Astronomical Evidences for the God of the Bible[a]

by Hugh Ross, Ph.D. FL Issue date: 02 Sept 2007

Contents:

Worldview and Theology:

"It really does matter, and matter very much, how we think about the cosmos," says historian and college president Dr. George Roche.[1] If the universe is uncreated, eternally self-existent, or accidental then it has no purpose and, consequently, we have no purpose. Determinism rules. Morality and religion are ultimately irrelevant.

If the universe is created and the creator is impersonal, then love, compassion, and care are merely illusions. On the other hand, if the Creator is personal, then these attributes and others such as beauty, altruism, mercy, and justice are real and meaningful.

If there is a personal creator and this creator is contained within the universe, then the universe itself is ultimate reality. The Universe, itself, is supreme, pre-eminent. By contrast, if there is a personal Creator and this Creator is transcendent, existing beyond the confines of the universe, then the Creator defines ultimate reality and wields authority over it. Extra-dimensional phenomena, such as miracles, heaven and hell, the Trinity, all become comprehensible.

To research cosmology (the origin and development of the universe) is, in a sense, to research the meaning and purpose of life. Unfortunately, many researchers have chosen to isogete rather than exogete the data available in the cosmos—searching for data that best fit the theology they have already chosen rather than integrating all the data to see which theology is consistent with the facts.

Agnostic Cosmology:

Agnosticism (roughly defined as the belief that God's existence cannot be known) has always had its adherents, but it was the work of Immanuel Kant that really propelled agnosticism to its current prominence. In his book on physical cosmology, *Universal Natural History and Theory of the Heavens*, Kant concluded that the universe must be infinite:

> "It is evident that in order to think of it [the universe] as in proportion to the power of the Infinite Being, it must have no limits at all ... It would be absurd to represent the Deity as passing into action with an infinitely small part of His potency."[2]

From his conclusion that the universe must be infinite, Kant proceeded to work out a strictly mechanistic model. For him, everything about and in the universe could be accounted for by the laws of mechanics newly described

by Sir Isaac Newton. Specifically, Kant reasoned that an infinite universe gives rise to the possibility of an infinite number of random chances. Thus, even such highly improbable events as atoms self-assembling into human beings might be possible. Ironically, the God who provided an excuse for assuming an infinite universe became unnecessary. Though Kant unequivocally claimed to be a theist, by denying all objective evidences for God Kant provided much of the foundation for 19th- and 20th-century agnosticism.

Kant's cosmology seemed validated by the leap-frog advances in astronomy during the 19th century. Observations through progressively larger telescopes revealed an ever multiplying number of stars and nebulae. No matter how much farther into deep space the newer telescopes penetrated, the universe appeared the same-no hint of boundary, no hint of change. When many faint nebulae were resolved into stars, infinitude seemed certain. Billions of stars and thousands of nebulae stretched imaginations to the breaking point. This mind-boggling universe powerfully suggested countless stars spread throughout limitless space. Thus, even the admittedly remote prospect of atoms self-assembling into living organisms seemed to fall within the realm of possibility.

Early Objections to Agnostic Cosmology:

Through the 19th century the reliability of Newton's laws of mechanics and of Maxwell's equations for electromagnetics was demonstrated repeatedly and widely. Scientists became convinced that these laws and equations described all natural phenomena. Toward the close of the century many physicists voiced the opinion that the only work left for their successors was merely to "make measurements to the next decimal place." No significant cosmological developments were anticipated, and the Newtonian infinite universe model was cast in concrete.

However, this concrete began to crack almost before it dried. The disturbance came from three unexpected developments in physics and astronomy:

1. discovery of heat transfer by radiation

In the 1880s Josef Stefan and Ludwig Boltzmann demonstrated from the laws of thermodynamics that, given enough time, a body will assume the temperature of its surroundings and, therefore, radiate away as much energy as it receives. This finding should have destroyed the long-accepted proposition that an interstellar medium absorbs the excess light from infinitely distant stars. In the process of absorption, that medium would reach a temperature at which it would radiate as much light as it received. The mere fact that the night sky is dark tells us that the universe cannot contain an infinite number of evenly distributed stars for an infinite time.[3, 4]

2. gravitational potential paradox

Not until 1871 did anyone attempt to calculate the gravitational potential within an infinite Newtonian universe. In that year Johann Friedrich Zöllner liner presented proofs that at any point within an infinite homogeneous universe the gravitational potential becomes infinite (infinite force with no definite direction)—a conclusion clearly at odds with all observations. However, only when his objection was independently raised by Hugo Seeliger in 1895 and by Carl Neumann in 1896 did astronomers acknowledge a dilemma.[5]

3. results of the Michelson-Morley experiment

In the 1880s physicists expressed certainty, on the basis of Maxwell's equations, that "light propagates with a fixed velocity relative to an all-pervading æther."[6] In 1887 two American physicists, Albert Michelson and Edward Morley, took up the challenge to determine the absolute velocity of the earth in the æther by measuring the speed of light in different directions and at different positions of the earth in its orbit about the sun. To their astonishment, the experiment failed to reveal any motion of the earth at all.

It was immediately obvious that the Michelson-Morley experiment posed a severe threat to any kind of Newtonian universe model. But, for almost twenty years physicists attempted to patch up the classical theories. They proposed wild hypotheses. One suggested that all material bodies contract in the direction of motion. Another that the velocity of a light wave remains associated with the velocity of its source. Various experiments and astronomical observations, however, forced the rejection of all these desperate stabs.

Any one of these three developments was sufficient in itself to throw the infinite Newtonian universe model onto the trash heap. However, so strong was the emotional attachment of most scientists to Kantian philosophy and so confident were all scientists in Newton's gravitational theory that the 19th century closed with the infinite Newtonian universe model as firmly entrenched as ever.

Einstein Discovers the Beginner:
As the 20th century dawned, the only conclusions consistent with all observations of the velocity of light were these two:

1. There is no absolute reference system from which absolute motions in space can be measured.
2. The speed of light with respect to all observers is always the same.

In 1905 a German engineer, Albert Einstein, who studied physics in his spare time, formally acknowledged these conclusions in his paper on the theory of special relativity.[7, 8] Further, he derived a dilation factor which revealed by exactly how much two observers moving with respect to one another would disagree on their measurements of length, velocity, mass, and time. Applying this dilation factor to the classical expressions for momentum and to Newton's law of force, any high school student can easily derive the famous equation governing the conversion of matter into energy:[9] $\mathbf{E=mc^2}$
Resistance to Einstein's theory broke early when experiments and observations repeatedly confirmed all of its dilation predictions. The success of Einstein's equations in predicting all manner of observations and experiments was overwhelming.[10, 11] In fact, a recent experiment[12] demonstrated the accuracy of the relativistic dilation factor to within one part in 10^{21}.
The triumph of special relativity gave Einstein the boldness to extend his theory beyond velocity effects and on to the acceleration effects between observers.[13, 14] The results were the ten field equations of general relativity. Subtracting one set of these equations from another yielded the surprising result that everything in the universe is simultaneously expanding and decelerating. The only physical phenomenon which expands and decelerates at the same time is an explosion. But, if the universe is the aftermath of an explosion, then sometime in the past it must have had a beginning. There must have been a moment at which the explosion began. If it had a beginning, then there must be a Beginner.
Einstein's own world view initially kept him from adopting such a conclusion. Rather, he proposed a new force of physics that would perfectly cancel out the deceleration and expansion factors. Astronomer Edwin Hubble soon proved that the galaxies indeed are expanding away from one another in the manner predicted by Einstein's original formulation of general relativity.[15] Confronted with this proof, Einstein gave grudging acceptance to "the necessity for a beginning,"[16] and to "the presence of a superior reasoning power."[17]

Search for Loopholes
Others were not so ready to concede a theistic world view. Through the years they proposed a variety of alternatives:
1. the hesitating universe
While accepting the general expansion of the universe, Georges Lemaître, a Belgian priest trained in astrophysics by British mathematician Sir Arthur Eddington, sought to lengthen the age of the universe by proposing that the general expansion had been interrupted sometime in the past by a near static phase. In Lemaître's model the universe expands rapidly from a beginning, but the density of the universe is such that gravity slowly brings the expansion to a halt. Then, through a judicious reintroduction of Einstein's hypothesized force of physics (a repulsive force) and a careful choice of its value, Lemaître proposed that just when gravity is taking the steam out of the cosmic explosion, the repulsive force builds up to cancel off the gravitational effects. Expansion is slowed almost to a standstill yielding a quasi-static period. Eventually, the cosmic repulsion begins to dominate again, producing a second phase of general expansion (the phase that the universe would now be in).
Eddington expressed his irritation that Lemaître's model still required "a sudden and peculiar beginning of things."[18] As he stated in a research paper, "Philosophically, the notion of a beginning of the present order of Nature is repugnant to me. .. I should like to find a genuine loophole."[19] Eddington tried to create one. He stretched Lemaître's quasi-static period to infinity, putting the "repugnant" beginning point all but out of the picture to "allow evolution an infinite time to get started."[20]
Not until the 1970s was enough evidence marshaled against Lemaître's, Eddington's, and others' hesitation models to eliminate them from contention. Iranian physicist Vahé Petrosian theoretically established that if the universe hesitates, the galaxies and quasars must be confined to certain spatial limits.[21] Observations have proved that those limits are exceeded.[22 - 26] Further, theoreticians have shown that if the quasi-static period exceeds a trillion years, galaxy formation during that period is guaranteed, but so is a subsequent and relatively immediate collapse back to the initial singularity.[27] (A complete list

and explanation of the evidences refuting hesitation models can be found in the author's book, *The Fingerprint of God*.)

2. the steady state universe

In 1948 three British astrophysicists, Herman Bondi, Thomas Gold, and Fred Hoyle, attempted to circumvent the beginning by proposing "continual creation."[28, 29] In their models, the universe, though expanding indefinitely, takes on an unchanging and eternal quality since the voids that result from expansion are filled by the continual, spontaneous creation of new matter. Their proposal made the creation of matter no longer a miracle from the past, but an on-going law of nature that can be tested by observations.

Right from the beginning the steady state proponents made their intentions clear. Bondi stated that the "problem" with other theories was that creation was "being handed over to metaphysics."[30] Hoyle in his opening paper confessed his "aesthetic objections to the creation of the universe in the remote past."[31] Later, in a book he expressed his opinion that the Christian view of creation offers to man "an eternity of frustration."[32] In 1982 he unfurled his religious colors: "The attribution of definite age to the Universe, whatever it might be, is to exalt the concept of time above the Universe, and since the Universe is everything this is crackpot in itself."[33]

During the 1960s, '70s, and early '80s a series of highly complex observational and theoretical tests were developed to prove or disprove the steady state model. But the simplest test, applied last of all, was proposed by Sir James Jeans in the 1920s: a universe that has no beginning and no end should manifest a "steady" population. The number of stars and galaxies in various stages of development should be proportional to the time required to pass through these stages. That is, there should be balanced numbers of infant, middle-aged, elderly, and extinct stars and galaxies.[34]

While it is true that stars with ages ranging from just a few days to billions of years can be seen, no star anywhere in the universe has been found to be older than about 16 billion years. As for galaxies, all, or very nearly all, are middle-aged. We see no newly formed galaxies.[b] Neither are there any extinct varieties. In fact, in 1985 Donald Hamilton determined that all the galaxies were formed at approximately the same time.[35] Table 1 presents a summary of evidence against the steady state models.

Table 1: Evidence refuting steady state models

1. The lack of very old galaxies near our galaxy negates an infinite age for the universe while the lack of very young galaxies near our galaxy negates continual creation.
2. The paucity of galaxies and quasars beyond a certain distance implies that we are not living in an infinite steady state universe.
3. A steady state universe lacks a physical mechanism (such as the primeval explosion) to drive the observed expansion of the universe.
4. The observed microwave background radiation (perfectly explained by the cooling off of the primordial fireball) defies explanation in a steady state universe.
5. The enormous entropy[c] of the universe makes no sense in a steady state system.
6. In a steady state universe, spontaneously generated matter must come into being with a specified ratio of helium to hydrogen, and that ratio must decrease with respect to time in an entirely ad hoc fashion. Instead, the measured helium abundance for the universe has exactly the value that a hot big bang would predict.
7. The observed abundances of deuterium, light helium, and lithium are predicted perfectly by some kind of big bang beginning, but cannot be explained in a steady state universe.
8. Galaxies and quasars at distances so great that we are viewing them from the remote past appear to differ so substantially in character and distribution from nearby, more contemporary galaxies and quasars as to render steady state models completely implausible.

3. the oscillating universe

Research that brought about the demise of the hesitating and steady state universe models simultaneously strengthened the case for the big bang and, thus, the prospect of a beginning and a Beginner. This turn of research dismayed many cosmologists. In their dismay they resurrected a model first proposed by early Hindu teachers and Roman atheistic philosophers-the oscillating universe. British physicist John Gribbin voiced the opinion of many:

> The biggest problem with the Big Bang theory of the origin of the Universe is philosophical—perhaps even theological—what was there before the bang? This problem alone was sufficient to give a great initial impetus to the Steady State theory; but with that theory now sadly in conflict with the observations, the best way round this initial difficulty is provided by a model in which the universe expands from a singularity, collapses back again, and repeats the cycle indefinitely.[36]

In the oscillating universe model the universe is presumed to have not only enough mass to bring the expansion to a halt (via gravity), but also enough to reverse the expansion. However, rather than crunching itself into a

"singularity"[d] the imploding universe somehow bounces back and expands again, and so the cycle continues according to this model. An infinite number of such cycles is thought to "relieve us of the necessity of understanding the origin of matter at any finite time in the past."[37] Our existence, then, could be attributed to that one lucky bounce out of an infinite number that just happened to convert particles into human beings through strictly random, natural processes.

Since 1965, when the oscillation model first received serious consideration, astronomers have engaged in a tireless effort to find sufficient mass to halt the expansion of the universe. All the evidence, however, both observational and theoretical, still points in the opposite direction.[38 - 46]

In 1983 and 1984, Marc Sher, Alan Guth, and Sidney Bludman[47, 48] demonstrated that even if the universe contained enough mass to halt its current expansion, the collapse would yield not a bounce but a thud. Because of the huge entropy of the universe, any ultimate collapse would lack, by many orders of magnitude, the mechanical energy needed to bring about a bounce. This huge entropy was the justification for the title of the paper by Sher and Guth, "The Impossibility of a Bouncing Universe." In other words, the universe would much more closely resemble a wet lump of clay falling on a thick rug than it does a basketball striking a hardwood floor. Apparently, the universe either expands continuously or goes through just one cycle of expansion and contraction.

The refutations of oscillation offered by Sher, Guth, and Bludman and an earlier one developed by Russian physicists Igor Novikov and Yakob Zel'dovich[49] failed, however, to address gravitational clumping or introduce any gravitational entropy. Thus, there has been a recent attempt to revive the concept of a bouncing universe. It involves speculations about the behavior of merging blackholes when the universe is compressed down to the point at which quantum-gravitational effects dominate.[50] However, as authors Arnold Sikkema and Werner Israel admit, no consistent quantum theory of gravity (see side-bar) yet exists, and the revived theory yields an oscillating universe with only a sharply limited number of bounces.

An even stronger statement against oscillation was established by Russian physicist Andre Linde at a recent Caltech symposium on the large-scale structure of the universe. Linde demonstrated that for realistic inflationary models,[e] that is, models that fit the currently observed universe, there will exist at least one domain (a volume) within the universe that ultimately will resist being crushed by a collapse.[51] Thus, in realistic inflationary models there exists no possibility for anti-inflation.

Inflation of the universe produces matter (particles) out of space, that is, out of the vacuum *and* a huge amount of entropy. Because of the entropy, the process is not reversible—the particles cannot be converted back into a vacuum. Thus, inflationary models that bear some resemblance to reality do not permit the universe to oscillate.

A summary of evidence against oscillation models is given in Table 2.

Table 2: Evidence against oscillation models

1. The maximum radius of the universe would increase from cycle to cycle because of irreversible thermodynamic changes. Therefore, a backwards look would show in finite time a decreasing radius down to a point.
2. The universe's observed density is at most only half of what is needed to force a collapse.
3. All inflationary models of the universe imply mass densities too small to force a collapse
4. Reasonable inflationary models of the universe do not allow for subsequent deflation.
5. No known physical mechanism can consistently reverse cosmic contractions.
6. Isotropic compression becomes violently unstable near the end of the collapse phase.
7. Even if the universe were to collapse, more than a very few bounces would be impossible because of the huge entropy in the universe.

The New Cosmology and Eastern Religions

Most eastern religions, old and new, are founded on the belief that the universe oscillates or reincarnates. In fact, the popularity of these faiths soared with the popularity of the oscillating universe model, more so when it was recognized that the Hindu number for the period of the oscillation, (specifically, four and a half billion years) came close to the twenty to thirty billion year period proposed by the astronomers working on the model. Many reasoned that for the ancient Hindu theologians to get that close to the "right" answer there had to be some truth to Hinduism.

Now that the hesitation, steady state, and oscillation models for the universe have evaporated in the face of new measurements and discoveries, so, too, has any scientific basis for the cosmology of the eastern faiths. The impossibility of the oscillating universe destroys the foundation of Hinduism, Buddhism, and its New Age derivatives. The impossibility of the eternal existence of the cosmos translates into the impossibility of pantheism and all of its daughter faiths.

The beginning of time

All this evidence against an infinitely old universe has become somewhat academic. In 1968 and 1970 three British astrophysicists, Stephen Hawking, George Ellis, and Roger Penrose, extended the solution of the

equations of general relativity to include space and time.[52, 53] Their papers showed that if these equations are valid for the universe, then, under reasonably general conditions, space and time also must have an origin, concurrent with that for matter and energy. In other words, time itself is finite. In 1970 general relativity still had not been overwhelmingly established by observations. By 1980 observations removed any doubts.[54] By 1990 eleven separate evidences had been accumulated. The observational verifications of general relativity are summarized in Table 3.

Table 3: Observational verifications of general relativity

The symbol ? means "change in," and the symbol " means "arcseconds." Hence, ? P means change in the period, while ? ? means change in the frequency (inverse of the wavelength). Note that the periastron advance for the pulsar PSR 1913+16 is more than 35,000 times greater than the perihelion advance for Mercury.

1. Comparison of theoretical and observed centennial precessions of planetary orbits [55]

planet	general relativity	observations
Mercury	43.03"	43.11"+/-0.45
Venus	8.6"	8.4"+/-4.8
Earth	3.8"	5.0"+/-l.2
Icarus	10.3"	9.8"+/-0.8

2. gravitational deflection of starlight [56]

general relativity: 1.751"	observations: 1.70"+/-0.10

3. gravitational deflection of radio signals from quasars [57]

general relativity: 1.75	observations: 1.73"+/-0.05

4 radar measurement of Mercury's perihelion advance [58]

general relativity: 43.03"	observations: 43.20"+/-0.30

5. rate of advance of periastron for the binary pulsar PSR 1913+16[59, 60]

general relativity: 4.20°+/-0.3/yr	observations: 4.225°+/-0.002/yr

6. orbital period change due to gravitational radiation for the binary pulsar PSR 1913+16[60]

? Pexperiment/? Ptheory = 1.13+/-0.19

7. echo delays of laser signals reflected from corner cube reflectors on the moon[61]

general relativity ? parameter = 1.0	observations: 1.003+/-0.005
general relativity ? parameter = 1.0	observations: 1.008+/-0.008

8. gravitational red shift of spectral lines on the earth's surface (Mössbauer effect)[62]

? ? experiment/? ? theory = 0.9970+/-0.0076

9. gravitational retardation of radio signals[63]

general relativity ? parameter = 1.0	observations: 1.000+/-0.001

10. gravitational red shift of the neutral hydrogen spectral line[64]

? ?experiment/? ? theory = 1.000000+/-0.000070

11. gravitational lens effect on quasar images[65-68]

With the knowledge that time has a beginning, and a relatively recent beginning (17 +/- 3 billion years), all age-stretching attempts to save non-theistic science should cease. Moreover, the common origin of matter, energy, space, and time proves that the act(s) of creation must have transcended the dimensions and substance of the universe—a powerful argument for the biblical account of origins.

Jesus Christ, Transcendent Creator

The Bible has much to say on the origin and characteristics of the universe. The early chapters of Genesis give some of the story, but other references are found throughout the Old and New Testaments. Table 4 provides a partial list of those references.

Most significantly for our sceptical times, the latest discoveries on the frontiers of astronomy and physics validate and help to amplify biblical cosmology. Moreover, the Bible among all "holy books" stands uniquely apart in its statements about cosmology. No other "sacred" writings teach an extra-dimensional reality independent of the dimensions of our universe. Most, in fact, flatly contradict it.

Table 4: Some biblical statements of cosmological significance

1. God existed before the universe. God exists totally apart from the universe, and yet can be everywhere within it. (Genesis 1:1, Colossians 1:16-17)
2. Time has a beginning. God's existence precedes time. (II Timothy 1:9, Titus 1:2)

3. Jesus Christ created the universe. He has no beginning and was not created. (John 1:3, Colossians 1:16-17)
4. God created the universe from what cannot be detected with the five senses. (Hebrews 11:3)
5. After His resurrection Jesus could pass through walls in His physical body, an evidence of His extra-dimensionality. (Luke 24:36-43, John 20:26-28)
6. God is very near, yet we cannot see Him, a further evidence of His extra-dimensionality. (Exodus 33:20, Deuteronomy 30:11-14, John 6:46)
7. God designed the universe in such a way that it would support human beings. (Genesis 1 & 2, Nehemiah 9:6, Job 38, Psalm 8:3, Isaiah 45:18

Quantum Mechanics, a Modern Goliath

The evidences for a transcendent Creator have grown too voluminous and too strong to be ignored by non-theists. For those unwilling to repent, some straw must be found to clutch. That straw increasingly has been quantum mechanics. Famous physicists and others have produced popular books exploiting the esoteric nature of the quantum phenomena to undermine the Christian view of origins. Unfortunately, some theologians have been taken in by this esoteric erudiction and have heralded quantum mechanics as "the greatest contemporary threat to Christianity."[69]

In their insistence that he inescapable Creator cannot be the God of the Bible, non-theists grope for a replacement. Five "possibilities" have been proposed:

1. quantum tunneling

British astrophysicist Paul Davies in his book *God and the New Physics* locks all cause-and-effect phenomena into the time dimension of the universe. Because the act of creating represents cause and effect, and thus a time-bound activity, the evidence for the origin of time, says Davies, argues against God's agency in the creation of the universe.[70]

Apparently, Davies is (or was) unaware that the Bible speaks of God's causing effects even before the beginning of time.[71] As indicated in Table 5, the Bible also speaks of the existence of dimensions beyond our time and space, extra dimensions in which God exists and operates.

Noting that virtual particles can pop into existence from nothingness through quantum tunneling,[f] Davies employs the new grand unified theories to suggest that in the same manner the whole universe popped into existence. Ironically, his argument against God's creating can now be turned against his hypothesis. Quantum mechanics is founded on the concept that quantum events occur according to finite probabilities within finite time intervals. The larger the time interval, the greater the probability that a quantum event will occur. Outside of time, however, no quantum event is possible.[g] Therefore, the origin of time (coincident with that of space, matter, and energy) eliminates quantum tunneling as "creator."

To Davies' credit, he has been revising his position. He recently argued that the laws of physics "seem themselves to be the product of exceedingly ingenious design."[72] Still more recently he posed this question: "If new organizational levels just pop into existence for no reason, why do we see such an orderly progression in the universe from featureless origin to rich diversity?"[73] He concludes that we have "powerful evidence that there is 'something going on' behind it all."[74]

2. infinite chances

As amazing as it may seem, astronomers and physicists have a good understanding of the development of the universe back to when it was only 10^{-34}) second old. We may see some
probing back to 10^{-34} seconds, but that represents the practical limit of research.

American astrophysicist Richard Gott has taken advantage of this infinitesimal period about which we know nothing. He proposes that there is an infinite loss of information about events before10^{-43} seconds. With this total loss of information, he says, anything becomes possible, including "the ability to make an infinite number of universes."[75] In this "possibility" for an infinite number of universes, some non-theists see an opportunity to replace God with chance, or, more specifically, with random fluctuations of a primeval radiation field.

This question remains, however: If the universe had zero information before 10^{-43} seconds, how did it acquire its subsequent high information state without the input of an intelligent, personal Creator? A personal Creator is required, too, to explain the existence of the primeval radiation field.

For centuries atheists and agnostics have mocked Christians for their "God of the gaps," that is, for invoking divine miracles wherever gaps were encountered in man's understanding of the physical universe. Now we are seeing the reverse situation, the "chance of the gaps." It seems that scientists (and others) are relying on gaps, and in this case a very minute one, to give them a way around the obvious theistic implications of scientifically established facts. Surely, the burden of proof lies with those who suggest that physical conditions and physical laws were totally different in the period before 10^{-43} seconds.

3. no singularity

While evidence for a transcendent creation event is receiving general acceptance throughout the physical science community, there have been some notable holdouts. American theoretician Heinz Pagels, for one, refused to acknowledge that physical singularities can ever exist. He said, "The appearance of such a singularity is a good reason for rejecting the standard model of the very origin of the universe altogether."[76] While admitting that Einstein's equations of general relativity, along with observationally verified conditions, do require an inevitable singularity, he nonetheless felt that in the region of ignorance at the beginning of time a loophole *must* exist. Pagels' point, similar to Richard Gott's, is that astrophysicists have a good understanding of the development of the universe only as far back as 10^{-34} seconds after the (apparent) singular creation event. What happens before, therefore, remains an open question.

As far back as 1973 Ed Tryon suggested that a quantum mechanical fluctuation in "the vacuum" created the universe.[77] Later he was joined by several other American and Russian theoreticians,[78-82] all of whom have posited that by the laws of physics "nothing is unstable." While one of this group's members, the inventor of the inflationary big bang model, Alan Guth, concedes that "such ideas are speculation squared," all of their models do circumvent the big bang singularity. They do not, however, circumvent the beginning of space-time-matter-energy. Thus, agreement with the Biblical doctrine of creation still stands.

One of the most elegant vacuum fluctuation models was published in 1984 when Steven Hawking teamed up with American physicist James Hartle.[73, 84] Their notion is that just as a hydrogen atom can be described by a quantum mechanical wave function, so can the universe be described. Thus, the singularity disappears, and yet the entire universe still pops into existence at the beginning of time. Here is Pagels response:

> This unthinkable void converts itself into the plenum of existence-a necessary consequence of physical laws. Where are these laws written into that void? What "tells" the void that it is pregnant with a possible universe? It would seem that even the void is subject to law, a logic that exists prior to space and time.[85]

Once again, the Biblical doctrine of creation is deduced. And, as physicist Frank Tipler pointed out, Hawking may simply be substituting, unawares, one kind of singularity for another, specifically a classical singularity of general relativity for a quantum singularity.[86]

Later, in his popular book *A Brief History of Time* (1988), Hawking reformulated his escape from the singularity:

> If the universe really is in such a quantum state, there would be no singularities in the history of the universe in imaginary time. .. .The universe could be finite in imaginary time but without boundaries or singularities. When one goes back to the real time in which we live, however, there will still appear to be singularities. ... Only if [we] lived in imaginary time would [we] encounter no singularities.... in real time, the universe has a beginning and an end at singularities that form a boundary to space-time and at which the laws of science break down.[87]

In other words, God, who according to the Bible transcends "real time,"[88] would not be confined to boundaries and singularities, but human beings and the physical universe, both of which are limited to real time, would be so confined. Hence, Hawking's famous query ("What place, then, for a creator?"[89]) notwithstanding, there is still no escape from the Biblical doctrine of creation.

3. man as Creator

A case for man as the creator has been fabricated from an analogy to delayed-choice experiments in quantum mechanics. In such experiments it appears that the observer can influence the outcome of quantum mechanical events. With every quantum particle there is an associated wave. This wave represents the probability of finding the particle at a particular point in space. Before the particle is detected there is no specific knowledge of its location—only a probability of where it might be. But, once the particle has been detected, its exact location is known. In this sense, the act of observation is said by some to give reality to the particle. What is true for a quantum particle, they suggest, may be true for the universe.[92, 93]

In other words, the universe produces man, but man through his observations of the universe brings the universe into reality. Here we find a reflection of the question debated in freshmen philosophy classes across the land: If a tree falls in the forest, and no one is there to see it or hear it, does it really fall? Quantum mechanics merely shows us that in the micro world of particle physics man is limited in his ability to measure quantum effects. Since quantum entities at any moment have the potential to behave either as particles or as waves, it is impossible, for example, to accurately measure both the position and the momentum of such an entity (the Heisenberg uncertainty principle). In choosing to determine the position of the entity, the human observer loses information about its momentum.

The observer does not give "reality" to the entity, but rather the observer chooses what aspect of the reality he wishes to discern. It is not that the Heisenberg uncertainty principle disproves the principle of causality, but simply that causality in this case is hidden from human investigation. The cause of the quantum effect is *not* lacking, *nor* is it mysteriously linked to the human observation of the effect after the fact.[i]

This misapplication of Heisenberg's uncertainty principle is but one defect in the "observer-as-creator" propositions arising from quantum physics. Some other flaws include these:

> Quantum mechanical limitations apply only to micro, not to macro, systems. The relative uncertainty approaches zero as the number of quantum particles in the system increases. Therefore, what is true for a quantum particle would not be true for the universe as a whole.
> The time separation between a quantum event and its observed result is always a relatively short one (at least for the analogies under discussion). The multi-billion-year time separation between creation of the universe and of man hardly fits the picture.
> The arrow of time has never been observed to reverse, nor do we see any trace of evidence that a reversal might have taken place beyond the scope of our observation. Time and causality move inexorably forward. Therefore, to suggest that human activity now somehow can affect events billions of years ago is nothing short of absurd.
> Intelligence, or personality, is not a key factor in the observation of quantum mechanical events. Photographic plates, for example, are perfectly capable of recording such events.
> Both relativity and the gauge theory of quantum mechanics, now established beyond reasonable doubt by experimental evidence,[96] state that the correct description of nature is that in which the human observer is irrelevant.

5. universe becoming God

In The Anthropic Cosmological Principle, British astronomer John Barrow and American mathematical physicist Frank Tipler[97] review many evidences for design of the universe. They go on to examine some radical versions of the anthropic principle, including the feed-back loop connection between man and the universe. Referring to such theories as PAP (participatory anthropic principle), they propose, instead, FAP (final anthropic principle). With FAP, the life that now exists in the universe (and, according to PAP, that created the universe) will continue to evolve until it reaches a state they call the Omega Point.[98] In a footnote they declare, "The totality of life at the Omega Point is omnipotent, omnipresent, and omniscient!"[99] In other words, the universe created man, man created the universe, and together the universe and man in the end will become Almighty God. *New York Times* book reviewer Martin Gardner gives this evaluation of their idea:

> What should one make of this quartet of WAP, SAP, PAP, and FAP? In my not so humble opinion I think the last principle is best called CRAP, the Completely Ridiculous Anthropic Principle.[100]

In their persistent rejection of an eternal transcendent Creator, cosmologists (and others) are resorting to more and more bizarre alternatives. There is a certain logic to it all, however. If for personal reasons the God of the Bible is unacceptable, then given the evidence for transcendence and design, the alternatives are severely limited to flights of fancy.

Often in such cases the stated basis for rejection of the God of the Bible is a lack of *absolute* proof of His existence. However, because we humans are confined to the space-time continuum of the universe, we cannot claim absolute proof of anything. But, that does not mean we cannot draw secure conclusions.

For example, we lack absolute proof that the earth is spherical rather than flat. Nevertheless, we accept the sphericity of the earth because the explanations for a flat earth fall into the category of the absurd, and as time and research progress, those explanations become increasingly absurd, A similar state of affairs has developed and is continuing to develop for the existence of the God of the Bible.

Design Parameters

Recently, it has become possible not only to investigate the transcendence of the Creator, but also to investigate something of His personality. Now that the limits and parameters of the universe have come within the measuring capacity of astronomers and physicists, the design characteristics of the universe are being examined and acknowledged; Astronomers have discovered that the characteristics and parameters of the universe and our solar system are so finely tuned to support life that nothing less than a personal, intelligent Creator can explain the degree of fine-tunedness. It requires power *and* purpose.

Approximately two dozen parameters of the universe have been identified that must be carefully fixed in order for any kind of conceivable life (not just life as we know it) to exist at any time in the history of the universe. Some examples of these are given in Table 5.

Table 5: Evidence for design in the universe[101 - 110]

1. gravitational coupling constant
   - ? *if larger:* no stars less than 1.4 solar masses, hence short stellar lifespans
   - ? *if smaller:* no stars more than 0.8 solar masses, hence no heavy element production
2. strong nuclear force coupling constant
   - ? *if larger:* no hydrogen; nuclei essential for life are unstable
   - ? *if smaller:* no elements other than hydrogen

3. weak nuclear force coupling constant
   - ? *if larger:* all hydrogen is converted to helium in the big hang, hence too much heavy elements
   - ? *if smaller:* no helium produced from big bang, hence not enough heavy elements
4. electromagnetic coupling constant
   - ? *if larger:* no chemical bonding; elements more massive than boron are unstable to fission
   - ? *if smaller:* no chemical bonding
5. ratio of protons to electrons
   - ? *if larger:* electromagnetism dominates gravity preventing galaxy, star, and planet formation
   - ? *if smaller:* electromagnetism dominates gravity preventing galaxy, star, and planet formation
6. ratio of electron to proton mass
   - ? *if larger:* no chemical bonding
   - ? *if smaller:* no chemical bonding
7. expansion rate of the universe
   - ? *if larger:* no galaxy formation
   - ? *if smaller:* universe collapses prior to star formation
8. entropy level of the universe
   - ? *if larger:* no star condensation within the proto-galaxies
   - ? *if smaller:* no proto-galaxy formation
9. mass density of the universe
   - ? *if larger:* too much deuterium from big bang, hence stars bum too rapidly
   - ? *if smaller:* no helium from big bang, hence not enough heavy elements
10. age of the universe
   - ? *if older:* no solar-type stars in a stable burning phase in the right part of the galaxy
   - ? *if younger:* solar-type stars in a stable burning phase would not yet have formed
11. initial uniformity of radiation
   - ? *if smoother:* stars, star clusters, and galaxies would not have formed
   - ? *if coarser:* universe by now would be mostly black holes and empty space
12. average distance between stars
   - ? *if larger:* heavy element density too thin for rocky planet production
   - ? *if smaller:* planetary orbits become destabilized
13. solar luminosity
   - ? *if increases too soon:* runaway green house effect
   - ? *if increases too late:* frozen oceans
14. fine structure constant (a function of three other fundamental constants, Planck's constant, the velocity of light, and the electron charge each of which, therefore, must be fine-tuned)
   - ? *if larger:* no stars more than 0.7 solar masses
   - ? *if smaller:* no stars less than 1.8 solar masses
15. decay rate of the proton
   - ? *if greater:* life would be exterminated by the release of radiation
   - ? *if smaller:* insufficient matter in the universe for life
16. ^{12}C to ^{16}O energy level ratio
   - ? *if larger:* insufficient oxygen
   - ? *if smaller:* insufficient carbon
17. decay rate of ^{8}Be
   - ? *if slower:* heavy element fusion would generate catastrophic explosions in all the stars
   - ? *if faster:* no element production beyond beryllium and, hence, no life chemistry possible
18. mass difference between the neutron and the proton
   - ? *if greater:* protons would decay before stable nuclei could form
   - ? *if smaller:* protons would decay before stable nuclei could form
19. initial excess of nucleons over anti-nucleons
   - ? *if greater:* too much radiation for planets to form
   - ? *if smaller:* not enough matter for galaxies or stars to form

The degree of fine-tunedness for many of these parameters is utterly amazing. For example, if the strong nuclear force were even two percent stronger or two percent weaker, the universe would never be able to support life.[111, 112] More astounding yet, the ground state energies for ^{4}He, ^{8}Be, ^{12}C, and ^{16}O cannot be higher or lower with respect to each other by more than four percent without yielding a universe with insufficient oxygen and/or carbon for any kind of life.[110] The expansion rate of the universe is even more sensitive.[113] It must be fine-tuned

to an accuracy of one part in 10^{55}! Clearly some ingenious Designer must be involved in the physics of the universe.

The discovery of this degree of design in the universe is having a profound theological impact upon astronomers. Fred Hoyle concluded in 1982 that "a superintellect has monkeyed with physics, as well as with chemistry and biology."[114] Paul Davies moved from promoting atheism in 1983[115] to conceding in 1984 that "the laws [of physics] ... seem themselves to be the product of exceedingly ingenious design"[116] to testifying in his 1988 book *The Cosmic Blueprint* that there "is for me powerful evidence that there is something going on behind it all. The impression of design is overwhelming."[117] George Greenstein in 1988 expressed these thoughts:

> As we survey all the evidence, the thought insistently arises that some supernatural agency-or, rather, Agency-must be involved. Is it possible that suddenly, without intending to, we have stumbled upon scientific proof of the existence of a Supreme Being? Was it God who stepped in and so providentially crafted the cosmos for our benefit?[118]

Words such as *superintellect, monkeyed, exceedingly ingenious, supernatural Agency, Supreme Being* and *providentially crafted* obviously apply only to a Person. But, more than just establishing that the Creator is a Person, the findings about design provide evidence of what that Person is like. One characteristic that stands out dramatically in His interest and care for living things and particularly for the human race.

For example, the mass density of the universe determines how efficiently nuclear fusion operates in the cosmos. As Table 5 indicates, if the mass density is too great, too much deuterium (a heavy isotope of hydrogen with one proton and one neutron in the nucleus) is made in the first few minutes of the universe's existence. This extra deuterium will cause all the stars to burn much too quickly and erratically for any of them to sup-port a planet with life upon it. On the other hand, if the *mass* density is too small, so little deuterium and helium is made in the first few minutes that the heavier elements necessary for life will never form in the stars. What this means is that the approximately one hundred billion trillion stars we observe in the universe, no more and no less, are needed for life to be possible in the universe. Evidently, God cared so much for living creatures that He constructed a hundred billion trillion stars and carefully crafted them throughout the age of the universe so that at this brief moment in the history of the cosmos humans could exist and have a pleasant place to live. Of all the gods of the various religions of the world, only the God of the Bible is revealed as investing this much (and more) in humanity.

It is not just the universe that bears evidence for design. The sun and the earth also reveal such evidence. Frank Drake, Carl Sagan, and Iosef Shklovsky were among the first astronomers to make this point. They attempted to estimate the number of planets (in the universe) with environments favorable for life support. In the early 1960s they recognized that a certain kind of star with a planet just the right distance from that star would provide the necessary conditions for life.[119] On this basis they made optimistic estimates for the probability of finding life elsewhere in the universe. Shklovsky and Sagan, for example, claimed that 0.001 percent of all stars could have a planet capable of supporting advanced life.[120]

While their analysis was a step in the right direction, it overestimated the range of permissible star types and the range of permissible planetary distances. It also ignored *many* other significant factors. Some sample parameters sensitive for the support of life are listed in Table 6.

Table 6: Evidence for the design of the sun-earth-moon system[121 -139]

1. galaxy type
   - ? *if too elliptical:* star formation ceases before sufficient heavy element buildup for life chemistry
   - ? *if too irregular:* radiation exposure on occasion is too severe and/or heavy elements for life chemistry are not available.
2. parent star distance from center of galaxy
   - ? *if farther:* quantity of heavy elements would be insufficient to make rocky planets.
   - ? *if closer:* stellar density and radiation would be too great.
3. number of stars in the planetary system
   - ? *if more than one:* tidal interactions would disrupt planetary orbits.
   - ? *if less than one:* heat produced would be insufficient for life.
4. parent star birth date
   - ? *if more recent:* star would not yet have reached stable burning phase.
   - ? *if less recent:* stellar system would not yet contain enough heavy elements.
5. parent star age
   - ? *if older:* luminosity of star would change too quickly.
   - ? *if younger:* luminosity of star would change too quickly.
6. parent star mass
   - ? *if greater:* luminosity of star would change too quickly; star would bum too rapidly.

- ? *if less:* range of distances appropriate for life would be too narrow; tidal forces would disrupt the rotational period for a planet of the right distance; uv radiation would be inadequate for plants to make sugars and oxygen.

7. parent star color
   - ? *if redder:* photosynthetic response would be insufficient.
   - ? *if bluer:* photosynthetic response would be insufficient.
8. supernovae eruptions
   - ? *if too close:* life on the planet would be exterminated.
   - ? *if too far:* not enough heavy element ashes for the formation of rocky planets.
   - ? *if too infrequent:* not enough heavy element ashes for the formation of rocky planets.
   - ? *if too frequent:* life on the planet would be exterminated.
9. white dwarf binaries
   - ? *if too few:* insufficient fluorine produced for life chemistry to proceed
   - ? *if too many:* disruption of planetary orbits from stellar density; life on the planet would be exterminated
10. surface gravity (escape velocity)
   - ? *if stronger:* atmosphere would retain too much ammonia and methane.
   - ? *if weaker:* planet's atmosphere would lose too much water.
11. distance from parent star
   - ? *if farther:* planet would be too cool for a stable water cycle.
   - ? *if closer:* planet would be too warm for a stable water cycle.
12. inclination of orbit
   - ? *if too great:* temperature differences on the planet would be too extreme.
13. orbital eccentricity
   - ? *if too great:* seasonal temperature differences would be too extreme.
14. axial tilt
   - ? *if greater:* surface temperature differences would be too great.
   - ? *if less:* surface temperature differences would be too great.
15. rotation period
   - ? *if longer:* diurnal temperature differences would be too great.
   - ? *if shorter:* atmospheric wind velocities would be too great.
16. gravitational interaction with a moon
   - ? *if greater:* tidal effects on the oceans, atmosphere, and rotational period would be too severe.
   - ? *if less:* orbital obliquity changes would cause climatic instabilities.
17. magnetic field
   - ? *if stronger:* electromagnetic storms would be too severe.
   - ? *if weaker:* inadequate protection from hard stellar radiation.
18. thickness of crust
   - ? *if thicker:* too much oxygen would be transferred from the atmosphere to the crust.
   - ? *if thinner:* volcanic and tectonic activity would be too great.
19. albedo (ratio of reflected light to total amount falling on surface)
   - ? *if greater:* runaway ice age would develop.
   - ? *if less:* runaway greenhouse effect would develop.
20. oxygen to nitrogen ratio in atmosphere
   - ? *if larger:* advanced life functions would proceed too quickly.
   - ? *if smaller:* advanced life functions would proceed too slowly.
21. carbon dioxide level in atmosphere
   - ? *if greater:* runaway greenhouse effect would develop.
   - ? *if less:* plants would not be able to maintain efficient photosynthesis.
22. water vapor level in atmosphere
   - ? *if greater:* runaway greenhouse effect would develop.
   - ? *if less:* rainfall would be too meager for advanced life on the land.
23. ozone level in atmosphere
   - ? *if greater:* surface temperatures would be too low.
   - ? *if less:* surface temperatures would be too high; there would be too much uv radiation at the surface.
24. atmospheric electric discharge rate
   - ? *if greater:* too much fire destruction would occur.
   - ? *if less:* too little nitrogen would be fixed in the atmosphere.
25. oxygen quantity in atmosphere

- ? *if greater:* plants and hydrocarbons would bum up too easily.
- ? *if less:* advanced animals would have too little to breathe.

26. oceans to continents ratio
    - ? *if greater:* diversity and complexity of life-forms would be limited.
    - ? *if smaller:* diversity and complexity of life-forms would be limited.
27. soil mineralization
    - ? *if too nutrient poor:* diversity and complexity of life-forms would be limited.
    - ? *if too nutrient rich:* diversity and complexity of life-forms would he limited.
28. seismic activity
    - ? *if greater:* too many life-forms would be destroyed.
    - ? *if less:* nutrients on ocean floors (from river runoff) would not be recycled to the continents through tectonic uplift.

Each of these 28 parameters cannot exceed certain limits without disturbing a planet's capacity to support life. For some, the limits have been measured quite precisely. This is typically the case for the stellar parameters. For others, the limits are more uncertain. This is typically the case for planetary parameters. Trillions of stars are available for study and star formation is quite well understood and observed. On the other hand, only nine planets can be studied, and though a fairly good theory of planetary formation is available, the details have yet to be worked out, nor can planetary formation be fully observed.

To get a feel for how confining these limits can be, the least confining would be parameters #1, #3, and #12 which would eliminate respectively 30%, 60%, and 20% of all candidates from contention. More confining would be parameters such as #2, #13, #15, and #19 which eliminate respectively about 80%, 90%, 90%, 90%, and 90% of all candidates from contention. Most confining of all would be parameters such as #6, #9, #11, #18, #21, and #25 which eliminate respectively about 99.9%, 99.9%, 99.9%, 99%, 99%, and 99% of all candidates from contention.

Of course, not all of the listed parameters are strictly independent of the others. Dependency factors could reduce the degree of confinement considerably. On the other hand, all these parameters must be kept within their limits for the total time spans needed for the support of life on a candidate planet. This will increase the degree of confinement.

About a dozen more parameters, such as the atmospheric transparency, atmospheric pressure, atmospheric temperature gradient, other greenhouse gases, location of different gases and minerals, and mantle and core constituents and structures, currently are being researched for their sensitivity in the support of life. However, the 28 listed in Table 6 in themselves lead safely to the conclusion that much fewer than a trillionth of a trillionth of a percent of all stars will have a planet capable of sustaining advanced life. Considering that the observable universe contains less than a trillion galaxies, each averaging a hundred billion stars,[j] we can see the not even one planet would be expected, by natural processes alone, to possess the necessary conditions to sustain life.[k] No wonder Robert Rood and James Trefil,[121] among others,[140] have surmised that intelligent physical life exists only on the earth.

It seems abundantly clear that the earth, too, in addition to the universe, has experienced divine design. Evidently, personal intervention on the part of the Creator takes place not just at the origin of the universe but also at much more recent times.

Creator or Chance?

In spite of all this evidence for design, some non-theists claim that our existence is simply testimony to the fact that the extremely unlikely did, indeed, take place by chance. In other words, we would not be here to report the event unless that highly unlikely event actually took place. A reply to this argument has been developed by philosophers William Lane Craig and Richard Swinburne:

> Suppose a hundred sharpshooters are sent to execute a prisoner by firing squad and the prisoner survives. The prisoner should not be surprised that he does not observe that he is dead. After all, if he were dead, he could not observe his death. Nonetheless, he should be surprised that he observes that he is alive.[141]

To extend Craig's argument, the prisoner could conclude, since he is alive, that all the sharpshooters missed by some extremely unlikely chance. He may wish to attribute his survival to an incredible bit of good luck, but he would be far more rational to conclude that the guns were loaded with blanks or that the sharpshooters all deliberately missed. That is, someone must have purposed that he should live. Likewise, the rational conclusion to draw from the incredible fine-tunedness of the universe and the solar system is that someone purposed that we should live.

Another consideration is the total lack of analogy in the world of observed natural processes. We do not see spontaneous generation of anything highly complex and fine-tuned.

If the God of the Bible may be seen—and seen as essential—in the existence and operation of galaxies and stars and our solar system, the simple systems in the cosmos, how much more clearly should we see Him in systems

that are orders of magnitude more complex, information-loaded, and living? Nothing produced by the ingenuity of man can compare with the complexity and efficiency of even the simplest of organisms. Organisms, in fact, are so complex that with all man's study of them we as yet know relatively little of how to build and operate them.
Through time, as we unlock more and more of the secrets of the vast cosmos and of the inner workings of organisms, we will continue to be awed. But, where will that awe be aimed, at the created thing or at the Creator? That is each individual's choice.

Conclusion
The more that astronomers learn about the origin and development of the universe, the more evidence they accumulate for the God of the Bible. Ironically, those who fought hardest against God as the explanation for the cosmos often were the ones whose work provided the most powerful new evidence for Him. Today, with the measuring of the creation has come the scientific equipment to make a positive identification of the Creator. Though not many who write about these new measurements acknowledge Jesus Christ as Lord and Savior, they typically confess that the only explanation for the universe we observe is the action of an entity beyond the space-time continuum of the universe who/that is capable of design and of carrying out that design. All they typically lack is the theological knowledge or the courage to recognize that in their confession they have testified of none other than the God of the Bible.

FOOTNOTES:
a. This chapter is an abridgement and update of a full-length book the author wrote in 1989 and revised in 1991 (*The Fingerprint of God*, Orange, CA: Promise Publishing).
b. A recent report of a newly formed galaxy is considered by most astronomers rather to be the aftermath of a collision between two other galaxies. Galaxies in the universe are so tightly packed together that such collisions and their aftermaths should occur on occasion.
c. Entropy of a system is the energy that is unavailable to perform work. A candle flame, for example, dissipates most of its energy as heat and light leaving little energy to perform work. The universe, by comparison, has a specific entropy that is five billion times greater than that of a candle flame.
d. The singularity for the universe is an infinitely shrunken space representing the boundary at which space ceases to exist or at which space comes into existence.
e. A new version of the big bang model, a model called the inflationary universe, answers most of the previously unanswered questions of big bang cosmology. In the standard big bang model, the universe expands smoothly and adiabatically (temperature dropping due to expansion alone without loss of heat from the system) from the beginning onward. In the inflationary model there is a very brief departure from adiabatic expansion. A much faster, exponential expansion occurs between about 10^{-35} and about 10^{-33} seconds after the beginning. There is now little doubt amongst astronomers that inflation must operate at some point. The discussion currently centers on what kind of inflation model is correct.
f. Quantum tunneling is the process by which quantum mechanical particles penetrate barriers that would be insurmountable to classical objects.
g. Since we lack thorough understanding about anything that occurs in that instant before the universe was 10^{-43} seconds old, there necessarily exists the *possibility* that the relationship between time and the probability for certain quantum events breaks down in that interval.
h. Hawking's stated goal "is a complete understanding of everything."[90] Since the existence of the God of the Bible or singularities would guarantee that his goal would never be reached, he seeks to deny both. Ironically, his goal was proven mathematically impossible by Kurt Godel in 1930. According to Godel's in-completeness theorem, with incomplete information about a system, one cannot prove a necessarily true theorem (i.e., a one and only one description) about that system. [91]
i. One can easily get the impression from the physics literature that the Copenhagen interpretation of quantum mechanics is the only accepted philosophical explanation of what is going on in the micro world. According to this school of thought: 1) There is no reality in the absence of observation; 2) Observation creates reality. Physicist Nick Herbert outlines and critiques six additional philosophical models for interpreting quantum events.[94] Physicist and theologian Stanley Jaki presents yet an eighth model.[95] While a clear philosophical understanding of quantum reality is not yet agreed upon, physicists do agree on the results expected from quantum events.
j. The average number of planets per star is uncertain. Research suggests only bachelor stars similar to the sun may possess planets. Many young stellar objects appear to have accretion disks, but the heavy elements comprising such disks have only been available recently. Regardless, an extreme upper limit would be about one planet per star.
k. The accepted assumption is that all life is based on carbon. Silicon and boron at one time were considered candidates for alternate life chemistries. However, silicon can sustain amino acid chains no more than about a

hundred such molecules long. Boron may allow a little more complexity but has the disadvantage of being relatively scarce in the universe.

REFERENCES:

1. Roche, George, *A World Without Heroes.* (Hillsdale, MI: Hillsdale college Press, 1987), p.120.
2. Kant, Immanuel, "Universal Natural History and Theory of the Heavens," in *Theories of the Universe.* edited by Milton K. Munitz. (Glencoe, Illinois: Free Press, 1957), p.240.
3. Harrison, E. R., "The dark night-sky riddle: a 'paradox' that resisted solution," in *Science, 226.* (1984), pp.941-945
4. Jaki, Stanley L., *The Paradox of Olbers' Paradox.* (New York: Herder and Herder, 1969), pp.72-143.
5. North, J. D., *The Measure of the Universe: A History of Modern Cosmology*. (Oxford: Clarendon Press, 1965), pp. 16-18.
6. Eisberg, Robert M., *Fundamentals of Modern Physics.* (New York: John Wiley and Sons, 1961), pp.7-9.
7. Einstein, Albert, "Zur Elektrodynamik bewegter Körper," in *Annalen der Physik, 17.* (1905), pp.891-921. The English translation is in *The Principle of Relativity* by H. A. Lorentz, A. Einstein, H. Minkowski, and H. Weyl with notes by A. Sommerfeld and translated by W. Perrett and G. B. Jeffrey (London: Methuen and Co., 1923), pp.35-65.
8. Einstein, Albert, "Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?" in *Annalen der Physik, 18.* (1905), pp. 639-644. The English translation is in *The Principle of Relativity* by H. A. Lorenta, A. Einstein, H. Minkowski, and H. Weyl with notes by A. Sommerfeld and translated by W. Penett and G. Jeffrey (London: Methuen and Co., 1923), pp. 67-71.
9. Eisberg, Robert Martin, *Modern Physics.* (New York: John Wiley and Sons, 1991), pp.30-35.
10. *Ibid.*, pp.37-38, 75-76, 580-592
11. Jackson, John D., *Classical Electrodynamics.* (New York: John Wiley and Sons, 1962), pp. 352-369.
12. Lamoreaux, S. K., Jacobs, J. P., Heckel, B. R., Raab, F. J., and Forston, E. N., "New Limits on Spatial Anisotropy from Optically Pumped ^{201}Hg and ^{199}Hg," in *Physical Review Letters, 57,* (1986), pp.3125-3128.
13. Einstein, Albert, "Die Feldgleichungen der Gravitation," in *Sitzungsherichte der Königlich Preussischen Akademie der Wissenschafen.* (1915), Nov.25, pp. 844-847. (The following reference includes this reference.)
14. Einstein, Albert, "Die Grundlage der ailgemeinen Relativititätheon.e," in *Annalen der Physik, 49.* (1916), pp.769-822. The English translation is in *The Principle of Relativity* by H. A. Lorenta, A. Einstein, H. Minkowski, and H. Weyl with notes by A. Sommerfeld and translated by W. Perrett and G. B. Jeffrey (London: Methuen and Co., 1923), pp.109-164.
15. Hubble, Edwin, "A Relation Between Distance and Radial Velocity Among Extra-Galactic Nebulae," in *Proceedings of the National Academy of Sciences, 15.* (1929), pp.168-173.
16. Douglas, A. Vibert, "Forty Minutes With Einstein," in *Journal of the Royal Astronomical Society of Canada, 50.* (1956), p.100.
17. Barnett, Lincoln, *The Universe and Dr. Einstein.* (New York: William Sloane Associates, 1948), p. 106.
18. Eddington, Arthur S., "On the Instability of Einstein's Spherical World," in *Monthly Notices of the Royal Astronomical Society, 90.* (1930), p. 672.
19. Eddington, Arthur S., "The End of the World: from the Standpoint of Mathematical Physics," in *Nature, 127.* (1931), p. 450.
20. Eddington, Arthur S., "On the Instability of Einstein's Spherical World," in *Monthly Notices of the Royal Astronomical Society,* 90. (1930), p.668678.
21. Petrosian, Vahé, "confrontation of Lemaître Models and the cosmological Constant with Observations," in *Proceedings of the I. A. U. Symposium No.63: Confrontation of Cosmological Theories with Observational Data.* edited by M. S. Longair. (Dordrecht-Holland, Boston-U.S. A. :D. Reidel Publishing, 1974), pp. 31-46.
22. McCcarthy, P. J., Dickinson, M., Filippenko, A. V., Spinrad, H., and van Breugel, W. J. M., "Serendipitous Discovery of a Redshift 4.4 QSO," in *Astrophysical Journal Letters, 328.* (1988), pp. L29-L33.
23. Warren, S. J., Hewett, P. C., Osmer, P.S., Irwin, M. J., "Quasars of Redshift a = 4.43 and a = 4.07 in the South Galactic Pole Field," in *Nature, 330.* (1987), pp. 453-455.
24. Schneider, Donald P., Schmidt, Maarten, and Gunn, James E., "PC 1158+4635: An Optically Selected Quasar with a Redshift of 4.73," in *Astronomical Journal, 98.* (1989), pp.1951-1958.
25. Dunlop, J. S., Downes, A. J. B., Peacock, J. A., Savage, A., Lilly, S. J., Watson, F. G., and Longair, M. G., "Quasar with a = 3.71 and Limits on the Number of More Distant Objects," in *Nature, 319.* (1986), pp. 564-567.

26. Peterson, B. A., Savage, A., Jauncey, D. L., and Wright, A. E., "PKS 2000-330: A Quasi-Stellar Radio Source with a Redshift of 3.78," in *Astrophysical Journal Letters, 260.* (1982), pp. L27-L29.
27. Brecher, Kenneth and Silk, Joseph, "Lemaître Universe, Galaxy Formation and Observations," in *Astrophysical Journal, 158.* (1969), pp. 91-102.
28. Bondi, H. and Gold, T., "The Steady-State Theory of the Expanding Universe," in *Monthly Notices of the Royal Astronomical Society, 108*. (1948), pp.252-270.
29. Hoyle, Fred, "A New Model for the Expanding Universe," in *Monthly Notices of the Royal Astronomical Society, 108.* (1948), pp. 372-382.
30. Bondi, Herman, *Cosmology, second edition.* (Cambridge, United Kingdom: Cambridge University Press, 1960), p. 140.
31. Hoyle, Fred, "A New Model for the Expanding Universe," in *Monthly Notices of the Royal Astronomical Society, 108.* (1948), p.372.
32. Hoyle, Fred, *The Nature of the Universe, second edition.* (Oxford, U. K.: Basil Blackwell, 1952), p.111.
33. Hoyle, Fred, "The Universe: Past and Present Reflections," in *Annual Reviews of Astronomy and Astrophysics, 20.* (1982), p.3.
34. Jeans, Sir James H., *Astronomy and Cosmogony, second edition.* (Cambridge, U. K.: Cambridge at the University Press, 1929), pp. 421-422.
35. Hamilton, Donald, "The Spectral Evolution of Galaxies. I. An Observational Approach," in *Astrophysical Journal 297.*(1985), pp. 371-389.
36. Gribbin, John, "Oscillating Universe Bounces Back," in *Nature, 259.* (1976), pp.15-16.
37. Dicke, R. H. Peebles, P. J. E., Roll, P. G., and Wilkinson, D. T., "Cosmic Black-Body Radiation," in *Astrophysical Journal Letters, 142.* (1965),pp.415.
38. Gott III, Richard J., Gunn, James E., Schramm, David N., and Tinsley, Beatrice M., "An Unbound Universe?" in *Astrophysical Journal 194.* (1974), pp.543-553.
39. Spinrad, Hyron and Djorgovski, S., "The Status of the Hubble Diagram in 1986," in *Observational Cosmology, Proceedings of the 124th Symposium of the International Astronomical Union, held in Bejing, China, Aug. 25-30, 1986* (ed.: Hewitt, A., Burbidge, G., and Pang, L. Z.), (Dordrecht-Boston: D. Reidel, 1987), pp.129-141.
40. Steinhardt, Paul J., "Inflation and the ? -Problem," *in Nature, 345.* (1990), pp.47-49.
41. Peebles, P. J. E., "The Mean Mass Density of the Universe," in *Nature, 321.* (1986), pp.27-32.
42. Hamilton, Donald, "The Spectral Evolution of Galaxies. I. An Observational Approach," in *Astrophysical Journal 297.* (1985), pp.371-389.
43. Sandage, Allan and Tammann, G A.,. "The Dynamical Parameters of the Universe: H_0, q_0, ? $_{0,}$? , and K," in L*arge-Scale Structure of the Universe, Cosmology, and Fundamental Physics, Proceedings of the First ESO-CERN Symposium, CERN, Geneva, 21-25* Nov., *1983,* edited by G. Setti and L. van Hove. (Geneva: CERN, 1984), pp. 127-149.
44. Yang, J., Turner, M. S., Steigman, C., Schramm, D. N., and Olive, K. A., "Primordial Nucleosynthesis: a critical comparison of theory and observation," in *Astrophysical Journal 281.* (1984), pp.493-511.
45. Uson, Juan M. and Wilkinson, David T., "Improved Limits on Small-Scale Anistropy in Cosmic Microwave Background," in *Nature, 312.* (1984), pp.427-429.
46. Ellis, C. F. R., "Does Inflation Necessarily Imply ? = 1?" in *Classical and Quantum Gravity, 5.* (1988), pp.891-901.
47. Guth, Alan H. and Sher, Marc, "The Impossibility of a Bouncing Universe, in *Nature, 302.* (1983), pp.505-507.
48. Bludman, Sidney A., "Thermodynamics and the End of a Closed Universe," in *Nature, 308.* (1984), pp.319-322.
49. Novikov, I. D. and Zel'dovich, Ya. B., "Physical Processes Near Cosmological Singularities," in *Annual Review Of Astronomy and Astrophysics, 11.* (1973), pp.401.
50. Sikkema, Arnold E. and Israel, Werner, "Black-hole Mergers and Mass Inflation in a Bouncing Universe," in *Nature, 349.* (1991), pp. 45A7.
51. Linde, Andre, "Self-Reproducing Universe," lecture given at the Centennial Symposium on Large Scale Structure, California Institute of Technology, Pasadena, California (September 27,1991).
52. Hawking. Stephen W. and Ellis, George F. R., "The Cosmic Black-Body Radiation and the Existence of Singularities in our Universe," in *Astrophysical Journal 152.* (1968), pp. 25-36.
53. Hawking, Stephen and Penyose, Roger, "The Singularities of Gravitational Collapse and Cosmology," in *Proceedings of the Royal Society of London, Series A, 314.* (1970), pp.529-548.
54. Vessot, R. F. C., Levine, M. W., Mattison, B. M., Blomberg, E. L., Hoffman, T. B., Nystrom, G. U., and Farrel, B. F., "Test of Relativistic Gravitation with a Space-Borne Hydrogen Maser," in *Physical Review Letters, 45.* (1980), pp. 2081-2084.

55. Weinberg, Steven, *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity.* (New York: John Wiley and Sons, 1972), p.198.
56. Van Biesbroeck, G., "The Relativity Shift at the 1952 February 25 Eclipse of the Sun," in *Astronomical Journal 58.* (1953), pp.87-88.
57. Counselman III, C. C., Kent, S. M., Knight, C. A., Shapiro, I.I., Clark, T. A., Hinteregger, H. F., Rogers, A. B. E., and Whitney, A. R., "Solar Gravitational Deflection of Radio Waves Measured by Very-Long-Baseline Interferometry," in *Physical Review Letters, 33.* (1974), pp.1621-1623.
58. Shapiro, I.I., Pettengill, G. H., Ash, M. E., Ingalls, R. P., Campbell, D. B., and Dyce, R. B., "Mercury's Perihelion Advance: Determination by Radar," in *Physical Review Letters, 28.* (1972), pp.1594-1597.
59. Taylor, J. H., Fowler, L. A., and McCulloch, P. M., "Measurements of General Relativistic Effects in the Binary Pulsar PSR 1913+16," in *Nature, 277.* (1979), pp. 437-440.
60. Taylor, J. H., "Gravitational Radiation and the Binary Pulsar," in *Proceedings of the Second Marcel Grossmann Meeting on General Relativity, Part A.* edited by Retno Ruffini. (Amsterdam: North-Holland Publishing, 1982), pp. 15-19.
61. Shapiro, Irwin I., Counselman III, Charles C., and King, Robert W., "Verification of the Principle of Equivalence for Massive Bodies," in *Physical Review Letters, 36.* (1976), pp.555-558.
62. Pound, R. V. and Snider, J. L., "Effect of Gravity on Nuclear Resonance," in *Physical Review Letters, 13.* (1964), pp. 539-540.
63. Reasenberg, R. D., Shapiro, I. I., MacNeil, P. E., Goldstein, R. B., Breidenthal, J. C., Brenkle, J. P., Cain, D. L., Kaufman, T. M., Komarek, T. A., and Zygielbaum, A. I., "Viking Relativity Experiment: Verification of Signal Retardation by Solar Gravity," in *Astrophysical Journal Letters, 234.* (1979), pp.219-221.
64. Vessot, R. F. C., Levine, M. W., Mattison, B. M., Blomberg, E. L., Hoffman, T. B., Nystrom, G. U., and Farrel, B. F., "Test of Relativistic Gravitation with a Space-Borne Hydrogen Maser," in *Physical Review Letters, 45.* (1980), pp. 2081-2084.
65. Porcas, R. W., Booth, R. S., Browne, I. W. A., Walsh, D., and Wilkinson, P. N., "VLBI Observations of the Double QSO 0957+561 A, B," in *Nature, 282.* (1979), pp. 384-386.
66. Weymann, R. J., Latham, D., Angel, J. R. P., Green, R. F., Liebert, J. W., Tumshek, D. A., Tumshek, D. E., and Tyson, J. A., "The Triple QSO PG 1115+08: Another Probable Gravitational Lens," in *Nature, 285.* (1980), pp. 641-643.
67. Henry, J. Patrick and Heasley, J. N., "High-Resolution Imaging from Mauna Kea: the Triple Quasar in 0.3 arc 5 Seeing," in *Nature, 321.* (1986), pp.139-142.
68. Langston, G. I., Conner, S. R., Lehar, J., Burke, B. F., and Weiler, K. W., "Galaxy Mass Deduced from the Structure of Einstein Ring MG1 654+1346," in *Nature,* 344. (1990), pp. 43-45.
69. Emerson, Allen, "A Disorienting View of God's Creation," in *Christianity Today,* February 1,1985, p.19.
70. Davies, Paul, *God and the New Physics* (New York: Simon and Schuster, 1983), pp. 25-43, specifically pp.38-39.
71. II Timothy 1:9 and Titus 1:2, *The Holy Bible.*
72. Davies, Paul, *Superforce: The Search for a Grand Unified Theory of Nature* (New York: Simon and Schuster, 1984), p. 243.
73. Davies, Paul, *The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe.* (New York: Simon and Schuster, 1988), p. 141.
74. *Ibid.,* p.203.
75. Gott, J. Richard, Ill., "Creation of Open Universes from de Sitter Space," in *Nature, 295* (1982), p. 306.
76. Pagels, Heinz R., *Perfect Symmetry: The Search for the Beginning of Time.* (New York: Simon & Schuster, 1985), p. 244.
77. Tryon, Edward P., "Is the Universe a Vacuum Fluctuation," in *Nature, 246.* (1973), pp. 396-397.
78. Atkatz, David and Pagels, Heinz., "Origin of the Universe as a Quantum Tunneling Event," in *Physical Review D, 25.* (1982), pp.2065-2073.
79. Vilenkin, Alexander, "Creation of Universes from Nothing," in *Physical Letters B, 117.* (1982), pp. 25-28.
80. Zel'dovich, Yakob B. and Grishchuk, L. P., "Structure and Future of the 'New' Universe," in *Monthly Notices of the Royal Astronomical Society, 207.* (1984), pp. 23P-28P.
81. Vilenkiln, Alexander, "Birth of Inflationary Universes," in *Physical Review D, 27.* (1983), pp. 2848-2855.
82. Vilenitin, Mexander, "Quantum Creation of Universes," in *Physical Review D, 30.* (1984), pp. 509-511.
83. Hartie, James B. and Hawking Stephen W., "Wave Function of the Universe," in *Physical Review D, 28.* (1983), pp. 2960-2975.

84. Hawking, Stephen W., "The Quantum State of the Universe," in *Nuclear Physics B, 239.* (1984), pp. 257-276.
85. Pagels, Heinz R., p. 347.
86. Tipler, Frank, "The Mind of God," in *The Times [of London] Higher Education Supplement, 14.10.88,* p.23.
87. Hawking, Stephen W., *A Brief History of Time: From the Big Bang to Black Holes.* (New York: Bantam Books, (1988), p.139.
88. II Timothy 1:9 and Titus 1:2, *The Holy Bible, New International Version.*
89. Hawking, Stephen W., p. 141.
90. Adler, Jerry, Lubenow, Gerald C., and Malone, Maggie, "Reading God's Mind," in *Newsweek, June 13.* (1988), p.59.
91. Jaki, Stanley L., *Cosmos and Creator.* (Edinburgh, U. K.: Scottish Academic Press, 1980), pp. 49-54.
92. Wheeler, John Archibald, "Bohr, Einstein, and the Strange Lesson of the Quantum," in *Mind in Nature,* edited by Richard Q. Elvee (New York: Harper and Row, 1981), p.18.
93. Greenstein, George, *The Symbiotic Universe.* (New York: William Morrow, 1988), p.223.
94. Herbert, Nick, *Quantum Reality: Beyond the New Physics: An Excursion into Metaphysics and the Meaning of Reality* (New York: Anchor Books, Doubleday, 1987), pp. 16-29.
95. Jaki, Stanley L., *Cosmos and Creator* (Edinburgh: Scottish Academic Press, 1980), pp. 96-98.
96. Trefil, James S., *The Moment of Creation* (New York: Charles Scribner's Sons, 1983), pp. 91-101.
97. Barrow, John D. and Tipler, Frank J., *The Anthropic Cosmological Principle* (New York: Oxford University Press, 1986).
98. *Ibid*., p.677
99. *Ibid*., pp.677, 682.
100. Gardner, Martin, "WAP, SAP, PAP, and FAP." in *The New York Review of Books, Vol.23, May 8, 1986, No.8* (1986), pp. 22-25.
101. Ross, Hugh, *The Fingerprint of God*, second edition. (Orange, CA: Promise Publishing, 1991), pp.120-128.
102. Barrow, John D. and Tipler, Frank J., *The Anthropic Cosmological Principle.* (New York: Oxford University Press (1986), pp.123-457.
103. Carr, Bernard J. and Rees, Martin J., "The Anthropic Principle and the Structure of the Physical World," in *Nature,278.* (1979), Pp.605-612.
104. Templeton, John M., "God Reveals Himself in the Astronomical and in the Infinitesimal," in *Journal of the American Scientific Affiliation, December 1984.* (1984), pp. 194-200.
105. Neidhardt, Jim W., "The Anthropic Principle: A Religious Response," in *Journal of the American Scientific Affiliation, December 1984.* (1984), pp.20l-207.
106. Carter, Brandon, "Large Number Coincidences and the Anthropic Principle in Cosmology," in *Proceedings of the International Astronomical Union Symposium No.63: Confrontation of Cosmological Theories with Observational Data.* edited by M. S. Longair. (Dordrecht-Holland, Boston, U.S. A.: D. Reidel, 1974), pp.29l-298.
107. Barrow, John D., "The Lore of Large Numbers: Some Historical Background to the Anthropic Principle," in *Quarterly Journal of the Royal Astronomical Society, 22.* (1981), pp. 404-420.
108. Lightman, Alan., "To the Dizzy Edge," in *Science 82, October.* (1982), pp. 24-25.
109. O'Toole, Thomas, "Will the Universe Die by Fire or Ice?" in *Science 81, April.* (1981), pp. 71-72.
110. Hoyle, Fred, *Galaxies, Nuclei, and Quasars.* (New York: Harper and Row, 1965), pp. 147-150.
111. Ross, Hugh., p. 122.
112. Barrow, John D. and Tipler, Prank J., pp. 318-327, 354-359
113. Guth, A. H., "Inflationary Universe: a possible solution to the horizon and flatness problems," in *Physical Review D, 23.* (1981), p. 348.
114. Hoyle, Fred, "The Universe: Past and Present Reflections," in *Annual Review of Astronomy and Astrophysics, 20.* (1982), p.16.
115. Davies, Paul, *God and the New Physics.* (New York: Simon & Schuster, 1983), pp. viii, 3-42, 142-143.
116. Davies, Paul, *Superforce.* (New York: Simon & Schuster, 1984), p. 243.
117. Davies, Paul, *The Cosmic Blueprint.* (New York: Simon & Schuster, 1988), p.203.
118. Greenstein, George, *The Symbiotic Universe.* (New York: William Morrow, 1988), p.27.
119. Shklovskii, I.S. and Sagan, Carl, *Intelligent Life in the Universe.* (San Francisco: Holden-Day, 1966), pp.343-350.
120. *Ibid.*, p.413.
121. Rood, Robert T. and Trefil, James S., *Are We Alone? The Possibility of Extraterrestrial Civilizations.* (New York: Scribner's Sons, 1983).
122. Barrow, John D. and Tipler, Frank J., pp. 510-575.

123. Anderson, Don L., "The Earth as a Planet: Paradigms and Paradoxes," in *Science, 223.* (1984), pp.347-355.
124. Campbell, I. H. and Taylor, S. R., "No Water, No Granite—No Oceans, No Continents," in *Geophysical Research Letters, 10.* (1983), pp.1061-1064.
125. Carter, Brandon, "The Anthropic Principle and Its Implications for Biological Evolution," in *Philosophical Transactions of the Royal Society of London, Series A, 310.* (1983), pp.352-363.
126. Hammond, Allen H .,"The Uniqueness of the Earth's Climate," in *Science, 187* (1975), p. 245.
127. Toon, Owen B. and Olson, Steve, "The Warm Earth," in *Science 85, October.* (1985), pp.50-57.
128. Gale, George, "The Anthropic Principle," in *Scientific American, 245, No.6.* (1981), pp.154-171.
129. Ross, Hugh, *Genesis One: A Scientific Perspective.* (Pasadena, California: Reasons to Believe, 1983), pp. 6-7.
130. Cottrell, Ron, *The Remarkable Spaceship Earth.* (Denver, Colorado: Accent Books, 1982).
131. Ter Harr, D., "On the Origin of the Solar System," in *Annual Review of Astronomy and Astrophysics,* 5. (1967), pp. 267-278.
132. Greenstein, George., pp.68-97.
133. Templeton, John M., "God Reveals Himself in the Astronomical and in the Infinitesimal," in *Journal of the American Scientific Affiliation, December 1984.* (1984), pp.196-198.
134. Hart, Michael H., "The Evolution of the Atmosphere of the Earth," in *Icarus, 33.* (1978), pp.23-39.
135. Hart, Michael H., "Habitable Zones about Main Sequence Stars," in *Icarus, 37* (1979), pp.351-357.
136. Owen, Tobias, Cess, Robert D., and Ramanathan, V., "Enhanced $C0^2$ Greenhouse to Compensate for Reduced Solar Luminosity on Early Earth," in *Nature, 277.* (1979), pp.640-641.
137. Ward, William R., "Comments on the Long-Term Stability of the Earth's Obliquity," in *Icarus, 50.* (1982), pp. 444-448.
138. Gribbin, John, "The Origin of Life: Earth's Lucky Break," in *Science Digest, May 1983.* (1983), pp.36402.
139. Davies, R. E. and Koch, R. H., *Philosophical Transactions of the Royal Society, 334B.* (1991), pp.391-403.
140. Tipler, Frank J., reviewing "The Search for Extraterrestrial Life: Recent Developments," in *Physics Today,* 40, December 1987, p.92.
141. Craig, William Lane, "Barrow and Tipler on the Anthropic Principle vs. Divine Design," in *British Journal of Philosophy and Science, 38.* (1988), p.392.