A New Alternative to the Big Bang Theory

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A new alternative to the "Big Bang" theory is proposed based upon the exponential decay of photons as they travel through space. The energy lost by the photons is converted into neutrinos having very small masses which eventually are attracted to galactic centers where they are "recycled" into electrons and protons. This alternative, coupled with the concept of an infinite hierarchical universe, overcomes the objections of Olbers and Seeliger to an infinite universe, as well as accounting for the frequency independent cosmic redshift, the "dark matter" which has puzzled astronomers for many years, the abundances of the elements, and the cosmic background radiation. It also provides a model by which radiant energy is recycled back into particles whose energy (mc^2) corresponds to the energy lost by the photons.

Introduction

The association of the shift of spectral lines to the red end of the spectrum in light from distant galaxies was first discovered by Vesto Melvin Slipher at Lowell Observatory in Flagstaff, Arizona. His work commenced about 1910 and was summarized in 1922. From the very first, the redshift was assumed by most astronomers to be a Doppler effect caused by mutual recession of the galaxies, and in 1929 Edwin Hubble announced his finding of a "roughly linear relation between velocities and distances." (Hubble 1929; Weinberg 1972, p. 417). However, in the same year, and in the same volume of the *Proceedings of the National Academy of Sciences of the United States*, Fritz Zwicky published an article in which he proposed that the cause of the redshift might be "a sort of gravitational analog to the Compton effect," (Zwicky 1929). Nevertheless, the vast majority of astronomers have concluded that the redshift is a Doppler effect or some similar effect due to expansion of the universe. Where there are multiple causes that may produce the same effect, it is logically fallacious, upon observing the effect, to conclude without further evidence that it resulted from just one of the several possible causes. Yet that is exactly what happened in the case of the cosmic redshifts, although there is no physical principle that might require all the matter in the universe to be expanding. Indeed, the idea of an expanding universe contradicts the principle of universal gravitation, which would tend to pull material bodies together.

The Big Bang Theory

No attempt will be made here to describe the so-called "Big Bang" theory, except to say that it is based on the supposition that the universe is expanding, and that the universe is homogeneous and isotropic, which means that all observers anywhere in it will observe the same expansion in all directions. This requires that speeds of recession be proportional to the distances of the receding galaxies, as originally proposed by Hubble. The greater the distance, the greater the speed of recession. An excellent recent history of the expanding universe theory by Edward Harrison appears in the *Quarterly Journal of the Royal Astronomical Society*, (1992), Vol. 33, pp. 335-349, (Harrison 1992).

This model of the universe has all the earmarks of a creation theory. Nevertheless, a large number of astronomers and other scientists believe in it "because it is supported by the evidence," the evidence being that we do observe redshifts indicating that speeds of recession are roughly proportional to distance in accordance with Hubble's hypothesis, that the abundances of elements found in the universe are what we would expect out of a titanic explosion some 10 to 20 billion years ago, and the cosmic background radiation does support the view that this radiation is the "leftover" from the Big Bang. But the same "evidence" supports the model described in this article, as will be shown later.

On the other hand, there are many things wrong with the Big Bang theory. There is no physical principle that calls for expansion of very dense material. A neutron star, for example, once created, stays put. And if the universe evolved in the manner called for by the theory we should see various stages of that evolution as we look back in time, but this is not the case. The most remote galaxies look much like those nearby. But the most compelling evidence against it might be the age of the oldest stars in our own galaxy (14 to 19 billion years) which exceeds the approximately 10 billion year "Hubble Age" based on a Hubble constant of about 100 kms/sec per megaparsec. Obviously, if the oldest stars in our galaxy are older than the age of the universe predicted by the Big Bang theory, then there is something seriously wrong with the theory. There is no consensus on this point, however, for the value of the Hubble constant is much in dispute. Finally, the Big Bang theory seems to violate the conservation of energy principle, for it calls for all galaxies to recede from each other at an accelerated pace. A mass multiplied by an acceleration is a force, and a force applied over a distance has the dimensions of an energy. Thus the acceleration of masses away from each other in the universe requires a continuing input of energy, and there is no apparent source of such energy. It apparently comes from nothing and therefore violates the conservation of energy principle. Furthermore, the theory is constantly changing, with some of its leading adherents disagreeing with each other. As Jean-Claude Pecker of the Collège de France in Paris put it: "So the simple model has moved progressively into a very complicated one, as one *ad hoc* assumption after another was added; and despite an already quite sophisticated construction, many questions remain unanswered. Occam is left to cry in his grave over the need for 'too many epicycles'," (Pecker 1988.)

The Hubble Constant

One feature of the Big Bang theory should be discussed in some detail, however, for it is relevant to any other theory that might be proposed. This is the Hubble Constant, H_o. It is the speed of recession per unit distance. According to the Big Bang theory, if we know the speed of recession, we may divide that speed by the Hubble Constant, and we obtain the distance of the galaxy in question. The value of the Hubble Constant is much in dispute at the present time, however, with estimates ranging from less than 50 kms/sec per megaparsec to about 100 kms/sec/mpc. The reciprocal of the Hubble Constant, $(H_o)^{-1}$ is the "Hubble Age," or the time since the Big Bang occurred. It is important, therefore, in the Big Bang theory, to know the value of this constant. But it is also important for other theories that its value be known, for the value of the redshift for the first unit of distance is equivalent to the energy lost by a photon in traveling that distance, and being a measured amount, it should be virtually identical for all theories. The loss of energy in photons in different theories varies only when the distances become large. Here we will use a figure of 30 kms /sec per million light years, which is equivalent to 97.8 kms/sec per megaparsec. This means that light from a galaxy one million light years distant will have a redshift of 10^{-4}, that is, the wavelength will have increased over that distance by one part in ten thousand. Such a value is in line with the values found by Marc Aaronson, Jeremy Mould and John Huchra (95 km/s/mpc ±5%.) On the other hand, Sandage and Tammann have found a value of 50 kms/s/mpc, or less. A value of 30 km/sec/10^6 ly leads to a Hubble age of exactly 10 billion years from the "beginning". In that case, the age of the oldest stars in our galaxy (14–18 billion years) reduces the Big Bang theory to absurdity instantly (see Zeilik 1982).

A Rival Theory

The evidence referred to above which is claimed to support the Big Bang theory is equally well explained under another theory, namely, by the hypothesis of an exponential decay of the energy of photons as they move through space for long periods of time. The energy of a photon is given by $h\nu$, where h is Planck's constant, and ν is the frequency (the number of cycles per unit time.) In the CGS system $h = 6.626 \times 10^{-27}$ erg second and unit time is one second. The number of cycles per second, ν, is a variable. Now if the energy of a photon is the product of ν cycles per second multiplied by Planck's constant, then the energy of one cycle is the energy of the photon divided by ν cycles, or 6.626×10^{-27} erg in all cases. And the mass of a photon is h/c^2 multiplied by the number of cycles per second. Therefore, the mass of one cycle is h/c^2 gram, or 7.36×10^{-48} gram in all cases regardless of frequency. Thus if a photon has a frequency of 10^{15} cycles per second, corresponding to a wavelength of 3,000 Angstrom units, its mass will be 7.36×10^{-33} gram. Now if the photon loses 1/10,000 of its mass per million light years, corresponding to $H_o = 30$ km/s/10^6 ly, then each cycle will lose one ten thousandth of its mass over the same period or 7.36×10^{-52} gram per million years. There are 3.1558×10^{13} seconds per million years, so that if a photon had a frequency of one cycle per second it would lose 2.33×10^{-65} gram per cycle.

A photon is a kind of harmonic oscillator, and all harmonic oscillators lose energy exponentially. Pendulums, vibrating strings, and tuning forks, for example, lose energy exponentially. And it should be clear that the energy loss occurs largely during two parts of the cycle, namely, on the two occasions when the curve crosses the equilibrium position. These are the positions where the oscillator (the pendulum, for example) has the greatest kinetic energy, and hence the loss, being a fraction of that energy, is greatest in the vicinity of those two portions of the cycle. Therefore, by analogy, if a photon loses energy, the loss should occur in the same two sections of the cycle. But unlike the pendulum, the photon does not lose energy by friction. If it loses energy at all, it must do so by casting off very small "neutrinos" having a mass corresponding to the energy loss. As stated in the preceding paragraph, the energy loss per cycle based on a fractional loss of 10^{-4} per million light years is equivalent to 2.33×10^{-65} gram per cycle which will be lost in the form of two neutrinos per cycle. These will be "Majorana" type neutrinos, having a rest mass of 1.165×10^{-65} gram each.

It would require 7.8×10^{37} such particles to equal the mass of one electron, the mass of the electron being 9.11×10^{-28} gram. This means that the particles cast off are fantastically small, and, being electrically neutral, they would be extremely difficult to detect. The enormous amount of these neutrinos cast off by all the radiant energy permeating the universe might constitute the "dark matter" or "missing mass" which has puzzled astronomers in recent years. Being massive particles they ultimately are drawn by gravity to the central stars ("superstars") that exist in all galaxies where they are converted back into electrons and protons by a process the details of which are presently unknown, although it is known that large quantities of electrons and protons are emitted from the central stars in jets that propel them into outer space. In this manner, the problem of recycling radiant energy back into material particles is solved.

It should be pointed out here that the reduction of energy (or mass) in a photon is exponential. If the energy of a photon is reduced after one million years to a value of $(1 - 10^{-4})\, h\nu$, then after y million years it will be reduced to $(1 - 10^{-4})^y\, h\nu$. And the loss of energy per photon is proportional to the energy of the photon. Thus a photon with a frequency of one cycle per second loses, for the reasons set forth above, 2 neutrinos per second, while a photon with a frequency of ν cycles per second loses 2ν neutrinos per second, which coincides with observation.

The fractional loss of energy in a photon is equivalent to the fractional increase in wavelength which is called the redshift (z). Given the measured value of the redshift, z, we may calculate the distance of the source of the light from us based on a loss of energy of 10^{-4} per million light years by the following formula:

$$\text{Distance} = 2.3027 \log (1 + z) \times 10^{10} \text{ light years}$$

When $z = 1$, the photon's wavelength has doubled and it has lost half its energy. Putting this into the above formula gives us a distance of 6.9318 billion light years in which the photon has lost half its energy. Thus we may say that a photon, regardless of its original wavelength, has a half life of 6.9318 billion years. And in that time half its energy, and therefore half its mass, will be converted into neutrinos, each having a rest mass of 1.165×10^{-65} gram and each having a rest energy of 1.05×10^{-44} erg.

Let us emphasize here the term rest energy. The neutrinos cast off by the photon will have zero speed, for if they did have a speed greater than zero their total energy (rest energy + kinetic energy) would exceed the energy lost by the photon, which is impossible if the conservation of energy principle is valid.

Critics of the process described here may say that conservation of momentum is violated. But conservation of momentum does not apply to the case of a photon whose energy is converted to rest energy. The principle involved is the same as that at work in "pair production" where the energy of a gamma photon (1.022 MeV) is transformed by the strong electric field in the vicinity of an atomic nucleus to a positron and an electron at rest, each of which has a rest energy of 0.511 MeV (see Atkins 1966, pp. 648-649.) Momentum is an attribute of kinetic energy. As long as the energy continues in the form of kinetic energy, which is the energy of motion, then the momentum that accompanies it will also continue. But when the kinetic energy of the photon is converted to rest energy ($E = mc^2$), the corresponding linear momentum becomes "rest momentum." But "rest momentum" is no momentum at all. Momentum ceases. Thus the principle of conservation of momentum is subject to the condition that the kinetic energy of the particle with which it is associated is not converted to rest energy.

In the case of pair formation, the entire energy of the gamma photon is converted to the rest energies of the two particles. If, in addition, the gamma photon imparted momentum either to the particles formed or to any other particle or particles, the resulting motion necessarily involves kinetic energy, howsoever small, and the principle of conservation of energy would be violated. Nevertheless, some writers suggest that the original momentum of the 1.022 MeV gamma photon is transferred to another particle and is therefore conserved. A. P. French, for example, says: "Thus it may be roughly true to say that all the energy of the photon goes into the electron and positron and that the nucleus takes care of the momentum balance." On its face, this constitutes an acknowledgment that conservation of energy must be violated if any momentum whatever is transferred (see French 1968, p. 190). Of course, if the gamma photon has energy in excess of 1.022 MeV, then that excess will be converted to momentum of the positron and electron created (as shown in the bubble chamber photo which appears on page 190 of French's book). It should be noted that if the momentum of the gamma photon were transferred to a proton (the hydrogen nucleus) as French suggests, then the speed imparted to the proton would be 326 kms/sec, which ought to show up as a track in the photo of the bubble chamber, but no such track appears.

By similar reasoning, in the case of a photon whose energy is converted gradually to motionless neutrinos, the momentum of that portion of the photon converted to neutrinos ceases, while the momentum associated with the remaining portion of the photon continues in existence.

Let us now couple this exponential decay hypothesis to a hierarchical universe, infinite in space and infinite in time, with no beginning and no end. By hierarchy we mean that all matter is divided into groups, made up of smaller groups separated by much space, while all groups in turn form larger groups consisting mostly of space, and so on *ad infinitum*. In that case, it is clear that the mean density of matter in space approaches zero as distance increases. It should also be clear that the values of the gravitational potential and of light intensity and temperature at our position in the universe should be finite. It would explain the cosmic background radiation as the highly redshifted light emitted from every part of the universe. It would also overcome the objections of Olbers and Seeliger to an infinite universe. And the abundance of elements in the universe is explained if we consider that the neutrinos produced by the exponential decay of photons are constantly being recycled in the great furnaces at the centers of all galaxies and converted first to electrons and protons, which in turn become hydrogen atoms, and thereafter helium and heavier elements are formed.

Conclusion

The exponential decay hypothesis, although to a large extent speculative, is more believable than the Big Bang theory; it does not not violate any known principles of physics; the objection that it violates the principle of conservation of momentum is not a valid objection; and it explains the "dark matter" problem, and the conversion of radiant energy to massive particles, which the Big Bang theory fails to do. Combined with the concept of an infinite hierarchical universe, it fully explains the observed cosmological redshifts in light from distant galaxies, and serves as a basis for an explanation of the cosmic background radiation. In addition, it overcomes the objections of Olbers and Seeliger to an infinite universe. And it is not incompatible with the observed abundances of elements. This hypothesis should be investigated further.

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