Rings, Rings, Rings

It's Saturn Giganticus!

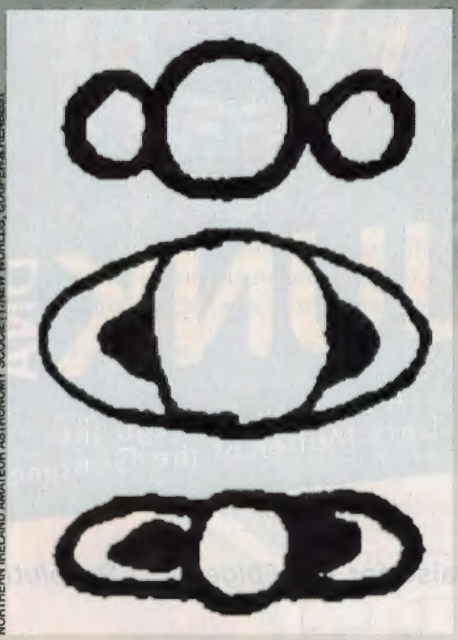
To see it, hop a spaceship and rocket toward the Scorpius and Centaurus constellations. After traveling a distance of some 400 light-years, you'll come upon a ringed planet that makes Saturn's rings look scrawny by comparison.

Several years ago astronomers had seen the planet's sun, known simply as J1407, undergo a complex series of eclipses. Over the course of fifty-six days, the star's light brightened and dimmed erratically. What could be causing such fluctuations? Astronomers from both the University of Rochester and Leiden Observatory in the Netherlands suggest those repeated eclipses were due to the transit of a giant ringed planet orbiting the star.

And not just any ringed planet. According to their model, this exoplanet's rings extend outward for some 56,000,000 miles. Such a disk would be quite a sight if it resided in our solar neighborhood, as its radius is more than half the distance from the Sun to the Earth. Saturn's most prominent rings reach out a mere 175,000 miles from the planet's equator.

This is one of the first ring systems suspected to reside outside our solar system—its discovery announced nearly four centuries after Saturn's planetary hula hoop was first recognized for what it was.

As with so many seminal moments in astronomy, the long path toward understanding that a planet could even be surrounded by a ring began with Galileo. With his publication of *Sidereus nuncius*, the "Starry Messenger," in March 1610, Galileo first announced to the world the cosmos-shattering revelations spied through his homemade telescope: that the lunar landscape was filled with mountains and craters; that a multitude of stars blended together to form the Milky Way's luminous white band;



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In 1610, Saturn's rings appeared to Galileo as two small blobs. By 1616, the flanking blobs had become "two half ellipses with . . . dark little triangles in the middle," which looked to Galileo more like jug handles or ears.

and that the planet Jupiter, like some mini–solar system, was repeatedly circled by a set of moons.

But that was just the start. Four months later, once Saturn became visible in the nighttime sky, Galileo turned his telescope to what was then the farthest known planet. And what he encountered he called a "very strange wonder." While keeping his discovery secret from fellow scientists for several months, Galileo swiftly notified the secretary of his Medici patron, the Grand Duke of Tuscany. " . . . the star of Saturn is not a single star," disclosed Galileo, "but is a composite of three, which almost touch each other . . ."

With the poor quality of his rudimentary telescope, Galileo was, of course, erroneously seeing Saturn's ring system as two small blobs, perched on either side of the bigger central planet. The seventeenth-century Venetian poet Giulio Strozzi, in an ode to the great astronomer, lyrically described the sight as "in three minor knots divided."

Likely thinking of Saturn's appendages as separate moons, much like Jupiter's, Galileo aimed to keep track of how they orbited the planet. But, to Galileo's great surprise, Saturn's telescopic image instead underwent "a strange metamorphosis," changing back and forth over the years. Johann Locher, an astronomy student in Bavaria, made this cyclic transformation the subject of his dissertation in 1614. ". . . Saturn deceives or really mocks the astronomers out of hatred or malice. For [the planet] has projected various appearances," he wrote. "Sometimes he is seen single and sometimes triple; at one time elongated and at other times round." By 1616, Saturn looked as if it had handles. All these variations were due to how Saturn's rings were positioned with respect to the Earth, although astronomers didn't know that yet.

By 1650, according to astronomy historian Albert van Helden, "the problem of Saturn's appearances had become a celebrated puzzle." As-

Background: This image taken by the Cassini spacecraft shows the intricate detail with which the rings of Saturn are striated. The brightest section in the image is Saturn's B ring.

SSI/JPL/ESA/NASA

tronomers were wondering whether Saturn was round, egg-shaped, or composed of three bodies.

It's easy to assume that better telescopes eventually solved the mystery, but that wasn't fully the case. The inventive Dutch astronomer Christiaan Huygens did build a fifty-powered telescope that allowed him in 1655 to discover Saturn's first moon, Titan, while Saturn itself, as Huygens described it, had "arms extended on both sides in a straight line, as though the planet were pierced through the middle by a kind of axis." By the start of 1656 these arms had disappeared altogether. Yet Huygens still reasoned at the time that Saturn's chameleonic changes could be explained by the planet being "surrounded by a thin flat ring, nowhere touching, and inclined to the ecliptic." First keeping this knowledge secret, needing more time to flesh out his theory and observe the ring with an even better telescope, Huygens finally made it public in his *Systema Saturnium*, published in 1659.


UNIVERSITY OF ROCHESTER

What J1407b's ring system would look like from Earth if it were in Saturn's orbit

His fellow astronomers, however, did not greet the ring hypothesis with open arms. An accomplished observer in Rome, Honoré Fabri, declared it "pure fiction." He preferred to think that Saturn was merely accompanied by several satellites. But within a decade, as telescopes improved, even Huygens's harshest critics came to accept his explanation.

From the start Huygens imagined the ring as solid, like some kind of celestial phonograph record. But that assumption was considerably undermined in 1675 when Giovanni Cassini, director of the Paris Observatory, discovered that Saturn's ring had a prominent gap, now known as Cassini's division. Cassini suspected that the ring was composed of small celestial bodies, a notion spurned by most astronomers. But a century later, the French mathematician Pierre-Simon de Laplace offered a further argument against the solid-ring idea. He demonstrated mathematically that a solid structure would be highly unstable.

It was not until the nineteenth century that both theory and observation at last resolved the makeup of Saturn's rings once and for all. In a prizewinning 1856 essay, the Scottish physicist James Clerk Maxwell lucidly proved that the ring had to be composed of innumerable particles, each orbiting Saturn like a minuscule moon. It was the only configuration that remained durable against gravitational and centrifugal forces. All doubts were erased in 1895 when James E. Keeler, then director of the Allegheny Observatory in Pennsylvania, pegged the velocity of Saturn's rings. Newton's law of gravity predicted that the tiny chunks circulating in the outer part of the ring would travel more slowy than those closer in—just as Pluto, far from the Sun, orbits at a lower velocity than the solar system's inner planets. And that's exactly what Keeler measured. Within days of his observation, he sent a report to the *Astrophysical Journal* ("A Spectroscopic Proof of the Meteoric Constitution of Saturn's Rings"), triggering a torrent of magazine and newspaper articles around the world.

Saturn's ring material, composed largely of ice and dust, ranges in size from grains to boulders the size of a house and larger. This material may have originated when an ancient ice-cloaked Saturnian moon was either ripped apart by tidal forces or shattered by an incoming comet. Or possibly it's simply material left over from the nebular disk out of which Saturn itself formed.

Saturn lost its special status as our solar system's sole ringed planet in the 1970s and 1980s, when both telescopic observations and spacecraft flybys of the other gas giants—Jupiter, Uranus, and Neptune—spotted rings around them as well. It took longer to find these ring systems, as they are far fainter and hence difficult to see.

That wouldn't be the case for Saturn Giganticus, or J1407b, as it is officially known. If it replaced Saturn within our solar system, the rings would appear many times larger than the width of the full Moon, and with our eyes alone we'd be able to marvel at their beauty during a long, dark night.

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