

Saturn's rings viewed in the mid-infrared show bright cassini division

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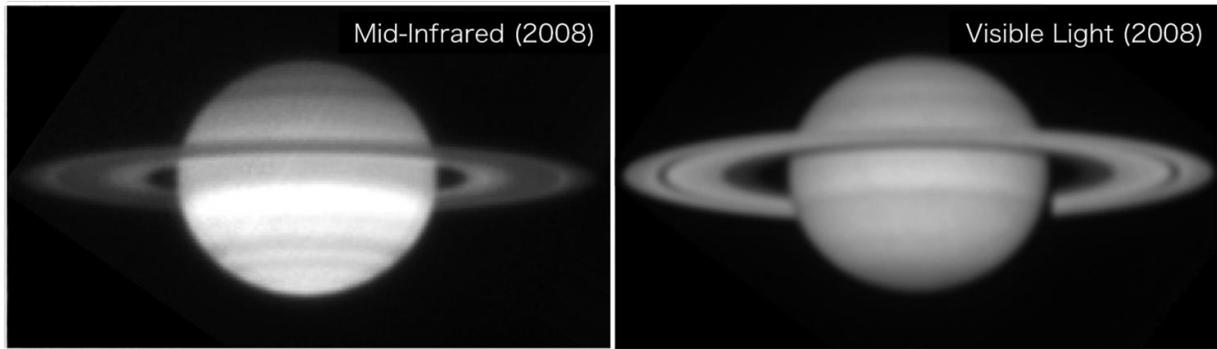
A three-color composite of the mid-infrared images of Saturn on Jan. 23, 2008 captured with COMICS on the Subaru Telescope. The Cassini Division and the C ring appear bright. Color differences reflect the temperatures; the warmer part is blue, the cooler part is red. Credit: NAOJ

A team of researchers has succeeded in measuring the brightnesses and temperatures of Saturn's rings using the mid-infrared images taken by the Subaru Telescope in 2008. The images are the highest resolution ground-based views ever made. They reveal that, at that time, the Cassini Division and the C ring were brighter than the other rings in the mid-infrared light and that the brightness contrast appeared to be the inverse of that seen in the visible light (Figure 1). The data give important insights into the nature of Saturn's rings.

The beautiful appearance of Saturn and its rings has always fascinated people. The rings consist of countless numbers of ice particles orbiting above Saturn's equator. However, their detailed origin and nature remain unknown. Spacecraft- and ground-based telescopes have tackled that mystery with many observations at various wavelengths and methods. The international Cassini mission led by NASA has been observing Saturn and its rings for more than 10 years, and has released a huge number of beautiful images.

Subaru Views Saturn

The Subaru Telescope also has observed Saturn several times over the years. Dr. Hideaki Fujiwara, Subaru Public Information Officer/Scientist, analyzed data taken in January 2008 using the Cooled Mid-Infrared Camera and Spectrometer (COMICS) on the telescope to produce a beautiful image of Saturn for [public information](#) purposes. During the analysis, he noticed that the appearance of Saturn's rings in the mid-infrared part of the spectrum was totally different from what is seen in the visible light



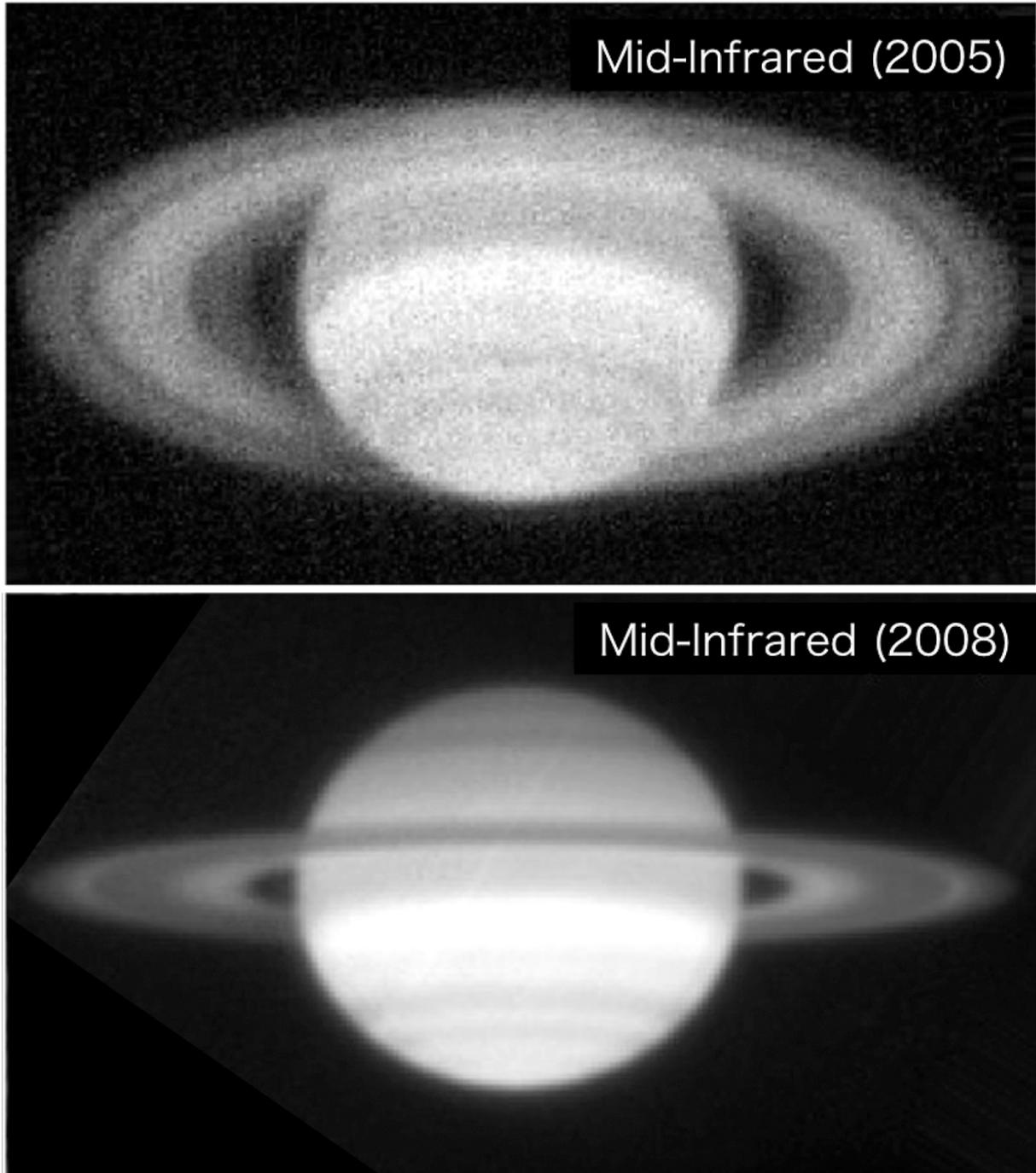
Comparison of the images of Saturn's rings in the 2008 view in the mid-infrared (left) and the visible light (right). The visible light image was taken on March 16, 2008 with the 105-cm Murikabushi telescope at Ishigakijima Astronomical Observatory. The radial brightness contrast of Saturn's rings is the inverse between the two wavelength ranges. Credit: NAOJ

Saturn's main rings consist of the C, B, and A rings, each with different populations of particles. The Cassini Division separates the B and A rings. The 2008 image shows that the Cassini Division and the C ring are brighter in the mid-infrared wavelengths than the B and A rings appear to be (Figure 1). This brightness contrast is the inverse of how they appear in the visible light, where the B and A rings are always brighter than the Cassini Division and the C ring (Figure 2).

"Thermal emission" from ring particles is observed in the mid-infrared, where warmer particles are brighter. The team measured the temperatures of the rings from the images, which revealed that the Cassini Division and the C ring are warmer than the B and A rings. The team concluded that this was because the particles in the Cassini Division and C ring are more easily heated by solar light due to their sparser populations and darker surfaces.

On the other hand, in the visible light, observers see sunlight being

reflected by the ring particles. Therefore, the B and A rings, with their dense populations of particles, always seem bright in the visible wavelengths, while the Cassini Division and the C ring appear faint. The difference in the emission process explains the inverse brightnesses of Saturn's rings between the mid-infrared and the visible-light views.



Comparison of the mid-infrared images of Saturn's rings on April 30, 2005 (top) and Jan. 23, 2008 (bottom). Although both of the images were taken in the mid-infrared, the radial contrast of Saturn's rings is the inverse of each other. Credit: NAOJ

Changing Angles Change the Brightnesses

It turns out that the Cassini Division and the C ring are not always brighter than the B and A rings, even in the mid-infrared. The team investigated images of Saturn's rings taken in April 2005 with COMICS, and found that the Cassini Division and the C ring were fainter than the B and A rings at that time, which is the same contrast to what was seen in the visible light (Figure 3).

The team concluded that the "inversion" of the brightness of Saturn's rings between 2005 and 2008 was caused by the seasonal change in the ring opening angle to the Sun and Earth. Since the rotation axis of Saturn inclines compared to its orbital plane around the Sun, the ring opening angle to the Sun changes over a 15-year cycle. This makes a seasonal variation in the solar heating of the ring particles. The change in the opening angle viewed from the Earth affects the apparent filling factor of the particles in the rings. These two variations - the temperature and the observed filling factor of the [particles](#) - led to the change in the mid-infrared appearance of Saturn's rings.

The data taken with the Subaru Telescope revealed that the Cassini Division and the C ring are sometimes bright in the mid-infrared though they are always faint in [visible light](#). "I am so happy that the public information activities of the Subaru Telescope, of which I am in charge, led to this scientific finding," said Dr. Fujiwara. "We are going to observe Saturn again in May 2017 and hope to investigate the nature of Saturn's rings further by taking advantages of observations with space missions and ground-based telescopes."

This research is published in *Astronomy & Astrophysics*, Volume 599, A29 and posted on-line on February 23, 2017 (Fujiwara et al., 2017, "Seasonal variation of the radial brightness contrast of Saturn's rings viewed in mid-infrared by Subaru/COMICS").

More information: Hideaki Fujiwara et al, Seasonal variation of the radial brightness contrast of Saturn's rings viewed in mid-infrared by Subaru/COMICS, *Astronomy & Astrophysics* (2017). [DOI: 10.1051/0004-6361/201527529](https://doi.org/10.1051/0004-6361/201527529)

Provided by Subaru Telescope

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