Rapid planet formation

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A recent model for the rapid formation of planets formed from rotating clouds of dust has been proposed by Alan Boss, a well-known specialist in extrasolar planet research. His disk instability model attempts to solve some of the problems evident with the standard slow accretionary models in light of recent evidence of extrasolar planets. Planets are simulated to form in periods of less than 1,000 years rather than hundreds of thousands to millions of years. This concept is of interest to creationists due to the shorter timeframes, and may be useful in explaining some phenomena consistent with a young-universe framework. However, the model itself is dependent on unlikely assumptions of initial and subsequent conditions and does not fit with some features of extrasolar and solar planets. Contrary to what evolutionary astronomers think, our solar system is looking more and more special.

Science fiction, such as *Star Wars* and *Star Trek,* has made the idea of 'other worlds out there' part of popular thinking. Are there other worlds, and could they be habitable?

For many years now, evolutionary astronomers have envisaged that the planets of our solar system built up gradually over millions of years from a rotating disk of gas and dust. They expected to find planets similar to those in our solar system orbiting nearby stars. Recently, astronomers have been delighted to detect a number of objects that seem to be planets orbiting stars outside our solar system. These objects, called *extrasolar planets*,[1] have been recognized from small periodic changes in the light from the star. However, rather than confirming existing evolutionary theories, and showing that our solar system is nothing special, these extrasolar planets have raised thorny issues for planet formation theories.[1]

In a parallel development, faintly-luminous, infrared objects have been observed in nebulae where many astronomers claim there are young 'recently' formed stars. These have also been interpreted as free-floating planets (objects which do not orbit stars), though the question of exactly what these objects are is still controversial.[2] Free-floating planets also raise difficult problems for the accepted theories of planet formation.[1]

Evolutionary astronomers have thus been forced to propose new models to explain the formation of planets around other stars. These new models of planet origins have also been applied by some scientists to the formation of the large 'gas giants' in our own solar system. Alan Boss is one well-known specialist in extrasolar planet research who has proposed a new theory of gas giant formation.[3,4]

Evolutionary models: new *vs* old

For years, most astrophysicists believed planets formed by *accretion*. That is, solid particles in a protoplanetary disk of gas and dust fuse together (accrete) to form solid planet cores. Once the planetary cores are large enough, their gravity draws gases onto the planet. But the accretion model does not explain the observed extrasolar planets, which have orbits more elliptical and much closer to their parent star than predicted.

Alan Boss hoped to explain extrasolar planets with his new *disk instability model,* which he adapted from a theory originally put forward to explain the origin of certain small stars. According to this model, large gaseous planets could form in less than 1,000 years. This is in great contrast to the accretion model, which requires hundreds of thousands to millions of years, depending on the size of the planet and the conditions.

In this model, 'instabilities' or clumps of material form in a rotating disk of dust and gas. These clumps contain both gaseous and solid material with the solid grains sinking rapidly toward the centre of the protoplanets, which grow and accumulate gas around them. The speed of formation, which needs to be rapid, is dependent upon the assumed initial conditions in the disk (i.e. magnetic field strength, temperature, density of the disk). Initially, the disk is assumed to be very cold and the clumps contain some ice. However, as the planet grows larger, the gases heat up, producing a large gaseous body similar to Jupiter.

Besides the protoplanet's own star, the disk instability model requires some other stars fairly close by. The strong ultraviolet radiation from these neighbouring stars drives off much of the outer layers of gas in the newly forming planets. So, according to the disk instability model, the gas planets grow to a large size quickly and then are greatly reduced in size due to this radiation.

Models are based on simulations, not observation

Discoveries of new planets have been made possible by improved telescope technology. For example, the Hubble Space Telescope has been used recently to not only find a new planet orbiting a star known as Gliese 876, but also to accurately determine the planet's mass by precise astrometric measurements of its motion (mass calculations had not been previously possible from Earth-based telescopes).[5]

However, it is important to understand that planet-formation models are totally theoretical. Although astronomers regularly discover extrasolar planets today, they have never observed a planet forming, thus the formation of planets can only be hypothesized using computer simulations.

Computer models are dependent on the assumptions built into them. In fact these origin models cannot be experimentally verified by observation since we cannot go back in time to collect the data. Rather, they can only be evaluated in the present in terms of their theoretical plausibility.

Problems with the new evolutionary theory, too!

Although the new 'instability' model is intended to explain planet formation by naturalistic processes, it has a number of serious difficulties.

One intended advantage of the model may be one of its greatest weaknesses. The model simulates clumps of material that can form relatively quickly, in less than 1,000 years; however, they can also break apart quickly due to the changing conditions in the spinning disk. Alan Boss himself refers to his results as 'tentative':

> 'In spite of these promising results, it must be admitted that the present disk instability models cannot yet be considered definitive, because of inherent limitations, such as the spatial resolution employed [on the computer] even in the highest spatial resolution models to date … and doubts regarding the long-term survival of the clumps.'[3]

The instability model proposes that solids present inside the clump of gases would sink to the centre. But it's not at all clear that the various gas currents would allow this. If the solids did not settle to the centre, then planets probably would not form because the 'clump', or 'fragment', would not stay together. It is also assumed that heating effects would not interfere too much with such sedimentation.

As the protoplanetary cloud collapses due to gravity, it breaks into fragments. In the simulations, these fragments become large enough to pull matter onto them and continue growing as long as gas and dust are available in the system. But the fragmentation process cannot work without the proper magnetic field and electrical properties in the cloud.[6] To model stronger magnetic effects, the force of gravity may be artificially weakened in the calculation.[6]

There are also many questionable assumptions regarding the initial density of such clouds and the properties assigned to the cloud in simulations such as this. Though there may be real clouds similar to those simulated in such studies, this does not necessarily mean they formed as such computer models show. There are many ways in which a real cloud might not follow the idealized scenario in a computer model.

Evidence which does not support the disk instability model

As what we know about extrasolar planets is insignificant compared to what we know about the planets circling the sun, it is instructive to consider the ability of the proposed model to explain the formation of our solar system. Our sun does not exist in a region of space near other stars as required by the model. Thus, for our gas planets to form in this way, they would have had to form while the sun was near other stars in some other region of our galaxy. Then, after the planets formed, the sun would have had to move to another part of the galaxy, perhaps by being ejected by a cluster of stars, dragging the recently formed planets by gravity.

Even if planetary clumps can form in the way the computer models suggest, it is not clear that the planets would form in stable orbits. Instead, they could very easily be ejected away from the star or fall into it. It seems improbable that the orbits of multiple planets (such as in our solar system) would be stable in Boss's new model. The planets would initially form in circular orbits, but as their star moves, the planetary orbits would elongate into ellipses.

Most planetary scientists now believe forces from the spinning disk would move the planets closer to the star and elongate their orbits, making them cut across each other. In these orbits, the planets would eventually collide catastrophically or eject one another away from the star or the star cluster. It is hard to imagine how even a few planets in any such a planetary system could survive such a process! It would take a great leap of faith to believe that our own orderly solar system could have formed that way.

Small gas-giants and brown dwarfs

Boss's model has additional problems with the smaller planets. Some extrasolar planets have been discovered that have masses comparable to Saturn and smaller,[7] not to mention Uranus and Neptune in our own solar system. Such small gas-giant planets would need even more of the outer layers of gas to be driven off by the radiation of the proposed nearby stars. They would require very intense radiation from a nearby star so they could be shrunk in a 'short' time of less than one million years—a most unlikely situation.

When a planet is at a large distance from its star, as Uranus and Neptune are, the disk may not be dense enough and the magnetic field may not be strong enough for the process proposed by Boss to work.

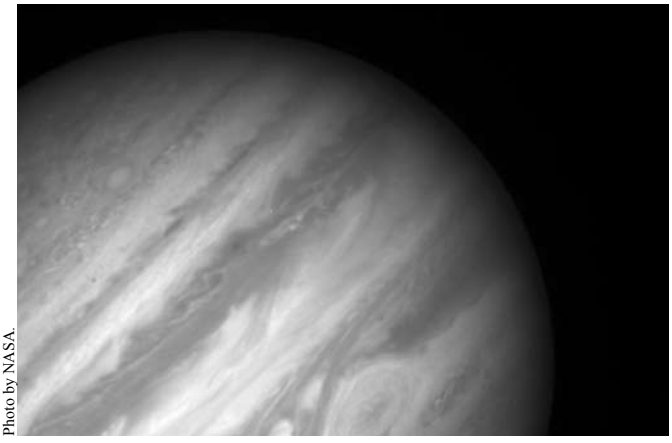

Photo by NASA.

New theories are being proposed for the formation of planets, especially the gas giants.

Another related problem with the instability model concerns the number of brown dwarf stars. If an object does not give off the light characteristic of stars and is about 15 to 80 times the mass of Jupiter, it is considered to be a *brown dwarf* rather than an extrasolar planet. If the instability model represented reality it would form brown dwarfs as well as extrasolar planets. This means astronomers should be able to observe lots of brown dwarfs. However, brown dwarfs are relatively rare, which does not agree well with the instability model.[8]

For all the above reasons, Boss's model could probably only explain a few cases, at best.

Biblical perspective

Contrary to what evolutionary astronomers think, our solar system is looking more and more special. The quest for a naturalistic model to explain its origin is as elusive as ever. This is consistent with special creation during the Creation Week (Genesis 1).

Genesis 2:1–2 indicate God's creation was completed on the sixth day. Does this mean that no inanimate objects formed in outer space after Creation Week? We may not be able to make an absolute statement on this question. Biblically, it may be that God's supernatural creation of planetary objects ended with Creation Week. After that week, natural processes would have taken their course. It's important to note that 'natural processes' and 'natural laws' are our descriptions of the orderly way God usually sustains the universe in the present (Colossians 1:17 and Hebrews 1:3). In fact, it was the belief in a God of order (cf. 1 Corinthians 14:33) that led to the rise of modern science, as even non-Christian historians of science agree.[9]

However, although God finished his supernatural creative work in the beginning, this does not mean that everything has remained in its original state. Stars could explode, galaxies could collide, and other highly energetic events could occur any time after the Creation Week. In the aftermath of some of these events, clouds might form into planets or stars through the influence of gravity and other physical processes.

If further research could show that Boss's new model was plausible, it may explain how some small stars and large planets could form in a timescale consistent with a young universe. Thus, creationists need not rule out Boss's model completely. It could be valid in special circumstances, such as after certain catastrophic events in space.

On the other hand, further theoretical studies of the model could reveal fatal problems. This frequently happens in astronomy. Science writer Dan Falk, in a recent article, commented about difficulties with planet origin theories in the light of the many extrasolar planets that have been discovered in recent years:

> 'Extrasolar planets have peculiar properties, and our understanding of how planets form, which was incomplete even before the new data became available, now looks even shakier.'[8]

In contrast, understanding these planets as only several thousand years old and having been created supernaturally avoids many of the difficulties with planet origin theories. And while human endeavour is slowly building our knowledge of astronomy, the Bible points out that God knows exactly how many stars and planets the universe contains and He is in control of the fate of every one of them (Isaiah 40:26)!

Meanwhile, the cosmos continues to surprise. Extrasolar planets exhibit a greater variety than astronomers expected, especially regarding their masses (or sizes) and orbital configurations. One planet nearly the same size as Jupiter was recently found that orbits its star in only 29 hours![10] This is extraordinary. It implies temperatures would be so high in the planet that elements like iron may exist as a gas. Such findings show the power and creativity of the Creator. They also contrast with how special our own planetary home is—God did not create Earth to be devoid of life, but purposely 'formed it to be inhabited' (Isaiah 45:18).

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