A SKEPTICAL SURVEY OF COSMOLOGY

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Nineteen paradigms purporting to explain the origin and evolution of the universe are compared to observation. It is concluded that not one has presented unequivocal evidence relating cosmological distance to redshift or time from the so-called formation of the universe. There are fully formed galaxies at a distance of 10 billion light years indicating an age of at least 20 billion years for the universe and it is probably old enough so that its age is irrelevant.

The Big Bang theory, notwithstanding numerous fixes and arbitrarily chosen constants, has failed to predict the primordial abundance of elements and the large scale structure of the universe. It uses physics that have never been tested in any laboratory. The hypotheses of Dark Matter and Dark Energy appear to be artifacts of attempting to fit inappropriate models to the data. The supernovae data indicating acceleration of the expansion can be fit as well by a static model. Thus there is, as yet, no way to make a choice between an expanding universe and a static one.

Space is 3-dimensional. It is senseless to appeal to multiverses and branes which can never, in principle, be observed.

Quasars exhibit intrinsic redshift and many (perhaps all) of them are local which accounts for their luminosity.

It is unlikely that the field of cosmology will advance in the foreseeable future given the sociological forces arrayed against the resources required to develop alternative theories.

Introduction

This paper discusses nineteen models having a bearing on the origin and evolution of the universe. There are many more, but these represent a broad variety proposed by respected scholars in their field. The implications of these models are discussed with respect to a set of observables.

<u>Observables</u>

1. Flatness of the universe
2. Darkness of the night sky
3. Uniformity (or lack thereof)
4. Black body spectrum of the Cosmic Microwave Background Radiation (CMBR)
5. Magnitude-red-shift relation for galaxies
6. Quasars and their redshift
7. Magnitude-red-shift diagram for supernovae

<u>Models</u>

1. FLRW (Friedman-Lemaitre-Robertson-Walker) (Big Bang) Λ-CDM (Lambda Cold Dark Matter)
2. Steady State (Hoyle)
3. Steady State Model (Assis)
4. Alternative Steady State (Hoyle, Narlikar, Burbidge)
5. Chronometric Cosmology (Segal)
6. Modified Newtonian Dynamics
7. Spatial Condensation (Leffert)

8. Mach's Principle (Ghosh)
9. Cosmological Natural Selection (Smolin)
10. The Strand Hypothesis (Schiller)
11. Plasma Cosmology Lerner
12. Curvature Cosmology (Crawford)
13. Galaxy Dynamics – Sciama's Principle (Rourke)
14. Conformal Cycle Cosmology (Penrose)
15. Hidden in Plain Sight (The Universe Contained Within An Event Horizon)(Thomas)
16. Modified Gravity (Moffat)
17. Particle Creation with Irreversible Thermodynamics (Chakraborty)
18. 3-Space Dynamics (Cahill)
19. An "Alternative" Cosmology (Blanchard)

Observables in Detail

1. Flatness of the universe

Utilizing the BOSS survey, Anderson (2014) claims that the universe is flat and therefore Euclidean. This survey covered more than one million galaxies covering 8500 square degrees in area and up to a redshift of $0.2<z<0.7$ using the Baryon Acoustic Oscillation technique. The redshifts are highly consistent with expectations from the Planck and WMAP Cosmic Microwave Background measurements assuming a Λ-CDM (Lambda-Cold Dark Matter) model. However, the vacuum energy, being 98 to 120 orders of magnitude larger than the Λ term in Einstein's equations would overwhelm the other terms and ensure a flat universe in any event. Finally, in his latest model of inflation, Linde (2014) predicted that the universe must be flat. Further discussion of inflation is reserved for later.

2. Darkness of the night sky

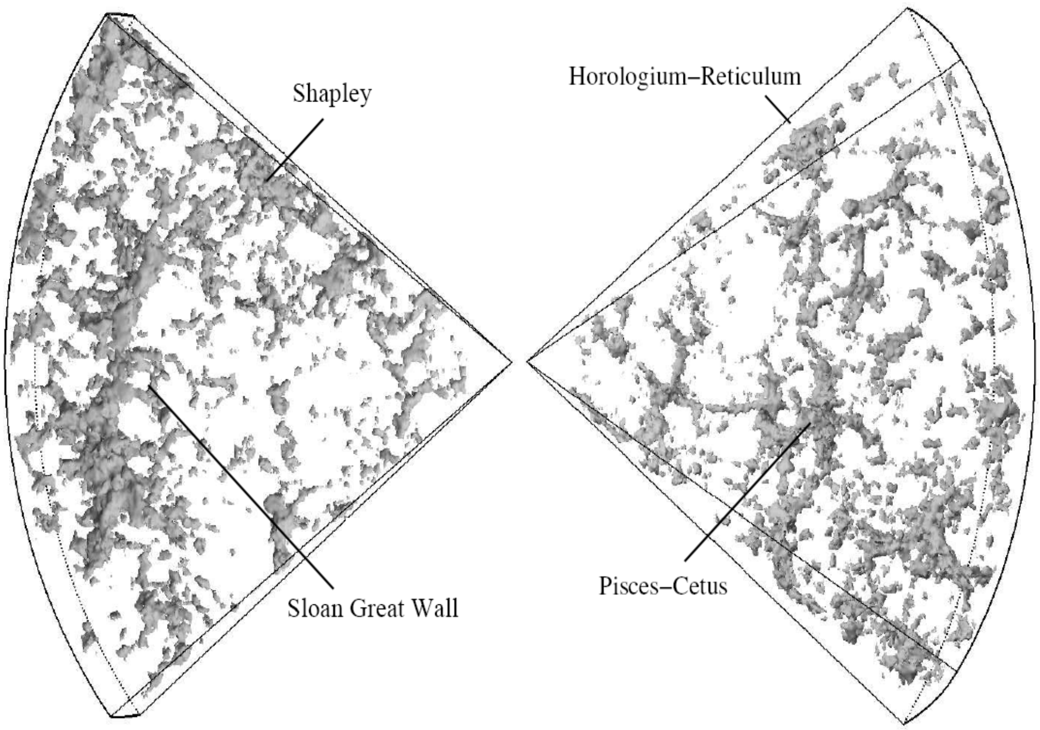
This is Olbers' Paradox: Why is the sky dark at night if the stars extend to infinity? This issue has been resolved by Harrison (2000) (p. 495 et. seq.) who shows that the look back limit is less than the lifetime of the average star. When we look out in space, we are looking back in time. Our sun is an average star and average stars have a lifetime of about 11 billion years. This means that one can only see stars out to 11 billion light years. This explanation was first developed by Kelvin (cited by Harrison p. 503) who developed the formula:

(brightness of the starlit sky/brightness of the sun's disc) = (luminous lifetime of stars/look back limit).

Using modern data we obtain the brightness of the night sky to be 10^{-13} of any point of the sun's disk. Wesson (1991) confirms this conclusion both for expanding and static models. However, Conselice (2016) states that it appears that the solution to the strict interpretation of Olbers' paradox, as an optical light detection problem, is a combination of nearly all possible solutions - red-shifting effects, the finite age and size of the universe, and through absorption by intergalactic matter. The darkness of the night sky has sometimes been explained as an effect of the expansion of the universe and the consequent redshift, but this cannot be correct because "it would mean that that the sky is covered with an enormous number of stars that we cannot see because their light is weakened by expansion. Yet we have found that it is impossible for the sky to be covered by stars because the luminous lifetime of stars is much less than the look back limit." (Harrison p.504)

3. Uniformity

Linde also stated that "Uniformity of the universe was somewhat of a mystery, and instead of explaining it, scientists invoked the cosmological principle, which states that the universe must be uniform because...well, because of the cosmological principle". He has graciously made his textbook available on the internet. Linde (2005) He states that "The universe becomes a multiverse, a huge eternally growing fractal consisting of different exponentially large locally homogeneous parts with with different laws of low-energy physics operating in each of them". This issue is important because almost every model depends on the cosmological principle: i.e. our universe is homogeneous (the same in every location) and isotropic (the same in every direction). The Sloan Digital Digital Sky Survey (www.sdss.org) is presented here.



This is the 2dF (2 degree Field) Galaxy Redshift Survey covering a distance of 2.5 billion light years (redshift ~0.2) roughly one fourth of the distance to the edge of the observable universe and an area of 1500 square degrees (about 3.6% of a sphere). The clumps are galaxy clusters and the dots are individual galaxies. There is no way that this slice of the universe viewed from earth could be called homogeneous or isotropic.

Buchert (2012) discusses this issue thoroughly. The effect of deviations from exact homogeneity and isotropy on the average expansion is known as backreaction. "Anything that changes the expansion rate and the corresponding distances at late times by the right amount (and that does not modify other things too much) accounts for all of the observed discrepancies, whether of luminosities of supernovae, anisotropies of the cosmic microwave background (CMB), the growth rate of structures or other probes." "Because the universe is inhomogeneous, different regions expand at different rates." This effect is not taken into account in the FLRW model nor in any other model, for that matter.

The current practice of cosmologists of trying to force the FLRW (Λ-CDM) (Big Bang) model to fit the universe at large has created a lot of mischief. For example, the concept of critical density has (along with galactic dynamics) led to the presumption of so-called “dark matter” which has never been detected in a laboratory after 50 years of searching. Besides the Large Underground Xenon (LUX) detector located in a converted gold mine, Arun (2013) describes half a dozen detectors which have failed in this effort. Only a cynic would suggest that these experiments will continue so long as money is available to pay for them.

4. The Cosmic Microwave Background Radiation.

In 1990, the COBE satellite measured the overall radiation between the wavelengths of 1 to 100 centimeters and provided a complete distribution of the light energy in perfect agreement with that of a black body at 2.75 K (Bonnet-Bidaud 2016). In 1992 COBE found variations in the temperature of ~30 millionths of a degree. In order to claim that these slight variations were the source of galaxy formation, “dark matter” had to be introduced in an amount ten times greater than observed to provide the additional gravity needed to allow matter condensation. This resulted in a universe that was younger than its oldest stars so a repulsive force “dark energy” was introduced to bypass the anomaly. The full final Planck satellite data release of February 2015 revised the age of the universe to be 13.813 billion years and the amount of dark matter to be 26.4%. It must be mentioned that these estimates required careful adjustment of 11 independent parameters. “The nature of the diffuse radiation is therefore a much more open question than it seems a priori. Is it really only a very distant fossil background radiation or simply a more universal radiation, filling the entire space and produced both locally and at long distances?” It is interesting to note that a calculation of the radiation from stars results in a temperature of space of 2.8 K.

Bonnet-Bidaut (2016) concludes that “The "cosmological" nature of the background 3K radiation cannot be considered as fully demonstrated today. The 3K does not represent a major component of the cosmos and, contrary to current consensus, diagnoses derived from it are less decisive than they seem. Due to its very low energy, it can be produced by a wide variety of physical processes. Its overall homogeneity and low level fluctuations can also be explained by different scenarios. Besides, its interpretation in the frame of the Big Bang brings insurmountable problems, because its excessive homogeneity requires the introduction of enigmatic additional components such as inflation, dark matter and dark energy. These unknown ingredients are among the weaknesses of this cosmological model, as long as no direct indication of their existence is found”.

Dark Energy is used to explain the supposed acceleration of the expansion of the universe. If the expansion is accelerating or even constant, then there is a point at which galaxies reach and even exceed the speed of light. Then a light ray emitted by a luminous object must then be stationary; a situation deemed impossible by both Maxwell and Einstein; (Ohanian 1976). Cosmologists explain “Because this expansion is caused by relative changes in the distance-defining metric, this expansion (and the relative movement apart by objects) is not restricted by the speed of light upper bound of special relativity. Two reference frames that are are globally separated can be moving apart faster than light without violating special relativity, although whenever two reference frames diverge from each other faster than the speed of light, there will be observable effects associated with such situations including the existence of various cosmological horizons.” (http://en.wikipedia.org/wiki/Metric_expansion_of_space). A somewhat different support of this hypothesis is found in Davis (2003). Such phenomena, by definition, will never be observable.

5. Magnitude-Redshift Relation for Galaxies

First of all, there are three types of redshift. The gravitational redshift is observed in region where the strength of gravity is greater then in the observer's region. The Doppler redshift occurs because of relative motion in space. When V/c is not small (c is the velocity of light, λ is the wavelength of a particular emission line measured in a laboratory on earth) the relativistic formula is:

$$\frac{\text{shift in wavelength}}{\text{wavelength}} = \frac{\Delta\lambda}{\lambda} = z$$

$$z = \sqrt{\frac{\left(1 + \frac{v}{c}\right)}{\left(1 - \frac{v}{c}\right)}} - 1$$

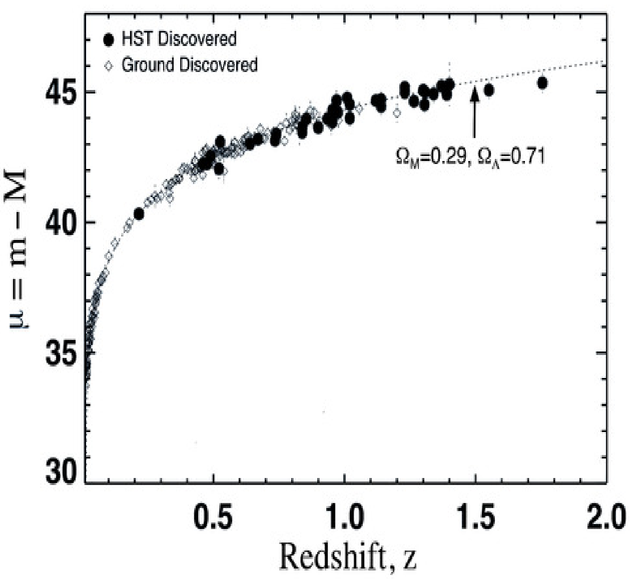
The expansion redshift is given by: $\mathbf{1+z= R_0/R}$

In common use is the velocity-distance law: $\mathbf{V = H_0 L}$

where H_0 = the current value of the Hubble constant

L = the distance to the object

These laws cannot be combined into a velocity distance law without a theory that describes how the universe has evolved in time. See Harrison (2000) Chapters 14 &15 for a thorough discussion. Here is a typical magnitude-redshift diagram:



The distance modulus, $\mu = m - M$, is the difference between the apparent magnitude and the absolute magnitude M. The absolute magnitude is the brightness that would be observed at 10 parsecs (32.6 light years). Note that magnitude has a logarithmic relationship to brightness and thus has the effect of suppressing differences. For perspective, the Andromeda galaxy has an apparent magnitude of 3.44 and an absolute magnitude of -21.5. Why bother with such detail? Because NASA and other institutions routinely report distances without mentioning the assumptions behind them. Harrison (2000) remarks that “there is a common failure to distinguish between $zc = H_0 L$ and

$V = H_0L$ This is only true for small redshifts: < 0.1 All that may be said correctly is that the universe has expanded 20% for z = 0.2" . Harrison is still the best introduction to cosmology. Furthermore, Paul Marmet (2013) discusses 59 mechanisms which could produce the observed redshifts. There is a fourth source of redshift: The intrinsic redshift from quasars (quasi-stellar objects, QSOs)

6. Quasars and their redshift

Rings and shells of galaxies and quasars surround galaxies which have active nuclei. An analysis of the positions, red-shifts, and magnitudes of 118,000 galaxies and 25,000 quasars in the 2dF (Hubble deep field) survey revealed concentrations of high-red-shift galaxies and quasars near galaxies (Arp 2008). Quasars of high red-shift are physically associated with low red-shift galaxies. (Arp 1998). Moreover, the detection of 40 quasars with proper motion ranging from 1 to 60 micro-parsecs indicates that these quasars cannot lie at cosmological distances or else they must be be moving at transverse velocities much greater than the speed of light. i.e. 760c, 5200c, and 2300c. Also, galaxy 3C 345 (a well studied radio source that has been identified visually) would have to be ejecting material at 7 times the speed of light; the movement can be seen in photographs taken over the last ten years. This would be a violation of special relativity if it lay at cosmological distances. Thus the concordance model of red-shift versus distance for quasars cannot be correct. Ratcliffe (2011). Finally, quasars would have to be 100 times brighter than the total output of a normal galaxy if they were at the cosmological distances indicated by their redshifts. This requires inventing new physics to explain. The conclusion is that there must be an intrinsic redshift associated with quasars. This intrinsic redshift is the fourth source of redshift mentioned previously. Neither a Google Science search of the literature nor a Wikipedia search discusses these discrepancies which suggest that the authors ignored any data which was not in accord with the concordance (Λ- CDM) model. As a consequence of his insistence that high redshift galaxies were physically connected to low redshift galaxies, Arp was denied observing time at the Mount Wilson and Palomar Observatories and subsequently found a more congenial position at the Max Planck Institute in Munich.

Hoyle, Burbidge & Narlikar (2002) is an excellent source of information on quasars including photographs of the physical association of quasars with galaxies. They include a table of 160 quasars close to galaxies. (p.131). Martın Lopez-Corredoira (2011) presents a good review of various theories. David Russell (2005) in a study of normal galaxies, concludes that "the redshift anomalies identified in this analysis are consistent with previous claims for large non-cosmological (intrinsic) redshifts. Panov (2013) in an examination of 225 quasar found that they exhibit an intrinsic redshift and states "Evidence if found in favor of Arp's evolutionary scenario: QSOs are ejected from their respective parent galaxy and evolve as they recede, building new small mass companion galaxies. Evidence is found that in the course of evolution the quasar density and redshift decrease while dimensions and luminosity increase." Kirov (2013) expanded the data to 341 samples.

7. Magnitude Redshift Relationship for Supernovae

In 1998 data was released based on the apparent brightness of Type 1a supernovae which purported to demonstrate the acceleration of the expansion of the universe. The introduction of "dark energy" to account for expansion so that observable baryonic matter accounted for only 4.56% of the universe is discussed in Panek (2011); a very readable and accurate narrative of the logic by which some scientists came to the conclusion that dark matter and dark energy must exist. Another, more technical series of lectures relating to dark matter and dark energy is presented by Krause.(2010).

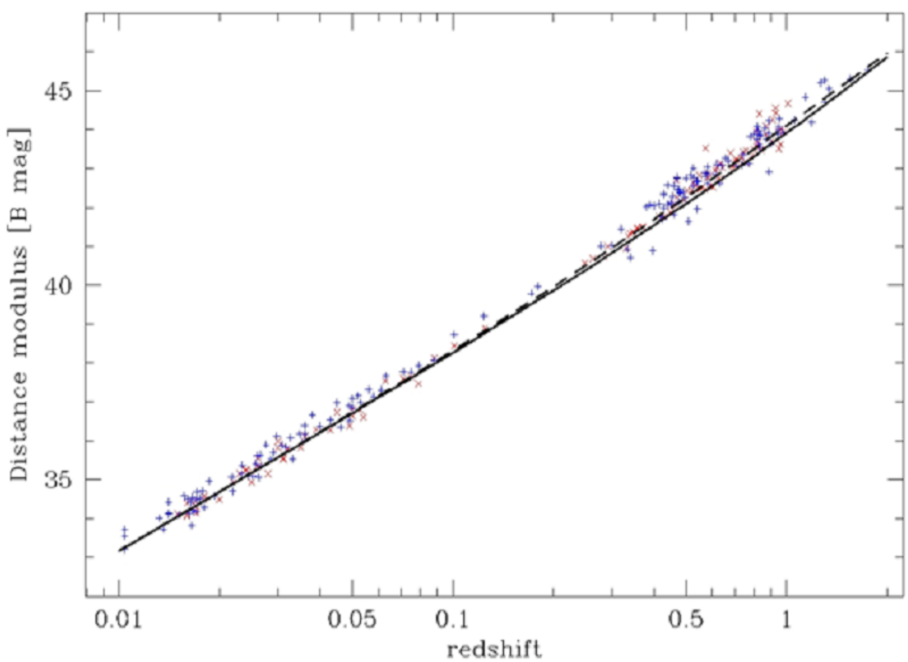
This issue is important to Big Bang cosmology because if the critical density ratio (to be discussed later) doesn't add up to 1.0, then the theory that all the elements were created in the big bang would fail and the universe would not have its observed flatness nor be closed.

David Crawford (2014) of the Sidney Institute for Astronomy claims that the discovery of dark energy in a frame of the standard cosmological model is only an artifact of the conjecture about the existence of time dilation. He also states that the supernova 1a data was selected in order to conform to the Big Bang theory. Furthermore he argues that the use of the brightness of the supernovae as a standard candle is not correct and that the total energy release should be used instead.

Crawford presents an extensive review of the available astronomical data which will be very valuable to anyone attempting to fit data to a cosmological model. In his opinion, it is impossible to conclude either way as to whether the Universe is expanding or static. The evidence is equivocal and open to more than one interpretation. He observes that cosmology is far from a precision science, and there is still a lot more work that needs to be done to resolve the apparently contradictory evidence. His paper is a model of careful analysis.

Ruth Durrer (2011) remarks that "our single indication for the existence of dark energy comes from distance measurements and their relation to redshift. Supernovae, cosmic microwave background anisotropies and observations of baryon acoustic oscillations simply tell us that the observed distance to a given redshift z is larger than the one expected from a Friedmann–Lemaître universe containing only matter, using the locally measured Hubble parameter. When evidence does turn up which appears to refute the Big Bang, supporters modify the theory to accommodate new observations." Thus this corpus of belief has been subject to continual expansion and osmosis. Nevertheless, critics are treated as heretics.

The graph shown below by Ratcliffe (2014) comprising calculations based on a plasma cosmology from Eric Lerner (2003) further draws into question the dark energy hypothesis. Note that the data end at a redshift ~1.



The apparent brightness of Type 1a supernovae (x and plus signs) are plotted against red-shift (the dimmer the star, the higher the distance modulus). The predictions for a static universe (solid line) hardly differ from that of the Big Bang theory (dashed line).

The Models

1. The Big Bang

aka Friedmann-Lemaitre-Roberston-Walker, Lambda Cold Dark Matter (Λ-CDM), Concordance model. The equation below is the basis for the FLRW model.

$$H^2 = \underbrace{\frac{8\pi G}{3}\rho}_{\text{matter density}} - \underbrace{\frac{kc^2}{R^2}}_{\text{curvature}} + \underbrace{\frac{\Lambda}{3}}_{\text{dark energy}}$$

H = Hubble's constant ρ = matter density of the Universe
c = speed of light k = curvature of the Universe
G = gravitational constant Λ = cosmological constant
R = radius of the Universe

H, the Hubble constant measures the rate of expansion of the universe and has a currently accepted value of ~ 70 km/sec/Mpc. or 13.9 billion years. However, as discussed by Harrison(2002) (p. 363 et seq.) the universe could be of any age, including long pauses of non-expansion.

ρ, the density, depends on the initial baryon to photon ration during the big bang and was chosen ad hoc to be $1.4\text{x}10^{-10}$. Hoyle (2002) p. 97-99.

k, the curvature constant can take on values of -1, 0, +1 respectively depending on whether the universe is open (will accelerate in its expansion), closed (but will continue to expand at a steady rate) or closed (will contract in a big crunch).

Λ, has had many interpretations over the years but is now used in the FLRW theory to supply enough matter through dark matter which along with dark energy produces a critical density sufficient to close the universe. This implies that only 4.6% of the universe is made up of visible baryonic matter. The supposed evidence for dark matter are the anomalous rotation velocities of the outer sections of many spiral galaxies.

Mordehai Milgrom (2008) attempted to explain the curves by introducing MOND (Modified Newtonian Dynamics) whereby the force of gravity fell off at far distances by a single factor which applied to all galaxies. He was successful in reproducing the rotation curves of many galaxies. However, Stewart (2016) discusses the work of Donald Saari (2015) who suggested that Newton's Law was misapplied. A realistic model of a galaxy involves an n-body problem where n is 100 billion. The assumption made by dark matter proponents is a continuum approximation which smooths out all the stars inside an arbitrary shell and excludes interactions between stars close to the shell and the star whose rotational speed one is trying to calculate. The implication is that the Virial equation (which relates the kinetic energy to the gravitational potential) underestimates rotational speeds at large distances. The consequences of Saari's calculations are that if dark matter exists, and forms vast massive halos around galaxies, then it doesn't explain the anomalous rotation curve.

The Big Bang theory is a cosmological model of the universe from the earliest known period through its subsequent large-scale evolution. The model describes how the universe expanded from an initial state of very high density and high temperature and offers an explanation for a broad range of observed phenomena, including the abundance of light elements, the cosmic microwave background (CMBR) radiation, and Hubble's Law – the farther away galaxies are, the faster they are moving away from Earth. If the observed conditions are extrapolated backwards in time using the model, the prediction is that just before a period of very high density there was a singularity. Georges Lemaitre first noted in 1927 that an expanding universe could be traced back in time to an originating single point, calling his theory that of the "primeval atom". Edwin Hubble concluded from analysis of galactic redshifts in 1929 that the galaxies are drifting apart; this is important observational evidence for an expanding universe. Backward extrapolation of the presumed expansion rate of the universe places the Big Bang at around 13.8 billion years ago. After its initial expansion, the universe cooled sufficiently to allow the formation of the elements. Giant clouds of these primordial elements – mostly hydrogen, with some helium and lithium – later coalesced through gravity forming early stars and galaxies. Helge Kragh (1996) does a marvelous job describing the early history of the Big Bang. Hoyle, Burbidge & Narlikar (2002) describe in detail the application of general relativity to cosmology.

Inflation: The Big Bang model requires the ad hoc assumption of inflation occurring within within 10^{-38} seconds to explain the flatness of the universe as well as the horizon problem exhibited by the uniform temperature of the CMBR. The absence of antimatter in the existing universe is explained away by positing a slight excess of matter over antimatter which survived annihilation. Chaotic inflation also requires the continuous creation of bubble universes which are unobserved. And recently Ijjas, Steinhardt, and Loeb (2014) have pointed out that classic inflation is predicted to be exponentially younger than the observable universe.

They go on to observe that the inflation paradigm has morphed into a new version where a complex energy landscape allows virtually any outcome; to date, no successful measure has been proposed and there is no obvious way to solve this problem. Inflation requires the continuing formation of bubble universes. Linde (2014) states that the new data release by Planck 2013 stimulated the development of new cosmological theories, by changing the goal from finding various complicated models capable of describing large local non-Gaussianity to the development of new elegant models of inflation capable of explaining increasingly precise data. In fairness, Jerome Martin (2019) makes a spirited defense of the inflation paradigm. But if the theory does not make testable predictions, how can cosmologists claim that the theory agrees with observations, as they routinely do? Penrose (2016 p. 297 et seq.) remarks that the variety in the suggested inflation potentials is indicative of the lack of an underlying theory. Even so, to exhibit the flatness that the universe exhibits now, it would have had to be flat to one part in 10^{60} just after inflation. That appears to be tantamount to an impossibility.

Discrepancies in the FLRW model

Stewart (2016) lists several reasons for the Λ-CDM speculation being such an inadequate model:

a) The actual amount of Lithium-7 is only a third of what the theory predicts. (Stewart p.160)
b) There's about a thousand times too much Lithium-6 (ibid. p.160)
c) The orthodox age of 13.8 billion years does not allow enough time for the observed large structures to form.(ibid. p.230)
d) The limited number of curvature constants (-1, 0, -1) proposed in the model are not the only constant curvature solutions of the field equations. (ibid. p.236)
e) Every universe in the big-bang family is homogeneous (the same at every point) and isotropic (the same in every direction). (ibid. p.256)
f) According to today's quantum mechanics, the value of Λ, the vacuum energy, should be 10^{120} times bigger than the value of Λ that fits the acceleration. (ibid. p.256)
g) The concept of inflation, brought in to save the appearances, although exquisitely fined tuned, has a major problem: New bubble universes should be appearing all the time. (ibid. p.254)
h) With regard to the use of Einstein's General Theory as the basis for a cosmological model, Kathleen Rosser (2018) observes that dark matter, a supposed non radiating transparent material, has never been directly observed astronomically, nor verified in existing particle accelerators, despite over half a century of searching.
i) GR (General Relativity) does not explain the apparent increasing expansion rate of the universe without the reintroduction of Einstein's abandoned cosmological constant Λ, which must be fine-tuned in a seemingly improbable way, or the postulation of some form of phantom pressure dark energy. (ibid.)
j) Incompleteness: Einstein's field equations are possibly incomplete in that the gravitational mass-energy density, which presumably comprises the source of the field, does not uniquely determine the metric, or equivalently, does not fully determine the geometry of spacetime, unless one selects an often ad hoc equation of state. (ibid.) Along this line of reasoning, one wonders why Einstein predicts local phenomena such as the decaying orbit of binary pulsars so well without an equation of state.
k) To understand GR, one must grasp that it is one and only one thing: a theory of geometry. (ibid)
l) Spacetime curvature, not acceleration, constitutes the fundamental nature of gravity in GR. Therefore it is clear gravity is equivalent not to acceleration but to curvature.
m) One commonly noted problem with GR is that it does not explain the apparent increasing expansion rate of the universe without the reintroduction of Einstein's abandoned cosmological constant Λ, or without the postulation of some form of phantom pressure called dark energy.
n) The cosmic expansion rate, is determined not just by mass density ρ, but also by pressure density p, which is fixed by an auxiliary equation of state specifying p as a function of ρ.
o) Supernovae Type 1a redshift versus distance data, among other evidence, suggest that the cosmic expansion rate is accelerating in the present epoch. The existence of dark energy, however, seems implausible to many researchers. This phantom energy not only has a negative sign for pressure, it supposedly makes up most of the energy in the universe, despite the fact that it has never been independently observed. Thus, many astrophysicists propose instead the introduction of a cosmological constant Λ. However, to match

observation, Λ must be fine-tuned in a way that seems improbable.

p) If the cosmological principle can be relaxed, it is possible to explain the apparent cosmic acceleration ... without invoking dark energy or modified gravity. For instance, giving up the cosmic homogeneity, it is reasonable to imagine we are living in a locally underdense void. In general situations, the Equation of State as a practical matter is often chosen ad hoc. A commonly used EoS is $p=w\rho$ where w is a coefficient often set to 1 or 0. The coefficient w can also be negative, as is assumed in descriptions of dark energy, although this may seem unphysical. Moreover, the EoS can in general vary with space and time. In the standard model of the expanding universe, for example, the EoS is assumed to change from epoch to epoch, depending on whether space is dominated by radiation, matter or the vacuum. However, the salient point is that the Einstein Field Equations, and hence General Relativity, offer only partial information about how the universe evolves through time. Incompleteness thus seems the most compelling reason to modify GR or reject it altogether as a framework for cosmology. GR's requirement for an equation of state seems proof of the incompleteness of the theory. (ibid)

In defense of the Λ-CDM hypothesis, Jean-Phillipe Uzan (2016) presents the most detailed, complete and balanced description of its development and comparison to observations. He recognizes a few of the discrepancies noted above and discusses their potential solution. He recognizes the importance of evaluating the extent to which our visible universe is representative of the universe as a whole. He recognizes that “This Copernican principle has strong implications since it implies that the universe is, at least on the size of the observable universe, spatially homogeneous and isotropic.” (We have seen that this assumption is problematic.) He states “This ΛCDM model is in agreement with all the existing observations of the large survey (galaxy catalogs, CMB, weak lensing, Hubble diagram etc.) and its parameters are measured with increasing accuracy. This has opened the era of observational cosmology with the open question of the physical nature of the dark sector,” while admitting that “one has however to be aware, that these parameters are defined within a very specific model and require many theoretical developments (and approximations) to compare the predictions of the model to the data”. Its main problems are (1) the lithium problem, (2) the origin of the homogeneity of the universe (which is a question of the peculiarity of is initial conditions), (3) the existence of an initial singularity and (4) the fact that it describes no structure, contrary to an obvious observation.)

Michael Disney (2011) provides a detailed review of the Big Bang theory and remarks “BBC is not a single theory any more but 5 separate sub-theories constructed on top of one another. The ground floor is a theory, historically but not fundamentally grounded in General Relativity, to explain the redshifts – this is Expansion, which happily also accounts for the Cosmic Background Radiation. The second floor is Inflation – needed to solve the horizon and ‘flatness’ problems of the Big Bang. The third floor is the Dark Matter hypothesis required to explain the existence of contemporary visible structures, such as galaxies and clusters, which otherwise would never condense within the expanding fireball. The fourth floor is some kind of description for the ‘seeds’ from which such structure is to grow. And the fifth and topmost floor is the mysterious Dark Energy idea needed to allow for the recent acceleration of the expansion, apparently detected in supernova observations.”

2. The Original Steady State Model

As published in a popular book by Fred Hoyle (Hoyle 1950), this theory required a creation tensor in an expanding universe that resulted in three new atoms of hydrogen per cubic meter per million years. This new matter is created randomly throughout space. This value was later modified on the basis of a new value for the Hubble constant and an updated estimate of the density of matter in space. For a scholarly and thorough study of the controversy surrounding the Big Bang and the Steady State model see Kragh (1996). The steady state model was vigorously attacked by Martin Ryle on the basis of source counts of radio sources. Ryle's data was later found to have serious errors which are discussed in chapter 7 of Hoyle, Burbidge and Narlikar (2000). Although it now appears that matter creation may occur in active galactic nuclei and quasars, this possibility has never been explored within the framework of the steady-state hypothesis.

3. The Steady State Model of A.K.T. Assis

Assis (1993) postulates a a boundless universe which has always existed and is homogeneous on the very large scale; in brief, the perfect cosmological principle. He modifies the Newtonian gravitational potential by an ad hoc term e^{-ar} to be used when there is a many-body interaction. This term represents an absorption of gravity and is used with Mach's Principal to determine the force of one body on another. He then derives Newton's first and second laws for an infinite and homogeneous universe. The exponential decay of the potential with distance resolves the paradox inherent in the Newtonian universe which would collapse upon itself. The red-shift is explained by the absorption of light by interaction with matter in interstellar and intergalactic space. Olbers' paradox is explained by the 2.7 degree background radiation. Assis further points out that this temperature was predicted 15 years prior to the work of Gamow and represents the average temperature of the cosmos.

4. The Quasi Steady State model (Hoyle, Burbidge, Narlikar)

This model is developed in Hoyle, Burbidge and Narlikar (2000). It envisions an oscillation of period Q superimposed on an increase of the scale factor of the universe characterized by t/P where t represents time and P is related to the Hubble constant. At each minimum of the oscillation, creation occurs. The book also points out the deficiencies of the Big Bang hypothesis in that there is no value of the ratio of protons to photons that accurately predicts the abundances of He, D, and Li. Furthermore, Hoyle proposes that all the elements are produced in stars. The cosmic microwave background radiation comes from absorption and re-emissions by small particles, primarily carbon and iron whiskers and with a uniformity that has occurred on a time scale of around 100 billion years at a distance scale of 10^{29} cm.

5. Chronometric Cosmology (Segal)

This concept was developed by Irving Ezra Segal (1976) and is based on the following postulates:

1) Light is red-shifted because it is traveling through a globally curved, four dimensional space-time continuum.
2) At each point in the cosmos there is a convex future direction, meaning, “the future can never merge into the past,” i.e., no space time curvature can close or loop.

3) Without temporal invariance there is no conservation of energy—indeed, the very concept of energy becomes ambiguous.

4) He assumes that space is homogeneous and isotropic; the concept of a spatially homogeneous non-expanding model resolves observational discrepancies that are inherent in the expanding universe models.
5) The cosmos is a four-dimensional manifold and is stationary which allows the use of Minkowski space locally in spite of the assumption of curvature. The relative motion, accessible via red-shift-apparent magnitude observations and their theoretical interpretation, is entirely “virtual”. In Segal’s words, “the true driving physics is cosmologically stationary.” Segal differentiates between a local time and a cosmic time. The difference between local time and cosmic time is ~ 1 part in 10^{19} in the course of a year. The theory predicts the observed red-shift cut off at ~2.5 for quasars.

The theory also predicts a quadratic red-shift-magnitude relationship. Roberts and Clauser (1999) used data from the 15,000 galaxies in the de Vaucouleurs catalog to show that neither the linear Hubble relationship nor Segal's quadratic relation fit the data. The best fit had a slope of 1.4. Their analysis also presented a sound method to determine the completeness of any astronomical data.

6. Modified Newtonian Dynamics MOND (Milgrom)

According to Mordehai Milgrom (2009), both Newtonian dynamics and General Relativity “fail miserably in accounting for the observed dynamics of most galactic and cosmological systems–such as galaxies, binary galaxies, small groups of galaxies, and rich galaxy clusters. These theories can be saved only if new, ad hoc, dominant ingredients of matter-energy are introduced into the universe; these ingredients are known as “dark matter” (DM) and “dark energy” (DE).” Milgrom developed a phenomenological formula based on galaxy rotation curves proposing that gravity does not follow Newtonian dynamics for accelerations less than $a_0 = 1.2\text{x}10^{-8}$ cm. s^{-2}. MOND has been successfully tested in a very large number of cases and explains the flat galaxy rotation curves with just this one parameter, thus obviating the need for dark matter. A relativistic formulation called TeVeS replaces Einstein's field equations for calculating the geometry of space-time.

7. **Spatial Condensation (Leffert)**

Charles Leffert (1999) proposes that the universe is the surface of a 4-dimensional sphere onto which plankton existing as hyper-cubes are condensing from a higher dimensional epi-space. These plankton reproduce exponentially on the surface of the 4-D sphere. This surface forms the space of our 3-D universe. The condensation is continuous. The resistance to this flow forms the basis of time. Thus, this is the only model which physically relates time to the expansion of space. There are two types of plankton: a c-type (acceptable to the core) and an x-type which floats on the surface and forms the “dark matter” which leads to gravitational clumping of c-type baryonic matter. The condensation process defines a cosmic time proportional to the logarithm of the plankton produced.

Values for five independent parameters are needed to fix the spatial condensation model. 1) The temperature of the cosmic background radiation fixes the radiation density. 2) Early nucleosynthesis fixes the matter density. 3) The gravitational constant fixes the dark mass density. 4) A boundary condition sets the radius of the universe resulting in 5) an age of the universe between 12 and 16 billion years. One result is a distance modulus vs. red-shift plot that duplicates the supernova 1a data. The model is self-contained and presents a basis for the formation of ordinary matter, dark matter, and dark energy.

8. Mach's Principle and the Origin of Inertia (Ghosh)

Amitabha Ghosh (2000) extended the ideas of Dennis Sciama to include a velocity induced inertial induction as a drag effect. Starting with the notion of a mean rest frame of the universe defined by the cosmic microwave background radiation he develops the concept of absolute motion with respect to the CMBR. However, it must be emphasized that he defines motion according to all the other masses in the universe which are themselves also in motion. Ghosh then assumes that gravitons are affected by drag and that the gravitational constant falls off with distance. He then shows that the force acting on a particle has two components: one depends on the velocity in the form of a drag (very small) and the other depends on the acceleration just as in Newton' Second Law. He then derives Newton's laws of motion.

The redshift is then shown to be linear at short distances and to increase exponentially at very long ranges. The observational evidence for this relationship is lacking. However, the predictions for red-shift in the solar spectrum is better than that of general relativity and Ghosh's method correctly predicts the redshift of photons grazing heavenly bodies. More importantly, he predicts that the velocity induced cosmic drag reduces the energy of photons without scattering (a major objection to so-called “tired light” theories) and results in a good prediction of redshift – distance relations for Cepheids and for spiral galaxies. He also predicts the velocity dispersion of the Coma and Perseid clusters.

This technique explains the the transfer of momentum from the sun to the planets and the secular retardation of the moon. Furthermore, Ghosh predicts that flat rotation curve of spiral galaxies without the need for dark matter.

What's important is that this model hangs together logically without any free parameters and is able to predict phenomena that have hitherto been unexplained. It is a sad commentary on the attitude of cosmologists who are wedded to the Λ-CDM model that this work has been largely ignored by the cosmological community.

9. Cosmological Natural Selection (Smolin)

Lee Smolin (1997) of the Perimeter Institute developed a theory of cosmic natural selection. He starts with two assumptions: 1) The world consists of an ensemble of universes. 2) Black holes evolve to initial states of expanding universes. At each such creation event there is a small change so that each resultant universe has similar but slightly different properties from the parent universe. In each black hole there are high energy density conditions equivalent to the Big Bang that created our universe, creating a new “child” universe.

The whole point of CNS is to demonstrate that one can make falsifiable predictions of the properties of the newly created universe even in the absence of detailed knowledge of the fundamentals. Similar to biological evolution, a universe that generates more black holes creates more universes with similar black hole-generating properties. Eventually most universes would have properties that would maximize the production of black holes. The theory purports to solve a potential problem because carbon is required for the copious production of astrophysical black holes. Without carbon, stellar evolution could not progress to the iron-burning cores of massive stars that, late in life, form supernovae that spew carbon and other heavy elements into the interstellar dust clouds that form new stars and planets.

Our universe has a gravitational constant that appears to maximize the production of black holes. Moreover, out of 21 constants that define our universe, Smolin believes that eight of them lie in the narrow range necessary to allow atoms, stars, and galaxies to form. He also declares that we already have evidence that the ΛCDM model may be breaking down at the present Hubble scale. He concludes with these questions: How are we to explain the choices of the parameters of the standard models of physics and cosmology? How are we to account for the observation of special tuning to values that allow the existence of long lived stars and complex chemistry? And can these be done in the context of a theory that makes genuine falsifiable predictions for doable experiments?

There are some problems with this approach: 1) we can never observe these other universes. 2) we do not know what happens inside black holes. Nevertheless, CNS remains vulnerable to falsification, and so is a cosmological model worth considering, It is the only scenario which offers a genuine explanation for the fine tunings and and present values of the parameters of the standard model of particle physics.

10. The Strand Hypothesis (Schiller)

The strand model, developed by Christoph Schiller (2010), a fully algebraic model of fundamental physics, reproduces the standard model of particle physics, quantum theory, and general relativity, while not allowing for any alternative or extension. This model attempts to account for the gauge symmetry of the Standard Model of particle physics, U(1)×SU(2)×SU(3), with the three Reidemeister moves of knot theory by equating each elementary particle to a different tangle of one, two, or three strands (selectively a long prime knot or unknotted curve, a rational tangle, or a braided tangle respectively). The following is quoted from Schiller (2014). “In the strand model, cosmology is based on one idea: The universe is made of one fluctuating strand. Fluctuations increase the complexity of the strand knottedness over time. The existence of finite size and of finite age then follows automatically.” The strand model predicts that the cosmic horizon is an event horizon, like that of a black hole. It is conjectured that the evolution of the universal strand just after the big bang automatically leads to a homogeneous and isotropic matter distribution and to flat space.

The strand model predicts a small positive cosmological constant, that leads to a small repulsion of masses. The model further predicts that the cosmological constant Λ decreases with increasing radius of the universe and that dark energy, or vacuum energy, is completely described by a Λ that is positive and changes with the radius R of the universe as $1/R^2$. Furthermore, the matter density of the universe decreases with age, roughly as t^{-2}. This prediction differs from the usual cosmological models. There is nothing beyond the cosmic horizon and matter, energy and space appear at the horizon.

This hypothesis is self-contained and develops Einstein's field equations and quantum theory. However, it also assumes that the universe is expanding and that it started with the Big Bang.

11. Plasma Cosmology (Lerner)

Eric J. Lerner (2003) has extended the work of Hannes Alfen to develop a concept of an infinite static universe filled with plasma filaments which are equivalent to gravitational forces. The basic assumptions of plasma cosmology which differ from standard cosmology are:

a. Since the universe is nearly all plasma, electromagnetic forces are equal in importance with gravity on all scales.

b. An origin in time for the universe is rejected, due to causality arguments.

c. Since every part of the universe we observe is evolving, it assumes that the universe itself is evolving as well, though

d. A scalar expansion as predicted from the FLRW metric is not accepted as part of this evolution.

e. Theoretical considerations and experimental evidence show that matter and antimatter always come into existence in equal amounts. In the plasma model, super-clusters, clusters and galaxies are formed from magnetically confined plasma vortex filaments. Naturally, since the plasma approach hypothesizes no origin in time for the universe, there is sufficient time for the development of large-scale structures.

f. Red-shifts are a ubiquitous phenomenon that is summarized by Hubble's Law in which more distant galaxies have greater redshifts. One of the key assumptions of plasma cosmology is that this phenomena does not indicate an expanding universe.

Plasma cosmology posits that the most important feature of the universe is that the matter it contains is composed almost entirely of astrophysical plasma that responds as a whole to electromagnetic forces. The charged particles are the ions and electrons resulting from heating a gas and play an important role in many astrophysical phenomena. As theoretical considerations and experimental evidence from particle physics showed that matter and antimatter always come into existence in equal quantities, Alfvén and Klein in the early 1960s developed a theory of cosmological evolution based on the development of an “ambiplasma" consisting of equal quantities of matter and antimatter. In the past twenty-five years, plasma cosmology has expanded to develop models of the formation of large scale structure, quasars, the origin of the light elements, the cosmic microwave background and the redshift-distance relationship.

12. Curvature Cosmology (Crawford)

David Crawford (2014) of the Sidney Institute for Astronomy proposes a static universe where the CMBR is produced by very high energy electrons via curvature-red-shift radiation in the cosmic plasma. This theory is based on two major hypotheses: The first is that the Hubble red-shift is due to an interaction of photons with curved space time where they lose energy to other low-energy photons. Therefore it is a tired light model. The second is that there is a pressure, curvature pressure, that acts to stabilize expansion and provides a static stable universe. This hypothesis leads to modified Friedmann equations which have a simple solution for a uniform cosmic gas.

The Hubble Telescope Ultra-Deep Field survey shows that there is a decided preference for a fit to the angular size data with a Euclidean non-expanding (ENE) universe over that of the expanding Λ-CDM concordance model. In fact, the data are a very poor fit to the Λ-

CDM model. If the red-shift range is restricted to $0.03 < z < 3.5$ then the ENE model provides a reasonably good fit. With a very small amount of extinction added the fit is nearly perfect. The discovery of dark energy in a frame of the standard cosmological model is only an artifact of the conjecture about the existence of time dilation. He also states that the supernova 1a data was selected in order to conform to the Big Bang Theory.

Crawford also determined that the cosmological model that uses a very simple linear Hubble law in a Euclidean static universe fits the angular size vs. red-shift dependence quite well, which is approximately proportional to z^{-1} , although the error bars allow for a slight size/luminosity evolution. The type Ia supernovae Hubble diagram can also be explained in terms of this static model with no ad hoc fitted parameter, i.e. no dark matter nor dark energy. He also raises serious doubts about the source of the CMB radiation.

Crawford presents an extensive review of the available astronomical data which will be very valuable to anyone attempting to fit data to a cosmological model In his opinion, it is impossible to conclude either way as to whether the universe is expanding or static. The evidence is equivocal and open to more than one interpretation. He observes that cosmology is far from a precision science, and there is still a lot more work that needs to be done to resolve the apparently contradictory evidence.

13. Sciama's Principle and the Dynamics of Galaxies (Rourke)

Colin Rourke (2011) has developed a new approach to the dynamics of galaxies using the precise formulation of Mach's principle due to Sciama. Observations show that the horizontal straight line section of the galaxy rotation curves extends far outside the limits of the main visible parts and the actual velocity is constant to within less than an order of magnitude overall for the galaxies observed (typically between 100 and 300km/s). The introduction of dark matter does not resolve this issue. For stability in a rotating system (such as the solar system or Saturn's discs) you must have a strong central mass to hold it together. The suggestion made here is that the center of a typical galaxy contains a huge rotating body (probably a black hole) and that the inertial drag effects coming from this rotating mass are responsible for the observed rotation curves. (However, as we have discussed, there is another explanation for the rotation velocities.) The weak Sciama principle states that a mass M at distance r from P rotating with angular velocity ω contributes a rotation of kM/ωr to the inertial frame at P where k is a constant. He then postulates that the central mass of a galaxy M, varies from 10^9 to 10^{14} solar masses with the range 10^9 to 10^{11} corresponding to so called "active galaxies" and the range 10^{11} to 10^{14} to full size spiral galaxies.

Based on these ideas, Rourke develops equations whose solutions predict very well the orbits of stars in several galaxies. Moreover he demonstrates that the Milky Way is a barred spiral and that galaxies shown in the Hubble ultra-deep field survey show fully developed spiral galaxies. (http://hubblesite.org/gallery/album/pr2014027a/) (A download of this picture at the highest resolution reveals that these furthest galaxies appear no different than those much nearer once account is made for distortion by gravitational waves.) All the strange shapes and unfamiliar objects in the HUDF can be explained as optically distorted images of familiar galaxies. Given the clear evidence of such distortion in the field, there are no grounds for concluding that an undistorted view of the universe in the region covered by the field would be qualitatively different from a more local region. In this series of five papers, Rourke goes on to discuss redshift, gravitational distortion of far galaxies, quasars, and gamma ray bursts in terms of his analysis.

In regard to the age of the universe, David Wiltshire (2009) makes use of the fact that the universe is dominated by empty voids, while clusters of galaxies are spread in a cosmic web of bubble-like sheets that surround the voids, along with thin filaments that thread them. The most startling conclusion of his analysis is that the age of the universe can vary by billions of years depending on whether one is an observer in a void or in a galaxy. Within a galaxy the best-fit age is about 14.7 billion years, at a volume average position of about 18.6 billion years, and in the center of a void even larger. Both of these references posit that the universe is at least 20 billion years old.

14. Conformal Cyclic Cosmology (Penrose)

Because of his concern with the apparent paradox of the big bang having a low entropy while exhibiting a uniform thermal profile, Roger Penrose (2016) proposed that the end of our universe is the start of a new one which involves a new big bang. Conversely, before the Big Bang of our present universe lies the future infinity of a previous one. To help in visualizing the concept, he uses conformal diagrams to clarify the low entropy state of the early universe. But where did the very low-entropy Big Bang come from? Penrose's answer (or part of it) is that black holes destroy the information that goes into them (whether or not black holes destroy information is still controversial.). Penrose calculates the entropy of our present universe by adding up the entropy of all the current black holes using the Bekenstein-Hawking formula. That means that when the black hole eventually evaporates by Hawking radiation, the entropy that was in the in-falling matter has been permanently destroyed.

He avoids using inflation by proposing that his conformal cyclic cosmology theory explains the things that inflation was invented for: The theory explains correlations in temperature in the cosmic microwave background between areas that are separated by large angles, and the scale invariance in the temperature fluctuations. The theory requires less assumptions than inflation and avoids the super rapid expansion. The basic point is this. The very early universe is smooth. The universe right now is lumpy, with stars and galaxies and black holes throughout. But the future universe will be smooth again — black holes will evaporate and the cosmological constant will disperse all the matter, leaving us nothing but empty space. However, while there is absolutely no observational evidence that a universe existed before the present one, there are logical reasons to suppose that the odds against there being a Big Bang are one part in $10^{10^{123}}$ based on thermodynamic considerations. Penrose (2007) p.729

15. Hidden in Plain Sight (The Universe Contained Within An Event Horizon) (Thomas)

Andrew Thomas (2013) in Book 2 starts with the premise that there is only one universe and that there is nothing outside of the universe. Thus, there are no absolutes and nature can only make relative measurements within that universe. This lack of absolutes has led to surprising results as one approaches the very small (quantum phenomena), speeds approaching that of light, and gravity near large masses. He has developed a novel theory which obviates the need for dark energy. He starts by considering that the universe must have zero total energy and then suggests an ingenious modification to the theory of general relativity. Instead of gravity attracting objects up to an infinitely small distance, (as is predicted by general relativity), his modified gravity theory predicts that objects would be attracted until they separated by an equilibrium distance which reflected the zero energy condition. The value of this equilibrium distance is well known as the Schwarzschild radius (a distance equal to the event horizon of a black hole).

For almost every object this equilibrium distance is an incredibly small distance. For example, the Schwarzschild radius of the sun is 3 km. This is why we only see gravity as an attractive force. However, for the universe as a whole, the Schwarzschild radius is very close to the radius of the observable universe, so if the universe is expanding to its Schwarzschild radius then this would explain the observed radius of the universe and its accelerating expansion (generally attributed to dark energy). It also matches the two main predictions of the inflation hypothesis by solving the horizon problem and predicting a flat universe (because spatial flatness arises naturally in a universe at its Schwarzschild radius). The Schwarzschild radius of the universe is $1.5x10^{27}$ m (based on a mass of 10^{54} kg), a distance which is larger than the observed universe. So, the whole mass of the universe is contained within its Schwarzschild radius. Then for the universe as a whole, the repulsive effect becomes highly significant. Here, gravity would act to expand the universe. Essentially, then, the boundary of the universe is equivalent to the horizon of a black hole.

Although he doesn't suggest it, this hypothesis would apparently work as well for a steady state universe because, while the derivation of the Schwarzschild radius of the universe uses the Hubble relation, the latter cancels out.

16. Modified Gravity (Moffat)

John Moffat (2009) developed the modified gravity theory (MOG) which successfully explains a range of astronomical and cosmological observations, including galaxy rotation curves, the CMB acoustic peaks, and the galaxy mass power spectrum. MOG was also used successfully to explain the unusual features of the Bullet Cluster without exotic dark matter. MOG is based on an action principle that incorporates, in addition to the Einstein-Hilbert term and the matter action, a massive vector field, three scalar fields corresponding to running values of the gravitational constant, the vector field coupling constant, and the vector field mass. It utilizes a “Fifth Force” which varies in time and a gravitational force which varies in distance. He then uses the Friedmann LeMaitre Rebertson Walker (FLRW) line element to produce a series of equations for the expansion rate and acceleration of the universe. These are then solved numerically using a set of initial conditions which include a lifetime of 13.7 billion years. The results predicted an accelerating expansion of the universe that conforms to the supernovae data without the need for dark matter or dark energy.

17. Particle Creation In The Framework of Irreversible Thermodynamics. (Chakraborty)

Subenoy Chakraborty (2015) and his colleagues have proposed a genuinely novel approach to cosmology. The work is an attempt to explain the recent observations and the past evolution of the universe without using dark energy or modifying Einstein's general theory of relativity. They start with Gibb's Equation for an open thermodynamic system. Thus, they are among the few to recognize that when one extracts a chunk of universe to analyze, one is dealing with an open thermodynamic control volume where matter (and hence entropy) can enter and exit and be created. Non-equilibrium appears as a result of particle creation (this is before inflation, i.e. before 10^{-36} seconds) and suggests dissipation due to high bulk viscosity by relating the bulk viscous pressure to the production of entropy. So the cosmic history is characterized by the fundamental physical quantities, namely, the expansion rate H and the energy density ρ, and, as a result, the gravitational creation rate can be defined in a natural way. They present in graphs the whole evolution of the universe starting from an early inflationary epoch to the present accelerating phase. The model predicts a possible transition from present accelerating stage to a decelerating phase again in the future. Finally, the model transitions to the ΛCDM era; H is found to be a constant, and, hence, the particle creation rate as well as the temperature are constant. They claim that it agrees with the latest Planck data.

18. 3-D Space Dynamics (Cahill)

Reginald Cahill has presented a solution which gives an excellent parameter-free fit to the recent supernova data without the need for dark energy or dark matter. Here the dynamical theory of 3-space is applied to Hubble expansion dynamics, with the result that the supernova data is well fitted without an acceleration effect and without the need to introduce any notion of dark energy. He develops an equation which is Newton's Inverse Square Law but with an effective mass M(1+ α2 +..) that is different from the actual mass M.

This effect has been shown to explain the so-called dark matter effect in spiral galaxies, and bore hole gravity anomalies. Experimental data from the Greenland bore hole (to a depth of 1.7 km) and Nevada (0.6 km) reveal that the slope of the deviation from Newton's law is the inverse of α, the fine structure constant, and show that gravity does not decrease as rapidly as predicted by Newtonian gravity or General Relativity as we descend into the earth.

He is able to correlate the masses of black holes at the centers of spiral galaxies which play a critical role in their formation. It was the inability of Newton's and Einstein's gravity theories to explain these observations that led to the notion of dark matter.

His generalized Maxwell Equations predict the expansion of the universe, agree with the available data, and do not require introduction of a cosmological constant or dark energy.

Thus, his proposal has a Hubble expanding 3-space solution without acceleration that is parameter-free and reveals that dark energy, like dark matter, is an unnecessary notion. He predicts a maximum age for the universe of 18 billion years.

19. An alternative to the cosmological 'concordance model' (Blanchard)

Alain Blanchard uses the observations of the CMB to test whether a cosmological constant, Λ, is really required by comparing Einstein de Sitter (E deS) models with data from the Wilkinson Microwave Anisotropy Probe (WMAP).

As discussed already, the concordance model has been built up over time in order to match observations, thus its a posteriori agreement with much of the large scale structure data is not a test of its validity. The only direct evidence so far for a cosmological constant comes from the Hubble diagram of distant Type Ia supernovae, a method which relies on the standard candle hypothesis and on empirical corrections to the observed peak magnitudes on the basis of the observed decay times. When the extinction and the luminosity–decay time relation are treated in a self-consistent way, the significance of the evidence for positive Λ is much reduced.

It is interesting that methods which are largely independent of the LMC and Cepheid distance scales do tend to give significantly lower values for H_0. Therefore, a Hubble constant in the range 55-65 km/s/Mpc rather than the currently accepted value of ~70 seems entirely plausible at the present time. The value he requires, 46 km/s/Mpc, is still below this range, but he believes the present paper provides a powerful stimulus for further research. It is important to establish reliably whether we do live in an low matter density universe (one in which the critical density is less than 1.0), and also to devise further tests for Λ independently of the SN Ia Hubble diagram.

He concludes that when the assumption of a single power law for the primordial fluctuation spectrum is relaxed, an Einstein de Sitter model with zero Λ can fit the CMBR data as well as if not better than the best ΛCDM concordance model. This is a clear and direct indication that the CMBR data alone does not require the introduction of a non-zero cosmological constant. However a model with only cold dark matter cannot simultaneously match both the CMBR data and the amplitude of matter fluctuations as indicated by clusters, peculiar velocity fields, and weak lensing measurements. An Einstein-de Sitter universe is not yet ruled out, as seems to be generally believed.

20. Angular Size as a Test of Cosmological Models (Lopez-Corredoira)

Martin Lopez-Corredoira (2010), in an exhaustive study of seven cosmological models, determined that the data favored a static universe model. The models studied were:
a. Concordance model with Hubble constant H0 = 70 km/s/Mpc, Ωm = 0.3, ΩΛ = 0.7
b. Einstein–de Sitter model with ΩΛ = 0, Ωm = 1
c. Friedmann model of negative curvature with Ω = 0.3, ΩΛ = 0, which implies a term of curvature ΩK = 0.7
d. Quasi-Steady State Cosmology (QSSC), Ωm = 1.27, ΩΛ = -0.09, Ωc = -0.18 (C-field density)
e. Static euclidean model with linear Hubble law for all redshifts
f. Tired-light/simple static euclidean model
g. Tired-light/"Plasma redshift" static euclidean model

Plots of the corrected angular size vs. redshift are presented. He carefully analyzes potential sources of systematic errors and applies a surface brightness test as a check. He considers the effect of galaxy evolution for both disc and elliptical galaxies and shows that the premise that younger galaxies are found at higher redshifts does not agree with the data. The data show that, with the static models, one can fit nearly the same Hubble diagrams as the concordance model with its cosmological constant, particularly for supernovae fits.

One conclusion is that perhaps the most immediate problem with the static Universe is understanding the cause of the redshift of galaxies, but there are several proposals for alternative mechanism to produce redshifts without expansion or Doppler effect, so the hypothesis of a static Universe is not an impossible one.
Further, the average angular size of the galaxies for a given luminosity with redshifts between z = 0.2 and 3.2 is approximately proportional to $z^{-\alpha}$, with α between 0.7 and 1.2,

depending on the assumed cosmology.
Any model of an expanding Universe without (strong) evolution is totally unable to fit the angular size vs. z dependence.
The conclusion of this paper is that the data on angular size vs. redshift present some conflict with the standard model, and that they are in accordance with a very simple phenomenological extrapolation of the Hubble relation that might ultimately be linked to a static model of the universe.
This paper (along with Crawford) is an excellent example of careful and conservative treatment of data which can be applied to any cosmological model. It therefore serves as a fitting conclusion of this survey of models.

Discussion

The reason for presenting such a diverse collection of models is to show that many respected physicists and mathematicians harbor grave doubts about the premises of Big Bang cosmology. Lal (2012) points out that "findings of the observational astronomy and also the revelations in the field of fundamental physics over the past two decades question the validity of the 'Big Bang' model as a viable theory for the origin of the universe." and "Although the "Big Bang" is often presented as if it is proven fact, there is a wealth of data, including recent revelations of the several space probes and findings in fundamental physics, which tell a different story." He cites about 100 references in support of his contention.

It should be mentioned here that the majority of models (including the Big Bang) use the Einstein de Sitter universe which can be described as a model for a flat matter-only FLRW universe with a fixed deceleration. It's used because of its simplicity and makes no provision for a possible coasting time in an earlier epoch. The matter is treated as dust. See Harrison pp.360 et seq. for a thorough discussion of many possible universes.

No consideration has been given in this paper to multiverses, higher dimensions, or string theory; nor to branes or multiverses. They are inherently unobservable and can only be speculation. There is only one universe. This universe has three spatial dimensions. This conclusion is supported by the fact that orbits can be stable only in three spatial dimensions. Boal (2001) An exhaustive analysis can be found in Barrow & Tipler p.260 et seq. Finally in Book 6, Thomas (2013) presents a compelling argument for three dimensions.

The Big Bang theory has yet to define where the Hubble flow or expansion of space begins. It is certainly beyond the Virgo super cluster of which the local group is a part, and certainly beyond the great wall (about one fifth of the distance to the edge of the observable universe).

Several of the models summarized above closely approximate the magnitude redshift curves of the Big Bang theory so those curves do not justify the selection of any particular model. Several of the models recognize the conceptual problems of having a sudden creation event and therefore propose cyclic universes with a "bounce" from a previously existing universe. As yet, no one has presented unequivocal evidence relating cosmological distance to time from the formation of the universe. Whether or not the universe is expanding or is static is still an open question not settled by any observations. The supernovae magnitude red-shift relationship can be fitted just as well by the assumption of a static universe.

There is little chance of progress in determining the past or future of our universe, at least not in the United States. Why? None of the alternative models will receive sufficient attention in the form of grants, or time on the major telescopes, or the development of centers where new ideas can be supported because of the following reason:

Consider the procedure by which new faculty are hired. First they are invited to give a presentation on their doctoral research. The senior faculty will decide whether the candidate will "fit in". The dean will consider how much funding the candidate can obtain. It would be irresponsible for a thesis advisor to put his student to work on a project which opposes the consensus view. How would a budding cosmologist find a job in the physics or astronomy department at a university (the only place where he can practice his trade) if he presented controversial ideas and later tried to publish in peer reviewed journals? I am quite familiar with this procedure, having been on both sides of it. This is the real tragedy of nearly a century of fiddling with an obviously inappropriate Big Bang model while stifling alternative theories. As an example of such stifling, try googling "Alternative Cosmologies". The Wikipedia page which displays is littered with such terms as "controversial" and "fringe" leaving no doubt as to the sympathies of the author.

The following thoughts were inspired by Lee Smolin (2015) p.426. What physical laws applied to the beginning of the universe before there was matter? How can something exist and not be made of matter? Laws and axioms consist of data and logic i.e. information. Information has to be expressed in matter whether it be the q-bits of a quantum computer or the human brain. This suggests that the laws had to evolve.

Conclusions

1. There are insufficient data to determine the age of the universe. It is certainly more than 20 billion years and probably old enough so that its age is irrelevant. The universe is lumpy and exhibits large scale structure.
2. Space is 3-dimensional. It is senseless to appeal to multiverses and branes which can never, in principle, be observed.
3. There is, as yet, no way to make a choice between an expanding universe and a static one.
4. Dark Matter does not exist. Its supposed existence is an artifact of misapplying an equation which applies to a 2-body orbiting system to a galaxy containing over 100 billion bodies.
5. Dark Energy does not exist. Its only purpose is to provide sufficient density to ensure a flat universe in the ΛCDM model.
6. The Big Bang theory, notwithstanding numerous fixes and arbitrarily chosen constants, has failed to predict the primordial abundance of elements and the large scale structure of the universe. It uses physics that have never been tested in any laboratory.
7. Quasars exhibit intrinsic redshift and many (perhaps all) of them are local, not requiring unknown physics to explain their luminosity.
8. It is unlikely that the field of cosmology will advance in the foreseeable future given the sociological forces arrayed against providing the resources required to investigate alternative theories.

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