The Current State of Creation Astronomy

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Abstract

The current state of creation astronomy is reviewed. Creationists have usually followed three basic approaches in the field of astronomy: 1) criticism of the big bang, 2) the argument of design, and 3) arguments for a recent creation. Many arguments that recent creationists use are found to be rather dated. Many of these arguments are still valid, but must be continually updated to reflect new ideas and discoveries in the field. A new argument for a recent lunar origin is presented. Suggestions for future research are made.

Keywords
Astronomy, cosmology, big bang, design, age of universe

INTRODUCTION

Among creationists there is much disagreement about the age of the earth and the age of the universe. Most opinions can be classified into one of three groups. One group is the belief that both the earth and the universe were created during the literal six-day creation week a few thousand years ago. That is the position of the Institute for Creation Research and most members of the Creation Research Society (CRS). A second opinion is that while the earth and all that is on it were created a few thousand years ago, most of the universe was created in the distant past of "in the beginning" of Genesis 1:1. A careful reading of the statement of belief of the CRS reveals that this belief is compatible with that statement. The third possibility is that both the earth and the universe are quite old, in general agreement with what most of modern science claims to be the ages. That position is difficult to reconcile with the CRS statement. The many writings of Henry M. Morris and John C. Whitcomb have addressed this issue and have argued that the first opinion is the correct one. This author is in agreement with that position, and for the purposes of this paper, that is the definition of the creation model.

The creation was only the first of three major events that have affected the world. The second event was the fall recorded in Genesis chapter 3. The fall had very strong spiritual implications (the introduction of sin, the need for salvation), but was also accompanied by physical consequences, such as death, the cursing of the ground, and the groaning of the whole world as recorded in Romans 8:22. There is some debate among creationists as to what the full effects of this fall upon the world were. For instance, many suggest that the second law of thermodynamics may not have been operating in its fullness before the fall [57]. The third major event was the world wide flood of Noah recorded in Genesis 6-8. Being one year in duration, the catastrophic flood must have had a profound effect not only upon life, but the shape of the earth's surface itself. There is also some discussion among creationists about how much affect that the flood had upon the rest of the universe.

What modern science has to say about the origin and history of the world has caused many to dismiss these three events. On the other hand creation scientists take the Biblical account seriously, and so accept these events as real and have attempted to reexamine the world for evidence for those events. In the fields of biology and geology much progress has been made. The biological creation model assumes that there was a sudden

appearance of life, with reproduction only occurring within "kinds." The term "baraminology" has been coined to mean the study of what constitutes a kind. It seems that for some organisms the kind is to be identified as the species, but for others it is at the genus or higher levels. At one time most creationists argued that speciation (as defined by reproductive viability) does not occur. However most now accept that reproductive barriers, and hence speciation, are observed to arise today, but our model allows this to occur within certain limits. This process operating since the flood would have greatly reduced the number of animals required on the ark.

The creation model of geology is basically a flood model, that is, the antediluvian world was totally obliterated by the flood to the extent that virtually all geological features that we see today were formed in the flood and its aftermath. The wealth of geological data available to us has made it possible for several competing flood models to be developed. The oldest and perhaps the most familiar is the hydraulic model propounded by Price early in this century and again by Morris in recent decades. This theory attempted to explain the general fossil sequence found in the geologic column (GC) by the tendency of objects to be sorted according to size, shape and density by hydraulic action while suspended in a fluid. In recent years several other models have been proposed to incorporate the apparent success of plate tectonics over the past three decades. Two of these models popular in the United States are the hydroplate theory (HPT) of Brown [12] and the catastrophic plate tectonics (CPT) theory [58]. Some would like to place the flood boundary much lower in the GC, making many strata post-flood, while others seem to doubt the reality of the GC itself. This is contrary to the position of Morris, who maintains that virtually no strata have been deposited in the post flood world. Such disagreements are encouraging in that they are evidence of the maturing of creation science. Creationists are often criticized for having rigid preconceptions that do not permit reevaluation of our ideas. Anyone making this point has obviously not considered the case of creationist geology.

Unfortunately the situation in astronomy is not as good. As with biology and geology, astronomy has become permeated with evolutionary assumptions and conclusions. Unlike those other disciplines, there is no overall theory or, if you will, paradigm, of astronomy from a creationist perspective. Part of the problem has been the lack of researchers in the field. Most people see the obvious effect that evolution and long time scales have had on geology and biology, and this has attracted Christian young people to pursue these sciences. The result has been that while evolutionary thinking has come to dominate much of astronomy, this has escaped the notice of most creationists.

A second cause for the lack of creationist astronomy is the lack of Biblical specifics. Genesis 1:1 mentions the creation of the heavens, and many understand that to refer to the creation of space. But space (astronomical heaven) was not filled with what we understand to be astronomical bodies (the sun, moon, and stars) until the fourth day of creation (Genesis 1:14-19). What, if anything, existed in space between these two events? Does the "whole creation" of Romans 8:22 include the astronomical world? That is, did the fall have an effect upon astronomical bodies? If so, what? Did the flood have an effect upon the astronomical realm? Some have offered speculations on this, but with the lack of Biblical specifics, these are not much more than conjecture.

It should be noted that some recent creationists have attempted to avoid the light travel time difficulty (to be discussed later) by asserting that the mention of the creation of the stars on the fourth day does not mean that the stars were created on that day. Instead, it is argued that mention of the stars in Genesis 1:16 refers to their purpose (for signs and time reckoning) rather than their creation at that time. In this scenario the stars would have been part of the primordial creation of Genesis 1:1 and are mentioned in verse 16 only in the context of purpose along with the sun and moon. It is true that the Hebrew of Genesis 1:16 merely mentions "the stars also," leaving in some peoples' minds the possibility of ambiguity whether this refers to the stars' creation or function. Another related variation is that the sun, moon, and stars existed all along and merely became visible from the surface of the earth when the atmosphere cleared on the fourth day. While it is true that a number of Biblical scholars have endorsed these interpretations of Genesis 1:16, this has been done to accommodate the supposed great age of

the astronomical world. It is the opinion of this author that these are quite a stretch of the passage and that it is quite doubtful one could reach such a conclusion from the Bible alone. For this reason it is assumed here that Genesis 1:16 refers to the creation of the sun, moon, and stars on the fourth day.

Paul Steidl made this basic assumption when he wrote what is perhaps the best book to date on creation astronomy [50]. Because this book does not go into great depth nor is a primary source in the sorts arguments that will be described here, it will not be referenced often in this paper. Its great strength is that it is a general treatment of astronomy that covers a broad range of subjects with emphasis given to Biblical and creation interpretations. While nearly 20 years old, the book has aged very well considering the rapid advances in astronomy in the intervening period.

Given these restraints, creationists have proceeded with some ideas. These ideas have generally fallen into three categories:

1. Criticisms of the big bang
2. Arguments of design in the universe
3. Arguments for a recent creation.

Each of these topics will be discussed here. The first review of creation astronomy was the one of Mulfinger [38] 25 years ago, so the time seems right for a second one.

CRITICISMS OF THE BIG BANG

Cosmology is the study of the structure of the universe, while cosmogony is the study of the history of the universe. For three decades the big bang has been the predominant theory of the origin of the universe, and so it is sometimes referred to as the "standard model." While until recently no creationists have done original research in cosmogony, many creationist writers have attacked assumptions and alleged evidences of the big bang or otherwise made use of the work of others that have revealed difficulties with the big bang. There are several creationist discussions of the big bang [12, pp. 21-22], [19], [35], [45].

Many supporters of the big bang model claim that three evidences support the big bang:

1. The expansion of the universe
2. The helium and deuterium (an isotope of hydrogen) abundances of the universe
3. The three-degree background radiation.

Creationists sometimes note that the first two items are not predictions of the standard model (for example, see [12, pp. 21,22]. The expansion of the universe was discovered before the model was devised, and in fact the big bang is an attempt to explain why the universe is expanding. This is a fine point involving logic and philosophy of science, and so should be further discussed here. Any model requires the input of facts or data to guide the construction of the theory. In many cases a fact involved is the problem that needs to be solved. In this case, the big bang was developed to explain the observed expansion of the universe. Any number of theories could be devised to explain why there is a cosmic expansion (e.g. the steady state theory). But can the expansion then be used as evidence of these theories since they were devised to explain the expansion? This appears to be circular reasoning. While a good theory must be explanatory, it must also be predictive. The big bang explains why there is a cosmic expansion, but it hardly predicts it. By necessity a theory must be consistent with the input data. The real power of a model is its predictive ability. What experiments or observations could be done that could conceivably falsify the theory? Cosmic expansion is hardly a prediction, given that it must patently agree with the big bang. This should not be construed as a criticism of the big bang model. Rather, it is an attempt to clarify the relationship between observed cosmic expansion and the big bang theory. Some sources list the expansion of

the universe as a prediction of the big bang model. It is not; it is, however, something that is well explained by the model. This topic urgently needs to be further developed by creationists.

There is a similar, yet less incestuous, relationship with the big bang model and the abundances of the lighter elements. These abundances generally were known when the standard cosmology was developed. While they have been helpful in deciding which versions of the standard model are more tenable, this does not appear to be a clean prediction either, but is rather more of an input.

On the other hand the 3K cosmic background radiation (CBR) is an impressive prediction of the big bang. The prediction was qualitatively made nearly 20 years before the discovery of the microwave background in 1965. The steady state theory, which was the competing evolutionary model at the time, did not predict this radiation. A few cosmologists such as Fred Hoyle still believe the steady state theory, but have had no success in explaining the background in the intervening years. Akridge, et al. [4], has attempted at least one creationist explanation for the 3K CBR. They suggested that the energy from starlight that was absorbed and re-emitted by dust particles over a few thousand years is the source of the 3K background. But given the very uneven distribution of dust, this should result in a much more patchy emission than what is observed in the CBR. In reality infrared emission from dust has long been observed, and at much higher temperatures than 3K.

But at the same time, this apparent triumph of the big bang could be its undoing. The universe today is arranged into stars and galaxies. Presumably these resulted from slight unevenness, or perturbations, in the early universe that caused gravity to vary from point to point and resulted in the clumping of material into these objects. These perturbations would have resulted in slight temperature differences in the cosmic background radiation. Cosmologists have estimated how great the perturbations should have been, as well as the amount of temperature fluctuations that should be observed today. The COBE (COsmic Background Explorer) satellite launched a few years ago was designed to measure these fluctuations. The first two years of observations revealed that the background is completely smooth (for a brief creationist discussion of this, see Matzko [35]). Only after a complex statistical analysis of the data were any variations allegedly found [43]. Though supposedly confirmed by two additional studies, there is much reason to be skeptical of the temperature fluctuations. First, the alleged fluctuations are well below the sensitivity of the detector. Second, no one can point to any spot in the sky and say, "this is a spot of warmer or cooler temperature" [24].

Even if the temperature fluctuations turn out to be real, it has generally been missed that these fluctuations are an order of magnitude too low for the standard cosmology. COBE was designed to measure the fluctuations predicted by the theory, but the fluctuations were not directly observed, hence the statistical treatments. Attempts are being made to refine the big bang model to fit the data. There are other problems with the big bang, such as the flatness problem, dark matter, and the assumption that the universe would have been in thermal equilibrium when it came into existence. Creationists have made use of all of these arguments against the big bang.

Another problem with the big bang is discordant redshifts. Halton Arp [6] has made a career producing data that calls into question whether the redshifts are cosmological, that is, is redshift directly proportional to distances? If Arp is correct, then at least some redshifts must be due to some other effect other than cosmic expansion. Quite understandably, creationists have made use of this [15].

There are several problems with the creationist approach to the big bang however. First, it is obvious that in some papers creationists have improperly stated the big bang model. For instance, some have assumed that the geometry of the universe is Euclidean, while others picture the big bang as having been an explosion of matter and energy into preexisting space and time [1], [2]. The standard model actually assumes non-Euclidean geometry, and the big bang is not so much an explosion of matter into space as it was an explosion of space

and time as well. In other words, there was no space or time before the big bang. Others deride the standard cosmology by asking such questions as "how can an explosion give rise to complexity?" What is missed in this is that the name "big bang" is a bit of a misnomer, and that the standard model has never actually been proposed as an explosion. A few years ago a popular astronomy magazine held a contest to give a better name for the standard cosmogony - no one won [8]. If a creationist misunderstands these basics of the big bang model, then would any of his conclusions regarding the big bang be valid?

Second, many creationists greatly overstate the case against the big bang. In some presentations it has been stated that cosmologists are in despair with the big bang and are nervous to debate the model (a statement that this author heard during a lecture by a prominent creation speaker a few years ago). A typical quote is that of DeYoung and Whitcomb [19, p. 11]:

> "However, in spite of the current popularity of this theory, the dramatic beginning of the universe which the "big bang" assumes has proven to be an embarrassment to many cosmologists."

While I share opposition to the big bang model with DeYoung and Whitcomb, it has not been my experience that cosmologists are embarrassed by the theory. While recognizing problems that the model has, most big bang scientists are convinced of the fundamental correctness of the model and believe that with time the model will be improved.

A third problem is our lack of an alternative. Even if we succeed in destroying the big bang, do we have a model with which to replace it? There have been several cosmological models that creationists have put forth (e.g. West's polytropic model [55], but only one cosmogony model has been proposed. This is the Humphreys white hole cosmogony [30], which will be discussed later.

THE DESIGN ARGUMENT

Much evidence of teleology (design in nature) exists in the universe. For human, animal, and plant life this is very easy to see. If certain changes are made in the physiology or the chemistry of organisms, then life becomes impossible. The same could be said about the universe as a whole. If certain constants of nature are changed, then the chemistry necessary for life becomes impossible, and the universe begins to appear very suited, or designed, for life [16]. The same is true for the earth: if we change its size, composition, distance from the sun, tilt of its axis, or any number of characteristics, then the earth becomes uninhabitable. Secular scientists have spent much thought on these questions, and have dubbed this the "anthropic principle" [7].

The anthropic principle as usually formulated has at least two great differences from the design argument used by creationists. First, the secular scientists that developed the anthropic principle have done so from an atheistic viewpoint. Their basic conclusion is that no matter how much the universe may seem to have design, it really does not. This sets the design argument completely upon its head, and it is time that creationists retake this argument. A second problem is that much of anthropic principle has been developed in the context of an old universe. Some creationists who are comfortable with an old universe have made great use of this kind of argument [40], [41]. These two objections have probably caused most creationists to ignore the anthropic principle. One exception is Bergman [9], whose recent paper is an excellent start on this subject. Creationists are encouraged to explore this topic.

Design is a very powerful argument, but can it be overstated? Have some seen design where none exists? When examining the diversity among the moons of the solar system revealed by the Voyager probes, some appeal to the design argument. The case is stated something like this: the moons of any of the Jovian planets exhibit varying orbital distances, compositions and surfaces, suggesting a very complex origin and history. Because uniformitarian and evolutionary theories have difficulty explaining all that we see, these must be the

result of design and creation. Similar arguments are made for ring systems, stellar diversity, and galactic structure. But does something like the orbital distances and ordering of planetary satellites reveal design? If there are ten moons orbiting a planet, they must each assume their own orbits. Though the number of possible combinations is virtually infinite and the probability of any particular one slight, the moons must be in some configuration. In order for a design argument to be valid, it must be demonstrated that any other configuration would not work. The root of the problem here may be a lack of a concise definition of design that can be objectively applied. Progress toward this definition and its application is encouraged.

ARGUMENTS FOR A RECENT CREATION

A much more fruitful argument is the one for a young creation. The universe is usually assumed to be between ten and twenty Gyr old, with the solar system and the earth having formed about 4.6 Gyr ago. Of course this is based on evolutionary and uniformitarian assumptions. Our model places an age of only a few thousand years for the earth and everything else in the universe. Thus a very clear distinction between the creation and evolution models exists. There have been several arguments put forth for the young age of the earth, such as the mineral content of the ocean [36] and the helium content of the atmosphere [54]. Several arguments for recent cosmic creation have been given [44], [46], [47]. We will discuss five arguments for the solar system and three for the universe.

A Young Solar System: Comets

The existence of comets has been used as an argument for a young solar system for a long time [47]. Comets have been known since ancient times. Bright ones are rare, occurring every decade or two. Comets appear without warning, erratically move across the sky, and then just as mysteriously disappear. The seemingly unpredictable nature of comets stems from their orbits being very different from the orbits of planets. One difference is that while planetary orbits are nearly circular, comet orbits are very elliptical. This means that the comets usually travel at great distances from the sun, but once each orbit they come very close to the sun, often closer than any of the planets. The orbits of the planets are nearly in the same plane, but comets can have any inclination to that plane, with some of them orbiting nearly perpendicular to the plane.

For about 40 years the model of a comet has been Whipple's dirty iceberg theory, and much evidence has been amassed in its support. It states that a comet consists of a nucleus only a few kilometers across made of various ices and dust. At great distances from the sun, where comets spend most of the time, the ices remain frozen. However as a comet is near closest approach to the sun, the intense radiation from the sun evaporates the ices to produce a tenuous cloud of gas around the nucleus called the coma. Solar wind and radiation sweep gas molecules and dust particles outward to produce the tail. During the spring of 1996 we were treated to Comet Hyakutake, followed by Comet Hale-Bopp in the spring of 1997.

Each close passage to the sun results in a large amount of material being removed from the nucleus. Obviously, given the small size of the nucleus, a comet cannot survive many trips around the sun. Comets of short orbital period that have been observed during many orbits have become noticeably fainter as a result of material loss. It has been estimated that a bright comet could not remain bright for more than 100 passes near the sun. With a period of about 10,000 years and being so bright, Comet Hyakutake could not have been orbiting the sun in its current orbit for very long, certainly not 4.6 Gyr, the supposed age of the solar system.

If comets date from the beginning of the solar system, and they can only survive 100 trips around the sun, what is the maximum age of the solar system? If comets travel too far from the sun, they will be lost to other stars. Let us assume that a comet nucleus can travel 1/3 the distance to the nearest star and still remain part of the solar

system (the maximum distance is probably less than that). Kepler's third law shows that the maximum orbital period would be about 10 million years.

One hundred trips would give an age of one Gyr. This is a maximum age: the actual would be less. This would result in no bright comets - we do see bright comets, so they could not be that old. Therefore we can conclude that the existence of comets gives us an age of the solar system far less than 4.6 Gyr.

This has long been recognized as a problem for the long age of the solar system, so in 1950 the Dutch astronomer Jan Oort suggested an explanation. He proposed that 4.6 Gyr ago during the origin of the solar system, comet nuclei either formed at great distances from the sun or formed in the inner solar system and were ejected to the outer regions. At these great distances from the sun the low temperature would allow the ices to remain frozen indefinitely. Occasional gravitational perturbations of other stars or molecular clouds would from time to time cause comet nuclei to change orbit so that they come toward the inner solar system once each orbit. As comets die they would be replaced by new incoming nuclei so that a steady state is achieved.

This Oort comet cloud is assumed to exist, even though there is absolutely no evidence for it. Of particular interest is the quote of Sagan and Druyan [42]:

> "Many scientific papers are written each year about the Oort Cloud, its properties, its origin, its evolution. Yet there is not yet a shred of direct observational evidence for its existence."

About the time the Oort cloud was suggested, Kuiper proposed a belt of comet nuclei just beyond the planetary region as the source of short period comets. For a long time the Kuiper belt was largely ignored, because it was thought that the Oort cloud could explain the existence of both long and short period comets. Since 1980 simulation studies have shown that the Oort cloud is incapable of producing short period comets in the number observed [20], [21], so the Kuiper belt has been invoked to explain comets of shorter orbital periods. In the view of some people today the Kuiper belt is considered to be an inner portion of the Oort cloud. In recent years a few studies have searched for Kuiper belt objects, with some apparent success. One search claimed to have found about two dozen "candidate" members of the Kuiper belt. The word "candidate" is used because none of the objects photographed can be clearly identified as a Kuiper belt object. Furthermore, a follow up search failed to reproduce the earlier result. The Oort cloud is something that has been devised to salvage the great age of the solar system, but perhaps the existence of comets is telling us that the solar system is young.

Slusher [47] and others, based upon studies done about a decade earlier, discussed this argument for a recent creation. A more recent article that includes original quantitave modeling is the one by Stillman [51]. Since Slusher's work the Oort cloud hypothesis has been refined, and the Kuiper belt hypothesis has been developed as well. Ejection from the solar system is now recognized as an important loss mechanism for comets, perhaps exceeding evaporation in the case of short period comets. With these recent developments, this whole issue from a creationist perspective has been in need of revision, which Faulkner [22] has done. His conclusion is that this is still a valid argument for a recent creation of the solar system, but that any discussion should include Oort cloud and Kuiper belt.

Lunar Dust

Back in the 1960's estimates of the depth of the dust on the moon were made. This was important information to know during the Apollo program, because if there were a thick layer, the lunar landers could have sunk and disappeared. The dust on the moon results from meteors falling onto the surface. Each meteor strike, no matter how small, knocks some debris from surface rocks, and this gradually accumulates along with the incoming material. If we can measure the rate at which meteors are falling today, then we can estimate how much should accumulate over 4.6 Gyr. Actually, this would be an upper estimate since the meteor flux would have been

greater in the past. Measurements of the meteor flux made nearly 40 years ago indicated that the lunar dust should be many meters thick. The actual depth is only a few centimeters, consistent with a recent creation but not an old one.

This remained a mystery until new meteor flux measurements in the early 1970's were far lower, consistent with the measured depth of lunar dust and an old age. Creationists apparently were ignorant of these newer measurements that were consistent with an ancient moon, and were rightly criticized [52, pp. 143-145], [53, pp. 67-82] for this lapse. Snelling and Rush [49] have reevaluated this issue, and they recommended against using this argument for recent creation.

Many creationists have abandoned this argument, but some continue to use it. It seems that there are some questions about the more recent meteor flux measurements, especially when one considers that the earlier measurements that were supposedly too high have never been explained. About the time that the paper by Snelling and Rush appeared, a new, more direct, and higher measurement of meteoroid influx was published [34]. This has been one factor in the rejection of some creationists to the warning by Snelling and Rush against this argument. The newer measurements should not be taken as the final word in this matter, and future measurements should be carefully monitored. Furthermore, laboratory measurements show that the bulk of lunar dust is made of lunar material rather than meteoritic material (the ratio could be as much as 67:1 [12, pp. 213-215]). If that is the case, then the depth of lunar dust would be more consistent with a young moon rather than a 4.6 billion year old moon.

Planetary Magnetic Fields

Many of the planets possess magnetic fields, and it is generally believed that a current in a metallic core of the planets causes these fields. In the case of the earth the current is in the iron and nickel core, while the Jovian planets have currents in a metallic hydrogen core or mantle. As with any current that is not externally sustained, these currents should eventually reduce and then vanish due to friction. Historic measurements of the earth's magnetic field show that it is decreasing. Thomas Barnes has shown that at the current rate of decay the earth's magnetic field would have been implausibly large much more than 10,000 years ago. Magnetic field reversals have been invoked to explain how the field can be decreasing today and yet be very old. There is some fossil evidence of reversals, but the CPT model predicts rapid reversals at the time of the flood, but with generally decreasing amplitude. What is left unexplained by gradual reversals over millions or billions of years is how the field is regenerated once it ceases to exist. It is assumed that some dynamo mechanism regenerates the current and hence the field, but the mechanism has not been identified. In all fairness it should be pointed out that the sun's magnetic field reverses approximately every 11 years.

Prior to the Voyager measurements of the magnetic fields of Uranus and Neptune Humphreys [28] used a recent creation model to correctly predict the strength of those fields. This is some of the more original research done by a creationist, and is an excellent counter example to critics who complain that the creation model offers no predictions.

Interplanetary Dust

There is much microscopic dust orbiting in the plane of the solar system. Presumably this material results from the breakup of comets and asteroid collisions. The problem is that solar radiation removes this material, smaller particles being ejected from the solar system and larger ones spiraling into the sun. Creationists have argued that the cleansing rate exceeds the dust production rate [47]. That is, if the solar system is 4.6 Gyr old, then there is far too much interplanetary dust currently present. An obvious solution could be that the solar system is quite young. Evolutionists [52, p. 145], who argue that interplanetary dust is in a steady state balanced between the creation

and destruction rates, have criticized this argument. This subject needs a new analysis from a creation standpoint paying particular attention to the rate at which new dust is introduced.

Tidal Evolution of the Earth-Moon System

Due to tidal interaction between the earth and moon, the moon should slowly spiral outward from the earth, while the earth's rotation slows. The rate of lunar recession has been measured by reflecting laser beams off of mirrors left on the moon's surface during the Apollo program and timing the transit times. The current rate is about 4 cm/year, which if extrapolated into the past, would place the moon at about half its current distance 4.6 Gyr ago. This distance would not have been a problem, but such a gross extrapolation into the past is not warranted. It is generally understood that the rate of lunar recession goes as the inverse sixth power of the moon's distance [26], and so the rate should have been greater in the distant past. DeYoung [17] has produced a plot of this functional dependence to show that for the past 1 Gyr the lunar distance has been a nearly linear function of time. At about 1 Gyr ago the slope dramatically changes, so that the moon would have been in contact with the earth less than 1.5 Gyr ago.

It is not only creationists who have drawn attention to this problem. The title of one article by a non-creationist scientist [33] asked the question, "Where Was the Moon Eons Ago?" One problem is that when the moon would have been in close proximity of the earth there would have been immense ocean tides that should have left clear records in the fossil record that are not seen. Another problem is that tidal evolution places an upper limit on the age of the earth-moon system that is scarcely 1/3 that of the usually assumed 4.6 Gyr age. It should be emphasized that this is not a clear indication that the earth and moon are only a few thousand years old, but that in a very young solar system tidal evolution is not a problem.

Evolutionists have countered that due to changes in the earth's surface due to plate tectonics, the distribution of ocean floor and continental shelves has varied with time. Much of the tidal braking that causes lunar recession occurs in relatively shallow water near coastlines, so it is conceivable that the rate of lunar recession has an additional time dependence [52, pp. 146-148]. This explanation requires that we live in a time of unusually large lunar recession rate. However, several studies of varve and fossil coral growth have suggested that the current rate of tidal evolution has been nearly constant for several hundred Myr. These studies have generally been dismissed, but a recent new study of varves spanning the past 900 Myr [48] present strong evidence that the average rate of lunar recession over that interval closely matches the current rate. Note that this agrees with DeYoung's contention, that the $1/r^6$ produces a nearly constant rate for the past 900 Myr. One could argue that the unusually high rate has coincidentally prevailed for nearly 1 Gyr, but with the shuffling of plates that should have occurred in that time, this seems extremely unlikely.

It must be noted that recent creationists reject the age and perhaps the interpretation of the varves in this recent study, but evolutionists are generally not in a position to do so. The topic of lunar recession has not been fully explored by creationists. A full discussion that goes beyond the relatively simple ones thus far is badly needed.

Lunar Ghost Craters

A final argument for the youth of the solar system that we will discuss is evidence that apparently has not been published in creation literature as of yet. The term "ghost crater" is perhaps an obscure one, and is not often heard in the post-Apollo era. Alter [5] defined a ghost as "the bare hint which remains of a lunar feature that has been practically destroyed by some later action." Alter also discussed a number of photographs that included ghost craters.

The moon has two types of terrain: the maria and the highlands. The maria are the relatively smooth, darker regions easily visible to the naked eye. On the other hand the highlands are lighter in color, much more heavily cratered, and as the name implies, are generally at higher elevations. The color difference is due to a difference in composition: the highlands are primarily composed of granite, a lighter colored, less dense rock, while the maria are made of basalt, a darker, more dense material. The density differences accounts for the different elevations between the two lunar terrains, but the difference in cratering is a matter of conjecture.

The moon is assumed to have formed 4.6 Gyr ago with the rest of the solar system. The leftover material at first was large in number and caused a huge amount of impacts on the formed bodies of the solar system. With time the amount of potential impacting bodies would have decreased exponentially, and this would have caused the formation rate of new craters to decrease as well. Under this scenario the highlands reveal a nearly primordial surface, while the maria have a more recent surface. Probably volcanic eruptions overflowed the maria, erasing most of the craters already there and preparing a smooth surface to record any impacts since the time of the overflow.

Why did the lava overflow only occur where the maria are today? A clue is provided by the roughly circular shape of the maria, which suggests that they were the sites of the largest impacts. Here is the history of the moon as generally believed [56]. The moon formed 4.5 - 4.6 Gyr ago. Many impacts followed, but decreased exponentially with time. The outside cooled and hardened first, while the interior slowly cooled. Sometime around 3.5 to 4.2 Gyr ago several final large impacts occurred, forming very large craters called "impact basins." The impacts facilitated the overflow of lava, either by providing the heat from conversion of kinetic energy to melt material or by providing deep fractures to allow molten material from the interior to reach the surface. Either way one would expect the overflow to rapidly follow the excavation of the impact basins. One would not expect that it would have taken many millions of years for the second event to follow the first.

However, it is generally thought that as much as a half Gyr elapsed between these two events [56]. The reason is the existence of many ghost craters, craters that are faintly visible due to volcanic overflow after they formed. Note that impact basin formation should have obliterated any craters that previously existed on the site, so that there can be no craters visible today that predate that event. But to be a ghost crater the crater must predate the volcanic overflow. The amount of ghost craters on the moon indicates that the amount of cratering between the two events (the formation of the impact basins and the subsequent volcanic overflow) must have been substantial. With a long time frame (4.6 Gyr) and the presumed cratering rate over time, one is forced to hypothesize a long period of time between the two events.

Above it was argued that it is more reasonable to conclude that the two events must have occurred in rapid succession. If that is the case, what else must follow? The amount of ghost craters and the brief period of time in which they could have formed forces the adoption of a past cratering rate several orders of magnitude larger than usually thought. At the same time the relative lack of fresh craters on the maria suggest that there was a much steeper decline in the cratering rate than is usually thought. Both of these concepts are unacceptable to uniformitarianism, but fit very nicely with a model of recent creation and catastrophism.

The Age of the Universe: The Break Up of Galaxy Clusters

Let us now turn our attention to the age of the universe. A galaxy is a vast collection of billions of stars orbiting about a common center of mass. Galaxies are usually found in clusters, collections of tens to thousands of galaxies. Several decades ago Fritz Zwicky noticed that the members of clusters of galaxies were traveling too fast to be gravitationally bound to one another. The result is that the cluster should evaporate over a time scale of about 1Gyr, far shorter than the 10 to 20 Gyr year age of the universe. Thus the existence of clusters of galaxies suggest that they must have been created more recently than generally thought [46]. As with some of the other

arguments of recent creation presented, this one does not directly produce an age of a few thousand years. Instead it indicates an upper limit for the age that may be better reconciled with a recent creation rather than an old one.

The answer that evolutionists have devised is that the clusters are held together by the gravitational force of unseen, or dark, matter. Calculations reveal that the amount of matter required to do this is many times the mass of the visible matter. In many estimates only about 10% if the total matter of the universe is visible. If the apparent break up of galaxy clusters were the only reason for hypothesized dark matter, then one could easily doubt its existence. Binney and Tremaine devote an entire chapter of their book [10, pp. 589-641] to the discussion of dark matter. They give several lines of evidence for dark matter that are independent of galaxy cluster dynamics. These include the motions of stars in the solar neighborhood, the motions of galactic Population II tracers, and mass-to-light ratios of the central regions of elliptical galaxies. Perhaps the best probes of dark matter are rotation curves of spiral galaxies. According to Binney and Tremaine [10, p. 599], nearly all of more than 70 spiral galaxies for which there are suitable rotation curves strongly indicate large amounts of dark matter. Rotation curves of galaxies suggest that dark matter may really exist, but the identity of the dark matter remains a mystery, despite many attempts to identify it. Only time will tell if this is a good argument for a recent creation. Given this additional data, it is doubtful that the alleged break up of galaxy clusters is a good argument for recent creation. Unfortunately, when discussing this topic, many creationists fail to mention that there is other evidence for missing mass, or even acknowledge that missing mass is a proposed explanation for the observed velocities.

Spiral Structure of Galaxies

Another possible clue to a recent origin of the universe is the existence of spiral galaxies. Spiral galaxies are called such because of the very beautiful spiral or pinwheel shape that they have. The inner portions of the galaxy should orbit more quickly than the outer portions, and so any patterns such as this should be smeared out in just a few revolutions. This smearing should require no more than 2 Gyr, much less time than the supposed 10-15 Gyr that the galaxies have existed. For a discussion of this from a recent creation perspective, see [46].

This was recognized as a problem for many years, but most thought that the problem was solved by "spiral density wave" (SDW) theory suggested more than 30 years ago. Briefly stated, this theory suggests that the spiral arms of a galaxy are a density enhancements, or shock waves, that continually move around in a galaxy's gravitational field. This shock wave would form the dense clouds and bright stars that we see in spiral arms. Humphreys [31] says that SDW theory requires that a number of parameters be fine tuned to make the theory work. If this is true, then the SDW is not such a straightforward answer to the problem of spiral structure in old galaxies as is usually thought. This entire subject is in serious need of a creationist reevaluation. Creationists are urged to discuss the possibility of SDW when using this problem as an indicator for recent creation.

The Lack of Supernova Remnants

A final young universe indicator that we will discuss is the age of supernova remnants (SNR). Supernovae are large explosions that destroy massive stars and can rival an entire galaxy in brightness for a short time. In a given galaxy three or four supernovae are believed to occur each century, a number confirmed from the many supernovae that are observed in other galaxies each year. While a supernova is only visible for a few months, the SNR consisting of expanding gas should be observable for millions of years. Our location in the galaxy does not permit us to observe most supernovae in the visible part of the spectrum (in the 400 years since the invention of the telescope a supernova in our galaxy has not been observed), but many SNR's are detectable in our galaxy with radio telescopes. In fact, observations in the radio portion of the spectrum are the most common means in which SNR's are studied.

The visibility of a SNR is a function of distance, size and expansion rate, and the age can be inferred from the observations. As a SNR ages, it becomes more extended and rarefied so that eventually it is no longer observable. Surveys of all of the observed SNR's in our galaxy reveal many young ones, generally thousands of years old. In fact, only a few older than a few thousand years are observed at all. Theoretical considerations show that many older SNR's should be observable, but observations seem to show that most of them are missing. This appears to be a very powerful argument for a recent creation, and has been discussed by Davies [14.

CONCLUSION

Let us now turn to some problems that creation astronomers face today and examine where work should progress. We have talked about the solar system and the universe as a whole, but we have talked very little about the "middle ground" of stellar astronomy. Stellar astronomers have developed very compelling evolutionary theories to explain the origin and diversity of stars as well as the elements. In the only creationist critique of stellar evolution, Mulfinger [37] argued for the rejection of all of stellar evolution theory. A possible problem with this approach is that the theory has a very strong basis in physics, a situation very different from biological evolution. Faulkner and DeYoung [23], who cautioned that creationists must be prepared to give strong physical arguments for rejecting stellar evolution, noted this.

There are many who reject biological evolution but accept stellar evolution. Indeed, there is some question of the word evolution meaning the same thing in these two fields. Many creationists view stellar and biological evolution in the same light. Morris has argued for the fixity of stars, that one type does not evolve into another. He has also argued that the birth of new stars would be tantamount to the appearance of a new kind of animal, something that the creation model does not allow. But is the birth of new stars more like the creation of new creatures, or is it more like the replacement of dead ones? We know that animals die and so must be replaced, so perhaps this is the proper analog to stellar birth. Some creationists seem to be in the inconsistent position of insisting that stellar evolution does not occur, but when it does, it is actually stellar decay.

While many Christians have entered the fields of biology and geology to combat evolution the takeover of astronomy by evolutionary thinking has scarcely been noticed, and there are few qualified creationist astronomers. Creationists need to do much more work in stellar astronomy. Many questions need to be addressed; we will briefly discuss two. First, are stars forming today? It is generally theorized that stars form from gas clouds. As mentioned above, many creationists insist a new star today would be equivalent to a new kind of animal arising today, and that the completion of the creation week precludes this possibility. But a supernova appears to be the death of a star, and if death occurs, why could not the birth occur as well? In other words, perhaps the birth of a star is equivalent to the birth of an individual organism rather than a new kind of organism. It has long been known that a cloud of gas is generally stable against collapse to form a star. The reason is that the gas pressure present in the cloud will resist the compression. If some agent condenses the cloud to a certain point, then the gravitational force of the cloud can lead to a star. The theoretical difficulty has been to identify a natural process that can bring an originally diffuse cloud to this point.

Several agents have been proposed to initiate the process of proto-stellar collapse. Two of the more popular, shock wave compression and cooling by radiation from dust, will be briefly mentioned here. It has been suggested that a supernova explosion near a gas cloud could cause the cloud to be compressed to a size that would allow gravitational contraction to occur. Alternately, for a given size and mass, a cloud could be caused to contract if it could shed some of its heat. This could be accomplished by the radiation of dust particles embedded in the cloud. Both of these mechanisms suffer from the same problem: they require that some stars must exist first. A supernova explosion obviously requires at least one preexisting star, but evolutionary theories of the universe demand that the elements found in dust particles could only have been produced by stellar

nucleosynthesis and that the dust grains themselves could only have been formed in the atmospheres of red giants. This presents the obvious problem of where the first stars came from.

In passing it should be noted that some creationists believe that the formation of a star violates the second law of thermodynamics [37], but this is not true. If one starts with a sphere of gas of larger radius and contracts the sphere to a smaller radius, then the simple application of gas equations does seem to suggest a decrease in entropy. It is also obvious that in the lab gases do not spontaneously contract, which seems to be a consequence of the second law of thermodynamics. At least two differences exist between the laboratory situation and a contracting protostar. One is that the protostar possesses considerable internal energy in the form of gravitational potential energy that the lab gas does not. The other difference is that the protostar sheds considerable energy by radiation. As the protostar contracts, the gravitational potential energy is liberated. By the virial theorem, half the released energy heats the gas, while the other half is radiated. Recall that the definition of entropy change is dS=dQ/T, where dQ is the heat flow and T is the temperature. Since the heat loss is negative, the entropy change of the protostar would be negative, as it is for any radiating object.

In fact, Mulfinger's entropy calculation can be generalized to any self-gravitating spherical gas (cloud, protostar or star) with the result (in molar units):

$\Delta S = 3/2\ R \ln(r_2/r_1)$

where R is the ideal gas constant, r_1 is the radius of the object at some time and r_2 is the size at some later time. Since the cloud or star is contracting, $r_2 < r_1$, so that ΔS is negative. Mulfinger applied this sort of equation to demonstrate that since this entropy change is negative, the second law of thermodynamics prohibited the contraction of a gas cloud to form a star. What he ignored was the fact that energy is radiated from the protostar (thus ΔS is negative), but that the absorption of that energy elsewhere produces an even larger positive increase in entropy, so that the total entropy change is positive.

To emphasize that something is amiss here, let us apply this approach to another self-gravitating gaseous object. Since the announcement in 1979 that the sun may be shrinking, many creationists have seized upon the possibility that the sun may be powered by the Kelvin-Helmholtz mechanism rather than by thermonuclear reactions. Of course this strongly implies a greatly reduced solar age [27] (this idea is less attractive than it once was; for a good creationist review of this see [18]). If the above approach is applied to the Kelvin-Helmholtz contraction, a negative entropy change seems to be the result. Of course, most creationists believe that Kelvin-Helmholtz contraction does occur.

The last problem that we will discuss is probably the single biggest problem that recent creationists face today: the light travel time. Simply stated, if the universe is billions of light years in size, then how did the light from most objects get here in a few thousand years? Several answers have been proposed. One is that light travels in a non-Euclidean geometry. This was suggested more than 40 years ago by a couple of non-creationist physicists to address a different problem. Though still mentioned from time to time, few take it seriously anymore [3]. There is a prediction about close binary stars that the model makes, and the predicted effect is not observed, but this apparently has not been published.

Setterfield, who showed that the measured speed of light had decreased since the first measurement was made three centuries ago, proposed a second answer. Extrapolating the much higher speed of light into the past could produce a speed that was near infinite in the early universe and would permit the light from the most distant objects to have reached us. In the past 15 years there has been much debate among creationists over this issue, with some insisting that the effect is real and others convinced that it is not. A mini-symposium on this topic appeared in the *Creation Research Society Quarterly* a few years ago. The early measurements provide the greatest evidence, but are also subject to the greatest error. It is most curious that the decrease seemed to end

about 1960. There are some theoretical problems as well. The speed of light is not a constant that can be arbitrarily changed. It depends upon some fundamental constants that have an effect on the structure of matter. If the speed of light is changed much, the structure of matter will be dramatically changed.

Most creationists have adopted the concept of a fully functioning universe as the best explanation for the light travel time problem. In the garden Adam would have been a particularly healthy male. If we could go back in a time machine and examine him we might have concluded that he was 20 to 30 years old. Of course we would have been wrong, because Adam was created only a few days before. In other words, creation implies some sort of apparent history. It is argued that in like fashion, for the stars to serve their intended purpose (for the marking of time and seasons) their light must have reached earth in time for Adam to see them two days later. Thus God must have created the light in transit.

But did Adam bear the scars of past history, such as injuries that never happened? When the fossilized remains of large extinct and previously unknown creatures were unearthed over a century ago, some Christians responded that the fossils were created in the rocks and that the creatures never existed; they just appeared to have existed. Most people would reject this as absurd. Yet the creation of starlight in transit raises a similar philosophical point. In the spring of 1987 a supernova was observed in a nearby galaxy called the Large Magellanic Cloud. Since that time the progress of the explosion and its aftermath have been carefully observed. We have been able to piece together many fine details of what happened. But if the notion of light created in transit is correct, then none of the observed events happened. How is this different from God creating fossils in the ground? This idea also has no predictive power like the other two suggestions above, which relegates it more to a philosophical idea rather than a scientific one.

On the other hand the white hole cosmogony of Humphreys [29], [30] is a very detailed scientific model that seeks to answer the light travel time question. As with the big bang or steady state theories, this model assumes modern relativity theory, but with a different set of initial conditions for the universe. One of the big differences is that the universe started as a white hole. Humphreys assumes that the matter of the universe is bounded. He had chosen to call his model a white hole cosmology, because he perceives that the initial condition is similar to what is called a white hole. Most people have heard of black holes: regions of space where matter and light are falling inward and cannot escape. Most people are not aware that the same theory predicts the possibility of white holes, regions of space very similar to black holes except matter and light are streaming outward. Such a condition is unstable, and so unlike black holes which may exist forever once they form, white holes exist for a relatively short time before ceasing to exist. That is one reason why white holes largely have been largely ignored. Another reason they have been ignored is that we have a theory of how black holes can form naturally at this time in the universe, but not white holes. Any primordial white holes should have ceased to exist by now.

The Humphreys cosmology assumes that the universe began as a white hole. Sometime during late in the creation week the white hole ceased to exist, giving us our present universe. The particle horizon swept past the distant stars on day four when the starlight reached the earth on that day. The important point is that through relativistic effects, time proceeds at very different rates in different parts of the universe. While only a few thousand years elapsed near and on the earth, billions of years could have elapsed elsewhere. This would allow light to travel millions or billions of light years to reach the earth while only a few thousand years occurred on the earth. This all happens because of the different rate at which time passes in different reference frames in general relativity. Not only does this cosmogony purport to answer the light travel time problem, it also provides creationists with a Biblically based cosmology as well.

However, several questions remain. For instance, why does the solar system, which is not the product of stellar nucleosynthesis, and the rest of the universe, which has undergone stellar nucleosynthesis, have the same basic composition? As mentioned earlier, most creationists reject stellar evolution, but the Humphreys cosmology seems

to demand that it has occurred. The Humphreys cosmology also demands that the universe is indeed Gyr's old, though only a few thousand years has elapsed since the beginning of creation in the reference frame of the earth. It would seem those indicators of a young universe, such as sprial structure in galaxies, the break up of clusters of galaxies, and the ages of SNR's cannot be reconciled to the Humphreys cosmogony. While only six days occurred on or near the earth, exactly when in those six days did the creation of the stars take place? If the particle horizon swept past the distant stars on the fourth day so that the stars first became visible on the earth, then how is that different from those who argue the same thing (that stars were created earlier, but only became visible on the surface of the earth on day four), but that the cause was a clearing of the atmosphere.

While the Humphreys cosmogony met with little discussion or opposition at first, the level of debate has increased tremendously. Several critical papers have been written [11], [13], and Humphreys has responded [32]. Humphreys' critics have charged that he has either misunderstood or improperly applied general relativity in his model. Byl [11] has argued that while time dilation effects are real, the sense of time corrections are always in the wrong direction and/or are too small to solve the light travel time. Byl, along with Connor and Page [13], concludes that the approach that Humphreys is attempting would more properly describe the time difference between an observer in the universe to one outside of the universe. If this is true, then the Humphreys model certainly does not succeed in addressing the question as framed. This criticism has led the editorial staff of the ICC to conclude that there was a failure in the peer review process of Humphreys' 1994 paper [29] in which he first publicly presented his model. Humphreys is convinced that his model is still viable and is continuing to correct and refine his model. Whether this model survives or not, we should applaud this very serious effort that Humphreys has made.

So what is the state of creationist astronomy? We have seen that it has some good points to make. We have also seen that there have been some false starts and some problems. We must go beyond arguing what is wrong with evolutionary models. What is needed is an overall model or paradigm to describe the universe. A formation and history of the solar system must be explored. A particularly important question to address here is when and how the cratering that we see in the solar system occurred. Did the cratering occur during creation, at the fall, during the flood, or at some other time? A few authors have begun work on this question [25], [39]. If we are not satisfied with stellar evolution, then we must provide physical arguments against it and supply our alternative. For the universe as a whole we must explain the light travel time in a plausible way.

Some progress has been made in creationist astronomy, but there is much work to be done. Older arguments must be continually reevaluated and expanded. The words of the late George Mulfinger in his early review are just as true today as they were 25 years ago [38]:

> "…much work remains to be done the in the area of creationist astronomy. Christians who have sufficient background in the field who have strong enough convictions to take a good stand on the issues involved should be encouraged to write."

It is hoped that this discussion has inspired some who are already competent in the field to pursue these matters or encouraged bright young people to enter the field for this purpose.

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