EXAMINING THE COSMOGONIES — A HISTORICAL REVIEW

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Astronomy now involves an unbelievable amount of guesswork. It is profitable for the Christian man of science to have a clear understanding of how much in this realm is truly solid ground, and how much is simply overzealous speculation.

Theories of the origin of the universe have a surprisingly short life expectancy. Each idea has lasted long enough to be attractive to a wide range of people living in a particular age. It is soon overthrown as a result of its own scientific absurdities and replaced by something "better."

Let him who scoffs at the Genesis record state specifically which hypothesis he would put in its place. Then let him attempt to resolve the insuperable difficulties inherent in that hypothesis and defend it against the onslaughts of future experimental findings.

Making plausible guesses as to the origin of the universe is evidently a challenging pastime. Given a generous supply of matter in a simple "undifferentiated" form, the known laws of nature, and almost infinite time, the object of the game is to derive the present state of the physical world. One of the rules, unfortunately, is that no intervention on the part of a Divine Creator can be tolerated. In refusing to retain God in their thinking, cosmogonists have "taken away the key of knowledge" and condemned their efforts to failure.

No system of evolutionary cosmology, once it has been given an adequate length of time to demonstrate its worth, has survived. In the final analysis, the only statements on the subject of origins that will weather the test of time are those set down by "holy men of God . . . as they were moved by the Holy Ghost." (II Peter 1:21)

The history of astronomy furnishes a convincing demonstration of the fickleness and transitoriness of man's best thinking in this realm. The various theories discussed in this paper are presented in two chronological sequences--one for the solar system and one for the universe in general. While this is by no means a complete listing, it does include what appear to be the major highlights in the historical panorama from Copernicus to the present time.

THE SOLAR SYSTEM

The Cartesian Hypothesis (1644)

In 1644 Rene Descartes, in his *Principles of Philosophy*, set forth a rather bizarre conception of the development of the physical world. He regarded the universe as a vast system of vortices originally set in motion by God, and then left to run spontaneously.[1]

As they age, the structures within each vortex gradually merge from one type to another. Stars decay to form comets. Comets in turn degenerate into planets, while terrestrial matter arises from the decay of planets.

Although this might on the surface sound like the second law of thermodynamics in action, it most decidedly was not. To Descartes there were no irreversible processes or entropic degradations in the system, for the "quantity of motion" remained constant.[2]

Newton was anything but favorably impressed with this type of thinking. In a letter to Richard Bentley he stated that "the Cartesian hypothesis . . . can have no place in my system and is plainly erroneous." As evidence to refute it he cited the fact that comets always leave the sun with a speed equal to that of their approach. There is never any indication that a cometary orbit is in the process of degenerating into a planetary orbit.

Were the planets derived from former comets, he noted, they would have highly disorganized eccentric orbits and would not have the coplanar arrangement of the planets as we know them. It is gratifying to see Newton, perhaps the greatest genius in the history of science, holding high the banner of the creationist position:

> It is plain that there is no natural cause which could determine all the planets, both primary and secondary, to move the same way and in the same plane . . . ; this must have been the effect of counsel. Nor is there any natural cause which could give the planets those just degrees of velocity, in proportion to their distances from the sun and other central bodies, which were requisite to make them move in such concentric orbs about those bodies.

He also found it remarkable that the solar system contains but one luminous body and that all the others are "opaque": "I know of no reason but because the Author of the system thought it convenient."[3]

Swedenborg's Nebular Hypothesis (1734)

Emanuel Swedenborg, the brilliant founder of the cult known as the "Church of the New Jerusalem," outlined a scheme to account for the origin of the solar system in his *Principia* published in 1734. This effort preceded Kant's hypothesis by several years and undoubtedly influenced it.[4]

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Swedenborg conjectured that what is now the solar system was once a rapidly rotating nebula. As it cooled and contracted its speed of rotation progressively increased. There was eventually enough force available to expel a large ring of material. Nuclei of condensation formed within the ring that subsequently developed into planets, while the dense central mass became the sun.

Swedenborg did not take the credit for originating this idea; he claimed to have received it in spiritualistic communications from inhabitants of the moon and distant planets.[5] Objections to this and other early nebular hypotheses will be taken up under the discussion of Laplace.

Kant's Nebular Hypothesis (1755)

In 1755 the German philosopher Immanuel Kant attempted to develop the idea that the solar system evolved from a tenuous gas spread uniformly throughout a vast region of space. As it contracted by gravitational forces the cloud began to rotate.

This process continued, with the rate of rotation increasing as more and more material gravitated toward the center of the system. After a time the cloud became almost disc-shaped as a result of "centrifugal force."

While this was happening the heavier elements were attracting the lighter elements from the regions around them, forming increasingly larger aggregations of material, the most sizable of which appeared in the center of the system to become the sun. Continual collisions reduced the number of the outer particles and formed them into more or less separate rings. The rings eventually coalesced into planets with orbits around the sun. Q.E.D.!

It has been said that Kant, though a self-styled expert on the entire universe, never once in his lifetime strayed from the city of Koenigsberg, Prussia. But this in no way limited his ambitions or his confidence. With the lack of humility that is so characteristic of cosmogonists in general he boasted, "Give me matter and I will construct a world out of it"[6]

There are several objections to this hypothesis from a scientific standpoint.[7] The first problem is that gravitational forces alone would not cause the rotation he envisioned. (Swedenborg and Laplace were shrewd enough *to begin* with a rotating system.) But Kant resorted to the use of repulsive forces as well as attractive, There seems to be little or no justification for this additional assumption.

Secondly, the diffuse material in the cloud would not condense into solid particles in the manner postulated. This fact has been very troublesome even to more recent nebular hypotheses. Finally, there are problems concerning the fine structure of the solar system which will be discussed more fully in connection with Laplace's hypothesis.

Buffon's Collision Hypothesis (1779)

Georges Louis Leclerc de Buffon, the noted French naturalist, sought to account for the existence of the earth by a celestial accident. In his *Epochs of Nature* which appeared in 1779 he theorized that a passing comet tore a quantity of material from the sun. This material cooled and formed the earth.

The idea was not well received either in scientific or in theological circles. It is said to have been too speculative for the scientists and too radical for the theologians of the day. Today our knowledge of the structure of comets, though still far from complete, makes it clear that they are not nearly massive enough to cause an event of such a magnitude.

It has been estimated that there are some 20 billion comets in the solar system having a *total* mass of only one-tenth the earth's mass[8]. And, of course, even if the idea were correct, there remains the problem of the origin of the comet and the sun.

Laplace's Nebular Hypothesis (1796)

Laplace's Nebular Hypothesis of 1796 holds a rather unique place in the history of cosmogony. Its acceptance was probably more widespread and long-lived than was that of any other "scientific" hypothesis down through the years. And even in the present century, after the disenchantment of the scientific world with the Planetesimal Hypothesis (to be described below) had reached proportions that rendered it untenable, there was a general reversion to the Laplacian type of thinking.

Laplace began with a hot slowly-rotating nebula. As it cooled it contracted and increased in rotational speed. Eventually it assumed the form of a rapidly rotating disc with a thin rim of material on the edge moving too fast to be held by gravitational attraction. This material, after being ejected from the nebula, coalesced to form the outermost planet of the solar system.

Further contraction and ejection of rings formed planets at various distances from the center of the cloud, while the material remaining in the center became the sun. Satellites (moons) were accounted for by rotational eddies in the rings that repeated the overall process on a smaller scale.

This hypothesis was readily and warmly received by many who were of an anti-religious turn of mind. Not anxious to "stare a gift horse in the teeth" they failed to scrutinize it closely, and the defects that later became only too apparent were all but overlooked for almost a century.

Among objections to the hypothesis, the following seem to be the most prominent:

1. The sun is rotating much too slowly to have been formed by a system that was continually contracting and speeding up. Stated another way, the planets have far too much angular momentum in comparison to the sun.[9]

2. The gaseous rings would have dispersed into space rather than condensing into planets.

3. The earth does not appear to have an "original crust" such as the hypothesis would demand.[10]

4. A number of stubborn peculiarities about the solar system militate against any such simple sweeping hypothesis. Some of these are the retrograde motions of 11 of the 32 known satellites, the highly inclined orbits of the asteroids and cornets, and the retrograde rotations of Venus and Uranus.[11]

Ironically, Laplace's hypothesis, originally based on a mathematical approach to the question of origins, was, in the final analysis torn down by mathematical scrutiny, beginning with the penetrating analysis of a well-known Christian man of science, James Clerk-Maxwell. "He disappointeth the devices of the crafty . . . He taketh the wise in their own craftiness." (Job 5:l2a, 13a)

Darwin's Tidal Hypothesis (1890)

George Darwin, son of the better-known Charles Darwin, anxious to extend the idea of evolution into the inorganic world, concocted an intriguing story of how the earth and moon evolved from a large mass of hot plastic material some four billion years ago.

Beginning with the fact that the moon is constantly receding from the earth a few inches each year and extrapolating backward in time, he deduced that originally there was zero distance between the two bodies. This is, of course, an example of uniformitarian thinking carried to the logical conclusion that it demands.

From angular momentum considerations Darwin computed that the primeval spheroid had a period of rotation of about five hours. The rapidly rotating body was of necessity quite oblate, and subject to vibrations of enormous amplitude.

One fateful day the sun's gravitational pull raised tides of such colossal proportions that the system was disrupted, giving birth to the earth's one and only "daughter". The hypothesis still enjoys surprising popularity, and many of its adherents affirm with great earnestness that the Pacific Basin is the scar from which the moon was ripped.

This fission type of approach to the origin of the earth-moon binary system was pretty well laid to rest in 1931 when Harold Jeffreys demonstrated that even had the necessary resonance been set up, the earth would have been too viscous for partition to occur.[12, 13]

But the question was reexamined in 1963 by Wise and others.[14] Wise chose to change some of the details in the original scheme, considering the system as a pear-shaped Poincare figure whose long axis lay in the plane of rotation, and choosing a period about half as long as Darwin's.

Presumably the stem end of the pear would fly off if such a high rotational velocity were invoked. But after the original system has been given enough energy for fission to occur, an insurmountable problem arises. The angular momentum at the beginning would then have been some 3.7 times that of the present earth-moon binary system, and theorists are forced to account for the disappearance of the excess energy.

The energy released in slowing the earth down to a 24-hour day would be sufficient to raise the temperature of the entire earth to 2500°C and melt it. And the great bulk of this energy would be released soon after the moon was ejected.

Others have tried their hand at making the tidal hypothesis work, but with no real success. Dr. Ralph B. Baldwin, author of *A Fundamental Survey of the Moon,* summarized the situation in 1965 by stating that we are left on the multi-pointed horns of a dilemma-there is still no acceptable explanation for the earth-moon system as we know it.[15]

Planetesimal Hypothesis (1900)

At the turn of the century nothing resembling a solid tenable hypothesis for the origin of the solar system *or* the universe had yet appeared on the scene. Still, vast multitudes of people had already been deceived by the cocksure materialism of the 1800's.

Popularized anti-Christian writings such as Ernst Haeckel's *The Riddle of the Universe* assured the general public that the "all-pervasive Law of Substance" adequately explained everything. Men of the scientific world knew better, however, and were desperately seeking a new synthesis that, unlike the previous attempts, would be in line with the astronomical and geological observations.

In 1900 Chamberlain and Moulton of the University of Chicago offered their Planetesimal Hypothesis as a substitute for the nebular approach.[16] Assuming that the earth had been formed gradually by the accretion of small solid particles similar to meteorites, they set forth the idea that the solar system had formed from a vast swarm of planetesimals or tiny planets, revolving around a central mass in intersecting elliptical orbits.

The pieces were gradually swept up into planets and satellites by gravitational attraction. This neatly solved the problem inherent in all previous hypotheses of the nebular type—namely, the reluctance of the material to coalesce into solid bodies. How simple! To produce a solid, simply begin with a solid! But this is somewhat unsatisfying to the intellect.

One might well ask how this highly-rigged picture of ready-made particles revolving around a ready-made sun came into being. Chamberlain and Moulton sought to answer that very question. Their first assumption in this endeavor, unfortunately, proved to be erroneous-that the spiral nebulas observed in the heavens were in fact other solar systems in the making.

Further study disclosed the existence of stars in the arms of these nebulas and revealed that their dimensions were of a far grander scope than any single solar system. But they proceeded to postulate a dynamic encounter between our own sun and another star to produce such a nebula, which in turn would hopefully yield the necessary planetesimals. The other star approached the sun closely in a hyperbolic orbit.

Although the encounter was brief it resulted in liberating two bolts of material from the sun, on opposite sides, imparting a circular motion to the material such that it soon became a double-armed spiral. Collisions of particles in the spiral coupled with normal attractive forces allegedly produced the desired planetesimals.

Subsequent mathematical analysis indicated, however, that the angular momentum distribution of the solar system could not be accounted for by the action of only two original stars. Accordingly, there was a ludicrous alternative proposal that *three* stars had happened to be passing the same way at the same time!

Finally in 1939 the Planetesimal Hypothesis received its inevitable death blow when Lyman Spitzer of Yale demonstrated that the bolts of material ripped from the sun could not possibly condense into solid particles. The material taken from near the sun's surface, with a temperature near 10,000°F, would simply keep expanding. It is retained in its normal compact form only by the immense gravitational pull of the sun.

Jeans-Jeffreys Tidal Hypothesis (1917)

This alternative close-encounter explanation of the solar system was the work of Sir James Jeans and Harold Jeffreys in 1917.[17] In their scheme, a star passing near the sun pulled loose a cigar-shaped gaseous filament-thick in the middle but tapering at the ends.

As the gaseous filament became more elongated, parts of it condensed, giving it the very picturesque appearance of a string of pearls. The more massive globules toward the center of the string ultimately formed the heavier planets such as Jupiter and Saturn, while the ends of the string became the innermost and outermost planets of the solar system.

Spitzer's refutation of the Planetesimal Hypothesis in 1939 served equally well to lay this hypothesis to rest. The advent of World War II found the slate wiped clean with regard to explanations of the solar system-every proposed evolutionary mechanism had been decisively refuted.

Von Weizsacker's Nebular Hypothesis (1944)

The delusions of the planetesimal and tidal type of thinking had reigned for nearly half a century, with nothing more attractive forthcoming to resolve the dilemma. Finally these speculations were abandoned as hopeless and a new trend was initiated.

The year 1944 saw the beginning of a wholesale return to Kant and Laplace, as the first of a series of revised nebular hypotheses appeared on the scene. But very few of the leading cosmogonists seem to trust one another when it comes to the rendering of the specific details, so a number of separate variations and modifications have sprung up. Carl F. von Weizsacker, who had gained considerable stature in the thirties through his studies of thermonuclear reactions in the sun, led the way with an approach that appeared to overcome some of the difficulties of the older nebular hypotheses.

The initial stages of von Weizsacker's *modus operandi* were similar to Laplace's. A large cloud of gas and dust already in slow rotation gradually contracted and flattened out. Instead of spinning off a ring as Laplace had envisioned, the first important event was the sudden contraction of the central part of the cloud, forming the sun. He was then faced with the problem of how to slow down the rotation of the sun to somewhere near the presently observed rate. Von Weizsacker's great ingenuity came to the fore at this point as he devised a mechanism for transferring angular momentum from the sun out to the surrounding cloud.

As the sun became hotter through nuclear reactions it induced turbulences in the cloud which ultimately gave rise to a semi-permanent system of eddies. These eddies, which were turned by the sun's rotational motion, functioned as roller bearings, carrying angular momentum from the sun to the periphery of the system. In the regions between the eddies condensation took place to form small solid particles or planetesimals. The planetesimals aggregated into larger bodies called protoplanets, which eventually formed planets and satellites.

One novel feature of this hypothesis is that it purports to account for the spacing of the planets in the solar system according to the pattern known as "Bode's Law."

Another innovation was an explanation of the fact that our solar system contains such a generous measure of heavy elements as compared with the rest of the universe. Von Weizsacker suggested that a large portion of the lighter elements had been repelled outward by the sun and permanently lost. Most of the postwar hypotheses have been of this general type—of such a nature that planetary systems are held to be an everyday phenomenon throughout the universe, and life is considered to be a common inevitable occurrence. This thought has great appeal to the modern cosmogonists.

One question that has been raised by some of von Weizsacker's critics concerns his use of five vortices per ring, to yield results in accord with "Bodes Law." Why, they ask, wouldn't this produce five planets in each orbit rather than just one? Another crucial question involves the stability of the system of eddies. As Whitcomb has pointed out,[18] it is questionable whether the vortices would last even 10 or 100 years; yet the hypothesis requires millions of years of such action for the planetary accretion to be completed. There are still other difficulties which will be discussed later under Kuiper's Protoplanet Hypothesis.

One can judge something about von Weizsacker's hypothesis by the number of modifications that have been deemed necessary by various astronomers:

(a) D. Ter Haar of Purdue University saw fit to substitute nuclei of condensation for vortices.

(b) Kuiper made such extensive modifications that he developed an almost independent hypothesis.

(c) Fred Hoyle, who had formerly endorsed a binary star hypothesis, has now largely fallen in line with recent nebular trends. But in place of von Weizsacker's "roller bearing" mechanism Hoyle advocates an idea proposed by the Swedish physicist Alfven--a "magnetic clock spring" contrivance for transferring angular momentum from the sun to the evolving planets.[19, 20]

(d) Other variations on the basic von Weizsacker system have been promoted by Urey, Chandrasekhar, and Schmidt.

Whipple's Dust Cloud Hypothesis (1948)

Fred Whipple of Harvard University proposed a new hypothesis in 1948 consisting of three evolutionary stages: (1) aggregation of interstellar material into a discrete cloud, (2) formation of the sun and planets, and (3) development of the detailed structure within the system.

To compress the interstellar material into a compact enough structure for gravitational attraction to be effective, Whipple utilized a proposal of Lyman Spitzer that light pressure from surrounding stars may be capable of forcing the material together. The cloud that is thus formed, although not rotating as a whole, contains local turbulences which give rise to streams of material spiraling inward toward the center of the system.

The streams condense into protoplanets, and the center of the cloud collapses to form the protosun. The protoplanets gradually acquire more circular orbits and grow in size by accretion to become the planets as we know them.[21] Here again we are relegating a discussion of some of the problems involved to the next section on the Protoplanet Hypothesis.

A little thought will disclose that inherent in the Whipple-Spitzer hypothesis is an intriguing "chicken-versus-egg" type of dilemma:

(a) If stars and planets condense from interstellar dust that is forced together by light pressure, where does the light pressure come from? From other stars.

(b) Where did those stars come from? By condensation of material utilizing the light pressure from still other stars.

(c) But where did the first stars come from? We have succeeded only in pushing the basic problem further back in time, but we have failed completely in explaining the ultimate origin of anything.

As neatly as the Bible answers the "chicken-versus-egg" problem it yields the *only possible answer* to this dilemma: the universe didn't evolve—it was suddenly created.

Protoplanet Hypothesis (1951)

Gerald P. Kuiper, an American astronomer, extended von Weizsacker's work and added enough original material to it to warrant its being considered as a separate hypothesis. Kuiper advocated replacing von Weizsacker's orderly arrangement of eddies by a random distribution, and indicated that the protoplanets would form in the centers of the eddies rather than in the regions of intersection.

A key point of this scheme is that the protoplanets were formed in darkness—the sun at this stage was still too diffuse to emit light. Eventually its contraction permitted a significant increase in temperature. Large quantities of radiant energy became available to disperse the hydrogen-helium envelopes of the protoplanets and bring their chemical composition into line with that of the present planets.

Kuiper believes that the same general mechanism by which a planetary system forms can also give rise to binary or multiple stars. In fact, planetary systems such as our own should only occur about 1% of the time, the other 99% presumably forming some type of star system. Assuming that our galaxy contains 100 billion stars, about one billion of them would have planetary systems.

One might legitimately ask what brought enough of the tenuous interstellar material together to bring the density of the cloud up to the point where gravitational contraction could begin. Kuiper treats the problem lightly and places his faith in a "chance eddy" that conveniently delivered all of the necessary raw materials to the proper location But to say that such a "chance eddy" did its work 100 billion times or even one billion times in our own galaxy is to make a rather strong appeal to the long arm of coincidence!

We are dealing here with a highly rarified material, less dense even than the vacuum of a thermos bottle. If we could push enough of it together from all sides to increase the density appreciably, would it not tend to expand again when left to itself, to occupy the surrounding void? And even if the nebula could be held together forcibly, would the particles really cooperate by aggregating together?

Kuiper, of course, realizes the weaknesses of his system, and unlike many of the cosmogonists, acknowledges that there may be insuperable difficulties. He goes so far as to state, with reference to the general problem of the solar system, that it is not a foregone conclusion that the problem has a scientific solution.[22]

We come now to the formidable riddle of the "anomalous" members of the solar system that are troublesome to all the hypotheses: (1) those whose orbits are inclined to the ecliptic, such as Pluto and many of the asteroids, comets, and meteors, (2) the 11 satellites out of the 32 in the solar system that revolve the "wrong way", (3) Uranus and Venus with their retrograde rotation, and (4) the "oversize" satellite with which the earth has been endowed.

The best the cosmogonists can do is to declare that these anomalies were not the case originally. By resorting to **catastrophism** of one form or another that worked to upset the original order, they seek to explain their way out of the dilemmas *caused by their penchant for uniformity.*

For instance, to explain Pluto's highly inclined orbit, a very popular theory, proposed by Lyttleton, places it originally in an orbit around Neptune. Through some misfortune Neptune lost its "grip" on Pluto, allowing it to assume a bold sweeping orbit around the sun. Did this type of accidental occurrence produce each of "the many "irregularities" in the solar system?

What strange tragedy befell Uranus and her retinue of five moons that they are tipped at such a curious angle? Whatever it was must have been a phenomenon of gigantic proportions--Uranus is nearly 30,000 miles in diameter, and is tilted 98 degrees from the plane of its orbit!

And why is our moon so large compared to the other moons in the solar system? There are some who maintain that it is a former planet. If so, by what extraordinary coup was the earth able to "wrest" it from the clutches of the sun?

If "the present is the key to the past" how can we accept such ad hoc speculations, when no such "accidents" have actually been observed? It requires a strong faith in the unlikely and a vivid imagination to fill in the missing details.

THE UNIVERSE

Primeval Atom Hypothesis (1927)

According to an idea set forth in 1927 by Georges Lemaitre, a Belglan Jesuit, the present universe is the result of the radioactive disintegration of a gigantic atom. This "superatom" had a radius perhaps as great as the radius of the earth's orbit, consisted only of closely-packed neutrons, and had a very brief existence corresponding to the neutron's half-life of thirteen minutes.

Following the blast there were three phases in the evolution of the universe: (1) rapid expansion, (2) deceleration caused by gravitation giving rise to an unstable equilibrium situation, and (3) followed by a renewed expansion which we now observe in the red shifts of distant galaxies.[23]

During the first and third stages galaxies and stars were structured by fortuitous aggregations of the ever-expanding materials.[24] Lemaitre even stated that the presently observed cosmic rays are the "fossil rays" which emanated from the original explosion and still "testify to the primeval activity of the cosmos."[25]

This hypothesis has been largely supplanted by the Gamow "Big Bang" hypothesis which is far more sophisticated from a mathematical standpoint. Both hypotheses, however, are philosophically unappealing--they embrace the doctrine of uniformitarianism back to the beginning, at which time they abandon it and resort to catastrophism.

It would seem that the cosmogonist should choose between uniformitarianism or catastrophism, but not greedily demand both. Also, it is a regrettable form of blasphemy to consider the universe-the intricate handiwork of God-to be mere debris left from the destructive action of a nuclear disintegration. One very interesting respect in which Lemaitre's hypothesis differs from all the others is that the primeval atom was created *ex nihilo;* a few minutes prior to the fireworks there had been nothing. Suddenly the "superatom" appeared. Thus, Lemaitre's effort represented a strange marriage of science and scripture.

"Big Bang" Hypothesis (1947)

While Lemaitre's recent obituary notices held him to be the actual originator of the "Big Bang" hypothesis,[26] George Gamow has without question been its leading proponent since the 1940's. Prof. Gamow has done an effective job of promoting the cause. A prolific writer, he has authored many books in the popular vein on a wide variety of subjects. His style is clear and persuasive, and he utilizes ingenious sketches and "homey" analogies that have endeared him to the hearts of science lovers the world over, earning him an awesome following. Because of Gamow, the "Big Bang" hypothesis probably enjoys a more widespread acceptance today than any other cosmogony of the universe, past or present.

Gamow has scaled up Lemaitre's "fireworks" to a far more impressive order of magnitude. While Lemaitre was content to begin with a primeval nucleus that would fit within our solar system, Gamow envisions an *already infinitely big* structure which suddenly exploded some five billion years ago, and ultimately expanded by an additional factor of 10^{44} to its present state!! (One might well ask at this stage how an explosion can be propagated over an infinite distance.)

He has named his primordial material "ylem" (pronounced i'-lem) This remarkable substance is said to have a density of 10^{14} g/cc, or one hundred trillion times the density of water! How did such an unlikely material ever get there to begin with? As a result of the "Big Squeeze"!

The pre-ylem condition of the universe was simply a contraction phase which apparently had been in progress from eternity past. When it had contracted to its limiting density of 10^{14} g/cc, a violent elastic rebound occurred. During this brief catastrophic episode the atoms as we know them were synthesized from neutrons in the intense heat of the blast in less than an hour.[27]

Since then, "various differentiation processes"[28] have produced stars in a few hundred million years, and man, in a period of some five billion years[29] He appears to believe that the expansion will continue indefinitely.[30]

Hannes Alfven, professor of plasma physics at the Royal Institute of Technology, Stockholm, also one of the world's leading cosmologists, is vigorously opposed to the idea that the universe could ever have attained such a fantastic density by virtue of a previous contraction. As particles come together in such a contraction there will be little actual contact. Consequently there can be little chance of packing them together.

To illustrate this point Alfven resorts to an amusing analogy set forth in the style of Gamow.[31] He asks his readers to visualize a housefly that has been condemned to death by a firing squad. The hapless fly is placed in the center of a large circle while an unusually large number of marksmen stand shoulder to shoulder around the circumference of the circle. If each man, firing on signal, can achieve perfect aim and timing, the bullets will aggregate together into one large cannonball. (We can forget about the fly.)

Such might happen, that is, in an idealized mathematical dream-world. But in real life the bullets will for the most part go streaking by one another without colliding And so it is with particles in the contraction phase of the universe. They would fail to "cooperate" in the formation of the postulated ylem.

Another problem, which has been recognized by Gamow and his co-workers, has to do with the production of the elements during the initial stages of the expansion. This view of atom-building is based on successive neutron-capture reactions to achieve elements of increasing atomic weights in a stepwise manner, starting from a 100-percent neutron content in the ylem

At the end of the first 30 minutes slightly more than half of the ylem has been converted into hydrogen, slightly less than half into helium.[32,33] There is an impasse, however, when we attempt to go past helium. A gap exists at mass 5 among nuclides that can actually be formed, since neither a proton nor a neutron can be attached to a helium nucleus of mass 4. Various ingenious devices have been attempted to patch up the scheme at this point, but to our knowledge nothing truly satisfactory has been forthcoming.

Gamow has also conceded that many of the heavier elements quite possibly weren't produced during the "Big Bang" at all, but were built up at a later date in the hot interiors of stars.[34,35]

It should be borne in mind that the Gamow hypothesis is predicated upon a Doppler interpretation of the red shifts of distant galaxies. While this is the simplest and most straightforward way to account for the red shifts, several present-day theorists remain unconvinced. Accordingly, several different non-Doppler cosmologies are being investigated, most of them based on some sort of "tired light" or time-depletion phenomenon. One such cosmology is the static universe of Gerald S. Hawkins.[36]

Even if we grant the basic premise of an expanding universe, we are on hazardous ground if we attempt to extrapolate this expansion back to a superdense state. To do so is to risk falling into the trap of uniformitarianism warned against in II Peter 3:3-5. A study of some relevant portions of scripture indicates the distinct possibility that most, if not all, of the expansion took place at the time of the Creation:

> I have made the earth, and created man upon it: I, even my hands, have stretched out the heavens, and all their host have I commanded. (Is. 45:12, also Is. 48:13a)

He hath made the earth by His power, He hath established the world by His wisdom, and hath stretched out the heavens by His discretion. (Jer. 10:12, also Jer. 51:15)

Steady-State Hypothesis (1948)

We come now to the most incredible hypothesis of all—that of continuous creation. First, let us try to imagine an infinitely old, infinitely big universe that is constantly expanding! As infinitely big as it might be already, it keeps increasing its size as galaxies recede from one another.

Rather than having the universe become depleted of matter as it expands, the originators of this scheme have suggested that *new* matter appears *out of nowhere* to replenish what has been lost in any given region of space. If the density of matter in the universe can be maintained thereby at a fairly constant level, we have what is commonly referred to as a steady-state situation.

In 1948 Fred Hoyle, Hermann Bondi, and Thomas Gold set forth their now-famous "steady-state cosmology." (Actually the idea of continuous creation had been suggested as early as 1925 by Sir Oliver Lodge[37] and 1928 by Sir James Jeans.[38]) The self-creating matter is said to be hydrogen (or neutrons which soon decay into the constituent parts of hydrogen). And this self-creating matter possesses the astonishing ability to condense into galaxies, within which evolve stars, planets, satellites, comets, plants, animals, and people. We ourselves, then, are condensations out of nothingness formed by natural processes—the progeny of a mere vacuum —if the chain of reasoning is to be carried to its logical conclusion.

With regard to the question of just where the newly originated matter comes from, Hoyle has averred that such a query is "meaningless and unprofitable."[39] However, the continuous creation hypothesis has been dignified somewhat by the introduction of a "creation field." This has been done by a bold extension of Einstein's equations of the four-dimensional space-time continuum.[40] The "C-field," as it is called, is said to propogate through space much as an electric or gravitational field, but is effective at greater distances than any of the recognized types of fields.

As in the case of known fields the C-field results from the presence of matter. If there are several contributions to the strength of the C-field in any given region, their effect is additive and can build up the intensity to the point where "matter happens." A particle forms if the C-field carries at least as much energy as the rest mass of the particle.

Operating in the manner Hoyle envisions, there is energy to spare. Baryons such as neutrons can be created with high initial velocities,[41] in a mode akin to the process of pair-production, in which electrons and positrons are formed from gamma rays. The created matter is capable of generating a C-field of its own which can participate in the formation of more matter, and so on it goes. The succession of events might be likened to a biological lineage with each generation of matter being created in accordance with some kind of "genetic code" carried by the C-field.

It is most difficult to reconcile this type of thinking with the well-established first and second laws of thermodynamics. The first law, known as the law of conservation of energy, would of course forbid the condensing of matter "out of nowhere" inasmuch as matter is recognized as being a form of energy. Hoyle's defense to this objection has been that we cannot balance the energy books strictly and completely in any locality because no such region forms an entirely closed system.[42]

Suppose, however, that rather than discussing a particular locality we consider the universe as a whole. The rate of creation in just the observable part of the universe has been estimated by Hoyle to be 10^{32} tons of material each second.[43] In the whole universe, of course, it might be considerably more. Here we have new material continually appearing on the plus side of the ledger with nothing to offset it.

The bookkeeping becomes most strained when viewed in this light, but such, apparently, is the paradoxical nature of infinity. To ease this situation the steady-state cosmologists have expressed the desire to rewrite the first law to read that the amount of mass-energy *per unit volume* remains constant, so that the newly formed matter just exactly compensates for the expansion of the universe. There is not, however, one shred of experimental evidence to warrant such a change!

Similarly, this school of thought is at odds with the second law. If the universe is truly "running down" as the second law implies, how can it maintain a steady state? And how can anyone with a knowledge of this law declare that the universe is infinitely old? If it actually did date from eternity past it would long since have run down. To make the universe infinitely old is to make of it a gigantic perpetual motion machine. One needn't delve too far into the study of thermodynamics to learn that perpetual motion is impossible, but an ardent pantheist could conceivably have a high enough esteem for "Nature" to believe that it could perform even the impossible.

Most devastating to the steady-state cosmology, however, has been the recent accumulation of observational data. In a lecture delivered Sept.

6, 1965, at a meeting of the British Association for the Advancement of Science, Hoyle admitted that there are several different types of findings that spell trouble for the steady-state cosmologists. The **crucial question** deciding the issue is whether the universe was once more dense than it is now. If so, then obviously there is an "unsteady" state with respect to time, and the cosmology is dealt a cruel blow. Hoyle cited evidence indicating that the universe was indeed more dense at one time, from the following lines of investigation:[44]

1. Radio astronomy counts by Martin Ryle and his associates indicate a density of radio sources too great to be compatible with the steady-state cosmology.

2. Red-shift measurements of fifteen quasi-stellar objects indicate that the universe has expanded from a state of higher density. The number of quasars studied is still rather small to carry any great weight, but a trend is indicated.

3. A radio background at a wavelength of 7 cm has been observed by Penzias and Wilson There is no known way that this phenomenon can be explained by present astrophysical processes. One might be tempted to conclude, therefore, that the radiation originated at some time In the past when the universe was different from what it is today.

4. Helium-to-hydrogen ratios for stars and gaseous nebulas within our own galaxy indicate such a high helium content that it cannot be accounted for by thermonuclear production from hydrogen. Here again, something other than present processes must have been acting in the past to bring this state of affairs about.

5. The structure of elliptical galaxies is more satisfactorily explained as a result of expansion from a highly dense state than by any condensation process.

In view of these findings, which taken together seem overwhelmingly to refute the steady-state hypothesis, **Hoyle announced that he no longer chose to believe the cosmology he had championed for so long!**[45] In its place, however, we have something new. In a recent book Hoyle describes his "Radical Departure" hypothesis which retains the concept of continuous creation, but oscillations from a steady state situation are permitted. Our part of the universe is likened to a gigantic bubble which is undergoing the "bounce" phase of a local oscillation.

This notion is, of course, still very young, and will probably be "developed" more as time goes on. While we can not yet tell how long it will successfully survive new experimental findings, there is no reason whatsoever for the Christian man of science to "wait and see," or reserve judgment on the matter. We should reject the hypothesis without hesitation or apology because of its clear-cut violation of both science and scripture.

One wonders why the theologians have failed to speak out more forcefully against continuous creation as an explanation for the world we live in—a system that denies the fact of a beginning or a Creation, that reduces man to a chance materialization from the void, and leaves little room for God. Just where does God fit into the picture?

The continuous creation cosmologists would clearly have Him abdicate His Creatorship; if the universe is infinitely old, then it never needed to be created. It was always there coexisting with God. The next question that arises is how much control He could wield over the universe if it were not, in fact, His own handiwork. They have succeeded, then, in casting doubts upon His omnipotence. In reality, a theistic continuous creation cosmology is virtually untenable; hence, it is rarely attempted. It is far more natural to weld it to an atheistic or pantheistic world view.

One might think that God could be inserted into the picture as the motivating force behind the continuous creation. But He would then be a God of incompleteness and imperfection, never having finished His work of structuring the universe, and Whose continuing efforts merely serve to keep an endless treadmill in motion. The following verses state unequivocally that Creation is *not* a continuing process:

> Thus the heavens and the earth were finished, and all the host of them. (Gen. 2:1)
>
> For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested the seventh day. (Ex. 20:11a)

Another conflict centers around the continuous creationist's insistence that the universe extends infinitely far in all directions. This would give an infinite number of galaxies each containing some 100 billion stars. Scripture reveals that although the number of stars is extremely great, and in fact innumerable as far as man is concerned, there is a definite total number of stars known to God: "He telleth the number of the stars; He calleth them all by their names," (Ps. 147:4)

Still another problem involves the fact that this hypothesis makes no provision for the symmetry between particles and anti-particles. As Alfven has pointed out,[46] a continuous creation of neutrons without a corresponding creation of antineutrons to offset them is in direct violation of the very basic principle of particle-antiparticle symmetry.

Alfven's Ambiplasma Hypothesis (1965)

In an attempt to obviate the difficulties of the foregoing systems, O. Klein, former professor of theoretical physics at the University of Stockholm, propounded a new view of the origin of the universe in the mid 1950's. Alfven's updated version of this conception which appeared in *Review of Modern Physics* in 1965,[47] probably represents the most advanced thinking on the subject to date.

Alfven begins with an extremely tenuous mixture of koinomatter (regular matter) and antimatter, occupying an enormous spherical region of space perhaps 10^{12} light years in radius.[48] He calls his primordial material "ambiplasma." Basically it was a mixture of protons, antiprotons, electrons, and positrons.[49]

Over a period of *trillions of years,* gravitational attraction will gradually shrink the sphere and increase its density. As this happens opportunities will increase for particles to come in contact with their antiparticles and undergo annihilation. In the case of proton-antiproton annihilation reactions, neutrons and electromagnetic radiation would result, leaving electrons and positrons. The radiation thus produced has a very significant effect in the overall picture.

After a few trillion years, the radiation intensity will increase to the extent that its outward push will not only hinder the gravitational contraction, but eventually reverse its direction completely. Thus we have arrived at an expanding universe without the need for catastrophism—a philosophical improvement over the "fireworks" type of hypothesis. Meanwhile, localized regions of perhaps a billion light-years across begin clumping together to form galaxies.

Prof. Alfven concedes that there are serious difficulties concerning the mechanism of galaxy formation. He is uncommitted as to whether the process began during the contraction of the metagalaxy (the observable part of the universe), or during the hypothetical 10 billion years since the beginning of the expansion. The detailed development within each galaxy at still later stages, he says, poses an even more formidable problem.[50]

Existing conjectures as to the formation of individual stars within a galaxy are based on the assumption of a condensing mass consisting exclusively of koinomatter. While these methods might be applied equally well to a system of antimatter, they break down disastrously when applied to a mixture of the two—presumably the realistic case. As the protostars contracted, bringing matter and antimatter particles closer together, annihilation reactions would soon blast them out of existence.

To overcome this Alfven has invoked an admittedly speculative mechanism by which koinomatter and antimatter become segregated into different regions of space separated by thin buffer zones of ambiplasma. Such, however, is a difficult feat to accomplish, and could well be analogous to the statistical improbability of spontaneously separating lukewarm water into regions of hot water and cold water. The separation of a mixture can be one of the knottiest problems of all, even when work is done on the system from the outside.

Alfven confesses that there are several problems involved here and that a systematic study of the question has not yet been undertaken.[51] The hypothesis is too new and unexplored yet to think in specific terms of when and where the supposed segregation might take place. Actually we are in a veritable wilderness of unknowns at this point because the observational data tell us so little.

We are uninformed, for instance, as to whether every second galaxy in the metagalaxy contains antimatter, or whether every second star in the galaxy contains antimatter, or whether the entire observable part of the universe contains koinomatter, with all of the antimatter placed at great distances in unobservable locations. Until it is known toward what finished product these segregation mechanisms are supposed to be working, it is rather futile to engage in any guesswork concerning the details of their operation.

We would submit that a large part of the trouble in devising an adequate mechanism for galactic evolution centers around the uphill nature of the process. Clearly we are attempting here to do the statistically improbable. Which, we would ask, is a more probable distribution of material—an undifferentiated mass of ambiplasma or an intricately structured galaxy with highly organized parts each performing their specific functions? We might ask equally well which is more statistically probable-a pile of stones or a stone house? The undifferentiated ambiplasma and the pile of stones are obviously the more probable structures.

The probability of a structure decreases as its organization increases. The natural direction for spontaneous processes, in keeping with the second law of thermodynamics, is from the less to the *more* probable. Therefore we are doing the statistically improbable at each stage of the supposed galactic evolution, and we are expected to believe that such has been happening for untold ages! As Williams has pointed out in his paper on entropy,[52] an occasional process that results in a more ordered, more complex product would be possible. But to postulate that a system would do the statistically improbable repeatedly over millions or billions of years is to betray a complete lack of belief in the second law!

Which Alternative?

If a person is bent on rejecting the facts of the Creation as revealed in the scriptures, we might ask which of the many schemes, specifically, he is going to put in its place. It is a most significant fact that every attempt, thus far, to bypass the book of Genesis sooner or later has run counter to some well-established scientific principle or principles.

However, even if a framework of cosmic evolution could be found that harmonizes with every known law (and this is undoubtedly impossible because of the entropy principle), there would be no guarantee that such was in fact what actually happened. And, more important, there would still be no accounting for the existence of the raw materials or the laws that governed their interactions.

Where *did* the laws of physics come from? *Is* there a naturalistic explanation? This question is probably just as vital as the less sophisticated problem of accounting for the material in the world that is so apparent to our senses. Did the laws of physics evolve from simpler laws? Did the Stefan-Boltzmann Law, which is a fourth power relationship, evolve its way up the evolutionary ladder by gradual stages from a first-power law? Did Coulomb's Law and Newton's Law of Gravitation, reasoning from their remarkable similarity, descend from a common ancestor? Such nonsense points up rather nicely the utter bankruptcy of the evolutionary approach in explaining one of the most important features of the universe-its orderliness.

All of the conflicting "scientific" cosmogonies do appear to agree on one thing—namely, that the Genesis account of origins is wrong. Aside from this one united front which they present, they oppose one another in countless ways. The cosmogonists have chosen to reject the witness of the one authoritative Source of information on the subject at hand. In so doing they have condemned their efforts to failure because of their ignorance of the basic axiom that "the fear of the Lord is the beginning of knowledge." (Prov. l:7a) And without Him there is no explanation of origins because "without Him was not anything made that was made. " (John l:3b)

What is the Universe?

Scientists are thoroughly stymied by the nature of the *present* world. Why should we speculate about where it came from when we don't even know what it is? A little reflection will serve to demonstrate that our ignorance is so great that we find ourselves mired down in the quicksand of conjecture merely attempting to describe our physical environment.

Let us consider the sub-microscopic makeup of things for a moment:

What is matter really made of? Atoms.

What are atoms made of? Subatomic particles.

Of what are these subatomic particles constituted? It is strongly suspected that each of these in turn possesses a complex internal structure. The neutron, for instance, apparently has a dense positive core surrounded by a negative meson cloud.[53]

Of what are these parts constituted? There are those who are satisfied with the explanation that each ultimate particle is a highly concentrated and localized bundle of energy.

But what is energy? Our stock definition that it is the ability to do work tells us nothing of its structure.

We do know, however, that it occurs in quanta. A quantum is a small bundle. Bundle of what? Energy!

Thus we are able to circumnavigate semantically in this realm without ever penetrating the **most vital problem** of all—namely, "What is the basic stuff of which we and the world we live in are made?". Stating the problem in another way, we may use atoms and fundamental particles to explain matter, but then we may not turn around and use matter to explain the atoms and particles. One is led, then, to the inescapable conclusion that there is a spiritual groundwork underlying the material world. " . . . and by Him all things consist." (Col. 1:17)

From the macroscopic point of view our ignorance of the universe is still more woeful. We might touch momentarily on the problem of gravitation. With all our fields, tensors, curved space, and other artificialities, we are still at a loss to explain why an object falls to the ground, or why the earth behaves as though it were swinging from the sun on a steel cable, when in fact the intervening space is practically a vacuum.

A hypothetical particle, the graviton, has been invoked to explain gravitation as an exchange force. But there is widespread pessimism concerning the prospects of verifying its existence, at least for the time being. We are not even sure now of the things we used to "know." For instance, the constant "G" in Newton's Law of Gravitation is suspected to change in accordance with the density of the universe.[54] If it can be shown that the laws of nature change, the principle of uniformity is apt to lose some of its popularity. A myriad of new question marks will then loom into view as we look back in time.

There are many other perplexing questions. What are the quasi-stellar objects and where are they located? Are the observed red shifts of distant galaxies due to the Doppler effect, some other effect, or both? Are portions of the universe composed only of antimatter? Does the universe, as is so often asserted, appear fundamentally the same to observers located at various points within it? How numerous are planetary systems? How do cosmic rays acquire such fantastic energies? It does not appear unreasonable to this writer to desire answers to these very basic questions concerning the present status of the cosmos, before embarking on a spree of conjecture concerning the remote past.

Limiting God

Were we to insist that one of the existing hypotheses must be the correct one, or even that some yet-to-be-devised scheme will in fact be the true one, we would be limiting God to the use of processes that we ourselves are capable of understanding, How utterly foolish and unrealistic! "For the wisdom of this world is foolishness with God." (I Cor. 3:19a) In fact, "the foolishness of God is wiser than men; and the weakness of God is stronger than men." (I Cor. 1:25) With an unlimited variety of methods and processes at His command, why should He restrict Himself to the use of only those few of which we have some awareness?

Having seen the failures of the various imaginations that have been engaged in apart from the Word of God, it is tempting to try to synthesize a picture of the Creation of the universe based on the scriptural clues to the methods God used. It is our belief, however, in view of the miraculous nature of the Creation, that such an endeavor would be as futile as trying to "explain" the feeding of the multitudes, the healing of the sick, or the raising of the dead. Were we able to explain such events they would, of course, cease to be miracles.

It is through just such great mysteries and wonders as these that God has demonstrated His power to mankind. "Great things doeth He, which we cannot comprehend." (Job 37:5b, also Job 9:10a) "For My thoughts are not your thoughts, neither are My ways your ways, saith the Lord. For as the heavens are higher than the earth, so are My ways higher than your ways, and My thoughts than your thoughts." (Is. 55:8, 9) "No man can find out the work that God maketh from the beginning to the end." (Eccl. 3:11)

Shifting Sand

If we can project into the future from what we have seen thus far, we may safely state that the present ideas will prove to be quite transitory. And not only is there a continual change within the field of cosmogony itself, but also within the individual cosmogonist. There is the ever-present struggle to bend an existing hypothesis to make it fit the newly-discovered facts, or, in other cases, an embarrassed disillusionment, the discarding of the former views and the initiation of a hopeful new synthesis. **Clearly, truth cannot be that flexible!**

Prof. Bondi makes the surprising admission, however, that such theories are not necessarily *meant* to be true! Their chief purpose, he states, is to be fertile—to provide new ideas for fruitful avenues of research.[55] But how many of the popular writers make the true intent of the theorists clear to the general public?

The *impression* that is almost always left with the reader is that such speculations constitute a "scientific alternative" to Genesis. With a steady diet of such material in the magazines and newspapers, it is small wonder that the man in the street is starting to look to nebulas, cosmic explosions, and creation fields as the source of his being, rather than the Creator God.

There was a day when the church had sufficient vitality to speak out forcefully against such blasphemy. Today, what "backbone" exists in the true church is limited to a few isolated pockets of resistance. Most disturbing of all is the manner in which many professing Christians take in these ideas and fondle them with such complete naivete, totally oblivious to their inherent dangers.

Why, indeed, should we be any more favorably disposed toward cosmic evolution than organic? Yet there are those among us who have compromised to the extent that "without form and void" is taken to mean a "vast undifferentiated nebula or dust cloud," and "let there be light" is interpreted as incipient thermonuclear reactions that have begun in the "baby stars" some several hundred million years later.

When we bend the scriptural account of Creation to fit some such artificial notion we are in grave danger of doing violence to its intended meaning. Such compromise can distort our thinking and mask the clear simple truths of scripture from our consciousness. There is no conceivable reason to be intimidated by a mere hypothesis.

Still, so many would rather take the easy route by retreating from a sound scriptural stand and attempting to accommodate the speculations of the day. How much more intellectually honest is the person who undertakes a critical study of the various hypotheses and learns to recognize them for what they are—guesswork perpetrated in the name of science.

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THE CREATION OF THE HEAVENS AND THE EARTH

JOHN C. WHITCOMB, JR.*

Sound Biblical basis is provided for belief in ***ex nihilo*** *creation, and statements are made as to why evangelical Christians need not consider that this view is philosophically "unhealthy," or that it makes God a deceiver.*

Following discussion of creation of the heavens and creation of the earth in separate sections, the author states his position regarding an extensive time interval between the first two verses of Genesis.

The author holds that the Genesis view that the earth was created before the sun, moon, and stars is in serious conflict with total evolutionary theory. He presents nine explicit reasons why the current astronomical idea that the earth came from the sun or from a proto-sun is not true. He closes with a section on the importance of stellar creation in God's eternal purposes.

Ex Nihilo Creation

The Word of God teaches that all non-living things were created supernaturally, instantaneously, and without the use of pre-existent materials. In the strictest sense, this is the meaning of Hebrews 11:3--"By faith we understand that the worlds *(aionas,* the time-space universe) were framed by the Word of God, so that what is seen hath not been made out of things which appear" (cf. Romans 4:17). This certainly cannot mean that visible material substances are composed of "invisible" atomic particles! Spiritual

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