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Some Observations on Current Cosmological Theories

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IT has been rightly said that there are fashions in science as in all other fields. This fact has been demonstrated lately by the large number of articles dealing with cosmological problems that have appeared in the last two years in both popular and scientific journals. There has been striking evidence of increased interest in cosmology, the study of the universe, and in cosmogony, the study of the origin of the universe and the world. One of the most popular programs of the British Broadcasting System in 1950 was a series of lectures on the origin of the world and the universe by Fred Hoyle of the University of Cambridge. These lectures were later printed in *Harpers Magazine*.[1] *Life* is currently running a series of articles on "The World We Live In." The first article was entitled "The Earth Is Born."[2] In recent lectures, widely reported in newspapers and in popular magazines, Nobel Prize winner Dr. Harold Urey of the University of Chicago has been explaining his "Recipe for Life." He develops the idea that life was formed on this planet and most likely on a "million billion" other planets throughout the universe by the action of ultraviolet light on a mixture of ammonia, methane, and water vapor.[3]

References to articles and lectures of this type would be greatly multiplied were one to offer a complete bibliography of such articles. The significance of this type of cosmological speculation by famous scientists is not difficult for the Christian theologian to grasp. A common item of all these schemes for explaining the origin of the earth, the sun, and the entire universe is that they are set in conscious opposition to the narrative of a special creation by Almighty God. Nor ought we think that these theorists are purely

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objective scientists carried away by their pursuit of objective truth. Modern cosmologists are very much aware of the fact that they are crusading against Biblical accounts, although they do sometimes point to similarities between their theories and the Scriptural account of Creation. Dr. Urey has openly professed his disbelief in miracles. *Newsweek* quotes him as saying: "I don't say that the things I don't understand are miracles. I just don't understand them."[4] Still more explicit was Fred Hoyle in the closing paragraphs of his book on cosmology. He writes:

> Is it in any way reasonable to suppose that it was given to the Hebrews to understand mysteries far deeper than anything we can comprehend, when it is quite clear that they were completely ignorant of many matters that seem commonplace to us? No, it seems to me that religion is but a desperate attempt to find an escape from the truly dreadful situation in which we find ourselves. Here we are in this fantastic universe with scarcely a clue as to whether our existence has any real significance. No wonder that many people feel the need for some belief that gives them a sense of security, and no wonder that they become very angry with people like me who say that this security is illusory. . . . I should like to discuss a little further the beliefs of the Christians as I see them myself. In their anxiety to avoid the notion that death is the complete end of our existence, they suggest what is to me an equally horrible alternative. . . . What the Christians offer me is an eternity of frustration.[5]

The Christian pastor and teacher is thus confronted with a fresh and vigorous attack by materialists on the Bible and the faith of his people. In the name of science, theories are being advanced to show how one can account for the Universe and all its wondrous heavenly bodies without acknowledging the hand of the Creator. It is therefore of significance to consider in some detail current cosmological theories with a view to discerning their weaknesses and errors.

There are those in our culture who might conceivably shrink back from seemingly so formidable a task. In his book *Science Is a Sacred Cow,* Anthony Standen states:

> Our world has become divided into the scientist, the infallible man of reason and research, and nonscientists, sometimes contemptuously called "laymen." The dividing line is drawn by the

fact that science has achieved so much, while the layman knows so little—not enough, certainly, to argue back. He might not even want to argue back, for the claims of science are extremely inviting, and a mere layman, his imagination stupefied by these wonders, is duly humble. Since it is only human to accept such flattery, the scientists easily come to share the layman's opinion about themselves. The laymen, on the other hand, get their information about scientists from the scientists, and so the whole thing goes round and round.[6]

In our opinion, Standen is quite right. Science has been made a sacred cow by many. Nevertheless it is obvious, even to the casual observer, that the cow has feet of clay. Despite the respectable and notable advances that science has made, there have been many mistakes, and there remain many unsolved mysteries. This in itself is not surprising; it is inevitable. But it serves to teach the valuable lesson that the "findings" of science should be scrutinized carefully and not accepted with quiet resignation.

For example, for long years now geologists have taught with great assurance that the formation of oil is an extremely slow process that requires millions upon millions of years. In 1934 a formidable team of scientists attacked the problem of determining whether oil might not be constantly forming at an appreciable rate in new marine sediments today. The result of the study was a rather definite negative and seemed to lend support to the idea that oil takes millions upon millions of years to form. So it was with some degree of shock that geologists noted the discovery of Dr. Paul Smith, Jr., of Standard Oil Co., who recently announced that oil is even now being formed in appreciable amounts in offshore muck and silt. Dr. Smith succeeded in demonstrating this by using the newly developed techniques of chromatography and radio-carbon dating. But the results were none the less embarrassing to a good many people.[7]

Moreover, it can be shown that astronomers are not immune to mistakes. At one time they claimed that an analysis of the light from the sun gave definite evidence of an element on the sun which was not on the earth. Its so-called spectral lines were different from any of the known elements. They christened the strange element *Nebulium*. It remained for the chemists to look into the mystery and to find that the mysterious lines were simply a mixture of the lines of oxygen and nitrogen in an ionized (highly excited) state.[8]

Many other astronomical opinions have been revised in recent years. At one time it was estimated that the universe was at least five trillion years old. That figure has now been revised to range from two to four billion.[9] While this is still far outside the indications of Scripture, it is quite a magnificent reduction in the right direction, since they have lopped off 4,996 billion years. Currently it is being stated that the earth shows evidence of being younger than many of the stars in our own Milky Way.[10] The universe was recently calculated to weigh ten times as much as was formerly estimated and to be much larger than previously thought.[11 12]

Moreover, it seems obvious that astronomers are having difficulties with comparatively simple problems that are, so to speak, almost in their laps. Many have long desired to know whether the amount of sunlight that the earth receives varies to any measurable extent. Last November it was announced that an astronomer named Gilcas, who works for the U. S. Air Force, had reported that three years of measuring solar energy as it is mirrored off the planets Neptune and Uranus justify the conclusion that there is no appreciable variation in solar energy. However, Dr. Abbot, former director of the Smithsonian Institute, is on record to the effect that there is as much as a five-per-cent variation in solar output. He bases his conclusions on data from observatories located all over the world where solar energy is measured directly as it comes from the sun. It is interesting that the two astronomers, each measuring the same thing, each using a different but apparently reliable method, arrived at very different conclusions.[13]

Early Theories of Cosmogony

Modern theories regarding the origin of the solar system can be traced to the philosopher Immanuel Kant, who published his *General History of Nature and Theory of the Heavens* in 1755. Kant postulated that the solar system had developed from a tenuous, homogeneous gas that extended throughout the space now occupied by the planets. Kant's theory is strikingly similar to those being developed today. However, it has never received so much attention as has the theory of Pierre Simon de Laplace, set forth some fifty years later. Laplace's Nebular Hypothesis stated that in the beginning the solar system was a great nebula or gaseous body. It was at a very high temperature, rotating rapidly, and flattened at the poles as a result of its rotation. As it cooled, it contracted. This contraction caused it to rotate faster and faster. Finally centrifugal force caused the rotating mass to bulge around its equator. The bulge grew until finally a ring of matter shot off into space. Several rings were shot off in this manner. Each in turn formed a planet. The central mass shrank until it became the sun. The planets continued in their rotation about this central mass. Thus the solar system was formed.

Laplace's theory went unchallenged for a century. However, it was finally discarded and is of only historical interest today. The nebular hypothesis was defeated primarily by the consideration of a simple principle of classical physics. Since most of the mass of the solar system is in the sun and very little is in the planets, the sun should have most of what is known as the angular momentum of the solar system. However, the planets, because of their great distance from the sun, have 98 per cent of the angular momentum of the solar system, leaving the sun a mere 2 per cent. This would not be the case had the solar system been formed in the manner suggested by Laplace. There are other considerations against the thesis. For example, Jeffreys and others have shown that a ring of matter equal in mass to the large planet Jupiter would not be gathered into a ring by gravitation, but more likely would break up into small bodies.[14]

The theories that followed the ill-fated nebular hypothesis may be grouped under the heading of "Encounter Theories." They postulated that the sun originally had no planets. However, a great star came from outer space and passed very close to the sun. According to Chamberlin and Moulton, who proposed the theory in 1905, the star's attraction released eruptive forces within the sun which caused great quantities of matter to be shot out from the sun. Some formed smaller bodies which were gradually swept up and became a part of the planets.

This original encounter theory had certain weaknesses that caused later theorists to modify it. In the "tidal theory," developed by Jeans, it was assumed that the near approach of the star caused a great filament of material to be drawn off the sun by gravitational attraction. This filament was like a great cigar in shape. It eventually broke up into a string of separate masses, forming the planets.

In 1929 Jeffreys modified this theory to the extent of stating that the star must have actually collided with the sun and torn a great filament of material from it. This met some of the objections to the earlier forms of the theory, but still failed to account for that important "angular momentum." The planets are simply too far away from the sun to have been formed in such a way. For the farther away from the center of rotation a body is, the greater its angular momentum. To understand the great distance of the planets from the sun, we may consider the description given by Hoyle:

> Think of the solar system as a model in which the sun is represented by a ball about the size of a large grapefruit. On this model the great bulk of the planetary material lies at a hundred yards or more from the sun. In other words, nearly all the planetary material lies very far out. This simple fact is already the death blow to every theory that seeks for an origin of the planets in the sun itself. For how could the material have been flung out so far? It was proved, for instance, by H. N. Russell that if Jean's well-known tidal theory were right, the planets would have to move around the sun at distances of our model of not more than a few feet.[15]

To get around this difficulty, the English astronomer R. A. Lyttleton assumed that the sun originally was a double star. A passing star collided with the sun's companion. As the two colliding bodies rebounded after the collision, they dragged out a ribbon of material between them. The two bodies went off into space, leaving behind a ribbon of material which condensed into planets.

Lyttleton's theory suffered from the weakness that it postulated an extra sun for which there is no evidence of any kind. Furthermore, it still had the weakness inherent in the fact that in the greatness of space the chance of a star coming close enough to this extra sun to do the damage postulated would be very small indeed. However, Lyttleton's theory did show a way to get the planets far enough from the sun to account for the observed angular momentum. But in March, 1940, H. N. Russell published an article describing the findings of Dr. Spitzer at Harvard. Spitzer, applying the knowledge of modern physics concerning the behavior of gases and the radiation of energy, concluded that the great filament of material spun out by the two colliding bodies of Lyttleton's theory would never have condensed into planets. Spitzer calculated that expansion would win the race between the cooling of the hot gas and its expansion. Russell stated: "The disparity between these two numbers is so great that there is no room for doubt that an actual filament of gas would expand so fast that it would never be able to check itself, long before cooling produced any perceptible effect." [16] So one must conclude that such a filament would spread itself out through space, but would not form planets.

Emergence of the Dust-Cloud Theory

1. *Von Weizsäcker — A New Approach*

During the 1940's astrophysicists attacked the problem of devising a new hypothesis to fill the embarrassing vacuum created by the proved inadequacy of the encounter theories. In 1944 C. F. von Weizsäcker of the Max Planck Institute, Göttingen, Germany, published a paper setting forth a new theory. Weizsäcker's theory was received in this country with much interest. Since the war had cut off the flow of scientific journals from Germany, a summary of the new theory was published in this country by G. Gamow and J. A. Hynek.[17] They hailed the new hypothesis as a fresh start on the difficult problem of cosmogony. It introduced new concepts of solar evolution, concepts capable of theoretical analysis.

Weizsäcker's theory is based on the observation that interstellar space apparently contains an astonishing amount of material in the form of gas and dust particles. Photographs of certain far-off groups of stars show large black areas in front of some of these nebulae. Astronomers have concluded that these spots are vast dust clouds, each containing about enough material to form a star and spread out over an area of the approximate size of our solar system.[18] The Dutch astronomer J. Oort has calculated that the total mass of interstellar gas in the universe is as great as all the material in all the stars. Yet it is reported to be scattered more thinly than the molecules of residual gas in the highest vacuum obtainable in a laboratory on earth.

Weizsäcker postulated that a star is formed when a great cloud, or nebula, of this interstellar gas and dust condenses into a compact mass. Planets, such as our earth, are formed from portions of the cloud that are on the outer periphery of the cloud from which the mother star is formed. Weizsäcker began his detailed account of his theory at that point in the evolution of the star known as the sun when a large primitive sun was already in existence. This was assumed to be fairly well developed and surrounded by a rotating shell of gas and dust containing approximately one tenth as much material as is in the sun today. In this large and diffuse cloud, each particle of matter was revolving about the sun in an elliptical orbit.

The great solar dust cloud is said to have been in the shape of a great disk. The material in the disk was of the same composition as that of the sun today. That is, ninety-nine per cent of the total mass was made up of the very light gases hydrogen and helium. The remaining one per cent was made up of heavier elements which were formed at an earlier time from primeval hydrogen and helium. Thus there was a great rotating stream of gas, intermingled with a much smaller quantity of solid particles. The temperature was not high. He theorizes that it was about the same as present planetary temperatures. Thus the formation of the planets was a relatively cold process, and the heavier elements were in the form of solid particles. As the disk rotated year after year, the light helium and hydrogen were dissipated into outer space, but the heavier particles condensed into solid bodies known today as the planets. Weizsäcker computed that this process took approximately a hundred million years.[19]

The chief problem that confronts the author of such a theory is to demonstrate that such a process could actually have taken place. That is, he must show that it is theoretically possible. For, as we shall see later, it is impossible to actually prove from observed facts that it did take place or that it is taking place in the universe today. Weizsäcker's proposal is that such a condensation took place in the cloud as a result of the combined effects of rotation and turbulence.[20] As the particles rotated around the sun, they had different angular velocities, depending on how far they were from the sun. This produced turbulence. The gas did not flow in a smooth fashion, but in a violent, tempestuous way. It broke up into distinct and separate eddies. Thus various parts of the gas and dust were shoved into closer contact. As the particles collided, they stuck together and gradually grew into larger particles by an accretion process. Eventually smaller eddies formed on the surface of the large eddies. These acted like "roller bearings" within the system. All of the eddies absorbed extraneous matter as they revolved. But the "roller bearings" built up to solid masses most rapidly.[21] Eventually certain large particles grew so large that they picked up everything that came within their gravitational attraction. Thus they cleared huge paths through the solar nebula. This process is said to have continued until the gas-dust cloud was depleted and the planets were formed. The satellites (moons) of the various planets were formed in essentially the same sort of process from the clouds that surrounded the early planetary masses.

Despite the fact that Weizsäcker's ingenious theory was proposed just nine years ago and was supported by impressive mathematical formulas and calculations, astrophysicists have now judged that "it must be abandoned."[22] In an article that appeared as a part of a symposium commemorating the fiftieth anniversary of the Yerkes Observatory, G. Kuiper pointed out certain basic weaknesses in Weizsäcker's theory which forbid its acceptance today.

As in the case of all such hypotheses, the element of time is of crucial importance. Weizsäcker himself has acknowledged that the nebula around the young sun eventually diffused into out space. But he attempted to show that the condensation of about one per cent of this cloud into the bodies known as the planets took place before the raw material blew away. However, Kuiper judges that Weizsäcker's mathematical conclusions are invalid. He has demonstrated that the condensation process, if it took place at all, would require thirty million years to form a small body of the size of our moon. On the other hand, Kuiper has also shown that in one third this time the nebula would have diffused itself into outer space, effectively stopping the condensation process. Kuiper states: "In view of the computed lifetime of the solar nebula, the process of planetary condensation appears barely possible."[23] He has also demonstrated that before the gravitational attraction of the growing bodies could be of help in speeding up the process, the bodies would have to be as large as the moon. But by that time the solar nebula would have been hopelessly scattered into outer space.

Kuiper attacks Weizsäcker's hypothesis on still another score. He points out that Weizsäcker's accretion formula is "highly idealized." He states that the implicit assumption behind the German physicist's theory is that the colliding particles of dust will stick together when they collide. Yet it is known that this is not true in general. Such a phenomenon does not take place, for instance, in terrestrial dust storms. Even very cold snow or hail does not combine in the air. He admits that Weizsäcker's formula of accretion may apply under certain very special conditions, but he insists that it would not operate as Weizsäcker has postulated. The particles would not stick together and form ever larger lumps of material.

Weizsäcker's system of "roller-bearing" eddies of gas and dust has also come under fire. A vital requirement of the theory is that a regular system of vortices must remain intact during essentially the entire period of planetary accretion. This is due to the fact that the planets all have regular motion, i.e., revolve in the same direction. In considering this phase of the theory Kuiper judges: "It is difficult to conceive that the beautiful system of vortices could actually have been in existence long enough — even for 10 or 100 years — to get the condensation of the building material for the planets under way."[24] Yet the proposed scheme demands not a hundred years, but millions.

Other weaknesses in the theory have been revealed by recent advances in hydrodynamical theory. One of the early claims for Weizsäcker's scheme was that it accounted for the definite arithmetical ratio governing the spacing of the planets from the sun (Bode's Law). However, it has now been recognized that Weizsäcker's theory in reality is based upon the empirical knowledge of Bode's Law and provides no theoretical explanation for it.[25] S. Chandrasekhar has also referred to the fact that Weizsäcker's theory is not in accord with present theories of turbulence. Nor does he feel that the science of turbulence has advanced far enough for anyone to draw definite conclusions. Chandrasekhar states:

> We cannot make bricks without straw. It is equally true that we cannot construct a rational astrophysical theory without an adequate basis of physical knowledge. It would therefore seem to me that we cannot expect to incorporate the concept of turbulence in astrophysical theories without a basis theory of the phenomenon of turbulence itself. It appears that the first outlines of such a physical theory are just emerging.[26]

It should also be noted that Weizsäcker's theory shares with other such schemes the fundamental weakness that it is not susceptible of direct proof. The nature of the process and the vastness of the universe is such that many astronomers are of the opinion that we are unable to check and see whether there are other star systems in which a planetary system is evolving out of a gas cloud. When Gamow and Hynek reviewed Weizsäcker's new hypothesis in 1945, they immediately pointed out that it would have to be judged on "other than observational grounds."[27] Kuiper points out that we are not even in a position to observe whether or not our sun is the only star that has planets. He states: "No other planetary systems are known to us, nor could they be."[28] Hence such ideas as Weizsäcker's remain in the field of speculation.

There are, however, certain astronomical facts known from observation which do militate against Weizsäcker's idea. Weizsäcker himself recently admitted that the existence of so much interstellar material in the vicinity of our sun, together with the fact that he can find no evidence whatever of stars being formed now from that material, constitutes a paradox. He hazards a guess that the presence of stars already formed prevents the condensation of any more of the interstellar gas.[29] But this is a poor defense. Greenstein, astronomer at the Mount Wilson Observatory, is of the opinion that the known stars rotate so fast that one must conclude that they could never have been formed by a condensation process.[30]

Despite these objections and others, Weizsäcker's theory has exerted tremendous influence on the work of other cosmogonists. An examination of current writings in the field shows this to be the case. Nevertheless it is obvious that this theory too has been rejected and passed by. It thus shares the fate of the earlier cosmogonies.

2. *Whipple and Spitzer — Light Pressure*

In 1948 the American astronomers Whipple and Spitzer proposed a new hypothesis.[31] They suggested that dust clouds under unusual conditions might be forced into larger clouds by the pressure of light from adjoining stars. They based this idea on the theory that it is light pressure that causes comets to form tails by forcing fine material away from the head of the comet. Applying the same idea to dust clouds, they postulated that light pressure might cause these clouds to slowly come together until finally the particles would be close enough for gravity to become effective and pull the body into a still more compact mass. It was proposed that such a cloud might collapse and form a star in something less than a billion years.

Spitzer and Whipple were immediately confronted by the perpetual problem of explaining why all the material did not form just one sun, without any planets being formed. How was it that the planets were formed at great distances from the sun? Like Weizsäcker they attempted to meet this difficulty by assuming that there were streams in the dust cloud. There was turbulence, constant motion. This, they thought, would account for the formation of planets through the condensation of concentrations of dust at various parts of the cloud. Some of these planets would be captured by the gravitational attraction of the sun; others would remain outside and finally form the planets as we have them today.

The originators of this theory were not blind to its drawbacks. It does not account for the spacing of the planets at their proper distances from the sun. These spacings, as Titius and Bode pointed out in the 18th century, follow a definite arithmetical rule. Secondly, it does not account for the retrograde motion of some of the moons of the planets. Three moons of Jupiter, one of Saturn, and that of Neptune revolve in a direction opposite that of their parent planets. This is a question that has bothered all the theories from the very beginning. And the dust-cloud hypothesis does not solve the problem. Whipple felt constrained to postulate that these moons were captured later by the planets when it was too late to change their spin, but this is a weak answer and has always been recognized as such. Finally, Whipple admits, the chief difficulty of the theory has to do with the question of how the protoplanets maintained themselves during the early stages. At that period dust clouds had to be very rare, their average density being more nearly a vacuum than is the vacuum in a thermos bottle. Yet they had to hold together sufficiently to pick up material from the rare spaces between them, and they had to be massive enough to grow and not spiral in toward the sun. Such a situation is difficult to imagine.[32] We might add that it also suffers from this difficulty: if one extends the idea to the very beginning, how were the first stars formed, those stars whose light was needed to drive the cosmic dust close enough together so that gravitational forces could take hold?

Despite these difficulties the dust cloud hypothesis as developed by Weizsäcker, Whipple, Spitzer, and others is today the ruling theory. In one modified form or another, modern cosmogonists use this concept. This will be evident as we now look at a few of the theories of this decade and attempt to evaluate them.

Representative American and English Cosmogonists

1. *Urey — the Cold Process*

Dr. Harold Urey, professor of chemistry in the Institute for Nuclear Studies of the University of Chicago, is among the more prominent American theorists, and is hailed today as the founder of a new science known as "Astrochemistry." The essence of his theory is contained in his recently published book, *The Planets, Their Origin and Development,* and in numerous articles and lectures.[33]

Urey's theory is based, to a large extent, on the work of the astronomer Kuiper, whose book *The Atmosphere of the Earth and the Planets* was also published last year. It starts out with a vast cloud of dust and gas in this particular region of space. Gravitational forces are said to have compressed the cloud after starlight had driven it close enough together. In some way the sun was formed in the center of this mass. Urey confesses that he is not clear on how this was brought about. Around this sun there wheeled a great cloud of dust. As it whirled, it broke up into eddies. At points of high concentration protoplanets formed.

Thus far Urey's theory is not distinctive. But at this point he emphasizes a "cold" process of formation. Urey is convinced that the earth was never so extremely hot as other theorists suppose. He thinks that if the earth had ever been in a molten condition, all of the iron would be in the center of the earth and much more sandy material (silica) would be in the outer part. He also points to astronomical evidence indicating that Mars contains about thirty per cent iron and nickel with a nearly uniform chemical composition. Urey concludes from this that Mars could never have been in a molten state.

Carrying through this "cold" motif, Urey postulates that the simple chemical compounds, water, ammonia, and methane (natural gas), condensed in various bands or regions of condensation in the cloud. This produced a sticky, mushy medium, which greatly speeded up the process of accumulating enough material to make a planet such as the earth. Urey recognizes the basic weakness of the dust cloud hypothesis, namely, that colliding solid particles of dust or smoke would bounce off one another or be shattered on impact rather than stick together and form enough of a lump of material to make a planet. Hence he takes advantage of the idea that the earth was most likely not molten at the time of its formation. This allows him to suppose the existence of a slushy snow of condensed gases that acted as a sort of glue to hold the material together. The temperature is thought to have been at about the freezing point of water.

Urey believes that at a later date the temperature of the earth rose to a level high enough to melt iron. This presumably was due to the effect of gravity as it crushed together the condensing material. As a result of this high temperature many of the lighter gases picked up enough energy to escape the gravitational attraction of the earth. Thus he seeks to solve the problem posed by the small amount of hydrogen gas in the earth's atmosphere today. The heavier gases, such as nitrogen, carbon dioxide, oxygen, and water did not escape, since they were heavy enough to be held by the earth's gravitational attraction.

The final step was the evolution of life on the earth, after the surface of the earth had lost most of its heat. Urey supposes that ultraviolet light from the sun caused ammonia, methane, and water molecules to rupture and recombine into more complicated compounds. This was repeated until one day there was born a "conglomeration so well organized that it could gobble up its neighbors, make replicas of itself, and do a bit of breathing. This, the first microbe, survived and multiplied. Its breathing, photosynthesis, introduced free oxygen into the atmosphere. And its progeny were plants and ultimately animals." [34]

It is obvious that Dr. Urey does not lack imagination. But the question is, What shall we say as to the possible validity of his theory?

It is best to start our critique by listening first to an admission by Dr. Urey. He states:

> None of us was there at the time, and any suggestions I may make can hardly be considered as certainly true. The most that can be done is to outline a possible course of events which does not contradict physical laws and observed facts. For the present we cannot deduce by rigorous mathematical methods the exact history that began with a globule of dust. And if we cannot do this, we cannot rigorously include or exclude the various steps that have been proposed to account for the evolution of the planets. However, we may be able to show which steps are probable and which improbable.[35]

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

But Urey, for one, has not yet won the game. He himself admits that his theory has no logical, reasonable way of accounting for the formation of the sun. If a mass started condensing, if enough condensed to form the sun, what stopped the process from continuing so that the entire mass of material did not form one large body? After all, the sun makes up 99$\frac{6}{7}$% of the mass of the sun and planets combined. Why did that paltry $\frac{1}{7}$ of one per cent not fall into the main body also? This is a serious question, one that has not been answered.

Prof. Otto Struve, of the University of California, raises other objections to Urey's theories. In a review of Urey's book he states:

If the solar system was formed from a cloud, should we not expect to see some traces of similar nebulae in connection with other solar-type stars? A nebula with an average density of 1/1,000,000 of a gram per cubic centimeter would have ten[36] atoms, mostly of hydrogen, in every cubic centimeter. If such nebulae are really numerous, there must be some whose planes are in our line of sight. We would then be observing their central solar-type stars through a screen of ten[37] centimeters thick. We should be able to detect such a nebula. . . . The fact that we have not done so, indicates that it rarely occurs in our galaxy, or, if it is common, lasts only a short time.[38]

In other words, there is no evidence to support Urey's extravagent claim that he would not be surprised if life existed on about a million billion planets other than the earth.

Struve pointed out other objections. He noted that Urey did not provide a time scale for the various condensation and evaporation processes he postulates. This is a serious weakness, for astronomers feel more and more that the universe isn't old enough to squeeze in too many of these theorized processes. Struve also points out the similarity between Urey's theory and the accretion mechanism proposed by Hoyle, Lyttleton, and Weizsäcker. These theories have been seriously criticized. Therefore Struve points out that Urey's use of them should not be taken as an indication that they are anything more honorable than pure assumptions. He finally makes this statement concerning Urey's book: "It contains many uncertain conclusions and in some places arouses doubt and disbelief."[39]

It is interesting to look at the criticisms Fred Hoyle, the Cambridge cosmologist, raises against this type of theory. His first point is the objection noted by us above; it does not account for the origin of the sun in a satisfactory fashion. Hoyle states:

The planets, they said, were not formed from the sun in a state as it is at present, but at the time when the sun had a vastly greater size, as it must have had when it was condensing out of the interstellar gas. But it is hard to see how this can help. To make it work at all, it would be necessary to demonstrate that a blob of primeval gas, the interstellar gas, could condense in such a way that the great bulk of it went to form a massive inner body — that is to say, the sun — surrounded at vast distances by a wisp of planetary material. And I do not think that this can be done. At any rate, all the attempts that have so far been made to cope with the difficulty seem to me to fall very short of the mark.[40]

A second and equally important point is made by Hoyle when he calls attention to the fact that the relative abundance of the various chemical elements in the sun is tremendously different from the terrestrial abundances. He says:

> Apart from hydrogen and helium, all other elements are extremely rare, all over the universe. In the sun they amount to only about one per cent of the total mass. Contrast this with the earth and the other planets where hydrogen and helium make only about the same contribution as highly complex atoms like iron, calcium, silicon, magnesium, and aluminum. This contrast brings out two important points. First, we see that material torn from the sun would not be at all suitable for the formation of the planets as we know them. Its composition would be hopelessly wrong. And our second point in this contrast is that it is the sun that is normal and the earth that is the freak. The interstellar gas and most of the stars are composed of material like the sun, not like the earth. You must understand that, cosmically speaking, the room you are now sitting in is made of the wrong stuff. You yourself are a rarity. You are a cosmic collector's piece.[41]

We may well observe that even though Hoyle is an agnostic, his observations give striking support to the manner in which the Bible treats the earth as of primary importance.

But perhaps the weakest point of all of Urey's theory is his bland assumption that the complex materials that make up living cells synthesized themselves from simple molecules of water, marsh gas, and carbon dioxide under the influence of ultraviolet light. It is a known chemical fact that ultraviolet light does cause certain chemical reactions and recombinations. But these are of the nature of a child building a tower of blocks versus the problem of the construction of an atomic-powered submarine, when you compare these simple compounds of hydrogen, carbon, and nitrogen with the complex protein molecules which are the simplest parts of living things but are nonetheless so complicated that the most skillful chemist of our modern day is still not able to synthesize them.[42] Even if a protein were to synthesize itself, that would be far from enough. Cells, living cells, contain a fantastically complicated organization, including the complex nucleic acids which have the ability to reproduce themselves. Nor would the synthesis of one protein or of one cell be enough. The extraordinary process would have to repeat itself again and again. Those who are interested in studying the mathematical odds against life coming into existence on its own initiative, purely by chance, are referred to the interesting discussion in Pierre Lecomte Du Nouy's *Human Destiny* and *The Road to Reason.*[43, 44] But perhaps the most painlesss way to see how far man is from establishing the plausibility that the miracle of life could have performed itself is to reflect on this, that while Urey is setting forth his theory of the origin of life, he admits that he has now one lone graduate student assigned to bombarding a gaseous mixture of methane, water vapor, and ammonia with ultraviolet light. He will carry out the bombardment and then check to see whether any complex compounds are formed in accordance with the theory.[45] I believe that it is obvious, even to the nonscientists, that this is putting the cart before the horse. It is hardly scientific to make great propaganda for an idea and apparently place great confidence in it before even the most elementary experiments checking it have been carried out. But this unscientific attitude is all too common among scientists when promulgating their favorite evolutionary theory.

2. *Gamow's Theory — Primeval Light*

Another prolific American cosmogonist is George Gamow, Professor of Physics at George Washington University. Gamow's theory is not too much different from other dust-cloud hypotheses after the first half-hour of creation. But he packs a lot into a half-hour. He reasons that at time zero there were nothing but protons, electrons, and neutrons floating around. These are the most important of the fundamental particles of which matter is now made up. The temperature of this original material was extremely high. He has, of course, no explanation as to where this primeval material came from, nor how it became so hot. However, he thinks that it was at a temperature of many billions of degrees. As it cooled, it finally hit the point where these particles began to condense and form chemical elements. At the end of five minutes only a few of the simpler species, such as helium, were left but there was a tremendous amount of radiant energy present. Since this radiant energy is a form of light, Gamow refers to this as primeval light. From Einstein's equation for the equivalence of energy and mass, Gamow computes that this light was so heavy that it was of the density of iron. At the end of a half-hour most of the light had been converted into matter which formed a great cloud of gas and dust. He figures this existed about 30 million years before it cooled enough to begin to condense into stars and planets.[46] From this point on, Gamow follows the conventional ideas of modern cosmology.

In looking at Gamow's theory, one is, of course, struck by his emphasis on primeval light being prominent at the beginning, as in Gen. 1:3. There were those who scoffed not so long ago because light was mentioned in the Biblical account before the sun. But it is obvious that modern physics does not regard this as unreasonable at all. Also remarkable is that the main part of Gamow's scheme of creation takes place in from five minutes to a half-hour.

Gamow's theory, however, is not without its faults. Even Dr. Gamow acknowledges that "It is too early to say if this theory accounts for all observed facts."[47] He points out that one of the main difficulties is that no known nuclear process exists for building weights across the number five. Below that and above that atoms can in general be built up by neutron bombardment. But there is no atom of weight five which is stable. This means that the whole scheme falls because a rung in the ladder is missing. But this is not the only isotope, or chemical atom of definite weight, that causes trouble. There are some others farther up the ladder. They are the so called "shielded isotopes," which cannot be formed by beta decay after neutron bombardment.

Another weakness of the whole dust-cloud hypothesis is emphasized in Gamow's work. Gamow calculates that the great galaxies were formed in what for cosmologists is a relatively short time, namely 70 million years. But when he tries to compute how fast the supposed gas-and-dust cloud had to spin around like a whirlpool to make this come out right in the formula, it becomes necessary for him to postulate that the cloud was moving with a velocity of 3,000 miles an hour.[48] This is a rather striking postulate, but Gamow makes it without taking a second breath.

It is typical of the remarkable flights of imagination that cosmologists are willing to take, all without anything that resembles respectable proof. We are not alone in this conclusion. In the November, 1952, issue of *Scientific American*, Gamow's recent book, *The Creation of the Universe*, is reviewed. The reviewer states: "Its hypotheses are as high, wide, and handsome, not to say as varied and ingenious, as the breath-taking flights of poets and philosophers who have speculated on the subject since ancient times." [49]

But the basic weakness of all such theories is revealed by Gamow himself. He states:

> Another question pertains to the forces that caused the original expansion of the universe and the state of affairs which must have existed prior to the maximum stage of contraction which was the starting point of our discussion. . . . No information could have been left from an earlier time, if there ever was one. This conclusion is in complete agreement with the statement made centuries ago by St. Augustine of Hippo, who in one of his writings was trying to answer the question of what God was doing before He made heaven and earth. "He was making hell," wrote St. Augustine, "for the persons who ask that type of question." [50]

3. *Fred Hoyle — Continuous Creation*

Prominent among the English cosmologists is Fred Hoyle, of Cambridge University. His theories are set forth in a series of articles in *Harper's Magazine*, December, 1950, to April, 1951,[51] and in book form under the title *The Nature of the Universe.*

We have the space to consider only two distinctive features of Hoyle's system of cosmogony. The first is stated compactly by himself in the March, 1951, issue of *Harper's*:

> There was once another star moving around the sun that disintegrated with extreme violence. So great was the explosion that all the remnants were blown a long way from the sun into space with the exception of a tiny wisp of gas. . . . This gas at a far distance from the sun took the form of a rotating circular disk. The planets condensed out of the material of this disk.[52]

Thus at one stroke Hoyle gets the material blown out far enough to account for the vast distances of the earth and the other planets from the sun, and he accounts for the chemical composition of the earth. For, he says, the heat of the explosion was enough to cause simple hydrogen and helium to fuse into larger elements.

The fundamental weakness of this part of Hoyle's theory is not hard to spot. Kirtley Mather of Harvard University reviewed Hoyle's book in the July, 1951, issue of *American Scientist*. He states:

> Mr. Hoyle's book, although stimulating and informing, should be read with great caution. . . . He overreaches when he comes to hypotheses of stellar and planetary evolution and to speculations concerning matters that are at present beyond the pale of "fruitful" contemplation. . . . For example, he writes dogmatically that "there was once another star moving around the sun that disintegrated with extreme violence." No hint is given that this is a speculative idea, as yet hardly qualified even to be rated as a working hypothesis, because no means are at hand for applying rigid tests to its validity. Or again, he states that he "has described the way in which planetary systems like our own came into being." He should have said, "a way in which planetary systems like our own may perhaps have come into being." Similarly he "estimates" that there are at least 100,000 planets within the Milky Way, suitable as the abode of life, but only the alert reader will be aware that, concealed behind the apparently conservative mathematics, there is a precarious inverted pyramid of speculation after speculation, interlarded with slippery assumptions.[53]

Mather's criticism is pertinent and powerful. But Hoyle stands also self-condemned. For despite all his efforts to explain the formation of the universe by natural means without the help of God, he finally must make the following admission:

> I find myself forced to assume that the nature of the Universe requires continuous creation — the perpetual bringing into being of new background material. . . . The most obvious question to ask about continuous creation is this: Where does the created material come from? It does not come from anywhere. Material appears — it is created. At one time the various atoms composing the material do not exist, and at a later time they do. This may seem a very strange idea, and I agree that it is, but in science it does not matter how strange an idea may seem so long as it works — that is to say, so long as the idea can be expressed in a precise form and so long as its consequences are found to be in agreement with observation. Some people have argued that continuous crea-

> tion introduces a new assumption into science — and a very startling assumption at that. Now I do not agree that continuous creation is an additional assumption. It is certainly a new hypothesis, but it only replaces a hypothesis that lies concealed in the older theories which assume, as I have said before, that the whole of the matter in the universe was created in one big bang at a particular time in the remote past. On scientific grounds this big bang assumption is much the less palatable of the two. For it is an irrational process that cannot be described in scientific terms. . . . Perhaps you may think that the whole question of the creation of the universe could be avoided in some way. But this is not so. To avoid the issue of creation, it would be necessary for all the material of the universe to be infinitely old, and this cannot be for a very practical reason. For if this were so, there could be no hydrogen left in the universe. . . . Hydrogen is being steadily converted into helium throughout the universe, and this conversion is a one-way process — that is to say, hydrogen cannot be produced in any appreciable quantity through the breakdown of other elements. How comes it then that the universe consists almost entirely of hydrogen? If matter were infinitely old, this would be quite impossible. So we see that the universe being what it is, the creation issue simply cannot be dodged. And I think that of all the various possibilities that have been suggested, continuous creation is easily the most satisfactory.[54]

It is interesting to see what Hoyle's fellow scientists think of his theory of continuous creation. Dr. Gamow judges:

> Although such a hypothesis may be quite attractive from the philosophical point of view, it encounters serious observational as well as theoretical difficulties and should be taken at present with a good-sized grain of salt.[55]

We agree with Dr. Gamow, but would extend this judgement to the theories of other cosmologists and also to his own.

A fuller critique of continuous creation is undertaken by Martin Johnson of Birmingham University, England. He discusses "The Meanings of Time and Space in Philosophies of Science." He shows that everyone, scientist and philosopher alike, is driven to an "aesthetic or imaginative choice among three inconceivables, the start of space, of time, or of matter." Recent cosmologists, including Hoyle have chosen the start of matter. The reason Hoyle chooses to think of continuous, gradual creation, rather than instantaneous creation is a purely subjective one. Johnson states: "The difficulty of envisaging an instantaneous spring to a full universe makes it inevitable that some bold minds should take the initiative and propose that it will be less difficult to suppose matter as being continuously created always." [56]

But, as Johnson points out, this is a purely arbitrary choice, without any relation to what is known as science. Nor can the correctness of such a move be established. He states:

> The continuous creation of matter may be a fact, but it is not at present susceptible of proof; and it is possible that it is essentially not provable, since no direct discriminatory evidence exists and we have shown logically that its mandate is to fill a gap.[57]

From this it is evident that Hoyle's theory, as those of Urey and Gamow and of earlier cosmogonists, is full of unproved and unprovable assertions. Furthermore, it is apparent that anyone who takes upon himself the task of solving the problem of the origin of the earth and the universe is inevitably driven to make certain assumptions that are no more susceptible of direct proof than is the Genesis account of creation. One should not be deceived by complicated mathematics and other badges of scientific respectability. No theory is better or stronger than its assumptions. Without good grounds for accepting the assumptions, the whole structure hangs suspended in the sky by the thread of imagination.

This idea is put very beautifully by Johnson in the article referred to above:

> Having contended that science is inevitably tied to dealing with time, but is ultimately driven to aesthetic or imaginative rather than logical grounds for selecting the way to formulate time relationships, we return to the beginning of our enquiry with this hint that the physicist and the poet or moralist may in some ways be not so far apart as at first supposed. An imaginative decision is one demanding provisional settlement on grounds other than sense experience or analytical proof, and the physicist attempts to make such a settlement in all his uses of the cosmological principle. The poet and the artist make a similar decision when they accept the world as well worth the selection of memorable aspects expressible through supreme skill in pattern of word, sound, or visual art. Without such imaginative acceptance of

unprovable value, the never ending struggle to express the glory and the pity and the terror of life would fail and art and poetry would die — and science would never go beyond technology . . . . I have tried to show that the physicist is also driven to an arbitrary selection, on aesthetic grounds, of a method of treating his fundamental quantity of temporal order. None of these trespassers beyond logical proof need be ashamed so long as the tresspass is honestly committed and no more claimed than is just.[58]

Also of interest in this connection is the approach of Karl Heim, of the University of Tuebingen, Germany, in his recent work, *Die Wandlung im naturwissenschaftlichen Weltbild.* He demonstrates how the discoveries of modern physics have severely shaken at least three of the basic tenets of materialism: the object, absolute time and space, and causality. Nature has been shown to be more complex than anyone ever dreamed. One of the leading German physicists, C. F. von Weizsäcker, has taken refuge in Kant's transcendentalism. He has stated that true reality, "das Ding an sich," lies beyond the realm of observation. It is an unknown "x" which lies beyond all methods of observation.[59]

From all this a Christian pastor may draw the conclusion that he may with truth tell his people that current materialistic propaganda regarding cosmological theories is just that — propaganda, unsupported by fact! The Biblical account of creation by Almighty God has not been disproved by science. It remains today, even from the viewpoint of reason, I believe, the most logical, believable account of the beginning of the earth and the rest of the universe (Ps. 19:1).

Finally, we should not conclude that the study of the universe leads inexorably to materialism. Many a scientist sees the glory of God's handiwork as it is to be seen all about us. The English scientist Dr. W. M. Smart recently wrote:

When we study the universe and appreciate its grandeur and orderliness, it seems to me that we are led to the recognition of a Creative Power and Cosmic Purpose that transcends all that our limited minds can comprehend . . . to one astronomer, at least, the heavens are telling the glory of God and the wonder of His works! [60]

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