Blue ring discovered around Uranus; Second known blue ring in solar system

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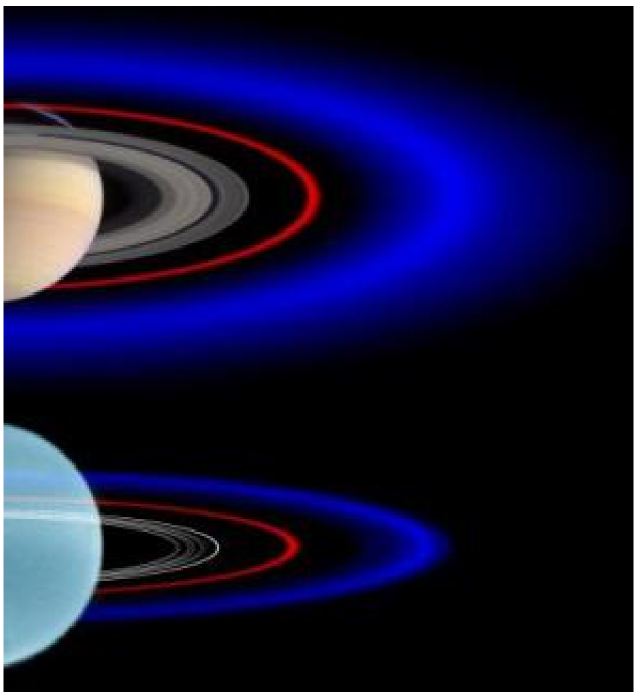

A schematic view of the outer rings of Saturn and Uranus, in which each system has been scaled to a common planetary radius. The main rings of Uranus have been drawn to emphasize that these rings are extremely narrow. Credit: de Pater, Hammel, Gibbard, and Showalter, courtesy of Science magazine

The outermost ring of Uranus, discovered just last year, is bright blue, making it only the second known blue ring in the solar system, according to a report this week in the journal *Science*. Perhaps not coincidentally, both blue rings are associated with small moons.

"The outer ring of Saturn is blue and has Enceledus right smack at its brightest spot, and Uranus is strikingly similar, with its blue ring right on top of Mab's orbit," said Imke de Pater, professor of astronomy at the University of California, Berkeley. "The blue color says that this ring is predominantly submicron-sized material, much smaller than the material in most other rings, which appear red."

The authors of the paper in the April 7 issue of *Science* are de Pater, Mark Showalter of the SETI Institute in Mountain View, Calif.; Heidi B. Hammel of the Space Science Institute in Boulder, Colo.; and Seran Gibbard of Lawrence Livermore National Laboratory in California.

The similarity between these outer rings implies a similar explanation for the blue color, according to the authors. Many scientists now ascribe Saturn's blue E ring to the small dust, gas and ice particles spewed into Encedadus' orbit by newly discovered plumes on that moon's surface. However, this is unlikely to be the case with Mab, a small, dead, rocky ball, about 15 miles across – one-twentieth the diameter of Enceladus.

Instead, the astronomers suspect both rings owe their blue color to subtle forces acting on dust in the rings that allow smaller particles to survive while larger ones are recaptured by the moon.

"We know now that there is at least one way to make a blue ring that doesn't involve plumes, because Mab is surely too small to be internally active," said Showalter. He and astronomer Jack Lissauer of NASA Ames Research Center in Mountain View, Calif., discovered Mab in Hubble Space Telescope images in 2003.

The likely scenario to explain Saturn's blue ring was proposed before plumes were discovered last November as the Cassini spacecraft flew by Enceladus. As modeled for the E ring, meteoroid impacts on the surface of Enceladus scatter debris into its orbit, probably in a broad range of sizes. While the larger pieces remain within the moon's orbit and eventually are swept up by the moon, smaller particles are subject to subtle forces that push them toward or away from the planet out of the moon's orbit. These forces include pressure from sunlight, magnetic torques acting on charged dust particles, and the influence of slight variations in gravity due to the equatorial bulge of Saturn.

The net result is a broad ring of smaller particles, most less than a tenth of a micron across – a thousandth the width of a human hair – that scatter and reflect predominantly blue light.

"This model can be transferred directly to what we now see in Uranus," de Pater said, although we still need to understand the details of the process.

All other rings – those around Jupiter, Saturn, Uranus and Neptune – are reddish. Though they contain particles of many sizes that reflect many wavelengths of light, red dominates not only because larger particles – many microns to meters across – are abundant, but also because the material itself may be reddish, perhaps from iron.

"Arguing by analogy, the two outermost rings, the two rings that have satellites embedded in them, are both the blue rings. That can't be coincidental, there has to be a common thread of dynamics that is causing both of these phenomena," Showalter said.

The discovery of the blue ring came after combining ground-based near-infrared observations by the Keck Telescope in Hawaii and visible-light photos taken by the Hubble Space Telescope. De Pater, Hammel and Gibbard have observed Uranus since 2000 with the second-generation NIRC2 infrared camera using the adaptive optics system on the Keck II telescope, and in August 2005 obtained 30 new images of the planet in hopes of seeing new features as the ring plane moves edge-on to Earth.

Showalter and Lissauer, on the other hand, captured numerous visible-light images of Uranus between 2003 and 2005 with Hubble's Advanced Camera for Surveys.

Neither team realized it had captured pictures of new rings until an extensive analysis, basically piling image upon image until faint features stood out from the background. In December 2005, as Showalter and Lissauer reported finding two new rings – Uranus's 12th and 13th – and two new moons, Mab and Cupid, numbers 26 and 27, de Pater, Hammel and Gibbard reported seeing the red, innermost of the two new rings but not the outermost. The blue ring peaks in brightness about 97,700 kilometers from the planet's center, exactly at Mab's orbit.

Further analysis proved to both teams that the outer ring seen in visible light was definitely not observable in the near-infrared, and so must be blue. The analysis also showed that Mab, which like its ring could not be seen in the infrared, is probably covered with water ice, like the other outer moons of Uranus, and is probably Uranus's smallest moon.

"If Mab would have been similar to Uranus' other inner moons, we would have seen it,", Gibbard adds, "which implies that it probably is covered by water-ice, like Uranus' classical moons.

The two teams plan further observations of Uranus to discover more about the rings as well as about the planet's surface. In 2007, with the rings edge-on to Earth, faint rings should be much more visible, Hammel said.

Source: University of California - Berkeley

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