Volume 3
Print Reference: Pages 513-524

Article 49

1994

The Origin and History of the Solar System

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KEYWORDS

Solar System; Catastrophism; Age

ABSTRACT

Much has been written on the origin of the solar system from evolutionary points of view. These views assume only natural processes were involved and that the solar system is billions of years in age. The currently accepted view, the Modified Nebula Hypothesis, and the Capture Theory are critiqued in the light of evidence for a young solar system. A creationist approach is proposed which allows for intelligent design, an age of less than 10,000 years, and a major solar-system-wide catastrophe in the history of our solar system. Two possibilities for such a catastrophe are examined, a destroyed planet in the asteroid region and a debris cloud passing through the solar system. This approach is more successful in explaining the solar system than the usual naturalistic origins theories.

INTRODUCTION

The evolution-based models of the origin of our solar system have experienced difficulties which have not been fully discussed in introductory astronomy textbooks. Thus there is the impression that the origin of our solar system by the collapse of a huge cloud is a completely settled issue. This gives the impression to astronomy students that long periods of time are essential, and that such nebula ideas cannot be questioned. This approach is not a good pedagogical practice considering the many limitations of solar system origins models. Also, this approach presumes a naturalistic philosophy and conveniently agrees with the relativistic values of our time. Many people trained in science incorrectly assume that this naturalistic approach is *necessary* in science.

Creationists, however, approach scientific observations with different presuppositions. To a creationist there is no a priori reason why scientists must explain things using only natural processes. Experimental science limits itself to considering only natural processes; the study of origins does not have this limitation. Supernatural processes are admissible to a creationist since he believes that a transcendent personal Creator-God was present before all else. However, most creationists would agree that supernatural processes were used primarily at the beginning. Creationists believe natural forces alone are insufficient for explaining first origins. The study of astronomy has long been very inspiring to Christian believers because it points us to the greatness of the God who made us all. The scientific implications of the creation view can be examined on their own merits, apart from the spiritual implications. But it is a tragic thing to be knowledgeable of all that the Creator-God made and yet completely miss the significance of it because of misunderstanding its origin. The study of these questions is not just facts and figures, it challenges us to consider the Creator and what His creation is revealing to us about Him.

The Creator-God is not limited merely to the familiar things we know of on Earth. There is an amazing variety in the worlds that exist in our planet's "neighborhood." Great extremes of all kinds are present, some of which indicate catastrophic events on a scale difficult for us to imagine. Close study of these worlds shows the great uniqueness of the Earth. Indeed it seems the Creator has been relatively gentle with the Earth, considering the evidence of catastrophes which have occurred elsewhere in the solar system. As Isaiah 45:18 says, "He did not create it to be empty, but formed it to be inhabited."

Three ideas have guided the author's study of the solar system: 1) that there is evidence of intelligent design, 2) that the solar system is less than 10,000 years in age, and 3) that some major catastrophe occurred in the past that affected much of the solar system in a relatively short time. Hints of such a solar-system-wide catastrophe include craters, the asteroids, planetary rings, and other observations. It is critically important in this study to pull together many different types of data. Catastrophes to be considered in this paper will be 1) an impact with a hypothetical tenth planet in the region of the asteroids, and 2) a debris cloud passing through the solar system.

Before addressing the question of a solar system catastrophe, some historical comments will be followed by a critique of two evolution-based models. It is important to briefly survey evidence for the solar system being young as well. Many processes relied on by planetary scientists require great periods of time, far more than 10,000 years. Insisting on the solar system being this young places constraints on what processes are plausible in explaining the characteristics of the various objects. A variety of facts will be related to a creation view of the history of the solar system. Assuming a young system and that there was a solar system catastrophe has advantages for explaining a number of observations. To an evolutionist the mystery is the origin of the solar system, but to a creationist who believes in an omnipotent God the mystery is its history, not so much its origin.

The History of Origins Models

In spite of some sophisticated modern modifications, the accepted model for the origin of the solar system is much like the "Nebula Hypothesis" proposed by Pierre Simon Laplace in 1796. Various criticisms arose of Laplace's hypothesis, prompting some to suggest models more catastrophic in nature. In 1917 Sir James Jeans proposed what is known as the Tidal Theory, which was the accepted view for a time. In the Tidal Theory a very massive star passes near our Sun, which had supposedly already formed by condensing from an interstellar nebula. Then the passing star causes a filament of matter to be pulled off the Sun, which would then break up into segments due to gravity. Serious problems were found with this theory as well, which even Jeans eventually conceded. The problems with the Tidal Theory led scientists in the 1930s and 40s to work on more complex approaches to the Nebula model.

Today most ideas from planetary scientists are virtually the same as ideas of the 1960s and 70s. Today solar system origins theories can be thought of as of two general classes, the Modified Nebula Models and Catastrophic Models. Modern "Nebula" ideas incorporate principles of plasma physics as well as theories on the evolution of our Sun. The Nebula models utilize the slow gradual approach in which the Sun, the planets, and all other objects condense from an interstellar nebula. The competing view to this today comes mainly from Michael Woolfson and John Dormand and is known as the Capture Theory [8]. The Capture Theory could be loosely described as the reverse of the Tidal Theory, with additional effects from a major collision of two planets.

Assumptions and Limitations of Today's Theories

Experts in planetary science have expressed concerns about the assumptions and limitations of today's theories. Modern Nebula models emphasize uniformitarianism, applied to the solar system. The Nobel prize winning astronomer Hannes Alfven makes this point very clearly [1, p.27]:

> This 'actualistic principle' which emphasizes reliance on observed phenomena, is the basis for the modern approach to the geological evolution of the Earth; 'the present is the key to the past.' This principle should also be used in the study of the solar system.

H. Reeves, writing the lead article in an important book on the origin of the solar system, calls the Nebula Model the theory with the "best fit" to the observational data. Reeves then makes the following comments [18, p.1-3].

> How much confidence can we place in this 'best fit' theory? Not very much.
>
> I will reconstruct the sequence of events leading to the formation of the solar system, choosing the chronological stages which seem to me to be the most likely. Even so the argument is highly speculative and some of it borders on science fiction.

If experts who have done extensive research directly related to origins make comments like this, then it is not appropriate for astronomy textbooks to treat the subject dogmatically. Textbooks are seldom written to give a balanced perspective on the various origins explanations.

Nebula models are meant to explain how a gigantic cloud in space, such as we observe, can contract and condense into our Sun, planets, over 60 moons, as well as thousands of asteroids and other small objects. Interstellar clouds are found to be rotating and possess a weak magnetic field. Some nebula models rely on the matter to come from the interstellar medium itself, rather than from a nebula. H. Reeves summarized the problems associated with forming coherent bodies from interstellar material. Three important problems are that "The clouds are too hot, too magnetic, and they rotate too rapidly" [18, p.9].

Because ideas based on uniformitarianism rely on natural processes such as gravity, gas pressure, magnetic effects, and collisions, each type of model predicts certain patterns. Standard Nebula ideas, for instance, led scientists to expect that the moons of Uranus and Neptune should not show much evidence of past geologic or tectonic activity. These moons were expected to have dull uninteresting surfaces as a result. This was due to the fact that small objects radiate heat more rapidly than larger ones and the temperatures at the time of formation would have been very cold at the distances from the Sun where Uranus and Neptune are found. Since planetary scientists assumed these moons to be very old (about 4.6 billion years), they reasoned that there should not be enough heat energy in the interiors to drive significant geological activity.

These assumptions were proven wrong as the Voyager spacecrafts discovered surprising and amazing features in the Uranian and Neptunian systems. For example, Neptune has the highest speed *retrograde* winds known--winds which travel in a left-handed sense instead of the usual right-handed sense. ("Right-handed" means that if one points upward or northward with the right thumb, the fingers will curl in the direction of the motion or spin.) These winds reach up to 2,100 kilometers per hour and change even more rapidly than the winds of Jupiter. Furthermore, on Triton an erupting geyser was discovered ejecting material eight kilometers above the surface [11, p.179]. These features are easier to explain if the solar system is only thousands of years in age, for then primordial heat left over from creation could still be driving these processes. An even more dramatic example of the failure of the uniformitarian assumptions is the moon of Uranus known as Miranda. Two well known solar system authors made the following striking comments about Miranda [6, p. 140].

> Even the earliest pictures of Miranda were enigmatic. From a distance, it looked as though some celestial giant had painted a big white check mark on its surface, as if to say, 'Here's the answer!' Later called 'the chevron,' the immense check mark remains unexplained to this day.

I find it easier to believe in a "celestial giant" than to believe that natural processes alone are responsible for surprising features such as this. However, I prefer to call the "celestial giant" God. Miranda possesses many additional strange surface forms, such as a cliff face which is nearly 10 miles in height! These surprises were found on a moon which is only 600 miles in diameter. The solar system writers referred to above quoted a NASA scientist as saying the following about Miranda's surface [6, p.140].

> If you can imagine taking all the bizarre geologic forms in the solar system and putting them on one object, you've got it in front of you.

The usual response of planetary scientists to major surprises is to add complex and speculative processes to the basic Nebula model rather than to examine the validity of the model itself. The assumption of the system being very old comes up again and again. But assuming the solar system to be young simplifies the process of explaining various features, as will be elaborated on later in this paper.

Age of the Solar System

Since many creationists hold to the position that the solar system and universe is less than 10,000 years in age, this raises many questions about processes believed to have shaped solar system objects and their surfaces. Various processes must have happened in a much shorter time span than is generally believed. Craters, for instance, are found throughout the solar system, but are not uniformly distributed. Instead of multiple episodes of heavy bombardment separated by periods of millions of years, a young solar system would imply that somehow the many craters observed must have formed relatively quickly compared to evolutionary time scales. Certain processes assumed to be plausible by most planetary scientists would become impossible if the solar system is "young." Various types of mechanical, thermal, chemical, and radioactive processes would have a very different role in the history of our solar system from a young age interpretation. This raises many issues that creationists need to study on a technical level.

Much could be written about evidences for a young solar system. The strength of the evidence for our system being young lies in the fact that a variety of *unrelated* processes point to the same conclusion. Creationists have documented many indicators of youth for our home planet, Earth. Other processes must be brought to bear on the question of the age of the solar system as a whole. It is necessary to assemble arguments for youth from unrelated processes in different parts of the solar system.

I have calculated a rough age figure for Saturn's moon Titan of 181,000 years based on the production of ethane in Titan's atmosphere [21]. I have also studied the argument for our Moon being young based on the influx of cosmic dust from space. Some creationist writings have used outdated unrealistic numbers for the thickness of a layer of dust there would be on an old Moon. The Moon dust argument no longer seems to be valid. At the present dust influx rate, the amount of dust which would be present on a 10,000 year old Moon would be virtually immeasurable [19]. Thus, the cosmic dust influx implies some significant catastrophe occurred in the past which caused a high influx of dust in a relatively short time. Other arguments for a young solar system could be mentioned. The author is aware of such an argument related to heat dissipation in Jupiter's moon Io. If Io were 4.6 billion years in age, its orbit would have shifted farther from Jupiter than the present position [15].

The Modified Nebula Model

The Modified Nebula Model begins with a Nebula in interstellar space and attempts to explain how this cloud could contract and condense into the existing objects. Following is a description of the stages involved in the model which is the accepted view today. It must be understood that numerous variations on this have been suggested by different scientists. After looking at the Modified Nebula models, the "Capture Theory," a catastrophic model with evolutionary assumptions will be examined as well. Then catastrophic models with creationist assumptions will be mentioned.

The nebula which our solar system is believed to have formed from is frequently referred to as the "protosolar nebula." The prefix "proto" is sometimes used in reference to planets or moons as well, indicating objects that are not yet completely coherent bodies. The protosolar nebula has been assumed to have a mass of about 100,000 times the mass of our Sun and is believed to have initially been much larger than our solar system. The nebula is assumed to be initially rotating slowly and possess a weak magnetic field. Cooling of the cloud would allow it to contract due to gravity. This contraction would cause the rotation of the cloud to accelerate and the initial magnetic field would increase in intensity. Matter pulling toward the center of the cloud would form a central ball called the protosun. The combination of contraction and rotation would cause the cloud to become a disk made up of solid mineral grains (microscopic in size) and ices, with the Sun in the center. Dust and gases would surround and envelop this disk.

At this point there would be no large macroscopic rocky objects but there could be small chunks of ices. These ices would be composed of water, methane, and ammonia and would primarily form only beyond about 5 A.U. from the Sun. Most of the matter in the nebula as a whole would be hydrogen and helium, with comparatively small amounts of other elements. If the contraction merely continued as described, almost all the mass in the solar system would today be found in the Sun, as would almost all the rotational energy. However, though it is true that nearly all the mass of the solar system is in the Sun, the planets possess most of the angular momentum while the Sun spins very slowly.

To attempt to explain this, modern nebula models apply plasma physics to the contracting cloud. Scientists have attempted to explain mechanisms that can transport matter inward toward the Sun and simultaneously transfer angular momentum outward. It is assumed that before there were significant macroscopic objects, an electrical current could have flowed through the cloud, causing a "magnetic coupling" between the central mass (the protosun) and the surrounding nebula. This effect is believed to have transferred angular momentum and rotational energy from the central mass to the surrounding medium to make the planets move rapidly in their orbits compared to the spin rate of the Sun. This magnetic effect is depended on to enable the particles in the disk to accelerate to speeds such that they will follow Kepler's Laws of motion. If the tiny grains do not follow Kepler's Laws at this early stage, then the planets would not be able to travel in stable orbits after they formed.

Next the system reaches what is often referred to as an accretionary stage. The protosun would continue to heat up as it contracted until eventually nuclear reactions could begin. This marks the "birth" of our Sun. Most of the solid material would lie in the plane of the disk. It is believed this disk would separate into rings, though there is not general agreement on how this would occur. These rings would then form into planets and a similar disk to rings to object process on a smaller scale would occur to form moons.

Scientists suggest the action of turbulence and random motions could lead to grains clustering enough so that gravity could begin pulling the matter together by its own weight. It is believed that over long periods of time these grains would, by occasionally sticking together, "accrete" into larger and larger objects. These solid accreting objects would eventually reach the size of what are called "planetesimals." Planetesimals vary in shape and other characteristics and might be up to a few hundred kilometers in size. The asteroids are believed to be planetesimals which were not able to accrete into planets.

At this stage, the solar system would still be filled with much dust and gas, enough to make the whole system opaque. The young Sun would then enter a stage of its own "evolution" known as the T-Tauri stage. The result is a very intense "solar wind" of various particles and radiation emitted from the Sun. It is believed this "solar gale" would clear much of the excess gas and dust out of the system. Some astronomers also believe that electric currents would flow through this "wind" in such a way as to slow the rotation of the Sun further. Scientists have suggested that our Sun may have lost about one half of its original mass in a period of one million years during this stage. By the end of this period the solar system would be transparent and the planets, moons, and other objects would be coherent bodies but would not be layered in their interiors since gravitational accretion would not produce layered objects.

It is thought that at this point there would be very heavy bombardment by meteorites throughout the system. Meteorites, volcanic activity, and radioactive decay are believed to have caused the newly formed planets and moons to heat sufficiently so that the more dense material would sink to the center and the less dense material would move closer to the surface. This would form layered structures within the large bodies such as planets and moons. This period of many impacts is believed to have ended about four billion years ago.

Difficulties with Nebula Models

How plausible is this process? Much mathematical work has been done to attempt to give a theoretical basis for it. This technical level work sometimes looks very impressive except when one looks critically at two things, the starting assumptions built in to the calculation and the degree of fit with the observed characteristics of the solar system. Frequently it is possible to put forth impressive looking mathematical models of a small part of the process. But scientists are not always able to connect one stage to the next in a way that is physically realistic. Just as in the study of paleontology, there are "missing links." Three general types of problems will be considered here. These are 1) problems in the collapse process, 2) problems in explaining present motions of objects, and 3) problems in explaining composition relationships in the solar system.

Various problems exist in the timing of the different processes occurring during the collapse of the Nebula. One of the more perplexing problems of current interest is what is referred to the "runaway formation of Jupiter" and the other gas giant planets. Nebula collapse theories imply that nearly all hydrogen and helium would be removed from the Nebula in a time of about one million years. This means that the four gas giant planets would have to form a central core of about 10 earth masses in less than one million years. The more massive the planet, the quicker it would form by gravitational contraction. Some models show a Jupiter core forming in as little as 700,000 years, Saturn in 3.8 million years (M.Y.), Uranus in 8.4 M.Y., and Neptune in 23 M.Y. [23, p.16-17]. This is too slow because the hydrogen, helium, and other light gases would not be available long enough for a 10 earth mass core to form. Without a core of about this size, gravity would not be sufficient to complete the accretion of matter onto the body. The end result then would be that the gas giant planets would not be as large as we find them today.

Various processes would interfere with the collapse of the Nebula. The initial temperature of the nebula is a critical part of the problem and a point of controversy. Theoretical collapse models begin assuming a density of the cloud much greater than the observed densities of interstellar nebulae. Other properties of interstellar nebulae also differ from the values used in the origins calculations. The cloud must collapse a great deal, causing rotation to accelerate, magnetic field strength to increase, and temperature to increase. All three of these changes tend to stop collapse. Also, the slow rotation of the Sun coupled with the rapid motion of the planets in their orbits is not adequately explained by collapse models. The angular momentum of the protosun during collapse must be decreased by a factor of 10^4 to 10^6, and the protosun must do this in such a way as to lose only about five percent of its mass [17]. (Note that this five percent of the protosun's mass does not correspond to the mass of the planets.) Mass must somehow flow to the Sun while the material which later becomes the planets is accelerated in orbit.

Scientists have not explained how so much angular momentum could be transferred to the planets and in such a way as to leave the Sun at its present size. Hannes Alfven, who does not agree with many of the standard accepted theories, lays great emphasis on the role of magnetic fields and plasma effects to explain the angular momentum. However, most scientists generally agree that Alfven's calculations assume an unrealistically strong magnetic field at the start. Alfven has written strong criticisms of the standard Nebula models [2]. Many scientists today assume that the angular momentum problem has been long since resolved by new models. But Stuart Ross Taylor in a recent book made the comment that "The ultimate origin of the angular momentum of the solar system remains obscure [23, p. 53]."

The second class of problems with Nebula models involves various motions that exist in our solar system which do not fit the pattern implied by Nebula models. Some aspects considered to be strengths of the Nebula model are the following. All the planets orbit nearly in one plane, travelling in the same right-handed manner around the Sun (prograde direction). Most of the planets also spin in the same right-handed manner, as does the Sun. Most moons also travel around the Sun and spin in the same right-handed sense. This is said to be due to the initial spin of the original nebula.

There are striking exceptions to these regular patterns. The Sun, for instance, is tilted about 7 degrees in angle compared to the rest of the solar system. What would cause the entire disk to be tilted in relation to the central body? Also, there are six known cases of moons which orbit retrograde, opposite the direction which the planet spins. Four of these are the outermost four moons of Jupiter, one is Phoebe at Saturn, the last is Triton at Neptune. Phoebe is particularly unique since it is the only moon which orbits retrograde but that spins prograde.

In the Nebula hypothesis all rotation and orbital motion comes from the motion of the original rotating nebula. Furthermore, Venus, Uranus, and Pluto all spin retrograde. There are too many exceptions to the pattern predicted by the Nebula model. Sometimes scientists have assumed that Uranus, which is tilted 98 degrees, was at one time tilted and spinning with an orientation more like the other planets. Then something caused it to tilt over and the moons were somehow spun off of Uranus into their present orbits. Alfven makes the following comment about this scenario [2, p. 219].

> In fact, to place the Uranian satellites in their present (almost coplanar circular) orbits would require all the trajectory control sophistication of modern space technology. It is unlikely that any natural phenomenon involving bodies emitted from Uranus could have achieved this result.

Another problem would include the distribution of mass across the solar system. The general approach of a cloud collapsing to form the Sun and planets should also explain the formation of moons. Again, Alfven comments [2, p.218-219].

> In addition to these obvious discrepancies between the implied uniform and the actually observed distributions of mass in the solar system, the whole disc idea is tied to the theoretical concept of a contracting mass of gas which could collapse to form both the central body and the surrounding secondaries via the intermediate formation of the disc. . . . small bodies cannot be formed in this way and it is questionable whether even Jupiter is large enough to have been formed by such a collapse process.

A third general type of problem for Nebula models has to do with the composition of the planets and other objects in relation to their distance from the Sun. This subject is quite complex and much has been published about it. The study of many different radioactive isotopes has been done to discover patterns in their amounts across the solar system. According to the Nebula model, the inner planets would form at higher temperatures than the outer planets. This and other processes occurring in the cloud would determine the composition of all objects. When amounts of an element or isotope do not easily or obviously fit into the Nebula Model, it is referred to as a composition anomaly. The elaborate theory related to this is referred to as the chemical equilibrium theory. Space does not allow elaboration on these anomalies. However, I would like to suggest certain types of anomalies for creationists to study.

Attempting to explain the amounts of the many isotopes present in the planets by natural processes alone is akin to attempting to juggle perhaps 200 balls at once. Scientists have not been able to explain processes that can give the right amounts of all the constituents all at once and do so for all the planets. You just cannot keep all the balls up. One example worth study in this regard would be water contents on Venus, Earth, and Mars. Oxygen and Magnesium isotopes in meteorites have been mentioned as anomalous by various researchers. Amounts of the Noble gases on Venus, Earth, and Mars also are anomalous [13]. One NASA scientist made the following admission in an article about composition anomalies[14].

> In fact, I would suggest that there is no model for the origin of our own Sun which successfully predicts all of the complex isotopic and chemical relationships observed in the comets, meteorites, and planets of our Solar System.

The Capture Theory

The modern Capture Theory represents a catastrophic evolutionary approach to the origin of the solar system. At the beginning of this scenario our Sun has formed. Then a protostar passes near our Sun, this protostar being a loosely held together ball of gas. The pull of our Sun on the protostar severely distorts its shape and a filament of matter is pulled off of the protostar. This filament then breaks into segments, which become six large gaseous planets. In this scenario, our solar system would not possess nine planets in the beginning, but six.

A large amount of gas pulled off of the protostar supposedly becomes a cloud that surrounds our Sun after the protostar passes by. All of these six planets would initially travel in highly elliptical orbits (eccentricities estimated to be .68 to .91)[8, p.156]. It is not possible for an object that is captured into orbit to have a near circular orbit. It is believed the surrounding medium of gas would round the elliptical orbits into circular orbits such as the planets now have. This would occur due to gas drag resisting motion. Time required for this rounding is estimated to be 10^5 to 6×10^6 years.

All of the new planets thus formed would be gas and fluid in nature. The inner two of these are referred to simply as A and B. A and B would have occupied the regions in which Earth, the Asteroids, and Mars are found today. These two planets no longer exist because it is believed they collided. It is believed that our Moon and Mars were moons of planets A and B. Mercury, Venus, and Earth are believed to be fragments from the collision. Other interesting captures, orbit changes, and tidal effects are believed to have occurred as well.

Problems with The Capture Theory

The work of Dormand and Woolfson on the Capture Theory provides valuable insights into the nature of collisions and tidal interactions between objects. The idea of a filament breaking into segments seems to be exactly like the older Jeans Tidal model. Other computer studies have shown that any kind of filament drawn off of a gaseous body will either disperse into space or just fall back to the object, not condense into planets [3, p. 378]. A major problem for both the Capture Model and the Nebula Model is the evidence for a young solar system. In less than 10,000 years there would not be sufficient time for orbits to round into being nearly circular. Other problems could be mentioned such as the orientation of Uranus and its moons.

The Capture Theory tends to give much attention to certain observations about the solar system which the Nebula Model cannot explain well. The reverse may also be true. The Nebula model gives more attention to explaining the "regular" patterns in the solar system while the Capture Theory attempts to better explain retrograde orbits, composition anomalies, and the angular momentum of the Sun and planets. Our solar system is too orderly to come from something like the capture and collision processes of the Capture Theory. At the same time, our solar system contains too many surprising and varied features to fit the relationships implied by the Nebula Model. The solar system can be better understood by acknowledging there is evidence of intelligent design in the orderly regular patterns, and yet evidence of catastrophic events that have altered what was originally created.

Catastrophism in a Young Solar System

Scientists addressing solar system origins, even Nebula theorists, frequently suggest various capture and collision processes. To the author's knowledge, orbit captures have been proposed for about nine different objects in our solar system. All of these seem very unlikely in the author's opinion, except perhaps one, Neptune's moon Nereid. Nereid is the only moon or planet in our system which has a very high eccentricity, its value being .75. Pluto's eccentricity is .249. (The eccentricity measures how elongated the orbit is.) Nereid's eccentricity is consistent with it being captured into its present orbit. To have so many capture processes in one solar system, including one for every moon orbiting retrograde, is very unlikely. Captures are not possible when an orbit is circular, not that is, if orbit rounding would require millions of years. Orbit rounding, for moons, could not take place by a resisting medium because extremely long times would be required greater than the lifetime of any medium. The interaction of tides and orbits can round orbits some, but in a young solar system this probably would not be very significant in most cases. Therefore, the origin of the retrograde moons by capture represents an unrealistic application of catastrophism. Rather, the motion of these moons indicates intelligent design.

Catastrophic processes destroy order, they do not produce order, not by natural processes at least. Evidence for catastrophism must be found in irregular or random characteristics. Craters and volcanic events also can be considered catastrophism. In 1992 the author discussed evidence for design and catastrophism in our solar system [20]. Large impact sites are found on a number of objects in the solar system [20, p. 166]. A number of these were evidently caused by impacts which had a major effect on the moon or planet.

Mars, for instance, possesses two hemispheres which are quite different, the northern hemisphere is 1-2 km lower than the southern hemisphere [5, p. 64]. The northern hemisphere is quite smooth and has few craters (except in small areas). The southern hemisphere is much more heavily cratered and possesses two extremely large impact sites called Hellas and Argyre. Hellas' outer ring is 4,200 km (2,610 mi.) in diameter. Nearly on the opposite side of the planet (antipodal) is the large bulge known as the Tharsis region. Several giant volcanic mountains lie on this bulge, including Olympus Mons [22]. Massive impacts on Mars could have stimulated a great deal of volcanic activity which covered a large fraction of the surface. Surface readjustments following the impacts might explain the difference in the two hemispheres. Most planetary scientists do not believe that the Hellas impact is related to the Tharsis volcanoes because long-age assumptions lead them to conclude the two regions are of very different ages.

Craters are very important clues for us regarding the history of the solar system. They represent a record of the past. The numbers and sizes of craters show interesting relationships. Note that the largest impact sites are not craters at all but flat smooth plains surrounded by concentric rings of mountains. On icy surfaces concentric circular ridges can indicate a large impact, such as Valhalla on Jupiter's moon Callisto (outer ring 3,000 km in diameter). These smooth plains on our Moon are called Mare. These are what I refer to as super-impacts. In these impacts, extensive volcanic flows completely fill the crater, and the only visible sign of the impact are the rings of mountains around it. On the Moon the largest of these super-impact sites are found on the near side. The largest clear site such as this is the Imbrium basin, whose main rim is 1,200 km (746 mi.) in diameter; a much larger basin which *may* be an impact site is Procellarum, which is 3,200 km (1,988 mi.) [10]. The impact sites and signs of volcanism on Mars gives evidence of a very violent history for that planet. On Mars there are a number of sites which are surrounded by 4, 5, and even 6 concentric rings of mountains. The largest of these is the Elysium impact basin, whose fifth ring is 4,970 km (3,088 mi.) in diameter [12].

If the solar system is 4.6 billion years in age one would expect many objects to be saturated with craters over much or all of the surface. Crater saturation is reached when a new impact would destroy at least one other, so that the number of craters in a certain area could no longer increase. It cannot be proven that *any* object in the solar system is saturated with craters over a large part of its surface. There is evidence that even the mostly densely cratered areas on the Moon are not saturated [25]. Also, crater density is not constant over the surfaces of several bodies in the solar system.
Figure 1 graphs the total number of large impact sites found in three size ranges and in three bands of latitude for our Moon. Only the 46 largest impact sites are represented [10]. The equatorial band extends from 19.5 degrees

North to 19.5 degrees South latitude, dividing the Moon's surface into three bands of equal area. The northern and southern polar bands include all other latitudes. Figure 1 shows that there are more large impact sites around the Moon's equator (this may or may not hold true for *all* sizes of craters). There are also more large impact sites at the south pole than the north pole. The size figures indicate ranges of diameters. For instance "250" includes all the large sites from 250 to 499 kilometers.

Asymmetrical crater distribution can be explained easily by assuming the solar system is only thousands of years in age and some event caused a high rate of meteoritic bombardment in a short time. Mercury and Saturn's moon Enceladus also exhibit asymmetrical crater distribution [20, p. 166]. Saturn's moon Rhea clearly has more craters around its North pole than near its equator [16]. A former planet between the orbits of Mars and Jupiter and a cloud of debris passing through the solar system would both cause high rates of meteor bombardment for some period of years.

A question that should be asked is "what object in the solar system has the highest density of craters in a given area?" The answer does not happen to be our Moon, but seems to be the inner moons of Saturn. This is illustrated by Figure 2, which compares the density of craters for four different objects in the solar system [14, 19, 21]. Note that Figure 2 uses a logarithmic scale to compress the vertical axis. In Figure 2, Epimetheus has the highest crater density. This is a very small object and is one of the two "coorbital moons" of Saturn which exchange orbits every four years. Mimas has a crater density graph similar to Epimetheus. Moons which lie farther from Saturn show fewer craters per unit area than our own Moon.

Planetary rings and the characteristics of the asteroids also give us clues on possible catastrophes in our solar system. Scientists have argued that some planetary rings, such as at Uranus, must be less than 1,000 years in age [9]. In 1992 I suggested that there may be two classes of rings--created rings and catastrophically formed rings [20, p.164-5].

There may also be two classes of asteroids. Though many asteroids are irregular in shape, some are spherical, which should not be possible in a very old solar system, due to collisions [24]. For instance, Ceres, the largest asteroid, has an equatorial radius of 480 km and a polar radius of 453 km, making it nearly spherical [23, p. 226]. Also, large asteroids exhibit a very strange rotation pattern (See Figure 3). Apparently no one has been able to put forth a natural mechanism to explain this relationship. For asteroids larger than about 120 to 150 km in diameter, the larger the object, the *faster* it rotates [7]. This does not seem possible for objects that are collision fragments since for a given amount of angular momentum, a larger object would rotate slower. Smaller asteroids, however, show the opposite pattern.

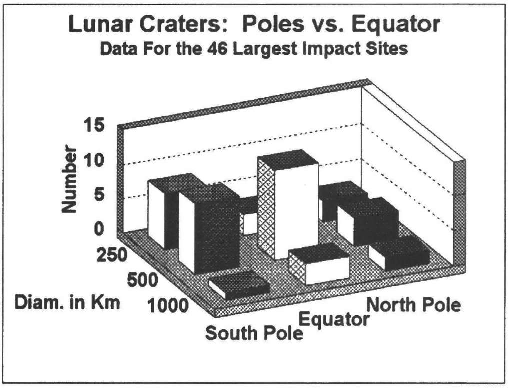

Figure 1 Number of large craters on the Moon in relation to latitude.

Two Possible Catastrophes

One possible catastrophic event which could affect the entire solar system is a former planet that existed in the region now occupied by the asteroids, between Mars and Jupiter. If a large object came from outside the solar system at high speed and struck a planet between Mars and Jupiter, what would happen? The impacting object and the planet could be deflected out of the system, leaving some debris that would scatter into various orbits within the solar system. Or, both masses might be destroyed, but in any case one would expect most of the mass to leave the solar system. Some fragments could go into orbits such as the asteroids now have. Other fragments could move off at higher speeds that could carry them to the outer solar system, for instance. After such an event, there would be collisions for some time. This impacted planet model has difficulties dealing with the rotation pattern of large asteroids.

It may be that some of the best clues on the history of our solar system come from the smallest things--such as comets and asteroids. Asteroids have varied orbital characteristics; many have elliptical orbits, but relatively few have highly elliptical orbits with eccentricity greater than 0.5. Similarly with the inclinations of their orbits: Relatively few of them have orbits inclined more than 20 degrees. This may suggest that they originate from within the ecliptic plane (the plane of the Earth's orbit), or nearly so. Asteroids seem to all orbit and spin right-handed in direction. These facts could agree well with a destroyed planet model. Comets, on the other hand, are found to travel either prograde or retrograde in their orbits. Comets also are icy objects whereas asteroids are rocky. Asteroids are today classified by their composition into 14 different types. These types have been described as either igneous (high melting point minerals), primitive (volatile lower melting point compounds), or metamorphic (volatiles removed). The igneous asteroids are found closer to the Sun while the more volatile ones are found farther from the Sun [4]. This pattern is somewhat similar to that of the planets, with the materials with higher melting and boiling points farther from the Sun.

There are certain other arguments for a possible planet breakup or collision in the asteroid region from what are called "new" comets, or "very long period comets." These are comets with very long orbital periods. From considering the orbits of these new comets, it is known that they must be on their first trip in toward the Sun. Also, the points on their orbits which are farthest from the Sun seem to cluster somewhat in certain parts of the sky. Their orbital periods also cluster about certain values, possibly indicating they could have come from a common point of origin [24, p.51-72]. This deserves further study as well and may be difficult to explain for the debris cloud model.

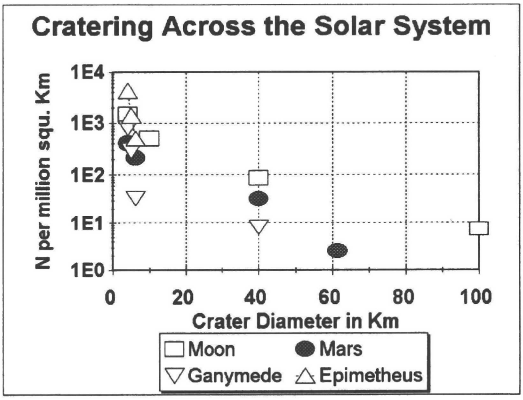

Figure 2 Number of craters per million square km area for various objects.

The "debris cloud model" would involve a cloud of solid objects passing through the solar system. Since the moons in the Saturn system have the highest crater density, perhaps that could be the region which the debris cloud first passed through. Since moons such as Enceladus and Rhea have more craters on the North poles, that could be the initial direction of approach of the debris cloud. Debris missing Saturnian objects would be scattered due to the gravitational pull of various objects into various paths. Many of these paths could take debris below the plane of the ecliptic and back up to pass through the ecliptic again "from below." By this time the debris would be in the inner solar system, having been deflected by the outer planets and perhaps Mars.

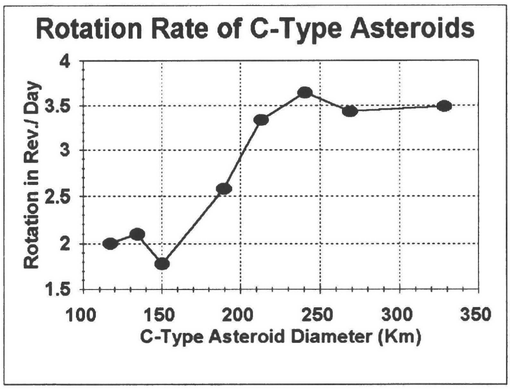

Figure 3 Rotation rate of asteroids as a function of size.

At this point could enter another assumption--that there were primordial asteroids present from creation in the asteroid region. These created asteroids may have simply been created with the "unnatural" rotation relationship mentioned above. As the debris cloud (or a portion of it) made its second pass through the plane of the ecliptic, more collisions would result, causing some asteroids to break up and go into unstable trajectories that would cause them to later collide with our Moon, Mercury, Venus, or Mars. The objects in the debris cloud, by this scenario, would need to be large enough to be able to significantly alter the motion of asteroids they collide with. Since there are few large impact sites in the outer solar system compared to the inner solar system, I would suppose that few of the debris cloud objects would be large (such as a large asteroid or larger). After the collisions with the asteroids, asteroids and collision fragments could impact with bodies in the inner solar system over a period of years.

This debris cloud model would imply that craters in the outer solar system would show evidence of being formed in a very short time. This is exactly what the moon Enceladus at Saturn looks like. By this model, however, craters in the inner solar system would be expected to have formed over a period of years, since the asteroids and other objects put into unstable orbits would fall onto inner solar system bodies at different times. This model might explain the differences in cratering between the inner versus the outer solar systems, since the craters in the two regions would be formed by different objects, and from different directions. Neither of these catastrophic models would preclude the possibility of other unrelated impacts. Neither of these models would explain all the craters or all the varied surface features around the solar system. However, this approach seems more plausible than the current popular approach of postulating many unrelated collisions and other events over 4.6 billion years of solar system history.

CONCLUSION

Obviously these ideas are speculative. Yet a creationist approach is a valid one for unravelling the true history of our solar system. There is a need for various computer calculations to be done to simulate these type of models. There is probably not enough information available at this time to definitively judge between these two catastrophes. At this time, I find the debris cloud model the most satisfying. These two catastrophic models--the destroyed planet model and the debris cloud model--are not necessarily the only possibilities.

Though dating the time of occurrence of a major solar system catastrophe may be impossible scientifically, I suspect it would correspond in some way with God's judgement on the Earth at the time of the Noahic Flood. I say this only for theological reasons, since such catastrophes would seem to have little purpose except judgement and display of God's power. Remnants of craters of significant size are being discovered on Earth at the rate of several per year. Some have been found which would be over 100 miles in diameter. The author suspects that along with the many other atmospheric, volcanic, and tectonic activities in the Earth at that time there were also impacts from space. The author doubts that it is possible for any of the impacts discovered on Earth to have changed the earth's tilt or caused all the processes of Noah's Flood. It may be that impacts played a more significant role *after* the Flood than during the Flood year.

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