CATASTROPHIC ORIGINS FOR THE ASTEROIDS AND THE RINGS OF SATURN

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This paper describes new information which point out the superiority of a catastrophic theory for the origin of the asteroids and the rings of Saturn to that of the nebular condensation theory currently in vogue.

Introduction

Two long-standing problems in astronomy are the questions of the origins of the asteroids and the rings of Saturn. The two dynamic systems have several similarities and are often treated together in the literature as will be done here. Similarities include: (1) both are entities in the solar system; (2) both are composed of myriads of individual particles; and (3) both have a marked spatial (temporal) structure.

Differences include the facts that: (1) the asteroids do not lie in a plane as do the rings of Saturn; (2) the asteroids do not presently lie within the Roche limit of an astronomical body as do the rings of Saturn, and (3) the compositions and size distribution of the particles in the two systems differ. (See Table 1)

The basic purpose of this paper is to show how a catastrophic theory of origin is preferred to the nebular condensation theory for the formation of these two systems. Catastrophism is the doctrine that objects in the solar system (and the universe), including planet Earth, have experienced sudden, overwhelming physical events in the past. The nebular condensation theories generally accepted today involve uniformitarianism, which is a doctrine in geology that existing processes acting in the same manner as at present are sufficient to account for all geological changes. Thus catastrophism and uniformitarianism are contradictory.

Asteroid Origin

The asteroids are irregular chunks of rock strung out between the planets Mars and Jupiter. The rock fragments have diameters ranging from fractions of a kilometer (km) to nearly 800 km and have been found to vary widely in composition.[1] Studies of asteroids and meteorites have led many scientists to postulate that many of the meteorites come from asteroids. This led Bronshten[2] to discuss the disintegration of a hypothetical planet Phaeton[3] in which iron-nickel meteorites were fragments of the nucleus, iron-stone meteorites were fragments of the middle layer, and stone meteorites were fragments of the mantle of the exploded planet.

The idea that the asteroids might be fragments of an exploded planet was first put forward by Olbers more than 150 years ago.[4] In recent years this view has become somewhat unfashionable but the idea has been revived independently by both Ovenden[5] (1973) and Woolfson[6] (1971). Their ideas have been detailed by Dormand and Woolfson.[7] Basically, Ovenden[8] (1974) has developed a principle of least interaction action and applied it to the planetary system of the sun. The principle requires that there was once a planet of mass approximately 90 times the earth's mass in the asteroid belt, which "disappeared" relatively recently in the history of the solar system.

Table 1. Comparison Between the Asteroids and the Rings of Saturn.

PARAMETER	ASTEROIDS	SATURN'S RINGS
Spatial (Temporal) Structure	yes (Figure 1a)	yes (Figure 1b)
In Equatorial Plane of the Sun?	no	no
Median Inclination to Ecliptic	8.6°	~26°
In Equatorial Plane of a Planet?	no	yes, Saturn's
Outer Scale Size of Orbits	1.5×10^9 km	2.7×10^5 km
Within the Roche Limit of an Astral Body?	not at present time	yes, Saturn's
Mass of System	1.7×10^{24} g	$< 5.6 \times 10^{22}$ g
Thickness of System	not well defined	10 km
Median Period	4.6 years (4.0×10^4 hrs)	~ 8 hrs
Particle Properties		
Size Range	dust size to 960 km	mean dia. = 1 cm
Size Distribution	power law	?
Composition	rocky	icy
Number	$>10^6$	myriads
Density (Probable)	3.5 g cm^{-3}	1.0 g cm^{-3}

There have been many associated papers and discussions on these papers but suffice it to say there is a catastrophic aspect in the theories of both Ovenden and Woolfson.

Patten et al.[9] discuss the problem of the origin of the asteroids and postulate a "fifth planet" named Electra after the Greek tradition. They detail how the planet Mars, in a slightly different orbit from the present-day one, came within the Roche limit of the planet Electra and gravitationally destroyed the smaller Electra. They propose further that, subsequently, some of the debris became: moons of Mars of which only two large ones still exist, i.e. Phobos and Deimos: the asteroids; and the four outer moons of Jupiter. These authors also discuss possible subsequent meteorite falls on the Earth and the Moon and Mars, which, they postulate, occurred in historical times.

Asteroid Orbit Distribution

In Figure 1a the frequency distribution of orbit sizes for 1,563 asteroids is plotted with the upper scale showing the corresponding mean daily motions. Fractions mark commensurabilities[10] between the mean daily motion of the asteroids and of Jupiter. These fractions tend to match dips in the curve (the so-called Kirkwood gaps). The Trojan asteroids (1/1 commensurability) have semimajor axes close to Jupiter's 5.2 astronomical units.

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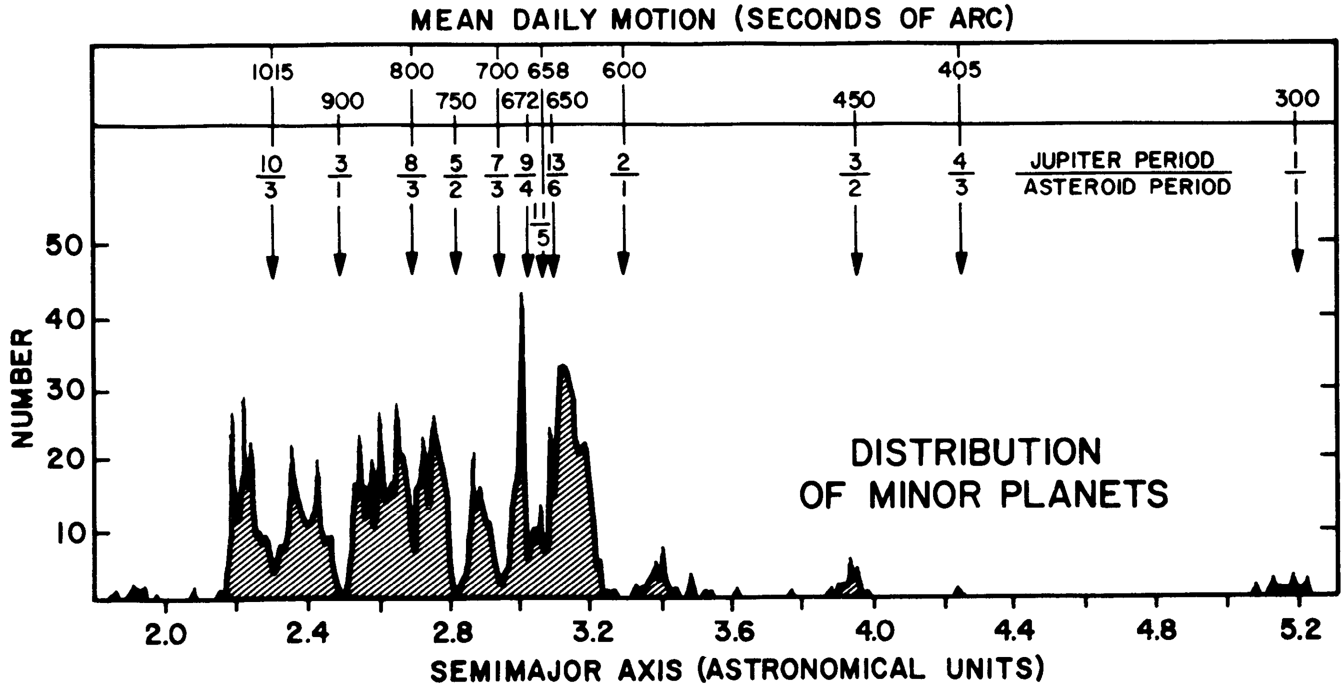

Figure 1a. Distribution of the asteroids (From *Sky and Telescope*, February 1974, p. 94, Courtesy of Yale University Observatory).

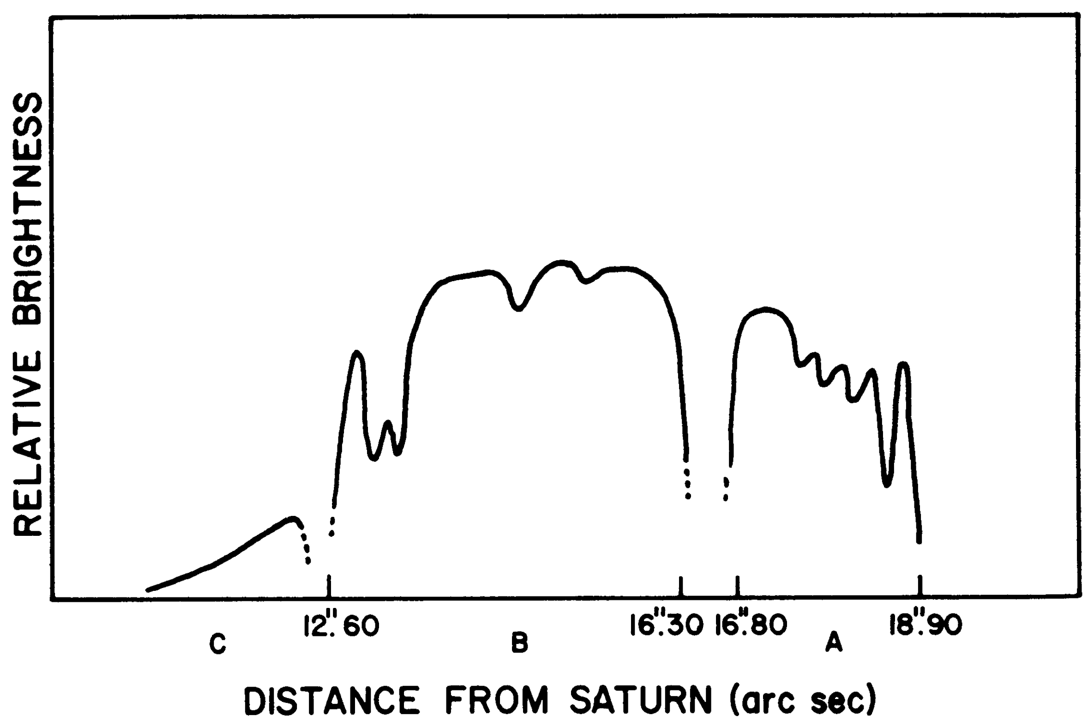

Figure 1b. Relative Photometric intensity of the rings of Saturn (After Dollfus). Angular distances given for Saturn at 10 Astronomical Units (From *Planetary and Space Science* 15, 53, Reprinted with permission of Pergamon Press Ltd.).

The clusters and gaps caused in the asteroids by Jupiter are not visually apparent, as they are in Saturn's rings (See cover illustration). This is because of the small number of asteroids with calculated orbits, and the considerable variation in eccentricity and tilt of the asteroid orbits. But the gaps or clusters become apparent when considering the distribution of the mean motions of the asteroids about the Sun, as is shown in Figure 1a.

In a recent Ph.D. thesis Wiesel[11] made a statistical study of the Kirkwood gaps in the asteroid belt (and also gaps in Saturn's rings). He found that there are no asteroids with periods which are a simple, rational multiple of the period of Jupiter. Wiesel's conclusions include the following:

> To date we have seen conclusive evidence that the pure statistical theory developed in this work is simply not capable of reproducing the type of gap seen in the real asteroid belt, or for that matter, in the rings of Saturn. (p. 153)
>
> . . . some mechanism, possibly collisions, has eliminated almost all of the librators[12] that *must* once *have existed* from the viewpoint of the nebular condensation theories of the formation of the solar system. (p. 84. Emphasis added)
>
> . . . some additional mechanism *must have* operated either now or in the past to change the assumed gapless initial distribution into the presently observed situation. (p. 153. Emphasis added)

Nowhere in the thesis is any mention made of a "fifth planet" hypothesis or of the work of such researchers as Reiffenstein[13] and Lumme[14] who propose catastrophic origins of the rings of Saturn. Note the terms such as "must have existed", or "assumed gapless initial distribution". There may now be good reason against assuming an initial gapless distribution, if the catastrophic theory of origin is taken seriously.

In summary, the asteroids, with irregular shape, manifold compositions, and varying sizes, could have come about from the breakup of a planetary-sized body. In fact, in a recent article on asteroid collisional evolution, Chapman and Davis[15] state that the present asteroids are a mere remnant of a much larger earlier population of planetesimals totaling a small planetary mass.

They state that the potential planet (nebular condensation theory) was interrupted in the process of accreting in the asteroid zone. Perhaps subsequent and continuing fragmentation generated the largest source of material during later epochs of solar system history for cratering and accreting on planetary bodies.[16] These conclusions might be said of a "fifth planet" hypothesis; and this climate of opinion is indicative of real progress in the asteroid origin problem.

Saturn's Rings

Saturn is the second-largest planet in the solar system and the sixth in the order of distance from the Sun. The most remarkable feature of Saturn's system is the rings surrounding it. The ring system is divided into four main regions, designated A, B, C, and D.[17] The cover illustration of this issue shows the divisions, Table 2 gives specific dimensions and Figure 1b shows the photometric brightness variations across the rings.

Table 2. Dimensions of Saturn's Rings and Appropriate Satellites.[a]

SATURN

Parameter	Value (km)	Saturn Radii	Commensurabilities of Periods
Equatorial radius of Saturn	60,000 ± 240	1.00	
Outer edge of ring D	72,600 ± 2,000	1.21	
Guerin division	width about 4,200	—	Approx. X/4; I/6; II/8
Inner edge of ring C	76,800 ± 2,000	1.28	
Outer edge of ring C	88,800	1.48	
unnamed division	width about 960	—	X/3
Inner edge of ring B	92,000 ± 850	1.53	
Outer edge of ring B	117,800 ± 350	1.96	
Cassini division	width about 2,600	—	X/2; I/3; II/4
Inner edge of ring A	120,400 ± 400	2.01	
Encke division	a marking	—	(3/5)X
Outer edge of ring A	136,450 ± 350	2.28	
Roche limit	146,400 ± 240	2.44	
Semimajor axis of orbit of Janus X	168,700	2.81	X/1
Semimajor axis of orbit of Mimas I	185,600	3.09	I/1
Semimajor axis of orbit of Enceladus II	239,700	4.00	II/1

[a]Adapted from a table in *Space Science Review* 3, 179-271.

The outer ring A, of moderate brightness, has an outside diameter of 272,900 km and an inner diameter of 240,800 km. It is separated from ring B by the dark Cassini division, which is 2600 km wide. Ring B, which is very bright, has an outer diameter of 235,600 km and an inner diameter of 184,000 km. It is slightly less bright in its inner regions and may be separated from ring C by a narrow dark division, perhaps 960 km wide.

Ring C, which is sometimes called the "crape" ring, is much fainter and semitransparent; it appears as a dark band in projection against the disk of the planet and as a faint dusky band against the sky. The outer diameter of ring C is 177,600 km. The inner edge is only 16,800 km above the surface of the planet at the equator.

Additional divisions have been noted in the rings by some observers, but others doubt their reality, however —see the picture on the cover. The Encke division, which marks the limit between the outer darker zone and the inner brighter zone of ring A, is more nearly a line of minimum brightness than a dark division. A fourth zone, D, of the rings of Saturn, between C and the globe, was discovered by P. Guerin at Pic-du-Midi Observatory in October, 1969. It is separated from C by a dark division similar to Cassini's; and the brightness is not more than 6% of ring B.

Both theory and observations prove that the ring system is made up of myrids of separate particles which move independently in circular coplanar orbits in the equatorial plane of Saturn. The visibility of the globe of Saturn through ring C, and to a small extent through ring A, the incomplete disappearance of the satellites when in the shadows of these rings, and the visibility of stars shining through them, prove that at least rings A and C are relatively transparent.

Photometric observations of the variation of brightness of the ring, as a function of phase angle (up to its maximum value of 6°), also show that the particles are rather far apart. Perhaps the particles occupy not more than a few percent of the volume of rings A and B, and a much smaller fraction in rings C and D.

The discontinuous, meteoric nature of the rings is also demonstrated directly by spectroscopic observations, which show that the inner edge of the ring rotates faster than the outer edge, and precisely with the velocities that independent satellites would have at the same distances from the planet.

The origin and nature of Saturn's rings was first proposed by E. Roche[18] in 1847 and by J. C. Maxwell[19] in 1856. Roche established that a satellite of a planet of the same density cannot form, because of destructive tidal forces, at a place closer to the planet than 2.44 times the radius of the planet. Stated another way, any astronomical body that is larger than approximately 200 km in diameter will break-up within this Roche limit.[20-22]

The outer edge of Saturn's rings is at 2.28 radii, inside Roche's limit, whereas the nearest satellite, Janus, is at a semimajor axis of 2.81 outside the limit.

Maxwell proved, further, that a ring system of small mass formed of a large number of independent particles is fairly stable against external perturbations such as those caused by the larger satellites. The aggregate mass of the ring system is very small, probably much less than one-quarter the mass of the Moon. Periodic perturbations by the major satellites are, however, usually considered responsible for the main divisions of Saturn's ring in the same way that perturbations by Jupiter cause the Kirkwood gaps in the asteroid belt. However, as mentioned already, the theory is really not developed yet. This could be an interesting research project.

The radius of Cassini's division between rings A and B corresponds to a revolution period equal respectively, to ½, ⅓, and ¼ of the revolution periods of the first three satellites; the limit or gap between rings B and C corresponds to a revolution period equal to ⅓ of that of the first satellite and the Encke division in ring A to 3/5 of the same period. The division between ring C and ring D has nearly ½ the rotation period of Cassini's division. While it seems that the periodic oscillations of the satellites of Saturn play some role in the shaping of the ring system it obviously is not the only mechanism (See previous discussion of asteroid orbit distribution). For example, Reiffenstein[13] would have the Cassini division formed by breaking up two satellites within Roche's limit, which thus formed two rings.

Presence of Water and Icy Bodies

The inner, regular satellites of Saturn all appear to be snowballs composed primarily of ices of H_2O (water), and ammonia. Pilcher et al.[23] and Kuiper et al.[24] both identified water frost in the spectrum of Saturn's rings. It seems to be the major constituent.

Morrison,[25] moreover, reported on the anomalously low densities of some of the inner moons of Saturn. He found that the densities of each of these satellites is less than 1.5 g/cm³ and that in the case of Mimas, it may well be as low as 1.0 g/cm³. By way of comparison, water has a liquid density of 1.0 g/cm³, and ice about 0.9 g/cm³. If these conclusions are correct, these satellites appear to comprise a previously unrecognized class of objects in the solar system that are hundreds of kilometers in diameter but composed almost entirely of low density ices.

Furthermore, there appear to be many icy bodies in the universe and in the solar system in particular.[27-29] The following conclusions seem obvious:

(1) Roche's limit (modified slightly) is applicable to Reiffenstein's model.[22]

(2) Low density, liquid water satellites are theoretically possible.[27, 28, 29]

(3) There are many icy bodies in the vicinity of Saturn with densities around 0.95 g/cm³ and several hundred kilometers in diameter, as postulated by Reiffenstein[13] and measured by Morrison.[25]

(4) The rings of Saturn are primarily composed of water ice.[23, 24]

Thus, the above conclusions are in quite close agreement with the satellite breakup model proposed by Reiffenstein, in particular, with regard to the density of his satellite A with a postulated density of 0.95 g/cm³ and an original diameter of 1721 km. Thus, a catastrophic type model seems to be in agreement with the observational facts and should be seriously considered as a possibility for the origin of the rings of Saturn.[30]

Discussion

It now seems that several different mechanisms were at work in the formation of the asteroid belt and the rings of Saturn. The initial mechanism in each case could well have been the catastrophic gravitational break-up of an astronomical body: (a) in the case of the asteroids, a rocky planet; and (b) in the case of Saturn's rings, an icy satellite (or inter-galactic astral body) containing large quantities of liquid water and ice.

Additional mechanisms for the formation and evolution of the asteroid belts may well be collisions as postulated by Chapman and Davis[15] and secular resonances postulated by Wiesel[11] and others. The theory as developed by Wiesel is accurate from an initial assumed gapless distribution to 50%. Possibly with different initial conditions these mechanisms can be shown to work and even on a different time scale than the always assumed 4.5 billion years.

In the case of Saturn's rings the presently available statistical theory is inadequate to describe the present situation as Wiesel[11] has stated,

> The case of Saturn's rings is particularly interesting, since the width of the observed gaps is some *orders of magnitude* too large according to the present statistical theory, instead of the approximately 50% discrepency in the Sun-Jupiter system. (p. 162, Emphasis added)

This paper has shown that there is adequate evidence to suggest an initial condition which allowed the break-up of an astronomical icy body which would create many mini-satellites around Saturn. Then secular resonances could be provided by the gravitational influences of the inner satellites of Saturn as well as by a hypothetical longitude-dependent part of Saturn's gravitational field as discussed by Allan.[31]

An additional factor which should be considered is the motion of the solar system in the galaxy in a huge helical path. Possibly part of the dynamical information is being missed by neglecting this motion in formulating a creationist view of the universe. Munzenrider[32] discusses this point which could usher in a whole new comprehension of dynamical astronomy.

In conclusion, Table 1 presented a brief comparison between the two dynamical systems: the asteroids and the rings of Saturn. In viewing the table I am impressed with the differences in the two systems. It could be that the problems should not be treated together and that each has a unique solution. It is hoped that this present paper will shed some light on the ultimate solution.

(Editor's Note: It may be remarked that consideration of catastrophic events is appropriate in a journal dedicated to Creation, for both Creation and catastrophe are antitheses of slow, uniform development. In deed, in many cases it would not be possible, by studying the situation after the event, to say whether it came about by sudden Creation or by a catastrophic event; but it would be apparent that it did not come about by slow, uniform evolution.

Besides, most creationists have reason to think about one catastrophe: the Flood. And there might have been catastrophes in the heavens, as well as on Earth, unless maybe Haggai 2:6 means that catastrophes in the heavens are yet to come.)

References and Notes

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[9]Patten, D. W., R. R. Hatch, and L. C. Steinhauer 1973. *The Long Day of Joshua & Six Other Catastrophes*, Pacific Meridian, Seattle.

[10]Commensurable means that two quantities are divisible by a common unit an integral number of times. These are also known as resonances of which there are many known in the solar system.

[11]Wiesel, W. E. 1974. A statistical theory of the Kirkwood gaps. Ph.D. thesis, Dept. of Astronomy, Harvard University, Cambridge, Massachusetts.

[12]Libration is an oscillation in the apparent aspect of a secondary body (as a planet or a satellite) as seen from the primary object around which it revolves. See Patten et al.[9] for details.

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[16]Chapman and Davis[15] discuss the possible cratering effects on the inner planets of the solar system caused by the asteroids. Patten et al.[9] also consider the same cratering effects with a greatly reduced time scale. Details on the cratering events may be found in references 21-25 of Chapman and Davis[15].

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[30]The present author is of the opinion also that the icy satellite or astral body may have come from regions outside the immediate solar system. There is no law of astronomy that states that all events in the solar system have to have been caused by solar system objects.

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Design in Inorganic Nature

(Continued from page 81)

Of course, that statement is true. But it is nothing to the point, for the evolutionists' purpose.

To see why not, consider an analogous case. Suppose that one, standing by the road, were to remark that the automobiles going by are obviously designed to travel. (Which, of course, everyone knows is true.) Suppose, though, that a companion were to object: "Not at all. If they were not able to travel, we should not see them going by". Again, that objection is true, as a simple statement, but it is not to the point. For the reply is:

> But in fact they are going by. So they are able to travel; and the reason that they are able is because they were designed to do so. The fact that badly designed ones would not be able to travel proves nothing; for we see some which are able to travel, and hence we conclude that they were designed for that purpose.

Is it not the same case with The Earth? About hypothetical Earths which would have been unsuitable for living beings one knows nothing; but he does know that this Earth which is inhabited is suitable. And the suitability implies intelligent, purposeful, design, an activity which, in the present context, is called Creation.

— Editor Armstrong