LET'S DEFLATE THE BIG BANG HYPOTHESIS!*

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The hypothesis that the universe is the product of a BIG BANG about ten billion years ago is challenged from several standpoints. It is shown to be in conflict with Einstein's special theory of relativity, and counter to the law of the conservation of mass-energy. In addition to this, semi-Newtonian calculations are submitted which indicate that the so-called PRIMORDIAL FIREBALL would vigorously collapse rather than violently explode. The gravitational collapse is irreversible by any known natural process, and a BLACK HOLE results. The big bang hypothesis is seen to fail as an explanation of the general expansion of the universe inferred from the galactic red-shift phenomenon.

Introduction

The big bang hypothesis is hailed as the "scientific genesis" of modern time. Some accept it because they feel it effectively does away with God as Creator of the universe. It is implicitly atheistic, and any theistic version of it is a patent contradiction in terms.

The main tenets are summarized in a physics text, as follows:

> According to the big bang theory, about 10^{10} years ago all of the matter and energy now in the Universe were concentrated in a single *fireball* in which the density was $\geq 10^{25}$ g/cm^3 and the temperature was $\geq 10^{16}$ °K. The radiation pressure was tremendous in this fireball and it expanded outward with explosive rapidity—the *big bang*. Those parts of the fireball that had the greatest relative velocities are now concentrated in the distant galaxies that we see (as they were $\approx 2 \times 10^9$ years ago) receding from us with high velocities. Thus, the general expansion of the Universe results in a natural way from the big bang theory.[1]

To this brief summary George Gamow, the main proponent of the big bang hypothesis, would add: In the beginning the vast infinite volume of space of the universe *was already* filled with a uniformly dense but very tenuous cloud of gas[2] which collapsed under its own gravitational force into a state of inordinately high temperature and density (the Big Squeeze).[3]

This superhot-superdense state was the so-called primordial fireball, which, Gamow said, was both infinite in mass and extent.[4] From it the present universe is supposed to have "evolved." The big bang hypothesis does not postulate any real *ex nihilo* creation;[5] instead, mass-energy is assumed to be eternal. Thus, the big bang belief is that the universe is the product of the IMPERSONAL x TIME x CHANCE.[6]

Basis of the Big Bang Hypothesis

The observational basis of the big bang hypothesis is the galactic red-shift phenomenon. Briefly put, distant galaxies are observed to have remarkably great red-shifts.[7] A red-shift is the displacement of lines in a spectrum toward longer wavelengths. The amount of red-shift of a galaxy is proportional to its distance from the earth.[8] (Figure 1)

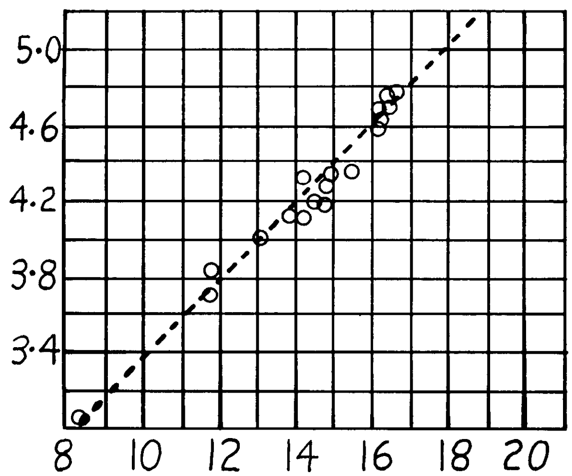

Figure 1. The galactic luminosity-redshift relationship. Logarithm of the redshift (plotted vertically) vs. logarithm of the bolometric magnitude (plotted horizontally). From this relationship astronomers have inferred that the universe is expanding, and that the rate of recession of a galaxy is proportional to its distance from the earth. This inference is based on the Doppler effect.

By means of the Doppler effect astronomers have inferred that the distant galaxies are receding from the earth at high speeds, which are said to be proportional to their distances from the earth.[9] The Doppler effect is the apparent change in the wavelength of light emitted by a source moving relative to an observer.[10] Light from an approaching source would appear shifted toward the violet end of the spectrum, while light from a receding source would appear red-shifted.

*The term "hypothesis" is not used in a rigorous way in this article. In scientific work all hypotheses are testable in some way. But the big bang "hypothesis" concerns origins which are untestable by scientific means. In this article the term "hypothesis" is taken to mean a guess or speculation.

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The fundamental assumption of the big bang hypothesis is that the universe is undergoing a general, large-scale, relatively uniform expansion. This assumption is vital to the big bang hypothesis. The idea that the universe is expanding has been *inferred* from the galactic red-shifts by using the Doppler effect.[11]

However, not all astronomers agree with the Doppler effect interpretation. One of these is Gerald Hawkins of Boston University.[12] Another is Gp. Horedt, who states: "It is shown that from the observational viewpoint no conclusive distinction can be made at present between expanding and static world models."[13] According to Horedt, the red-shift may not be caused by any actual recession of galaxies, but by the exponential decay or energy loss of photons of light.[14]

He also mentions problems of the discrepancy between observed and calculated mass-energy densities, singularities, and the immense forces needed to produce the expansion in the big bang models.[15] It is unsafe to be dogmatic that the universe is expanding, although for the sake of argument the expansion assumption will be granted in this paper.

It goes without saying that, if the Doppler interpretation of the galactic red-shift phenomenon is ever demonstrated to be incorrect, then the observational basis of the big bang is gone, since it is an attempt to explain an expanding universe.

The philosophical basis of the big bang hypothesis is the "vaporous verbiage" known as uniformitarianism. Briefly, this is the idea that the universe is a closed system where there is no God to alter the order of cause and effect.[16] It is a dogma of evolutionists that existing physical laws and processes are sufficient to account for the origin and all past changes in the earth and the universe.

By means of unwarranted extrapolation, the evolutionist attempts to do the impossible—to account for the present existing order and complexity of the universe where only a statistical thermodynamic equilibrium should exist, and to account for the existence of man as a personal, rational, conceptualizing being of great dignity where only impersonal, inanimate mass-energy should exist.[17]

Circular Reasoning

It should be noted that the big bang is supported mainly by circular reasoning. Imagine the following during an astronomy class where the big bang concept is being taught:

Instructor: ". . . As we have noted, the universe is in a present state of expansion as the result of the big bang which occurred thirteen billion years ago."

Student: "Sir? How do we *know* that there was a big bang?"

Instructor: "Well, we know there was a big bang *because* the universe is still expanding as a result of the blast. . . ."

It takes little discernment to detect this line of thought. Yet this type of reasoning is often used to "provc" evolution.

The Big Bang Is Not Science

One thing should be obvious at this point: *there were no human beings present to observe the creation of the universe. Since there were no observers, then the matter of creation is outside the legitimate realm of science.* Paul A. Zimmerman points this out very well:

> This shows clearly what cosmogonical thinking is. It is good, clean fun for an astronomer, a mathematician, a chemist, a physicist. It is an exercise in working out a logical scheme of proposed events which would lead to the formation of the earth and solar system as we find them now. It is a game, the rules of which are observed physical and chemical laws. But even if one wins the game by devising a perfect system that accounts for every detail of the properties of the heavenly bodies, he still will not have proven things did, in fact, take place as he deduced they might have.[18]

Without observational authority to back it up, the big bang hypothesis is nothing but a mental construct, a philosophical speculation, the product of the minds of men who have not observed the event "described." This clearly is not science.

Furthermore, the big bang hypothesis does not "fit" the *rules* of cosmogonical speculation. There is something about *observed physical laws* that tends to debar the big bang even as a tenable hypothesis. The rules in question, in this paper, are: (1) Einstein's special theory of relativity, (2) the law of the conservation of mass-energy, and (3) Newton's law of universal gravitation. The big bang concept clearly is counter to these observed "physical laws."

Current Cosmological Confusion

To analyze the big bang hypothesis, one must select a model as a basis for making calculations and conclusions. But to do this requires having a set of "initial" values or conditions. One needs figures for the mass, density, temperature, and composition of the fireball at the instant the expansion began. There is confusion, however, about what these initial values are.

George Gamow called for a maximum density of 10^{14} g/cm^3 and an unspecified temperature.[19] Menzel, *et al.*,[20] call for an initial temperature of about 10^{12} °K. Jerry B. Marion[21] gives a density and temperature in the neighborhood of 10^{25} g/cm^3 and 10^{16} °K.

Tayler mentions the proponents of a "hot big bang" favoring infinite density and infinite temperature.[22] But proponents[23] of the "cold big bang" (Zeldovich) favor infinite density and absolute zero (0 °K!).

There is also confusion about how long ago the big bang took place. Gamow seemed to have trouble making up his own mind about this. He has given figures of several billion years,[24] 4.3 billion years,[25] and 5 billion years ago.[26] Peebles and Wilkinson say it happened 7 billion years ago.[27] Marion wants 10 billion years,[28] and Sandage desires 18 billion years.[29] (I suggest that the big bang has never occurred, and that all of these dates and densities are irrelevant.)

Big Bang and Special Relativity

According to Einstein's special theory of relativity, no material object having a "rest" mass greater than zero can equal or exceed the velocity of light in a vacuum.[30] The "massless" particles travel at the speed of light (photons and neutrinos). According to the theory, any object, which has a non-zero "rest" mass, as it approaches the speed of light increases in mass beyond all bounds.[31] Mass increase:[32]

$$m' = m_0/\sqrt{1-v^2/c^2} \tag{1}$$

where m' is the "relativistic" mass in grams, m_0 is the "rest" mass in grams, v is the velocity of the moving object with respect to the observer's "rest" frame in cm/sec, and c is the speed of light *in vacuo.*

As the object approaches the speed of light its mass, and *hence its resistance to further acceleration,* increases beyond all bound. Consider the left-handed limit as v approaches c, (i.e. v is still less than c):

$$\lim_{v\to c^-} m_0/\sqrt{1-v^2/c^2} = +\infty \tag{2}$$

By definition an infinite mass cannot be accelerated by any finite force. Newton's second law can be written:

$$\vec{F} = \frac{d}{dt}(m\vec{v}) = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dt} \tag{3}$$

The effect of an accelerating force is to increase the mass as well as the velocity.[33] It is seen that as the velocity of the object gets closer to that of light, its acceleration slows down due to the increasing mass. Thus it is not possible for a finite force to accelerate a finite mass to exactly the speed of light in any finite period of time.

How is all this relevant to the big bang? In his book, *Matter, Earth, and Sky,* Gamow made it clear that he believed that the primordial fireball was both infinite in mass and extent.[34] In other words, the fireball at the beginning of the expansion *already filled* the vast infinite reaches of space! According to Gamow, this infinite fireball expanded uniformly.[35]

In a uniformly expanding fireball, the rate of recession of a particle from any given reference point is directly proportional to its distance from that reference point. Since an infinite fireball has nothing that can be properly called a center of expansion (an infinite fireball, by definition, has no center nor edge), one can arbitrarily select a reference point as the "relative center of expansion." Let everything recede from this point. Assume that the Hubble relationship[36] is valid, i.e. that the speed of recession is found by the formula

$$v = Kr \tag{4}$$

where the velocity is v, K is the Hubble constant (which isn't a "constant" because it changes with time—changed from 536 km/sec per megaparsec to 53 km/sec per megaparsec)[37] and r is the distance of the receding particle from the reference point.

Suppose several particles are observed in the fireball receding from the earth at high speed. Let particle *one* be at a distance of, say, 65 million miles and moving at 0.5 times the speed of light; particle *two* at 130 million miles and 1.0 times the speed of light; and particle *three* at 260 million miles be receding at 2.0 times the speed of light, etc.

Since the expansion is uniform, a particle at n x 130 million miles would recede at n x 1.0 times the speed of light. It makes no difference if $n = 3.145926536\ldots$, or if $n = 6.023 \times 10^{23}$! Something an infinite distance away would have to travel at infinite speed. This is something to think about, since Einstein's theory is incompatible with this kind of fireball.

In fact, all the matter beyond the point

$$r = c/K \tag{5}$$

would have to exceed the speed of light.[38] That is an infinite amount, since the fireball is infinite. (Only the finite amount of matter within this radius would be traveling at speeds less than that of light.) Einstein's theory rules this part of the big bang hypothesis out. Theoretically matter cannot exceed the speed of light in a vacuum. This means that an infinite fireball could not expand.

The big bang must involve a finite fireball, which has an actual center of expansion, and whose surface recedes from its center at less than the speed of light. Now that the necessity of a finite fireball is seen, it is possible to make a meaningful analysis based on the cosmogonists' figures for the "initial" state.

Big Bang and Conservation of Mass-Energy

In the calculations to follow, figures representing the initial conditions will be those from Jerry B. Marion.

According to Marion the source of pressure which caused the expansion of the fireball was furiously hot radiation.[39] Gamow certainly agreed with this, that radiation is very important to the big bang hypothesis. He stated:

> From the laws of classical physics, we can derive the fact that the density of radiation in an expanding volume will drop faster than the density of matter in the same volume. We then have to assume that *during the earlier stages of expansion the weight of the radiation in each volume of space exceeded that of the matter in the same volume.* During these epochs ordinary matter did not count, and the main role was played by intensely hot radiation.[40] (Emphasis in original.)

To this Gamow added the following note:

> If the edge of a cubical container is increased by a factor *a*, its volume will increase by a factor a^3, and the density of matter in it will decrease by the factor a^3. But the temperature of the radiant energy in the volume will decrease by the factor *a* (Wien law), so that its density drops by the factor a^4 (according to the Stefan-Boltzmann law).[41]

Interesting! To find the "weight" (ponderable mass) of the radiation in the fireball, one need only invoke Einstein's famous principle of equivalence of matter and energy:[42]

$$E = mc^2 \tag{6}$$

where E is energy in ergs, m is mass in grams, and c is the velocity of light in cm/sec. Divide the energy density of the radiation (erg/cm^3) by the square of the velocity of light to get the density or "weight" in grams per cubic centimeter.

Radiant energy having ponderable mass is no trivial matter. This fact alone ruins the big bang hypothesis, for Gamow's statements above clearly mean nothing less than absolute and total annihilation (and not mere conversion or transformation to something else) of huge quantities of mass-energy.

According to the first law of thermodynamics, in any natural process, mass-energy is conserved. It may change its form from matter to energy or vice versa, but it is neither created nor destroyed by the natural process. This is the law of the conservation of mass-energy. The big bang hypothesis runs counter to this law of conservation.

Calculation of Mass-Energy Loss in Big Bang

Using, as a specific example, the initial density and temperature specified by Marion, it is possible to compute how much mass-energy would have to vanish right out of existence according to the big bang hypothesis. Marion calls[43] for a density of matter of 10^{25} g/cm^3 and a temperature of radiation of 10^{16} °K. To compute the ponderable mass of the radiation in the fireball, the following assumption will be made: the radiation is isotropic blackbody radiation. The energy density, $u(T)$, of the radiation is:

$$u(T) = \frac{4\pi}{c} I(T) = \frac{8\pi^5 k^4}{15 c^3 h^3} T^4 = aT^4 \tag{7}$$

where $u(T)$ is the energy density in erg/cm^3, c is the speed of light, $I(T)$ is the specific intensity of the blackbody radiation,[44] k is the Boltzmann constant, h is the Planck constant, T is temperature Kelvin, a is the Stefan-Boltzmann radiation constant of 7.5634×10^{-15} erg/cm^3 deg.^{4} The energy density of 10^{16} °K radiation is 7.56×10^{49} erg/cm^3, which corresponds to a ponderable mass of 8.40×10^{28} g/cm^3. That is 4.2 tons of radiation for each pound of matter! (Figure 2)

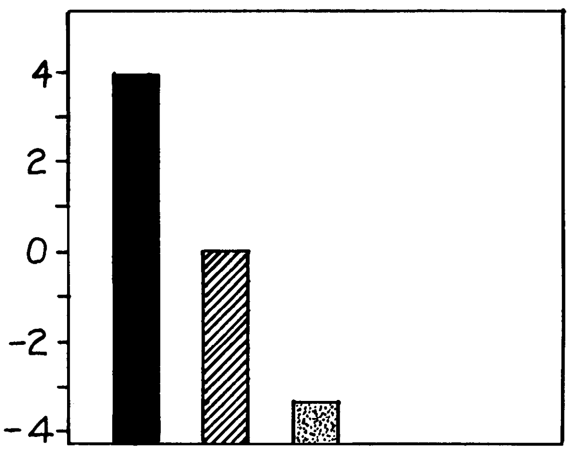

Figure 2. Ratio of the density of so-called fireball radiation to that of ordinary matter in the universe. (Plotted vertically as a logarithm). Left: as it once was (8,400:1); middle: at some intermediate stage (1:1); right: as it is now (0.000446:1). According to the big bang hypothesis there were once tons of radiation for each pound of matter. But the reduction in energy density compared with that of matter indicates that the big bang does not agree with the law of the conservation of mass-energy.

Now the question is, how much of this fireball radiation is there compared to the matter today in the universe? The average density of matter in the presently observable universe is estimated[45, 46] to be about 10^{-30} g/cm^3. This is about one hydrogen atom for each 1.67 cubic meters of space.

Much of the radiation in space now is starlight. But there is some microwave, blackbody, background radiation, which the big bang proponents are calling fossil fireball radiation (long sought but accidentally discovered).[47] This so-called fireball radiation is very nearly isotropic and has a temperature of a very cool 2.7° K, according to Marion,[48] which should embarrass supporters of the "hot big bang" because it is so cool.[49]

It should be noted that not all astronomers agree that this background radiation is a remnant of a primordial fireball. David Layzer and Ray Hively of Harvard University present an alternative to the "conventional interpretation" of the cosmic microwave background as fossil fireball radiation. They state:

> We postulate that the radiation was generated by ordinary astronomical processes (thermonuclear reactions in stars or gravitational collapse of objects of galactic mass) and subsequently thermalized by interaction with dust grains.[50]

As in the case of galactic red-shifts, so it is here; there is no monolithic bloc of opinion even among cosmogonists themselves—except perhaps that creationists are wrong.

By equation (7) the 2.7 °K blackbody radiation has an energy density of 4.02 x 10^{-13} erg/cm^3, which corresponds to 4.46 x 10^{-34} g/cm^3 of ponderable mass. Instead of 8400 pounds of radiation for each pound of matter, there is presently about 2200 pounds of matter for each pound of radiation.

Expressed as a ratio the change is apparent: from 8400 to 1 down to .000446 to 1! This is a reduction of almost 19 million times! That so much mass-energy could vanish without a trace is hard to accept.

It is therefore evident that the big bang hypothesis fails to agree with the law of the conservation of mass-energy. It fails to "fit" the "rules" Zimmerman has mentioned for cosmogonical speculation.

Big Bang and Gravitation

Could it be that all this radiant energy would be "lost" in overcoming the gravitational potential energy of the fireball? Could it be that this lost radiation was converted into kinetic energy in the far off fast fleeing galaxies (provided they are really receding)?

This is a possibility if and only if there was enough thermal and radiant energy in the fireball to cause expansion in the first place. The proposed high density and temperature would result in incredibly high pressure, but the gravitation of all the matter and energy in the universe would also be very great.

For example, the sun, even though a hot mass of plasma, does not violently explode because the gravity produced by its immense bulk keeps it in hydrostatic equilibrium. In this case of the sun, the thermal forces that would tend to cause it to expand are counterbalanced by the gravitational force that would tend to cause it to collapse.[51] However, *the primordial fireball would collapse rather than explode!*

A Model Fireball

Since it would be ill-advised to attempt to calculate forces in an infinite fireball, one would do well to use a finite model fireball. An infinite fireball is absolutely meaningless and is incompatible with the special theory of relativity.

Marion maintains that the fireball was a mass of furiously hot super-energetic protons, neutrons, electron-positron pairs, neutrinos, and photons.[52] This mass of nuclear gas was heated to 10^{16} °K, and had a density of 10^{25} g/cm^3 for the matter. It is assumed that the baryon composition is 50% protons and 50% neutrons.

If the big bang occurred 10 billion years ago, as Marion said it did, then one can assume that the Hubble radius (that distance from the earth, where the rate of recession of a galaxy in a uniformly expanding universe would be the speed of light) would not be more than 10 billion light years or 9.46 x 10^{27} cm. Assuming that the space of the universe is Euclidean (zero curvature), the volume of the present universe would be about 3.55 x 10^{84} cm^3.

Taking this volume and multiplying it by the mean density of matter (10^{-30} g/cm^3), one gets a mass of 3.55 x 10^{54} grams as the mass of the matter in the presently observed universe (about 1.8 x 10^{21} solar masses).

All of this matter, if squashed to a density of 10^{25} g/cm^3, would fill a volume of 3.55 x 10^{29} cm^3, resulting in the fireball having a radius of 4.39 x 10^9 cm. This model fireball is assumed to be uniformly dense throughout.[53]

Calculation of Outward Versus Inward Forces in Fireball

The concepts of outward and inward forces need to be defined. An outward force is one that tends to cause the fireball to expand. In this case the outward force comes from the thermal energy of the hot gas and the radiation. The pressure of the gas and radiation tends to cause expansion. If there were no gravitational force in the fireball, the expansion would be very rapid indeed! But the big bang hypothesis fails to take gravity into account.

An inward force is one that tends to collapse the fireball by squeezing it to greater densities. In this case the inward force is strictly gravitational. Every one of the particles of matter and photons of radiation in the fireball attract one another with a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them. This is the law of gravitation. In no case can the gravity of all the mass-energy in the universe be neglected.

To determine whether or not the fireball can expand, one need only to calculate the force outward produced by the hot gas and radiation and compare it to the force inward due to gravity.[54] In this case the comparison will be made at one point. Consider the fireball as made up of concentric layers or shells, each having a thickness of only one percent the total distance from edge to center, and take the point at the bottom of the outermost layer.

If the downward weight of all the matter and energy above this point is less than the upward force of the hot gas and radiation, then the outer layer will be accelerated upward at a rate proportional to the force remaining after the inward is subtracted from the outward, then by definition an expansion is indicated. But if the weight of the mass-energy in the outer shell exceeds the upward force then a collapse is indicated.

The amount of force that will accelerate this outer shell is equal to the difference between the inward and outward force,[55] and will carry the sign of the larger.[56] (Figure 3)

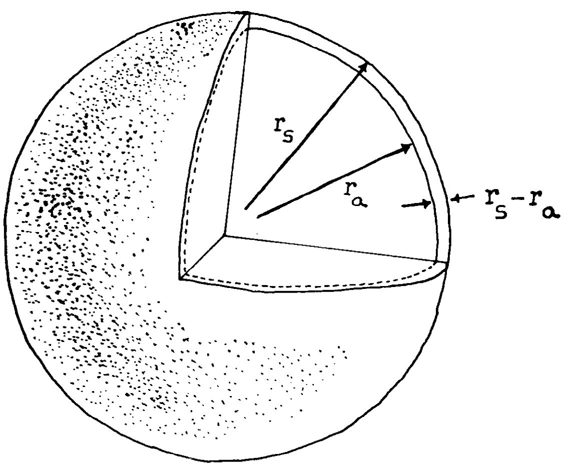

Figure 3. The inward pressure, P_{in}, is the weight of the mass-energy above the radius r_a, which is 99% of r_s. The difference, $r_s - r_a$, is 1% of r_s, and is the thickness of the outer layer which contains about 3% of the total mass-energy in the fireball. The force of gravity is so great that the outer pressure of hot gas and radiation cannot blow the outer shell off.

Outward Force

The outward force is caused by the pressure of hot gas and radiation, and has at least three components: degenerate electron gas pressure, baryon pressure (the pressure of an ideal gas of protons and neutrons), and the radiation pressure. The equations of state in this discussion are standard, and can be found in the astrophysics texts listed in the references.

The degenerate electron pressure is the consequent of the Pauli exclusion principle. S. Chandrasekhar was the first to derive a relativistically accurate equation for this.[57] His equation will be used here, because the extreme density of the model fireball would indicate that the electrons would be degenerate, and their pressure would be related to the 4/3 power of their density.[58]

$$P_e = \frac{hc}{8H}\left(\frac{3}{\pi h}\right)^{1/3}\left(\frac{\rho}{\mu_e}\right)^{4/3} \tag{8}$$

where P_e is the degenerate electron pressure in dyne/cm^2, h is the Planck constant, H is the mass of one proton, ρ is the density of matter, and $\mu_e = 2$ for a mixture of 50% $_1H^1$ and 50% neutrons. The electron pressure in Marion's fireball is 1.052 x 10^{48} dynes/cm^2.

The ideal gas law will be used to approximate the pressure of the heavy particles of the fireball (baryons). As it relates pressure to temperature it is[59]

$$P_b = NkT \tag{9}$$

where P_b is the baryon pressure in dyne/cm^2, N is the number of baryons per cubic centimeter, k is the Boltzmann constant, and T is temperature Kelvin. In terms of density the above is

$$P_b = \frac{1}{\mu_b}\,\frac{\rho kT}{H} \tag{10}$$

where μ_b is the "mean molecular weight" of the baryons ($\mu_b = 1$), and H is the mass of a proton. The baryon pressure is 8.257 x 10^{48} dynes/cm^2.

Finally there is the radiation pressure. According to the Stefan-Boltzmann law the energy density is related to the fourth power of the temperature. As a result of this the pressure is[60]

$$P_R = \frac{1}{3} a T^4 \tag{11}$$

where P_R is the radiation pressure in dyne/cm^2, and a is the Stefan-Boltzmann radiation constant of 7.5634 x 10^{-15} erg-/cm^3 deg^4. The radiation pressure is 2.521 x 10^{49} dyne/cm^2. Radiation acts like an ideal gas having one degree freedom of movement. It could be considered a photon "gas."

The total pressure produced by the hot gas and radiation is the sum of the individual components:

$$P_{out} = P_e + P_b + P_R \tag{12}$$

The total outward pressure is 3.452×10^{49} dyne/cm^2, which, if gravity could be ignored, would be capable of blowing off the outer layer with an initial acceleration of 8.04×10^{12} cm/sec^2! The velocity of the expansion would become infinitesimally close to the speed of light within a matter of seconds, but gravity cannot be ignored.

Inward Force

The question now is, outward pressure against what? The outward pressure or force in this calculation is exerted against a thin outer layer or shell of matter and energy having a thickness of one percent the total distance from edge to center, and about three percent of the total mass. This is a fair proposition. If the outward force is not sufficient to exceed the weight of this thin outer shell, then it is ridiculous to retain the big bang even as a tenable hypothesis of how the universe got here.

To more easily compute the force of gravity on the fireball, it is necessary to make one simplifying assumption, which George Gamow has already granted, that is that the fireball had a uniform density.[61] Now it is necessary to apply the equation of hydrostatic equilibrium and to invoke the principle of equivalence of matter and energy. The hydrostatic equilibrium equation:[62]

$$\frac{dP}{dr} = -\frac{GM'(r)}{r^2}\rho' \qquad (13)$$

since uniform density and temperature are assumed,

$$\frac{dP}{dr} = -\frac{4\pi G\rho'^2 r^3}{3\,r^2} \qquad (14)$$

$$= -\frac{4\pi}{3}G\rho'^2 r \qquad (15)$$

In differential form (note that M(r) is the mass inside radius r)

$$dP = -\frac{4\pi}{3}G\rho'^2 r\,dr \qquad (16)$$

which integrating from the surface, r_s, to some interior radius, r_a, yields

$$\int dP = \int_{r_a}^{r_s}\left(-\frac{4\pi}{3}\right)G\rho'^2 r\,dr \qquad (17)$$

$$P_{in} = -\frac{2\pi}{3}G\rho'^2(r_s^2 - r_a^2) \qquad (18)$$

if the special case of $r_a = O$ (i.e. the center) the central pressure is the reduced form

$$P_c = -\frac{2\pi}{3}G\rho'^2 r_s^2 \qquad (19)$$

But if r_a is the distance from the bottom of the outermost layer, then

$$P_{in} = -\frac{2\pi}{3}G\rho'^2(r_s^2 - r_a^2) \qquad (20)$$

but since in this case $r_a = 0.99r_s$, then $r_a^2 = 0.9801r_s^2$, and $(1 - .9801) = 0.0199$, which further reduces the shell pressure equation to

$$P_{in} = -\frac{0.0398\pi}{3}G\rho'^2 r_s^2 \qquad (21)$$

where G is the universal gravitational constant, ρ' is the density of the mass-energy of the fireball in g/cm^3, and r_s is the radius of the fireball from edge to center (4.39×10^9 cm).

According to Einstein's famous principle of equivalence of matter and energy, 9×10^{20} ergs of energy will exert as much gravity as one gram of matter. The tremendous quantities of thermal and radiant energy, even though a source of tremendous outward force, are also the source of great gravitation.

According to this principle, *every form of energy produces a gravitational field.*[63] This is not only true of the particles themselves, but also of diffuse energy fields and photons.[64] In fact radiation possesses some very particlelike properties:

(a) it exerts pressure like a gas made of fast lightweight particles (a photon "gas");[65]

(b) it has momentum (or else it could not exert pressure);[66]

(c) it loses energy when traveling upward out of a gravitational field (Einstein effect[67] demonstrated with the help of the Mossbauer effect[68]—photons, instead of slowing down, lose energy by means of a gravitational red-shift.[69]);

(d) and, it can be deflected by a gravitational field[70] (the bending of starlight passing near the sun has been observed during total eclipse).

This is bad news for big bang proponents. By invoking this equivalence principle, it is possible to see what contribution the ponderable mass of thermal and radiant energy make on the gravitational field.[71] The ponderable density, ρ', is the sum of the density of the matter and the density of thermal and radiant energies divided by the square of the speed of light:

$$\rho' = \left[\rho + \frac{3\rho kT}{2\mu_b Hc^2} + \frac{a}{c^2}T^4\right] \qquad (22)$$

where the thermal energy density of the baryon gas is[72]

$$u_b(T) = \frac{3\rho kT}{2\mu_b H} \qquad (22')$$

and the radiant energy density is[73]

$$u_R(T) = aT^4 \qquad (22'')$$

This then makes the equation of central pressure to be

$$P_c = -\frac{2\pi}{3} G\left(\rho + \frac{3\rho kT}{2\mu_b Hc^2} + \frac{a}{c^2}T^4\right)^2 r_s^2 \qquad (23)$$

and the inward shell pressure to be

$$P_{in} = -\frac{0.0398\pi}{3} G\, r_s^2 \left(\rho + \frac{3\rho kT}{2\mu_b Hc^2} + \frac{a}{c^2}T^4\right)^2 \qquad (24)$$

For Marion's fireball this results in a central pressure of 2.574×10^{70} dyne/cm^2 and an inward shell pressure of 1.024×10^{69} dynes/cm^2. This shell pressure is the weight of the mass-energy above each square centimeter of the shell radius. This is the downward force crushing the fireball. It is clear that there is not enough thermal and radiant energy in the fireball to make a pressure that can overcome this titanic crush of the gravitational field of the fireball. The inward pressure is 2.97×10^{19} times greater than the outward pressure. A gravitational collapse is indicated.

Limiting Mass for Hot Condensed Objects

It is interesting to note that the gravitational force would be sensitive to temperature changes in the fireball. It remains approximately constant until the temperature increase raises the density of the thermal and radiant energy to near that of matter. Then as the density of the energy equals, and then exceeds that of the ordinary matter, the gravitational force starts to increase proportionally to the square of the increasing energy density. See Figures 4, 5, and 6 for this relationship.

The author of this article has performed sufficient calculations to plot the curves on the graphs representing the ratio of inward force divided by the outward force for three different densities and several radii of various model fireballs.

There is a definite relationship to radius, density, and temperature in the fireball models. The smaller radii all favor expansions. The larger radii all favor collapse.

Also there is an optimum temperature favoring expansion. Any further increase of temperature beyond this point also increases the gravitational field on account of the increase in the density of the energy. Therefore, a critical or limiting mass for *hot* condensed objects exists!

Any mass greater than this limiting mass (which depends only on density and radius) cannot expand or even remain in hydrostatic equilibrium, but instead is doomed to gravitationally collapse no matter how hot it may be! The existence of such a limiting mass for *hot* condensed objects would definitely rule out the big bang hypothesis as being valid. This should not seem too hard to believe, since Chandrasekhar,[74] Wheeler,[75] and others already have proposed the existence of limiting masses for such *cold* condensed objects as white dwarf stars and neutron stars.

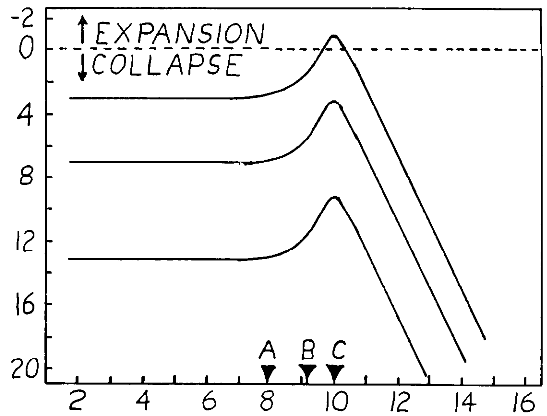

Figure 4. Logarithm of the ratio of inward force to outward force in three model fireballs having a matter density of 10^5 g/cm^3 vs. logarithm of the temperature. The three curves, from top to bottom, are for initial radii of 2.039×10^{11}, 2.039×10^{13}, and 2.039×10^{16} cm; and initial masses of 3.55×10^{39}, 3.55×10^{45}, and 3.55×10^{54} g. respectively. This takes into account matter only. (A) At 8.15×10^7 °K, the baryon pressure exceeds the degenerate electron pressure. (B) At 1.49×10^9 °K, the radiation pressure exceeds the baryon pressure. (C) At 1.04×10^{10} °K, the density of the radiation exceeds that of matter. The curve plunges rapidly due to the gravitational force of the energy content of the fireball, which is proportional to the square of its density.

I am proposing the existence of a limiting mass for *hot* condensed objects. Because of this it is useless for big bang proponents to invoke temperatures in the magnitude of thousands or even millions of times hotter than the 10^{16} °K proposed by Marion. The increased temperature can only serve to dig a deeper grave under a greater gravitational field for the big bang hypothesis. The big bang should be discarded; a gravitational collapse is the only "fate" of the supposed primordial fireball.

Escape from Gravity?

It is highly unlikely that any of the particles of the gas in the fireball will have sufficient kinetic energy to escape. How much energy would a particle (say a hydrogen atom) need to escape? Thermal energy of *one* particle, a hydrogen atom, is[76]

$$E_k = \frac{3kT}{2} \qquad (25)$$

This is the kinetic energy of a particle expressed as a function of its absolute temperature.

The potential energy of the gravitational field is the amount of energy the particle must over-

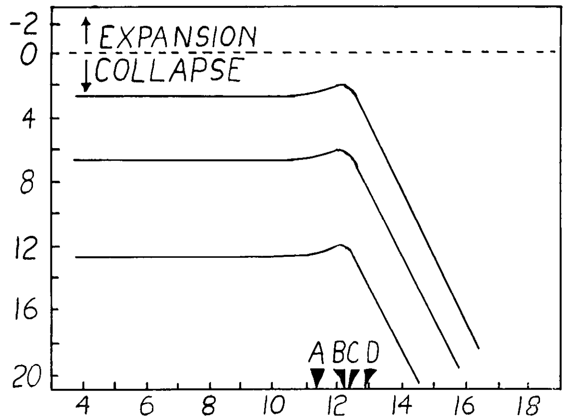

Figure 5. The same as Figure 4, but here the matter density is 10^{14} g/cm^3. This is the density specified by George Gamow. (A) At 2.75 x 10^{11} °K, the baryon pressure exceeds the degenerate electron pressure. (B) At 1.49 x 10^{12} °K, the radiation pressure exceeds the baryon pressure. (C) At 1.86 x 10^{12} °K, the density of the radiation exceeds that of matter. (D) At 7.27 x 10^{12} °K, the density of the thermal energy of the baryons exceeds the density of the matter itself. The masses indicated by the three curves are the same as in Figure 4; the initial radii, from top to bottom, are 2.039 x 10^8 cm, 2.039 x 10^{10} cm, and 2.039 x 10^{13} cm respectively.

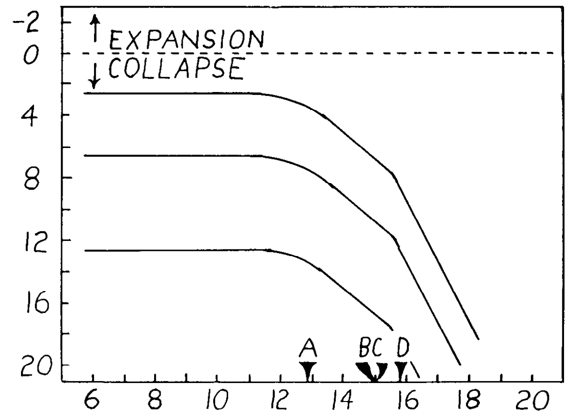

Figure 6. The same as Figure 4, but here the matter density is 10^{25} g/cm^3. This is the density specified by Jerry B. Marion. The masses indicated by the three curves are the same as in Figure 4; the initial radii, from top to bottom, are 4.39 x 10^4 cm, 4.39 x 10^6 cm, and 4.39 x 10^9 cm respectively. (A) At 7.27 x 10^{12} °K, the density of the thermal energy of the baryons exceeds that of matter. (B) At 1.04 x 10^{15} °K, the density of the radiation exceeds that of matter. (C) At 1.27 x 10^{15} °K, the baryon pressure exceeds the degenerate electron pressure. (D) At 6.89 x 10^{15} °K, the radiation pressure exceeds the baryon pressure. This model has no optimum temperature favoring expansion unless one considers near absolute zero an optimum temperature! The inward force increases proportionately to the square of the increase in the energy density.

come if it is to escape. It is the amount of "work" that is done in moving a particle from a point on the surface of the fireball to a point infinitely far away. In this case the potential energy to be overcome is[77]

$$E_p = -\frac{GMm}{r_s} \tag{26}$$

where M is the mass of the fireball, m is the mass of the particle trying to escape, and r_s is the radius of the fireball from center to edge.

By using these two equations as an approximation, one should get a pretty good idea whether or not an average particle can escape. From equation (25) the kinetic energy of an average proton or neutron in a 10^{16} °K fireball is 2.07 ergs (which corresponds to a relativistic mass increase of 1.38 x 10^3 times). This is about 1.29 x 10^3 GeV of energy.

From equation (26) the energy needed for a proton or neutron to escape the fireball is 9.01 x 10^{13} ergs or about 5.6 x 10^{16} GeV. This is assuming a cold fireball where there is no thermal or radiant energy to increase the gravitational field whatever. That's something to think about—a 10^{16} °K hot particle cannot escape from a 0 °K fireball.

Even when all the ponderable mass of the energy is completely neglected, the energy needed to escape is 4.35 x 10^{13} times greater than what is available to a particle at that temperature. And if the ponderable mass of energy is included in the calculation, then obviously this difference will be even far greater. Considered from the standpoint of shell pressure and energy of escape, the conclusion seems inescapable: the primordial fireball must collapse rather than explode.

Big Bang or Big Black Hole?

But what about the radiation? Could it escape and thus reduce the ponderable mass of the fireball to the point where the ordinary matter can escape? This also appears unlikely.

The gravitational field around the primordial fireball would be so intense that not even light quanta (photons) could escape. This state of affairs is known as a *black hole*.[78] This is the logical consequent of the Einstein effect, otherwise known as the gravitational red-shift phenomenon.

The idea is essentially quite simple: since photons have zero "rest" mass, they can travel only at the speed of light. But because photons do possess energy (and hence ponderable mass), they can be acted on by a gravitational field. So instead of slowing down as a particle of matter would, a photon moving upward against a gravitational potential energy gradient will lose energy by means of a red-shift. This has been verified by the work of Rebka and Pound.[79, 80]

It is not necessary to resort to the sophistication of the general theory of relativity to illustrate this. This idea can be checked out quite well by ordinary Newtonian gravitational theory and quantum theory.

According to quantum theory, the energy of a light quantum (a photon) is a function of its frequency.[81]

$$E_q = h\nu \tag{27}$$

where E_q is the energy of a quantum in ergs, h is the Planck constant, and v is the frequency. According to the principle of the equivalence of matter and energy, the photon has a definite ponderable mass:[82]

$$m_q = \frac{E_q}{c^2} = \frac{h\nu}{c^2} \tag{28}$$

where m_q is the mass of a photon in grams. Inertial mass is equivalent to gravitational mass according to the general theory of relativity.[83] So gravity can act upon a quantum of light entering or leaving a gravitational field.

How much "work" must a quantum of light do in overcoming the potential energy of a gravitational field? If a light quantum moves a very small distance dr, against gravity of intensity $GM(r)/r^2$, it does work of amount $(hv/c^2)(GM(r)/r^2)$, its energy decreases by that amount, and thus its frequency decreases by an amount dv, given by

$$h\,d\nu = -\frac{GM(r)\,h\nu}{r^2c^2}\,dr \tag{29}$$

This is a differential equation for v and r. It can be solved in one of the standard ways: by separating the variables and integrating each side. The result comes out in terms of the natural logarithms to base $e = 2.718\ldots$. The result perhaps looks better when put into terms of exponents of e, then the result is:

$$\nu = \nu_s e^{\frac{GM(r)}{c^2}\left(\frac{1}{r}-\frac{1}{r_s}\right)} \tag{30}$$

Here v_s corresponds to the distance r_s from the center; at any greater r the formula gives some v less than v_s. In other words, there is a red-shift.

The exponential form of equation (30) reminds one somewhat of the formula for the decay of a radioactive isotope. That decay, it will be recalled, is characterized by a half-life, the time in which the amount of isotope is reduced to half of what there was at the beginning.

By analogy, it may be of interest to introduce (and "introduce" is right, for as far as is known the notion has not been used before) the notion of a "half-distance." At a half-distance, measured from the center, the frequency would be shifted to half of v_s. By putting $v = v_s/2$ into equation (30), going back to logarithms, and doing some rearranging, it is seen that:

$$r_{1/2} = \frac{r_s GM(r)}{GM(r) - 0.69\,r_s c^2} \tag{31}$$

Here the half-distance is indicated by $r_{1/2}$.

In dealing with radioactive material it may be said, as a practical matter, that after 10 or 20 half-lives there is no activity left. Just so here, at a distance of some half-distances, there would, for practical purposes, be no radiation escaping.

The treatment above has been Newtonian and semi-classical. A more general treatment would give a sharper cut-off of radiation at some distance. So the more general treatment would make the present case even stronger; but it is much too long to be given here. Also, the more general treatment would have the effect of replacing the factor 0.69 . . . by 1. That does not matter much; for most purposes it will be enough to consider orders of magnitude.

It will be noted that equation (31) shows that, according to the treatment used, there would be a finite half-distance provided.

$$GM(r) > 0.69\,r_s c^2 \tag{32}$$

It will be convenient, for the remainder of the discussion, to use the results of the more general treatment; viz.: an actual cut-off at what was the half-distance, and 0.69 . . . replaced by 1. At the distance R_h corresponding to the half-distance in the semi-classical treatment, there will be what is called an absolute event horizon.

At the horizon, radiation will be shifted down to zero frequency, i.e., extinguished. Such a horizon exists if r_s is less than $GM(r)/c^2$; and an observer far outside the horizon would see nothing from within the radius r_s; no light from within it would reach him. This is the basic notion of a black hole: a system with gravitation so intense that light cannot escape.

For the model fireball based on Marion's temperature and density (ignoring the gravitational effect of the thermal and radiant energy) the radius of the absolute event horizon, R_h, would be 2.63×10^{26} cm, or 2.78×10^{8} light years (assuming Euclidian space, of course). This is a big black hole!

So far it has been shown that there is an absolute event horizon at some very great distance. Could there be a horizon at some more modest distance r_x? From equation (30), it is plain that there can be. If $(GM(r)/c^2)\ (1/r_s - 1/r_x)$ is greater than one, there would be a shift to zero frequency and hence a horizon; otherwise, no.

Suppose a light source were somehow placed in a fixed position at a distance of, say, 10^{25} cm from the center of the fireball (which is 3.8% of R_h). None of the light from that source would go beyond a distance of 1.040×10^{25} cm from the center. If there were an observer at 1.040×10^{25} cm, the event horizon for him would be 3.95×10^{23} cm away.

The distance to the event horizon is relative to the position of the observer, if the event horizon exists. The closer one gets to the fireball the less will be the distance between him and the event horizon. It would seem as though the event horizon were fleeing from before him as he gets closer, but that he is steadily approaching it.

But if he had left a friend behind further out in space, that friend might be shocked to see his buddy disappear into the never-never-land of another event horizon which would exist for the one who stayed behind. He would watch as his friend's signals got redder and redder, fainter and fainter, and then finally no signals at all. Light can go into a black hole, but it can never get out.

The author attempted to resolve the integral equation for the r_s to be the surface of the fireball, and the r_x to be the event horizon which is closest possible to the surface. This event horizon is so close to the surface that it could not be resolved with a calculator. The light can only travel a *very small* distance from the surface before it is infinitely red-shifted.

To find this distance one can go back to the differential form of the equation (29). Even if one neglects the change of gravitational force as it decreases with increasing distance, since the distance must be very small, this difference can be ignored and the field considered as being uniform.

When $\frac{GM(r)}{r^2c^2}$ dr is greater than one, then red-shift to zero frequency, i.e., extinction, is indicated. If one takes 3.55×10^{54} grams (exactly) as mass of the fireball, and 4.39×10^{9} cm (exactly) as radius of the fireball, then the distance light can travel before it is red-shifted to zero is only about 7.33×10^{-8} cm! Any observer further away than this would not be able to see the surface of the fireball. That gravity is so strong that light cannot even travel as far away as the thickness of the page you are reading. It cannot escape.

The primordial fireball, instead of exploding, would be a black hole from which neither matter nor energy could escape. There is no doubt in my mind that the big bang hypothesis is not valid. The law of gravity rules it out. The big bang is a modern myth.

Deflation of the Big Bang Hypothesis

It has been argued, so far, that the big bang hypothesis conflicts with Einstein's special theory of relativity, is counter to the law of the conservation of matter and energy, and disagrees with the law of gravity.

Calculations have been submitted to demonstrate that the inward force due to gravity is so far greater than the outward force due to the thermal and radiant energy of the fireball, that no expansion is possible, and that none of the particles of the gas nor any of the photons of the radiation can escape.

The proposed models cannot expand, it has been suggested, because they are larger than a limiting mass for *hot* condensed objects. Instead of a violent big bang, there would be a catastrophic collapse as the immense gravitational field of the fireball would crush it to a "cosmic pulp."

My opinion is that the collapse would be irreversible by any known natural process. As the fireball collapsed, potential energy from the gravitational field would be converted to heat via the Kelvin-Helmholz process. This thermal energy would have ponderable mass also, which in turn would put an even tighter squeeze on the fireball.

This is a sort of regenerative effect, whereby gravitational potential energy would be converted into gravitating mass-energy by means of homologous contractions. The increasing heat and radiant energy would be unable to halt the collapse because of the limiting mass consideration. It would seem that the collapse might proceed to infinite density—a *singular state*.[84]

It should be noted, that in this discussion, the gas and radiation pressures were considered isotropic—i.e. equal in intensity in all directons. In a real situation this simply would not be so. Both the gas and radiation pressures would be strongly affected by the presence of the intense gravitational field. Outward bound particles would exert less pressure due to the tremendous deceleration of gravity. The photons undergoing red-shift would also exert less pressure.

Particles and photons headed inward would exert greater pressure due to traveling in the preferred direction of the gravitational field. This anisotropic gas and radiation pressure makes for a situation less favorable for the big bang than the calculations actually show.

Could the collapse reverse itself and become an expansion? No definite answer is available. I do not think it would.

On the basis of what is known about gravitation, it would seem that, as the radius of the collapsing fireball became closer and closer to zero, the ratio of the inward force divided by the outward force would increase beyond all bound. Even though at zero radius the outward pressure of a gas at infinite density and infinite temperature would be infinite, the inward force would be infinite also, but still greater.

It's like the limit of x^2/x as x approaches infinity. The limit has an infinite value, even though it's one kind of infinity divided by another kind. Go back to equation (21); in a collapsing fireball every time the radius decreases by a factor a the density increases by a factor a^3.

It just doesn't look as if the collapse could reverse itself. The laws of nature don't seem to work that way.[85] All big bang proponents can do now is invoke "black magic" to get their hypothesis out of the black hole it's in.

Any further discussion of gravitational collapse can lead only to such esoteric contrivances as tensors, curved space-time, and zero world lines; constructs which form a part of the general theory of relativity—and that is far beyond the scope of this article.

Concerning the problem of collapse one should consult men who have done their major work in that field. Peter Bergmann says that a collapse to a singularity would take an infinite amount of time because of "relativistic time dependence."[86] This eliminates problems of infinite densities by saying it would take forever for a collapsing fireball to hit the bottom. As the gravitation around the collapsing object gets more intense, time would dilate asymptotically beyond all bounds.

Roger Penrose says that such a collapsing object would bend space around it, and that once the curvature of space becomes infinite, the object would be sealed forever in a burial urn of a Riemannian space—closed off from the rest of the universe.[87]

Cosmogonical thinking is a lot of "good clean fun," but to win one must play by the "rules." Proponents of the big bang hypothesis have failed to do so. Their position is meaningless irrationality. Creationism is still a viable alternative to this empty speculation.

Acknowledgements

I am sincerely thankful to Mr. George Mulfinger and to Dr. Emmett Williams of the Bob Jones University department of physics. Their kindness in critically evaluating and reviewing the manuscript has been most helpful. Their encouragement has been very much appreciated. My thanks also to Editor Harold Armstrong for suggesting the concept of "half-distance."

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