New science on the young sun, and Earth migration

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For many years planetary scientists and Earth scientists have debated what is called the 'faint young sun paradox'. Creationists have also addressed the issue, as it demonstrates a problem with evolutionary origin of life scenarios on Earth.[1-3] The sun's luminosity increases gradually with time and projecting this back more than about 2 Ga implies Earth would receive much less energy from the sun. The lower luminosity of the sun could possibly freeze Earth's entire surface. One recent source looking at variations in solar luminosity has it about 15% less at 2 Ga before present (BP), about 20% at 3 Ga BP, and reaching a minimum of 26% less than today's luminosity at around 4.2 Ga BP.[4] In 1972 Carl Sagan estimated the luminosity to be roughly 40% less than today at about 4.5 Ga BP.[5] Thus the questions come up, 'How could life evolve?' and 'How did life survive?'.

Difficulties with atmospheric solutions

In 1972, Carl Sagan addressed the issue of the young sun by suggesting that ammonia in the atmosphere of the early Earth would have enhanced the greenhouse effect and kept Earth warm, similar to the way Venus's thick atmosphere is kept hot. Scientists have explored a number of variations on Sagan's idea, such as the atmosphere having higher concentrations of methane and carbon dioxide. The usual accepted answer today in the scientific community to the young sun paradox is still that Earth's atmosphere was once more dense than today and had an enhanced greenhouse effect that kept it hot for possibly tens of millions of years.[6] So this answer to the young sun issue applies atmospheric science. Sagan's original idea is not likely because ammonia is very susceptible to destruction by ultraviolet radiation. Methane, in addition to being subject to ultraviolet, also tends to form organic hazes that reduce the light levels. In the greenhouse effect, if a substance like methane is of higher concentration, this makes the greenhouse heating greater, but if the concentration is too great, the hazes start cooling the earth because of the lower light levels. Concentrations of carbon dioxide much greater than today's have also been considered.[2] An important difficulty with carbon dioxide and the young sun is that it tends to cause more cloud cover, which cools Earth.[7] Scientists who have worked on the problem have generally concluded that carbon dioxide, methane, and ammonia in Earth's early atmosphere are not likely to be adequate explanations of the young sun paradox. Creationist Michael Oard also recently addressed some of these aspects of the problem.[2]

Difficulties with planetary motion solutions

There are other proposed explanations of the young sun issue from planetary science. One is that our sun was approximately 7% more massive in the past.[8] When it was more massive, its radiation to Earth would have been greater by a few percent, enough to provide for the origin of life. Noted Purdue University planetary astronomer Dr David Minton has recently addressed some of the difficulties with this scenario.[7] The main objection to it may be that young stars similar to our sun are not observed to be losing mass at the high rates that this model would require. Our sun would have to lose mass at a high rate for a very long time of over 2 Ga. It is true that some stars are observed to apparently go through stages where they lose mass at a greater rate, such as from an enhanced solar wind or coronal mass ejections. But it seems implausible that our sun could undergo this magnitude of mass loss and settle down to the present sun we benefit from.

A new solution from planetary science

Minton has recently proposed a new answer to the young sun paradox, suggesting that Earth was once approximately 6–7% closer to the sun than today and migrated outward to its current orbit. Planet migration is now a well-accepted theory in planetary science and has been applied to explain the origin and history of many extrasolar planetary systems. There are three types of mechanisms for planet migration that have been proposed. First is essentially that the protoplanetary dust disk causes the planet to migrate. Scientists believe both inward and outward migration is possible, depending on the scenario. The second mechanism more recently proposed is that a massive disk of planetesimals could make a planet migrate. The third says that another planet (or possibly another star in some systems) could make a planet migrate. It is the third of these possibilities that Minton is suggesting for causing Earth's orbit to change. The idea has not been fully developed in detail yet and apparently Minton has not yet published a paper on it, as of this writing. But Minton did a presentation at the Space Telescope Science Institute in April 2012, the video of which is available on the internet.[9] Some non-technical articles have picked this up and have been published on the internet.[10,11]

Minton seems rather tentative about this proposal, judging from his presentation. The most likely scenario for Earth migration would be something like the following: Mercury, Venus, and Earth form near where they are now but a fourth unnamed rocky planet forms somewhere near Earth or Venus. This fourth rocky planet collides with Venus. Venus is disrupted to some degree by the collision and

reforms from the debris; it is also subsequently resurfaced by volcanism. Presumably Earth's orbit would be caused to migrate outward because of the fourth planet passing near Earth before it strikes Venus. Another possibility is that the fourth planet was in an elliptical orbit that crossed both Venus's and Earth's orbits. Planets in relatively close proximity like this could also affect each other by orbit resonances. So a number of scenarios along these lines are conceivable. Minton calculates that if Earth were only about 6–7% nearer the sun in its semi-major axis, this would increase the radiation on the earth, with the sun as it is today, so as to allow for liquid water on Earth.

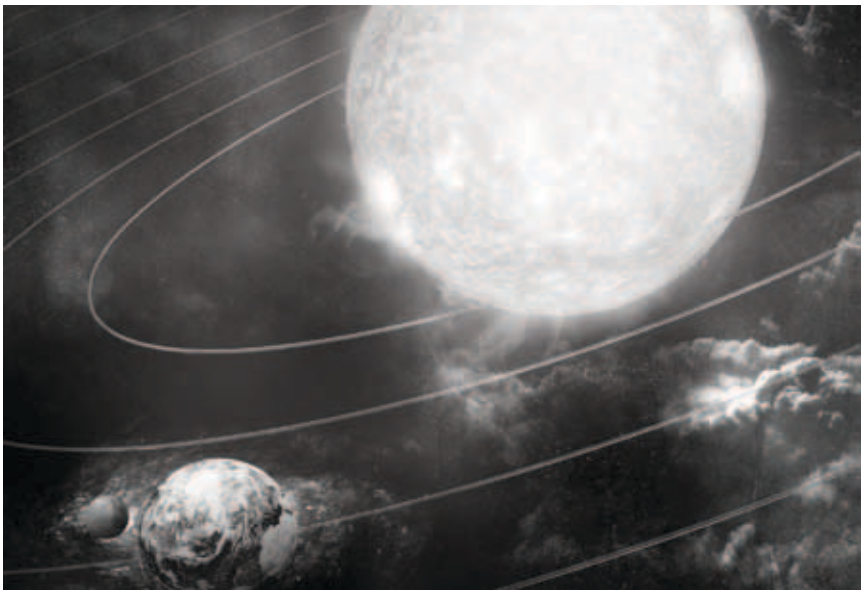

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Figure 1. Earth orbiting the sun. New theories on the young sun point to the stability of the earth and sun as a designed system.

New solution: science fact or science fiction?

In his presentation Minton acknowledges that this idea may be closer to science fiction than to real science. But, a modification of Earth's orbit of a few percent does not seem too implausible from a celestial mechanics standpoint, when you believe in an old solar system and allow only natural processes in explaining origins. Purposeful design of the solar system to be a safe abode for life is not usually considered in planetary science. Considering the great variety of extrasolar planetary solar systems that has been discovered today, this approach might seem, to some, to be a logical application of today's ideas to our own planet. But what are some of the potential difficulties with the earth's orbit migrating?

First, what would happen to the moon? When a planet has a moon like Earth, anything causing Earth's orbit to change would also significantly affect the motion of the moon. The moon could possibly be thrown out of its orbit, especially if the fourth planet came near it. The moon could also go into a more elliptic orbit around the earth. Assuming the moon stayed in orbit, the tidal changes on Earth caused by orbital changes to the moon could be very dramatic. It may even be possible for the moon to collide with the earth as a result of this kind of event. The moon's orbit could also undergo various oscillations that could last to the present. Scientists have indeed debated why the moon has the unique orbit it does around the earth. This aspect of the earth migration idea has apparently not been seriously studied yet by Minton. The effect of Earth migration on the moon could have major consequences for life on Earth.

Another important question about Minton's scenario is about the timing and relationship with Earth's early history. Scientists generally believe Earth formed over 4.5 Ga ago and that life evolved possibly over 3 Ga ago. Minton seems to put the Venus collision and Earth-scattering event at around 1 Ga ago at the latest. This puts it long after the solar nebula has dissipated and the heavy cratering event has happened in the early solar system, by evolutionary models. It also puts the event long after the alleged impact of a Mars-sized object with Earth which is believed to have formed the moon. This moon-forming impact is believed to have happened before Earth was 100 Ma old. The proposed Venus collision and Earth-scattering event would also be long after the origin of life on Earth. Apparently in Minton's approach, Earth would be presumably warm enough for liquid water to exist on the surface from 3 Ga to 1 Ga ago or until Earth's orbit settled to its present configuration. What about the increase in the sun's luminosity before the Venus impact event? Before Earth migrated it may have had to endure significant temperature changes from the sun's luminosity over approximately 2.5 Ga.

The migration of Earth's orbit from the gravitational influence of a lost planet may seem like science fiction. Yet planetary origins models today explore such ideas seriously.[12] In planetary systems outside Earth, the planets can be less stable in some way than in our solar system.[13,14] Thus planetary scientists accept the possibility that in the multi-billion-year processes of the formation of a solar system, some planets could form that get destroyed or thrown out of the system. There is now some possible observational evidence for a few rogue exoplanets drifting in space, not tied gravitationally to any star.[15] These 'free-floating' objects are believed to have formed in a solar system but were thrown out, probably by interactions with other planets or possibly stars in

binary or trinary star systems. So in the light of extrasolar planet research, astronomers do not consider it outside the realm of possibility to propose that a planet could have existed in our own system that is no longer present today. Still, this requires believing in a planet for which there is no observational evidence. Moreover, the real test of the idea is the question that if such a planet–planet- scattering event happened, how could the earth, the moon, and Venus be in their present orbits?

Scattering events like this would not be likely to leave remaining planets in such regular circular orbits as those in which Earth, Venus, and the moon are found. In the case of Venus, after the collision, there would undoubtedly be some gas and dust present around the region of Venus's orbit and this could have a rounding effect on the orbit of the reformed Venus. On the other hand, this material might dissipate before Venus's orbit could be sufficiently rounded. Venus's orbit presently has an eccentricity of 0.007, almost a perfect circle. The moon is also nearly circular in its orbit, with an eccentricity of only 0.055. Such a low eccentricity for Venus does not seem to suggest a significant catastrophic event in the past. However, note that the orbital eccentricity is not a constant. For our moon, it is possible past impacts could have caused oscillations in the orbit, though it is not clear if there is observational evidence of this. This theoretical possibility was addressed by Samec.[16]

The same effect for Earth would require a larger object striking Earth or passing near. Earth's orbital eccentricity varies over thousands of years, but its variations are generally believed to be due to the gravitational attractions of Jupiter and Saturn. So orbital oscillations do not necessarily imply a major change in a planet's orbit in the past from a planet–planet-scattering event. A 6–7% change in Earth's orbit implies Earth's orbit would shift by roughly 10 million kilometres. This is much more than a minor oscillation. Minton has apparently not yet published a specific model in a scientific publication about his Earth migration proposal. If a specific scenario for Earth migration were put forward, perhaps it could be evaluated in relation to orbital variations of Venus and Earth. But to the author there seems no compelling reason to believe that the orbits of Venus or Earth have changed significantly since creation.

The faint young sun paradox is also a problem for explaining Mars. For Mars, the issue revolves around how liquid water could have existed on its surface in the distant past. Mars has a thin atmosphere composed mostly of carbon dioxide. Currently liquid water would evaporate, yet there is evidence of erosion by water on the surface in the past. The faint young sun compounds the problem of explaining how Mars could have had liquid water for causing erosion features. It has been proposed that Mars once had a much thicker carbon dioxide atmosphere than at present, some of which was lost due to large impacts. But attempting to increase the carbon dioxide concentration on Mars enough to adequately increase the pressure and the greenhouse effect for liquid water leads to the formation of a CO_2 cloud cover that defeats the concept.[7]

Conclusions

We live in a solar system that was designed by God to have a high degree of stability for our benefit. Intelligent design is not only implied for the earth itself, but also for our sun, and in the placement of other planets in our solar system. Scripture implies that the solar system was complete by the end of the Creation Week (Exodus 20:11). Planet orbit changes and planet collisions that could threaten life on Earth do not fit into the orderly stable system that seems implied by the Bible. Perhaps more importantly, such catastrophic processes require millions and billions of years, when the Bible implies the solar system is only several thousand years in age.

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