# Two World Systems Revisited: A Comparison of Plasma Cosmology and the Big Bang

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***Abstract*—Despite its great popularity, the Big Bang framework for cosmology faces growing contradictions with observation. The Big Bang theory requires three hypothetical entities—the inflation field, nonbaryonic (dark) matter, and the dark energy field—to overcome gross contradictions of theory and observation. Yet, no evidence has ever confirmed the existence of any of these three hypothetical entities. The predictions of the theory for the abundance of $^4$He, $^7$Li, and D are more than $7\sigma$ from the data for any assumed density of baryons and the probability of the theory fitting the data is less than $10^{-14}$. Observations of voids in the distribution of galaxies that are in excess of 100 Mpc in diameter, combined with observed low streaming velocities of galaxies, imply an age for these structure that is at least triple and more likely six times the hypothesized time since the Big Bang. Big Bang predictions for the anisotropy of the microwave background, which now involve seven or more free parameters, still are excluded by the data at the $2\sigma$ level. The observed preferred direction in the background anisotropy completely contradicts Big Bang assumptions. In contrast, the predictions of plasma cosmology have been strengthened by new observations, including evidence for the stellar origin of the light elements, the plasma origin of large-scale structures, and the origin of the cosmic microwave background in a "radio fog" of dense plasma filaments. This review of the evidence shows that the time has come, and indeed has long since come, to abandon the Big Bang as the primary model of cosmology.**

***Index Terms*—Big Bang, intergalactic radio absorption, large-scale structure, light element abundance, plasma cosmology, voids.**

## I. INTRODUCTION

THE DOMINANT theory of cosmology, the Big Bang, is contradicted by observation, and has been for some time. The theory's predictions of light element abundance, large-scale structure, the age of the universe and the cosmic background radiation (CBR) are in clear contradiction with massive observational evidence, using almost any standard criteria for scientific validity. This situation is not new. In 1992, I reviewed these contradictions [1], and concluded that theory had already been clearly falsified. Since that time, the evidence against the Big Bang has only strengthened.

There is a second framework for cosmology–plasma cosmology. This approach, which assumes no origin in time for the universe and no hot, ultradense phase of universal evolution, uses the known laws of electromagnetism and the phenomena of plasma behavior to explain the main features of the universe. It was pioneered by Hannes Alfven, Carl-Gunne Falthammar, and others [2]–[4] and has been developed since then by a small group of researchers including the present author and A. L. Peratt [5]–[13]. In contrast to the predictions of the Big Bang, which have been continuously falsified by observation, the predictions of plasma cosmology have continued to be verified.

The present review seeks to update the comparison between these two world systems in light of recent observations and theoretical developments, including some new results not yet published elsewhere. At the end of this review, I will consider some of the reasons why the Big Bang remains dominant in the field, despite its clear falsification by observation. In many respects this resembles the situation of 400 years ago, when the clearly falsified Ptolemaic system remained dominant some 60 years after the introduction of the Copernican system.

There is of course a third main cosmological perspective, the Steady State theory developed by Hoyle *et al.* [14]. However a systematic comparison of plasma cosmology and the Steady State theory requires its own article and is outside the scope of this review.

## II. FUNDAMENTAL METHODOLOGICAL PROBLEMS OF THE BIG BANG

The Big Bang theory requires three hypothetical entities—the inflation field, nonbaryonic (dark) matter, and the dark energy field—to overcome gross contradictions between theory and observation. Yet no evidence has ever confirmed the existence of any of these three hypothetical entities.

In each of these cases, the hypothetical entities were introduced without any physical justification purely to address contradictions with observations that would have otherwise led to the rejection of the Big Bang theory. The inflation field, which causes a super-rapid expansion of the early universe, was introduced after it was realized that the "horizon problem" prevented parts of the universe that are currently more than a few degrees apart on the sky from coming to the same equilibrium temperature, and thus producing the same temperature background radiation, as observed. Without this field, the Big Bang does not predict an isotropic CBR.

But the inflation hypothesis predicted a matter-energy density for the universe equal to the critical closure density, $\Omega = 1$. Unfortunately, Big Bang nucleosynthesis predictions of the abundance of ordinary baryonic matter predicts $\Omega < \sim 0.05$, a gross self-contradiction. The idea of nonbaryonic (dark) matter was introduced to overcome this contradiction. By this hypothesis, 95% of the matter in the universe did not participate in the reactions that formed the light elements.

However, such a large amount of matter would cause a marked deceleration of the expansion of the universe and led to predictions that the age of the universe was less than 10 GY, considerably less that the age of the oldest globular clusters in

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Manuscript received March 17, 2003; revised October 11, 2003.

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Digital Object Identifier 10.1109/TPS.2003.821478

the Milky Way. To overcome this problem, as well as growing evidence that there could not be anywhere near this much gravitating matter, cosmologists introduced the cosmological constant and the corresponding dark energy field, which would account for 70% of the matter-energy in the universe, accelerate expansion, and increase the predicted age of the universe to 14 GY.

In no other field of physics would the introduction of three hypothetical entities, each unconfirmed by experimental evidence, be allowed to save a theory. In addition, the hypothetical dark energy field violates one of the best-tested laws of physics—the conservation of energy and matter—since the field produces energy at a titanic rate out of nothingness. No evidence has ever indicated the existence of nonbaryonic matter. Indeed, there have been many lab experiments over the past 23 years that have searched for nonbaryonic matter, all with negative results [15]. Continued discovery of more ordinary matter in the form of white dwarfs [16] and diffuse plasma clouds [17] has further decreased the ability of theorists to claim that there is far more matter detected by gravitational attraction than can be accounted for by ordinary matter.

Moreover, the Big Bang theory relies fundamentally on the violation of another very well-confirmed conservation law—conservation of baryon number. This law dictates that baryons and antibaryons are always produced from energy in equal numbers, and has been confirmed up to Tev energies. Yet an equal mixture of baryons and antibaryons at high density as in the Big Bang would result in an extremely dilute universe [1], so the Big Bang requires baryon nonconservation, in conflict with all existing observations. Such baryon nonconservation also implies a finite lifetime for the proton, a prediction also contradicted by extensive experiments unsuccessfully seeking proton decay.

## III. ABUNDANCES OF LIGHT ELEMENTS

### *A. Big Bang Nucleosynthesis*

Big Bang nucleosynthesis (BBN) predicts the abundance of four light isotopes ($^4$He, $^3$He, D, and $^7$Li) given only the density of baryons in the universe. These predictions are central to the theory, since they flow from the hypothesis that the universe went through a period of high temperature and density—the Big Bang. In practice, the baryon density has been treated as a free variable, adjusted to match the observed abundances. Since four abundances must be matched with only a single free variable, the light element abundances are a clear-cut test of the theory. In 1992, there was no value for the baryon density that could give an acceptable agreement with observed abundances, and this situation has only worsened in the ensuing decade.

The observational picture has improved the most for $^7$Li and D, and there is now no assumed baryon density that will provide a good fit to just those two abundances alone. In 1992, there were no measures of D abundance for objects with low metallicities (abundances of CNO generated by stars) and, therefore, presumably early in their history. The "primordial" value for D abundance was calculated back from the present-day observed values of $1.65 \times 10^{-5}$ relative to H by assuming the D was destroyed by recycling through stars. Delbourg–Salvador *et al.*, for example [18], calculated that the primordial value was perhaps $6 \times 10^{-5}$.

However, since 1998, D abundances have been measured in five QSO absorption line systems. Since these systems show low abundances of heavy elements known to be created by stars, they are assumed to be close to a "primordial" or early-galactic abundance. The weighted average of these abundances is $2.78 +- 0.29 \times 10^{-5}$ [19], much lower than the values that had been anticipated by BBN theorists a decade ago. According to BBN predictions, this range of D abundances would correspond to a range of baryon/photon number density $\eta$ of from $5.9 - 6.4 \times 10^{-10}$.

Lithium abundances in metal-poor Population II stars (the oldest in the galaxy) are also considered to be a measure of pregalactic or at least early galactic abundances and exhibit a remarkably small variation (about 5%) [20]. Lithium abundances as a result can be very accurately measured as $1.23 + 0.68 - 0.32 \times 10^{-10}$, relative to H, where the errors are $2\sigma$ limits [21]. BBN prediction based on $^7$Li abundance imply a firm upper limit on $\eta$, the baryon photon ratio, of $3.9 \times 10^{-10}$, which is completely inconsistent with the prediction based on D.

A "best fit" $\eta$ to these two abundances alone would be $4.9 \times 10^{-10}$. Since this would predict values that are in excess of $4\sigma$ from observations for both $^7$Li and D, this pair of observations alone would exclude BBN at beyond a $6\sigma$ level.

There is no plausible fix to this problem, which has been recognized by BBN theorists, but not ever as a challenge to the validity of the theory itself [19], [21]–[24]. Attempts to hypothesize some stellar process that reduce the $^7$Li abundance by a factor of 2 or more are rendered totally implausible by the observed 5% variation in existing abundances. No plausible process could reduce the $^7$Li abundance so precisely in a wide range of stars differing widely in mass and rotation rates.

The situation becomes considerably worse for BBN when $^4$He is also considered. There are extensive measurements of $^4$He abundances in low-metallicity galaxies, yet the estimates of a minimal, or "primordial" value for $^4$He vary considerably. These various values determine a percentage of $^4$He by weight of $21.6 +- 0.6$ [25], $22.3 +- 0.2$ [26], $22.7 +- 0.5$ [27], $23.4 +- 0.3$ [28], or $24.4 +- 0.2$ [29].

By comparison, the BBN prediction for $^4$He abundance is 24.4, using the D- $^7$Li "best fit" value of $\eta = 4.9 \times 10^{-10}$, which would be compatible only with one of the estimates [29] of primordial $^4$He from observations. It should be noted that this highest value was only obtained by arbitrarily excluding several of the galaxies that have the lowest $^4$He abundances and is therefore not an unbiased, statistically valid estimate. For the other cited values, the BB prediction is excluded at between a $3\sigma$ and $10\sigma$ level. Indeed, a value as high as 24.4 is excluded at a $3\sigma$ level on the basis of even individual low-metallicity galaxies, such as UM461 $(21.9 +- 0.8)$ [25].

While there is considerable controversy over interpretation of measurements of $^3$He abundances in the present-day galaxy, these measurements only add to the difficulties of BBN. Measurements indicating an abundance of $^3$He/H of $1.1 +- 0.2 \times 10^{-5}$ [30] make this an upper limit on the "primordial" value, since it is generally agreed that stars, on net, produce $^3$He. For BBN, this in turn implies that $\eta > 6.0 \times 10^{-10}$ makes worse the conflicts with the observed values of lithium and $^4$He.

Even ignoring $^3$He, the current observations of just three of the four predicted BBN light elements preclude BBN at least at a level of nearly $7\sigma$. In other words, the odds against BBN being a correct theory are about 100 billion to one. It is important to emphasize that BBN is an integral part of the Big Bang theory. Its predictions flow from the basic assumption of the Big Bang, a hot dense origin for the universe. If BBN is rejected, the Big Bang theory must also be rejected.

Recently, Big Bang theorists have interpreted precision measurement of the anisotropy of the CBR as providing a direct measurement of the baryon density of the universe [19]. (The CBR will be examined in more detail in Section IV). These calculations imply $\eta = 6.14+-0.25 \times 10^{-10}$, a D abundance of $2.74+-0.2 \times 10^{-5}$, a $^7$Li abundance of $3.76 + 1.03 - 0.38 \times 10^{-10}$, and a $^4$He abundance of $24.84+-0.04\%$. While much has been made by Big Bang advocates of the agreement with D observations, overall this makes matters still worse for the validity of BBN, for the $^7$Li value alone is now excluded at a $7\sigma$ level, and the $^4$He is excluded at a $2\sigma$ level even for the highest estimate and at between a $4\sigma$ and $12\sigma$ level for the other estimates. Very conservatively, this increases the odds against BBN, and therefore against the Big Bang itself, being a valid theory to above $2 \times 10^{14}$ to one. The overall discordance with observation is summarized in Fig. 1.

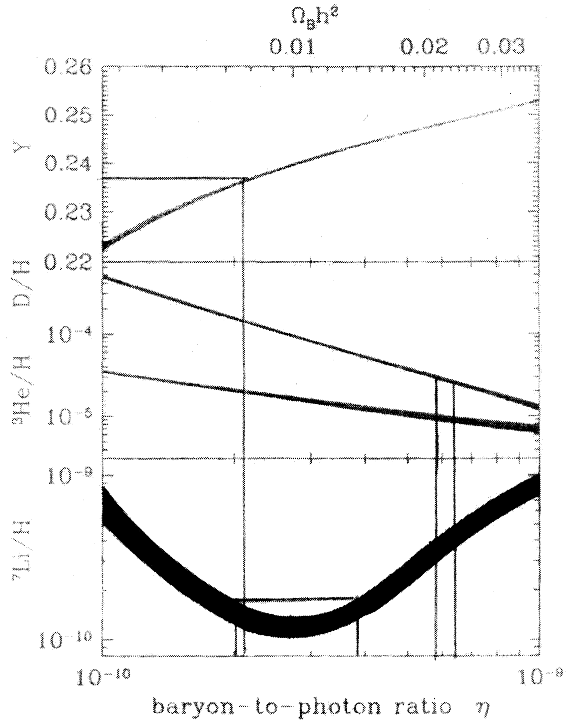


Fig. 1. Big Bang nucleosynthesis predictions are compared with observations. The curves give BBN predictions as a function of the baryon to photon ratio based on [15]. The vertical bands give the values consistent with observed D abundances (rightmost band), lithium abundances (central band), and helium abundances (leftmost band) with $1\sigma$ limits. For helium, the observed values are based on the range of values from [25]–[28]. For the theory to be valid, there must be some value where all three bands overlap, but this is not the case.

### B. Plasma Theory of Nucleosynthesis

In contrast to the extremely bad performance of BBN, the predictions of the plasma alternative have held up remarkably well. Plasma filamentation theory allows the prediction of the mass of condensed objects formed as a function of density. Magnetically confined filaments initially compress plasma, which is then condensed gravitationally. For this to happen, the plasma must be collisional. Given the characteristic ion velocity in the filament, calculated from instability theory, the collisional condition generates the relation that stars of mass $M = 1.8\, n^{-2}$ form from plasma of initial density $n$, where $M$ is in solar masses and $n$ in ions/cm$^3$. This in turn leads to predictions of the generation of large numbers of intermediate mass stars during the formations of galaxies [8]–[10]. These stars produce and emit to the environment large amounts of $^4$He, but very little C, N, and O. In addition, cosmic rays from these stars can produce by collisions with ambient H and He the observed amounts of D and $^7$Li.

The plasma calculations, which contained no free variables, lead to a broader range of predicted abundances than does BBN, because the plasma theory hypothesizes a process occurring in individual galaxies, so some variation is to be expected. The range of values predicted for $^4$He is from 21.5% to 24.8% [8], [9]. However, the theory is still tested by the observations, since the minimum predicted value remains a firm lower limit (additional $^4$He is of course produced in more mature galaxies). This minimum value is completely consistent with the minimum observed values of $^4$He abundance, such as UM461 with an abundance of 21.9+−0.8.

Further confirmation of these 16-year-old predictions is in the widely noted observations that no galaxies, indeed no stars, have been observed that are entirely free of heavier elements, which is in accord with the predictions of the plasma-based stellar production of light elements.

Deuterium production by the $p + p- > d + \pi$ reaction has been predicted by plasma theory to yield abundances of the order of $2.2 \times 10^{-5}$ [8]. While more precise calculations will have to be done to improve this figure and to define the range of values that are likely, it is notable that this prediction was made in 1989, at a time when no observations of D in low-metallicity systems were available and the consensus values for primordial D from Big Bang theory were 3–4 times higher. Yet this predicted value lies within the range of observed “primordial” D values, although somewhat below the average D values.

In its present form, the plasma-stellar theory of light elements does not give a prediction for the absolute abundance of $^7$Li. However, the theory unambiguously predicted that abundance depended on CNO abundance and subsequent observations have clearly verified that prediction [20]. Observations of the abundances of $^6$Li, which is also generated by cosmic rays, but is destroyed much more readily in stars, is also completely consistent with a cosmic-ray origin for $^7$Li.

The most dramatic confirmation of the predictions of the plasma-stellar model is in the discovery of large number of white dwarfs in the halo of the Milky Way. Since the theory predicts the formation of an initial population of intermediate-mass stars, it is a straightforward deduction that these stars must leave behind white dwarfs that should exist at present. Specifically, the theory predicts that somewhat less than half the total mass of the galaxy should exist in the form of collapsed cores—either white dwarfs or neutron stars [31], and for the intermediate stars, which are too small to become supernovae, the normal end-point would be white dwarfs.

Recent observations of high proper motion stars have shown that halo white dwarfs constitute a mass of about $10^{11}$ solar masses, comparable to about half the total estimated mass of the Galaxy [32], [33]. While these observations have been sharply criticized, they have been confirmed by new observations [16]. Not only are the existence of these numerous white dwarfs confirmation of much earlier predictions by the plasma theory, they create new and insurmountable problems for BBN. Even if the progenitor stars were only 2–3 solar masses, a mass of He equal to about 10%–15% of the mass of the remnant white dwarfs would be released into the ISM. This would account for a minimum of 50% of the observed He abundance, reducing the possible contribution from the Big Bang to less than 12% of the total mass. Such a low production of $^4$He is impossible with BBN for a baryon/photon ratio even as low as $1 \times 10^{-10}$. Thus, the plasma model has successfully predicted a new phenomenon, while the BBN model has been decisively contradicted by observation.

## IV. LARGE-SCALE STRUCTURE AND VOIDS

The large-scale structure of the universe is inhomogeneous at all scales that have been observed [34]. While there is controversy over inhomogeneity at the very largest scales, there is agreement that galaxies are organized into filaments and walls that surround large voids that are apparently nearly devoid of all matter. These voids typically have diameters around 140–170 Mpc (taking $H = 70$ km/s/Mpc) and occur with some regularity [35].

These vast structures pose acute problems for the Big Bang theory, for there simply is not enough time to form them in the hypothesized 14 Gy since the Big Bang, given the observed velocities of galaxies in the present-day universe. Measurements of the large scale bulk streaming velocities of galaxies indicate average velocities around 200–250 km/s [36], [37]. The well-known smoothness of the Hubble relation also indicates intrinsic velocities in this same range, as do the observation of relatively narrow filaments of galaxies in redshift-space, which would be widened by high intrinsic velocities.

Since the observed voids have galactic densities that are 10% or less of the average for the entire observed volume, nearly all the matter would have to be moved out of the voids to form them [38]. An average particle will have to move $d = D/8$ Mpc, where $D$ is the diameter of the void. For void diameters of 170 Mpc, $d = 21$ Mpc. For a final galaxy velocity of 220 km/s, travel time would be 87 Gy or 6.3 $H^{-1}$, where $H^{-1}$ is the Hubble time, the assumed time since the Big Bang, taking this to be 13.7 Gy. Of course this is a crude estimate, since in the Big Bang theory, distances to be covered would be smaller early in the universe's history, reducing travel time. On the other hand, no physical process could produce instantaneous velocities, so velocities would also presumably be smaller in the past. This is especially true if acceleration is by gravitational attraction, since time would have to pass before substantial gravitational concentrations are built up from assumed homogenous initial conditions of the Big Bang.

An explosive mechanism that rapidly injects energy into the medium could form voids more rapidly than gravitational attraction. For a cold dark matter Big Bang model, the time $t$ in years, of formation of a void $R$ cm in diameter in matter with density n/cm$^3$ and final velocity $V$ cm/s is [39], [1]:

$$T = 1.03\, n^{-1/4} V^{-1/2} R^{1/2}.$$

For $V = 220$ Km/s, $R = 85$ Mpc, and $n = 2.4 \times 10^{-7}/\text{cm}^3$ (assuming $\eta = 6.14), t = 158$ Gy. This is 11.6 times as long as the Hubble time.

Detailed computer simulations, which also include the hypothesized "cosmological constant" run into the same contradiction, in that they produce voids that are far too small. Simulations with a variety of assumptions can produce voids as large typically as about 35 Mpc [40], a factor of five smaller than those actually observed on the largest scales. In addition, such simulated voids have bulk flow velocities that are typically 10% of the Hubble flow velocities [41] which mean that voids larger than 60 Mpc, even if they could be produced in Big Bang simulations, would generate final velocities in excess of those observed, and voids as large as 170 Mpc would generate velocities of over 600 km/s, nearly three times the observed velocities.

Thus from any standpoint, the production of the large voids observed requires three to six times as much time as that allowed by the Big Bang theory. Again, this clearly rules out the theory.

The plasma cosmology approach can, however, easily accommodate large scale structures, and in fact firmly predicts a fractal distribution of matter with density being inversely proportional to the distance of separation of objects [10]. As noted above, this relation, equivalent to the relation $M = 1.8\, n^{-2}$, flows naturally from the necessity for collapsed objects to be collisional, and from the scale invariance of the critical velocities of magnetic vortex filaments, which are crucial to gravitational collapse. This fractal scaling relationship $(\text{fractal dimension} = 2)$ has been borne out by many studies on all observable scales of the universe [42]. In addition, the numerical constant in the predicted relation between mass and density, or equivalently, mass and separation of objects ($M = 9.7 \times 10^{10} R^2$, where $R$ is in Mpc and $M$ is in solar masses) has been borne out by observation. In the plasma model, where superclusters, clusters and galaxies are formed from magnetically confined plasma vortex filaments, a break in the scaling relationship is only anticipated at scales greater than approximately 3 Gpc. Naturally, since the plasma approach hypothesizes no origin in time for the universe, the large amounts of time need to create large-scale structures present no problems for the theory.

## V. COSMIC BACKGROUND RADIATION

Recent measurements of the anisotropy of the CBR by the WMAP spacecraft have been claimed to be a major confirmation of the Big Bang theory. Yet on examination, these claims of an excellent fit of theory and observation are dubious. First of all, the curve that was fitted to the data had seven adjustable parameters, the majority of which could not be checked by other observations [43]. Fitting a body of data with an arbitrarily large number of free parameters is not difficult and can be done independently of the validity of any underlying theory. Indeed, even with seven free parameters, the fit was not statistically good, with the probability that the curve actually fits the data being under 5%, a rejection at the $2\sigma$ level. Significantly, even with seven freely adjustable parameters, the model greatly overestimated the anisotropy on the largest angular scales. In addition, the Big Bang model's prediction for the angular correlation function did not at all resemble the WMAP data. It is therefore difficult to view this new data set as a confirmation of the Big Bang theory of the CBR. (This is not the first such case. Big Bang theorists, such as George Gamow, predicted a CBR temperature as much as 20 times that eventually observed, yet the observations were still credited as a success of the theory [44]).

The plasma alternative views the energy for the CBR as provided by the radiation released by early generations of stars in the course of producing the observed $^4$He. The energy is thermalized and isotropized by a thicket of dense, magnetically confined plasma filaments that pervade the intergalactic medium. (Hoyle and Narlikar have proposed a different mechanism to produce the same effect [14]). While this model has not been developed to the point of making detailed predictions of the angular spectrum of the CBR anisotropy, it has accurately matched the spectrum of the CBR using the best-quality (high-galactic latitude) data set from COBE [31]. This fit, it should be noted, involved only three free parameters and achieved a probability of 85%.

Since this theory hypothesizes filaments that efficiently scatter radiation longer than about 100 $\mu$m, it predicts that radiation longer than this from distant sources will be absorbed, or to be more precise scattered, and thus will decrease more rapidly with distance than radiation shorter than 100 $\mu$m. Such an absorption was demonstrated by comparing radio and far-infrared radiation from galaxies at various distances—the more distant, the greater the absorption effect [5], [7].

This work was done using an IRAS sample limited to flux of more than 5.24 mJy at 60 $\mu$m. More recent results, reported here for the first time, extend this demonstration of absorption.

If long wavelength radiation is being absorbed or scattered by the intergalactic medium (IGM), then this effect should be constant for all wavelengths longer than about 100–200 $\mu$m. Absorption at one wavelength in this range should be the same, for a given galaxy, as absorption at another wavelength. The recent observations of submillmeter 850-$\mu$m wavelengths by the SCUBA survey [45] is an opportunity to test this prediction.

Using the SCUBA Local Universe Survey (SLUGS) sample and eliminating 16 Seyferts, we obtain 88 galaxies that have 60, 100, 850 $\mu$m and 1.4 GHz fluxes. If we ignore absorption by the IGM, we find a correlation of $\log L_{850}$ on $\log L_{60}$ of $\log L_{850}{\sim}0.61 \log L_{60}$ with a correlation $r$ of 0.839, where the $L$'s are luminosities at the respective wavelengths. This nonlinear relation has been interpreted as a correlation of dust temperature with increasing galaxy size [45].

However, if we use the quantity $A_{1.4} = 1.2 \log L_{60} - \mathrm{Log}\, L_{1.4}$ as a measure of relative absorption at 1.4 GHz and calculate the "corrected" or intrinsic $L'_{850}, = L_{850} + A_{1.4}$, the correlation of $L'_{850}$ on $L_{60}$ improves to $r = 0.942$ and the dependency become linear $L_{850}{\sim}L_{60}^{1.00+-0.04}$, thus implying the temperature of dust in galaxies is independent of the size of the galaxy (Fig. 2). This result is reinforced by the observation that the ratio $L_{850}/L_{450}$ is virtually constant for the SLUGS galaxies [46], again implying a constant temperature. In the plasma model, this constant ratio is to be expected, as both wavelengths should be absorbed equally.

Similarly, if we use $A_{850} = L_{60} - L_{850}$ as a measure of relative absorption at 850 $\mu$m and look at the correlation of $L'_{1.4}, = L_{1.4} + A_{850}$ on $L_{60}$, we find that the correlation improves from $r = 0.895$ to $0.958$ as compared with the correlation of $L_{1.4}$ on $L_{60}$. The slope of $L'_{1.4}$ on $L_{60}$ is $1.20+-0.04$, which is consistent with theoretical work showing that the cosmic rays that generate the 1.4 GHz radiation are more efficiently trapped in large galaxies, so have time to produce more radiation [5].

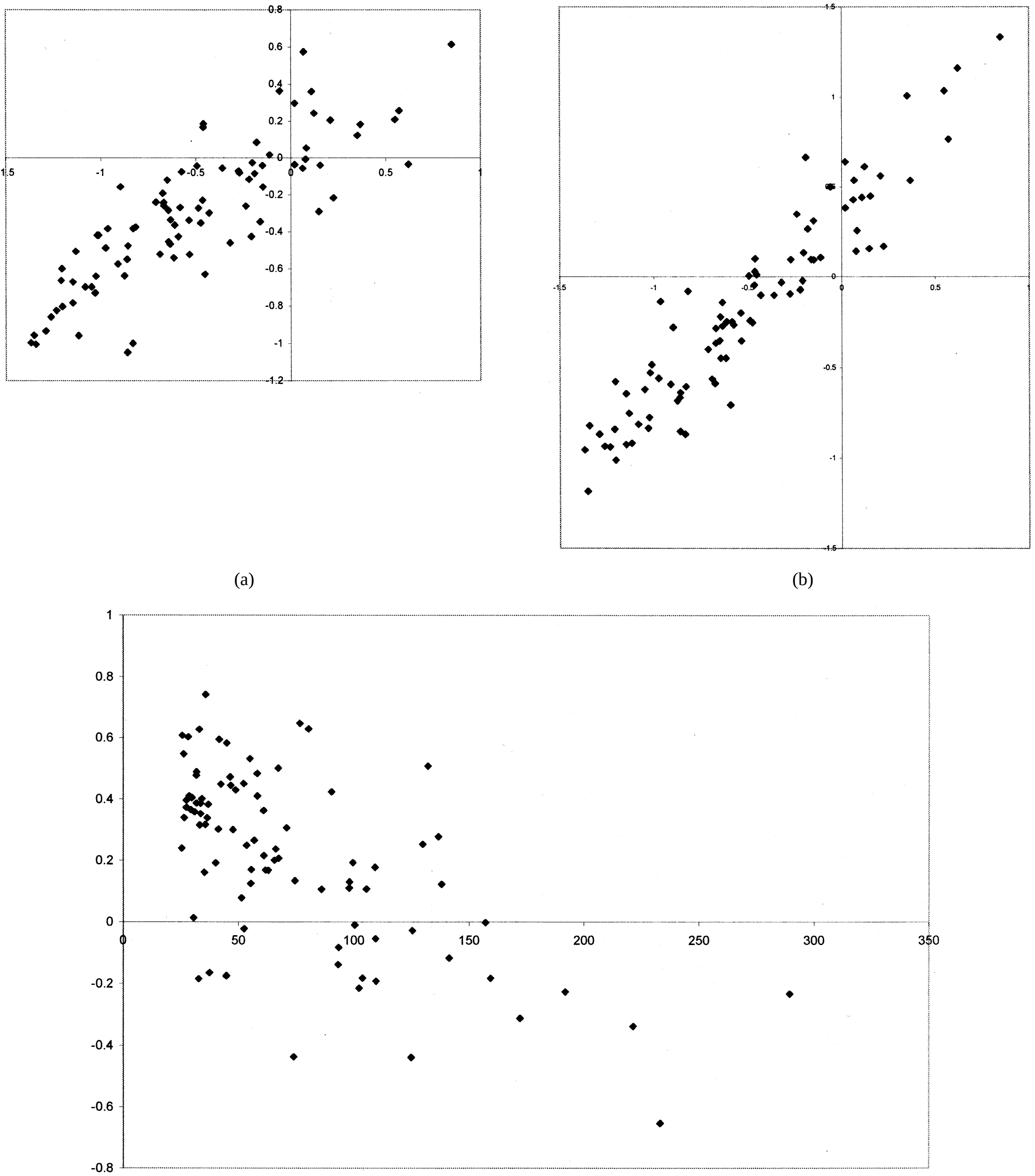
We can then compare absorption at 1.4 GHz, $A_{1.4}$ with absorption at a 850 $\mu$m, $A_{850}$. We find a correlation of $r = 0.80$. The slope of $A_{1.4}$ on $A_{850}$ is 0.80 and of $A_{850}$ on $A_{1.4}$ is also 0.80, so the "true" correlation is consistent with unity, as predicted. (Strictly speaking this shows that the two absorption values are proportional to each other, not equal. To prove equality, we would have to look at very nearby galaxies and show that the same proportionality holds to small distances, where absorption can be neglected. The present sample does not contain such nearby galaxies.)

We find, as expected by the plasma model, that the measures of absorption at both wavelengths increase with increasing distance. The slope of $A_{1.4}$ on $D$ (in 100 Mpc units) is $0.408+-0.040$ while the slope of $A_{850}$ on $D$ is $0.359+-0.046$, which are consistent with each other. It should be emphasized that, since the distribution of the filaments should follow the distribution of matter generally, and thus follow a fractal pattern, this level of absorption will not be expected to extend out indefinitely in distance, but the rate of absorption should itself fall with increasing distance from any point, as does matter density.

Together with the previous work, these results further confirm that long wavelength radiation is absorbed or scattered by the IGM. This entirely contradicts the Big Bang hypothesis that the CBR is primordial and is observed unchanged from a redshift of several thousand.

The WMAP results contradict the Big Bang theory and support the plasma cosmology theory in another extremely important respect. Tegmark *et al.* [47] have shown that the quadruple and octopole component of the CBR are not random, but have a strong preferred orientation in the sky. The quadruple and octopole power is concentrated on a ring around the sky and are essentially zero along a preferred axis. The direction of this axis is identical with the direction toward the Virgo cluster and lies exactly along the axis of the Local Supercluster filament of which our Galaxy is a part.

This observation completely contradicts the Big Bang assumption that the CBR originated far from the local Supercluster and is, on the largest scale, isotropic without a preferred direction in space. Big Bang theorists have implausibly labeled the coincidence of the preferred CBR direction and the direction to Virgo to be mere accident and have scrambled to produce new



(a)

(b)

(c)

Fig. 2. Correlation of $\log L_{850}$ on $\log L_{60}$ for 88 SLUGS galaxies (a), where $L_{60}$ is 60 $\mu$m luminosity/100 kJyMpc$^2$ and $L_{850}$ is 850 $\mu$m luminosity/JyMpc2. The correlation is significantly improved, (b) when $\log L'_{850}$, the 850 $\mu$m luminosity corrected for absorption by the IGM, is plotted against on $\log L_{60}$ and the relationship becomes linear. When the log of the ratio (times $10^5$) of the 850- and 60-$\mu$m fluxes are plotted against distance in Mpc (c), the correlation of absorption with distance is clear.

ad-hoc assumptions, including that the universe is finite only in one spatial direction, an assumption that entirely contradicts the assumptions of the inflationary model of the Big Bang, the only model generally accepted by Big Bang supporters.

However, the plasma explanation is far simpler. If the density of the absorbing filaments follows the overall density of matter, as assumed by this theory, then the degree of absorption should be higher locally in the direction along the axis of the (roughly cylindrical) Local Supercluster and lower at right angles to this axis, where less high-density matter is encountered. This in turn means that concentrations of the filaments, which slightly enhance CBR power, will be more obscured in the direction along the supercluster axis and less obscured at right angle to this axis, as observed. More work will be needed to estimate the magnitude of this effect, but it is in qualitative agreement with the new observations.

## VI. Why Is The Big Bang Still Dominant?

All the basic predictions of the Big Bang theory have been repeatedly refuted by observation. The plasma cosmology approach has been supported by thousands of times less resources than has the Big Bang, but it has presented alternative explanations for many of the basic phenomena of the universe, has predicted new phenomena, and has not been contradicted by any evidence. Yet the Big Bang remains by far the domain cosmological model. It is appropriate to ask why this is so.

Even the most blunt contradictions of theory and observation are viewed by Big Bang advocates as, at most, the indications of "new physics," never a refutation of the theory. For example, Pebbles, in considering the void phenomenon, admits that there is an "apparent inconsistency between theory and observation," but does not conclude that theory is in any way imperiled [48], rather only that an "adjustment of the model" may be necessary. Similarly, Cyburt *et al.* [15] agree that there are "clear contradictions" between BBN predictions and light element abundances, but conclude that "systematic uncertainties have been underestimated," not that the theory is wrong. Consistently new observations have led to new parameters, such as dark matter and dark energy, so that the number of adjustable parameters in cosmological theories has increased exponentially with time, approximately doubling each decade.

Four hundred years ago, a similar situation existed, at least in Catholic countries. Sixty years after the formulation of Copernican hypothesis, the Ptolemaic view of the solar system remained the dominant one among Continental astronomers. Galileo's elegant comparison of the Copernican and Ptolemaic systems, his *Dialog on Two World Systems*, should have ended any scientific doubt as to the validity of the Copernican approach. Yet many additional decades would pass before the Copernican system, already accepted at that time in England, would be accepted in the Catholic areas of Europe.

There is no mystery as to why this was so in the 16th century. The Ptolemaic theory was a state-supported scientific theory. The Catholic Church's advocacy of this theory would not have much mattered if the Catholic states had not given the Church the power to enforce, with state backing, its ideological edicts. Galileo, for his pro-Copernican writing, was subject to a civil penalty—house arrest—and famously forced to recant under threat of far worse penalties.

Today, the situation is similar, although the penalties for dissent are milder: loss of funding rather than loss of liberty or life. The Big Bang survives not because of its scientific merits, but overwhelmingly because it has effectively become a state-supported theory. Funds for astronomical research and time on astronomical satellites are allocated almost exclusively by various governmental bodies, such as the National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA) in the United States. The review committees that allocate these funds are controlled tightly by advocates of the Big Bang theory who refuse to fund anything that calls their work into question. It is no secret that, today, no one who pursues research that questions the Big Bang, who develops alternatives to the Big Bang, or, for the most part, who even investigates evidence that contradicts the Big Bang, will receive funding.

As a result, with very few exceptions, those who want to make a career in cosmology are constrained to work within the Big Bang framework—to do otherwise is to risk being cut off from funding, and, if a junior researcher, from tenure.

It is beyond the scope of this review to discuss how the Big Bang came to be state-supported theory (see [49] for a more detailed treatment). However, as long as such bias in the funding process continues, it will be extremely difficult for cosmology to extricate itself from the dead-end of the Big Bang.

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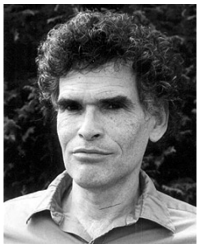

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