The age and fate of Saturn's rings

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When Saturn was the only known ringed planet, the rings were believed to be as old as the solar system—4.6 billion years in the conventional chronology. The existence of the rings to the present day was taken as evidence of this chronology. In the 1970s and 1980s, other planets were found to have short-lived, rapidly dissipating rings with life times of the order of millennia. Subsequently, the view of the age of Saturn's rings began to change. They are now viewed conventionally as no more than hundreds of millions of years old, and a former prop of the conventional chronology has now vanished. Furthermore, an examination of ring observations and data unconstrained by conventional chronology indicates that the actual life time of Saturn's rings may be of the order of tens of thousands of years, and possibly less. This age fits in perfectly with the biblical Creation/Fall/Flood model, and opens up possibilities for effectively explaining their origin within a biblical framework.

A puzzle for evolutionary chronology began with the Voyager 1 flyby past Saturn's rings in 1980. Before then, Earth-bound telescopes provided little ring detail, and planetary rings were assumed to have endured virtually changeless since the emergence of the solar system from the solar nebula—a vast cloud of gas and dust—some 4.6 billion years ago.[1–3]

> 'Everyone had expected that collisions between particles in Saturn's rings would make the rings perfectly uniform.'[4]

For example, Jeffreys had claimed that

> 'the frequency of collision [of ring particles] is very great, and ... on account of the loss of relative motion at every collision, the rings must long ago have reached a state in which all the particles are moving in very accurate circles, all in the same plane.'[5–7]

This view arose from belief in the rings' great age,[8] but Voyager 1 showed that the rings are highly structured and probably young,[9] as there is more structure than can be expected to persist over 4.6 billion years. Efforts to locate sufficient binding forces have failed, and a 'growing number [of astronomers] believe that the rings of Saturn are constantly ... changing due to fragmentation of moonlets and input of new ring particles.'[10,11]

However, there remains a reluctance to associate ring change with ring dissipation,[12] since this could imply a young solar system. This reluctance did not exist before the ascendancy of evolutionary chronology, as in James Maxwell's day, Saturn's rings were acknowledged to be rapidly changing and possibly dissipating.[13]

Today, space probes have rediscovered rapid ring change and dissipation, as is evident from statements by many astronomers. For Jupiter, ring 'particles should last only a very short time—perhaps only a few thousand years ...'.[14,15]

Of Saturn's rings and planetary rings generally, 'it now appears that the length of time for planetary rings to dissipate is relatively short.'[16,17]

Regarding Uranus' rings,

> 'The thin outer atmosphere of Uranus extends into the rings, so it should slow down very tiny dust particles and cause them to sink into the inner atmosphere in a few thousand years or less ... Collisions between ring particles ... slowly [make] the ring wider.'[18,19]

Saturn's rings have little matter, 'only about a millionth of the mass of our moon',[20] similar to that of smaller asteroids such as 243 Ida or 253 Mathilde.[21] Their small mass suggests that the rings could 'empty out' fairly quickly. Indeed, Jupiter's rings are thought to be, in part, the product of the dissolution of two moons, Adrastea and Metis,[22] both with masses comparable to the mass of Saturn's rings.[23]

Saturn's rings have been widening rapidly

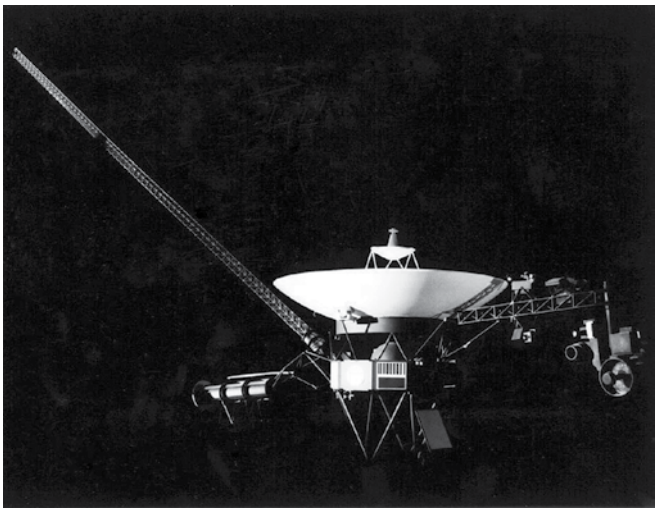
In the 1960s, Alexander documented 350 years of widening in Saturn's A and B rings.[24,25] One of his sources was Otto Struve, who in the 1850s assessed observations from the previous two centuries, which indicated ring-spreading into Saturn at a rate of about 100 km per year.[26–28] Unfortunately, however, the reigning hypothetical assumptions from the popular nebular hypothesis (which claims a naturalistic origin, an old age and little change in the solar system presently) caused many to question Struve's analysis.[29] So strong had belief in the nebular hypothesis become that Taylor inconsistently claimed ring spreading was compatible with it.[30]

However, Maxwell had shown that Saturn's rings are particulate rather than rigid disks or liquid, and considered Struve's analysis to be consistent with his theory,[31] the predictions of which have been confirmed by observation.[32,33]

Nevertheless, Struve failed to measure continued ring spreading,[34] and in 1895 Lewis concluded that ring observations were not in agreement ('accordant') because of 'the great difficulty in making these measures'.[35] But he then dogmatically stated that Saturn's rings were 'certainly' not undergoing long-term change, even though his data showed C-ring spreading.[36] Lewis thus laid the groundwork for Jeffreys' concept of very old rings.

Saturn's C ring formed recently

Saturn's most prominent rings are the A, B, and C



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The Voyager 2 probe was launched on 20 August 1977.

rings.[37,38] However, the C ring was not visible until the 1800s:

> 'William Herschel, the foremost astronomical observer of his time (1738–1822), makes no mention of the [C ring] in any of his writings, and it is inferred that it was not then a conspicuous object. If this inference be correct, we must conclude that this ring is rapidly growing, and that the rings of Saturn are probably comparatively recent introductions to the solar system.'[39]

Today the C ring can be seen 'with telescopes of moderate size'.[40] Since Herschel's telescopes were among the best of his day, with Saturn a 'favourite object of study',[41] one is led to conclude that he missed the C ring because it was absent. The first recorded observation of the C ring was in 1848.[40,42] Thus one of the three prominent rings of Saturn has evidently developed since the early 1800s. The inner edge of the C ring is approaching the planet, and Napier and Clube calculated the rate of approach as 100 km per year.[43]

The history of C ring observations implies rapid ring spreading and dissipation. The inner edge of the B ring is now 91,975 km from the center of Saturn and the inner edge of the C ring is at 74,658 km.[44] Thus the width of the C ring is 17,317 km, or about 15,000 km, a width which developed since about 1850. This implies an infall of ring particles in agreement with the computation of Napier and Clube.

Like Jupiter's and Uranus's rings, Saturn's rings appear to be decaying in a millennial time-frame. Ring dissipation does not require millions of years. When planetary rings were thought to be old, they were taken as evidence for an old solar system. Intimation of their youth therefore obliterates a prop of the conventional chronology.

Have new Saturnian rings formed since the C ring?

In 1954, Baum reported 'dusky nebulous matter in the form of an additional ring' beyond ring A, with 'a diffuse fringe [extending] the ring system beyond its normal limits'.[45] Baum may have been seeing one or more of the now-recognized tenuous outer rings (the F, G, and E rings). On the other hand, he may have been seeing dissipation of A ring material outward, and if ring particles 'reach the outer edge of the rings, they leave the ring system'.[16]

In 1967 Feibelman likewise reported 'an extension or at least a gradual tapering of the outer edge of the A ring'.[46] Thus it appears that the A ring is losing particles to the outer F, G, and E rings, and eventually to space beyond. How trustworthy are such ground-based observations? Dismissing them as subjective phenomena would be premature. In fact, existence of the F ring had been theorized before the Voyager flybys, though in characteristic fashion Jeffreys discounted this prediction.[47]

Furthermore, inside the C ring, 'the possibility of a faint ring ... was raised some time ago [from ground-based observations], and this D ring was actually found'.[38,48] Ground-based discovery of the D ring before its Voyager detection implies validity for ground-based ring-spreading observations. Like the outer F, G, and E rings, the D ring seems to be composed of small particles. These particles are spiralling into Saturn:

> '[I]ndividual ring particles work their way slowly inward ... If they move inward far enough, they encounter the tenuous outer layers of the planet's atmosphere and are destroyed.'[16]

Ring particles of Jupiter and Uranus also show this behavior.[49,50] To sum up, particles in outer rings dissipate into space; those in innermost rings fall toward the planet.

Efforts to save long chronologies for rings have failed

The Uranian and Jovian ring systems were discovered shortly before the Voyager views of Saturn's rings and, according to NASA, appeared too young to exist in an old solar system:

> 'The theory that explained how Saturn's rings could persist through 4.6 billion years of solar system evolution also explained why Saturn was the only planet that could have a ring. Then those theories had to be revised to account for the rings of Uranus. The revisions implied that Jupiter would not have a ring. Now Jupiter has been found to have a ring and we have to invent a theory to explain it.'[51]

The older 'unworkable' theory was the orbital resonance hypothesis.[52] When Saturn was the only known ringed planet, orbital resonances, due to moons of Saturn gravitationally acting on ring particles, could account for the limited ring structure visible from Earth. The resonance hypothesis 'had been worked out with fewer than a half-dozen rings [of Saturn] known. The ring structure the Voyagers discovered is too complex to ... explain thousands of rings.'[53] 'A thousand rings seemed a monumental problem for theorists. They had run out of resonances long ago.'[54,55] NASA's conclusion: 'No theory has yet been developed that

explains how all three of these planets could have rings for so long', i.e. 4.6 billion years.[51]

The 'shepherd moon hypothesis' was subsequently proposed to give planetary rings a long lifetime. As originally conceived, shepherd moons were supposed to corral ring particles, keeping entire ring systems together over eons.[56,57] The shepherd moon theory was, therefore, once used to account for all ring structures of Saturn, Jupiter, and Uranus.[22,58,59]

After the Voyager 2 flyby of Uranus' rings in 1986, NASA scientist Bradford Smith stated, 'We are assuming [the existence of shepherds], because we don't know any other way to do it [i.e. preserve the rings].'[60] Since then, conventional opinion on the antiquity of planetary rings has changed due to difficulties in the shepherd moon theory. Rings are no longer viewed as debris from the solar nebula with an age of billions of years.[61,62] Instead the rings have formed by the fracturing of one or more moons, and therefore must have formed 'recently'.[63] 'Recently', however, is a relative term, and may signify millions of years.[19,64]

Nevertheless, shepherd moons continue to be presented as the reason planetary rings exist.[65] Though ring decay occurs, it is still not acceptable to allow this fact to imply a young solar system, and shepherds are invoked to extend a ring's chronology. Therefore, rings must be simultaneously decaying, yet confined by shepherds:

> '[Planetary rings] tend to spread ... Sometimes planetary rings are kept in place by the gravitational force of shepherd moons. Saturn has a very intricate ring system with lots of moons helping to keep its rings together.'[66]

This is *false*—'lots' of shepherds have not been found. Another false claim is that the '"shepherding" effect has been found to confine a number of rings in the solar system'.[67] Out of hundreds of thousands of ringlets in planetary ring systems, only a few have been found with nearby moonlets interpreted as shepherds. Most notable are the F ring of Saturn, Jupiter's ring system, and Uranus's thick ring. As mentioned above, the last two are now viewed primarily as rapidly decaying, despite putative shepherding effects.

Where are the shepherd moons?

'Shepherd moons' such as Prometheus and Pandora (moons of Saturn near the F ring) have been photographed,[68] but mere existence does not confirm they are acting as shepherds. Further, moons once described as 'shepherds' seem to be disintegrating into the ring structure, as is acknowledged for Jupiter and Uranus.[69]

During the 1995 Saturn ring plane crossing, the Hubble Space Telescope looked for new satellites. Two were announced as new in a press release and were designated 1995S1 and 1995S2.[70] They turned out to be the already-known moons Atlas and Prometheus. Even more interesting, five other bodies, 1993S3 to S7, were observed, but were later 'hypothesized to be shattered moonlets' in the F ring.[71] The obvious conclusion is that bodies perceived as

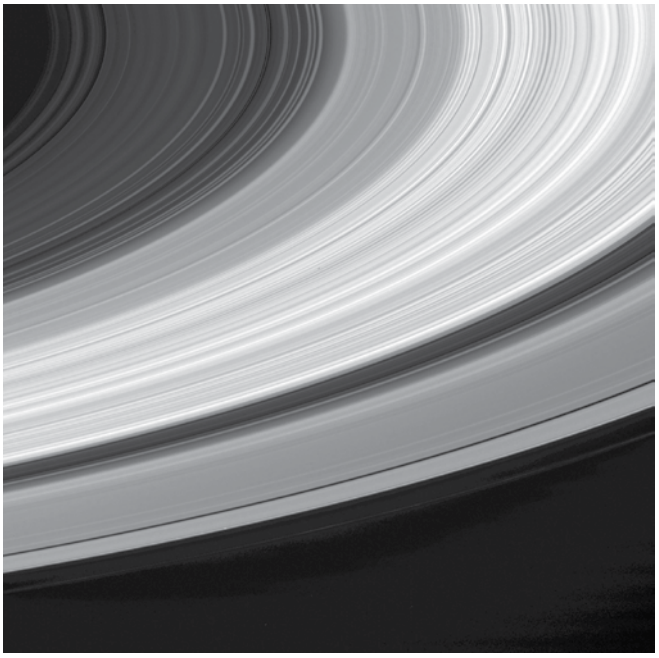

Photo by NASA

Saturn's rings are increasingly recognized as being relatively short-lived rather than essentially changeless over millions of years.

'shepherd' moons of Saturn are undergoing disintegration within the ring structure.

Discussing these fragmented satellites, Philip Nicholson of Cornell University said:

> '[O]ne scenario for the origin of Saturn's ring system is that it is made up of countless fragments from several pulverized moons. ... the new objects orbit Saturn near the narrow F ring, which is a dynamic transition zone between the main rings and the larger satellites. [Fragmented moons would eventually] spread around the moon's orbit to form a new ring.'[72]

Showalter surmised that Saturn's narrow G ring, thought to be composed of very fine dust, may in fact be the 'decaying corpse' of a moon destroyed by meteoroid impact.[73] Since the F ring is a 'dynamic transition zone' where satellite fragmentation is likely to occur, what is the possibility that the so-called 'shepherds', Prometheus and Pandora, could be undergoing the same type of dissolution?

A stunning observation answered this question. The reason the previously mentioned satellite 1995S2 was not initially recognized as Prometheus is that its location did not match the position expected. Prometheus had 'slipped in its orbit by 20 degrees from the predicted position ... a consequence of a "collision" of Prometheus with the F ring, which is believed to have occurred in early 1993.'[72] Thus Prometheus is not so much 'shepherding' the F ring as mutually interacting with it, sometimes colliding with it and likely disintegrating as a result.

It is doubtful that the so-called shepherds of the F ring ever fulfilled that function. In 1980, Voyager 1 detected a twisting or 'braiding' in the F ring attributed to Prometheus

and Pandora, but Voyager 2 in 1981 detected 'no signs of braiding in the F ring'.[53,74] Thus the 'shepherds' Prometheus and Pandora are not shepherds after all. Instead, Prometheus and Pandora are fragments of larger bodies *en route* to further disintegration, the same process thought to have produced the moonlets 1995S3 to S7. Prometheus and Pandora are not spherical and have an irregular shape.[75] They seem either to be captured asteroids or fragments of a larger moon. The F ring itself is expected to widen over time, eventually dissipating altogether.[76]

The Voyager missions demolished the belief that planetary rings must be old. The Cassini probe began orbiting Saturn in 2004. Preliminary Cassini data confirm that at least some of the ring structure is the 'crumbled remains of an ancient Saturnian moon' destroyed possibly by meteorite impact.[77]

During the ring-plane crossings of 1995 and 1996, Earth-based fluorescence measurements indicated that 'the Saturnian ring system must be losing about 3 tons of water per second. That's too much to be explained by the impact of interplanetary dust alone.'[78] Despite this evidence of ring dissipation, total replenishment of the ring system by meteoritic impact was modeled as a way of preserving the rings.[79] However, preliminary Cassini data indicate that oxygen is given off by the rings at about 4 times the expected rate, again confirming high collision rates and dissipation of material from the rings.[80]

Conclusions

Longevity estimates for Saturn's rings have undergone steady downward revision since the 1970s. The resonance theory was invoked to prevent such downward revision, but failed to counter indications that planetary rings are much younger than the conventional age of the solar system. The shepherd moon theory continues to be employed to minimize the downward revision. Despite widespread belief that shepherd moons such as Prometheus and Pandora have preserved Saturn's rings for possibly hundreds of millions of years, the putative shepherd moons appear to be pulverized and dissipating along with the ring structure.

The origin of Saturn's rings seems to be the 'destruction' of once-existing moons [81] and appear to be a short-lived phenomenon which will have dissipated in a timeframe of the order of tens of thousands of years at most—possibly only thousands of years. This demonstrates amazing consistency with the biblical model because it shows the rings are young and only recently formed. It also opens up plausible explanations within the model of how the rings formed, e.g. on the fourth day of creation with the creation of the planets or a meteorite collision near Saturn around the time of the Flood.[82]

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