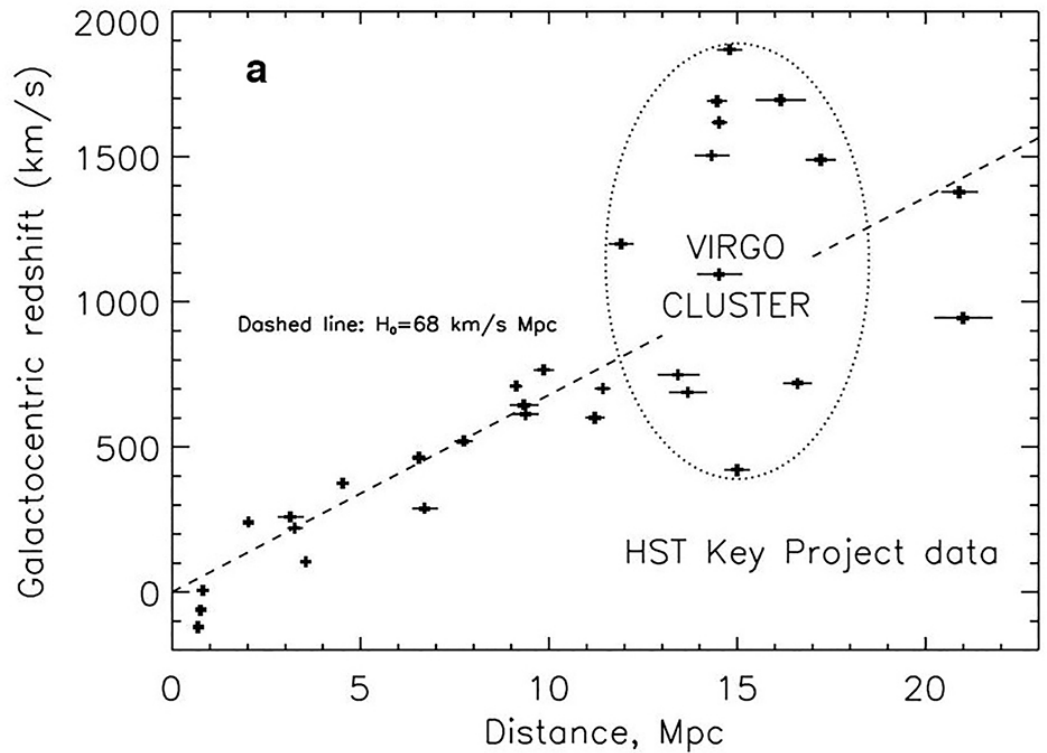


Fig1 (a) The redshift-distance relation, or Hubble law, as presented in "The Road to Galaxy Formation, 2nd edition" (1). The data are from (2) and rather old (for example galaxies M91 and M98 in the Virgo cluster show blueshift).

(b) The redshift-[past]time relation resulting from (a) when the distance in x-axis is replaced with the time when light started its journey to the observer (1 parsec \sim 3.26 light years).

It appears that the expansion rate (redshift velocity) was larger in the past (not to be confused with the proposed acceleration of expansion, as explained later). The further a galaxy is away, the further to the past belongs the redshift information we record. There is no way we can have a snapshot of the universe at any instant. In other words, there is no way we can know how the Universe is now (or at any particular moment in general) as a result of the limited speed of light and this is an essential principle. No direct observation can give us a "picture" of the Universe at any particular moment. Theories and/or models can be proposed but in general any theory that is not verified with an experiment (direct observation) is of limited credibility. It took a measurement of the precession of the perihelion of Mercury to verify the validity of general relativity. Attempting to trace back or forth any redshift information requires the use of the Big Bang theory but this would be a typical example of trying to verify a theory based on its validity which of course is an oxymoron.

The slope of the fitted line in Fig1(b) evaluated in km/s /million years, after including a more recent set of data, yielding a Hubble constant 73.40 ± 1.2 km/s/Mpc (3), gives a value of negative acceleration (deceleration) of the cosmic expansion $71.4 \pm 1.2 \times 10^{-14}$ km/s², Fig. 2 (which is based on ref. (4), appropriately modified). It appears that the deceleration was constant at all times. The 3 points in Fig1(a) close to the origin with negative redshift (blueshift) belong to local galaxies (such as Andromeda). Their motion towards our galaxy is attributed to gravitational effects, rendering them of no value for the Hubble-Lemaitre law. However, in the light of the present work, this might not be so. Besides, there are almost 100 local galaxies with blueshifts.

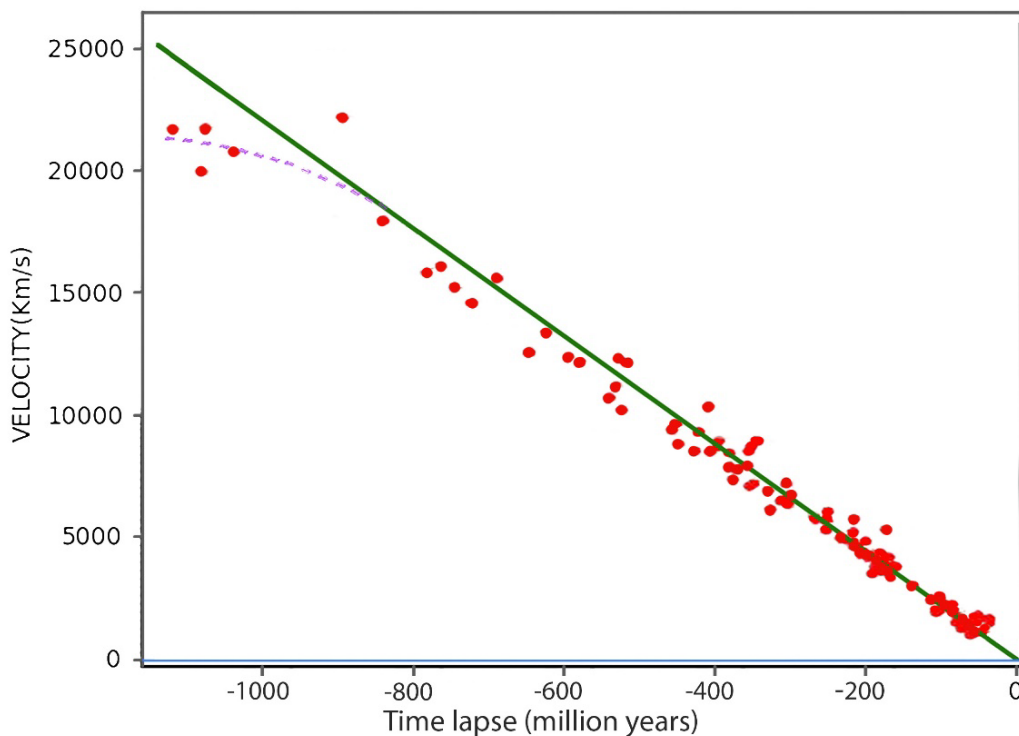


Fig. 2 The redshift-[past]time relation based on data that include distant supernovae type Ia. The dashed line extension in the upper left corner is based on these supernovae.

More recent attempts to improve the cosmic distance ladder using distant type Ia supernovae do not actually affect the above reasoning. The observations related to these supernovae indicated that they were slightly too faint when compared to what was obtained from their intrinsic brightness. If so, they must be further away than estimated using the up to then cosmic ladder. As a result, it was proposed that the expansion of the Universe was slower in the past, compared to the estimated one for galaxies at closer distances (5). The findings were interpreted as a prove that the expansion is accelerated and Dark Energy was invoked to drive this acceleration but in fact, they confirm the proposed ideas in this work. If plotted correctly, the turning point of the fitted curve might indicate if and when the mode of expansion changed, from linear or even accelerated expansion to a slowing down. However, more data beyond 1.2 billion lightyears are needed and observations related to such distances are almost impossible. It should be noted that the term velocity used in this work is the redshift velocity since it is unambiguous for experimental observation, as opposed to recessional velocity. However, the arguments presented in this work are equally valid for both cases.

When the expansion rate is considered in this new perspective, the story revealed is entirely different from the one generally accepted. The expansion is slowing down. Furthermore, the intersect of the fitted line with the x axis indicates that the expansion reached (or is about to reach) a zero value. In other words, the first pillar of the Big Bang cosmological model, the redshift, must be reconsidered.

The second pillar, the cosmic microwave radiation background (CMBR) is interpreted with an a-priori acceptance of the expansion of the universe. The reasoning is that if there were such an expansion, then these remnants of the initial radiation would expand their wavelength accordingly. Thermal equilibrium would require that the current temperature would have dropped to the observed value of 2.7 K after the era of photon decoupling, assumed to be at a temperature of around 3000 K. The important question is what actually is meant by "current temperature". Obviously, the photons of the cosmic background radiation originate - almost uniformly - in all parts of the universe and subsequently all times, due to the limitations of the speed of light. So, the meaning of "current" is an open question. The suggested surface of last scattering as a set of points in space at the "right" distance from us would have a meaning in a "static" universe but not in a continuous expanding one. What is more disturbing is that the Hubble constant deduced from the red shift does not agree with the one estimated from the CMBR using various methods and models, such as the Λ CDM model (6) that assumes the validity of the BB theory (an initial much hotter and dense universe expanding ever since). A different method uses the temperature measurements based on the excitation of rotational levels of some interstellar molecules such as CO (7), linking them to the expansion rate through the relationship $T_{\text{CMB}}(z) = T_r \times (1 + z)$, where T_r is the "currently" measured MBR temperature value and z is the redshift. The overall discrepancy is of the order of 6-8%, even considering the uncertainties in the measurements [$H_0=67.74 \pm 0.46$ km/s/Mpc(8)], as opposed to 73.4 ± 1.2 km/s/Mpc, being one of the latest using an updated cosmic ladder(3). Baryon acoustic oscillation (BAO) measurements are in

agreement with those of CMBR (8) and the research for even smaller uncertainties is in progress.

One possible source for the observed CMBR, since the deceleration was constant in all times as proposed here, would be the bremsstrahlung resulting from the deceleration of charged particles. However, this needs to be verified theoretically and in a set of laboratory measurements.

Inflationary Cosmology attempted to solve some of the disputed (or without plausible answers) questions arising in accepting the Big Bang theory (9) but still has its limitations and is not generally accepted, although it can count for the homogeneity of the Universe. One of the major problems in Inflationary Cosmology is the failure yet to observe CMBR polarization B-modes, although there is still research in progress.

3. Conclusions

In general relativity, Einstein had predicted the expansion of the Universe but naturally could not predict the current expansion status. If there were a Big Bang, then the Universe does not appear to be expanding increasingly but rather is slowing down at a constant deceleration, against the general belief for the opposite. Alternative explanations for the creation and its continuous inflation/de-inflation of the universe might shed some light in what the Cosmos can reveal. Various proposed ideas include the time dependence of various cosmological parameters, even the speed of light itself. For the moment what is certain is that the Universe is evolving and changing size. The proposed ideas in this work suggest that the Big Bang theory must be "revisited" and perhaps the Universe is older than the current estimation. If the latter is true then it will eliminate the need for an inflation theory. In addition, the so called "dark energy" (introduced to explain the "accelerated" rate of expansion) might find its place in the realm where "ether" (introduced to explain the propagation of light waves) now rests.

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