Seasonal variation of radial brightness contrast of Saturn's rings viewed in mid-infrared by COMICS

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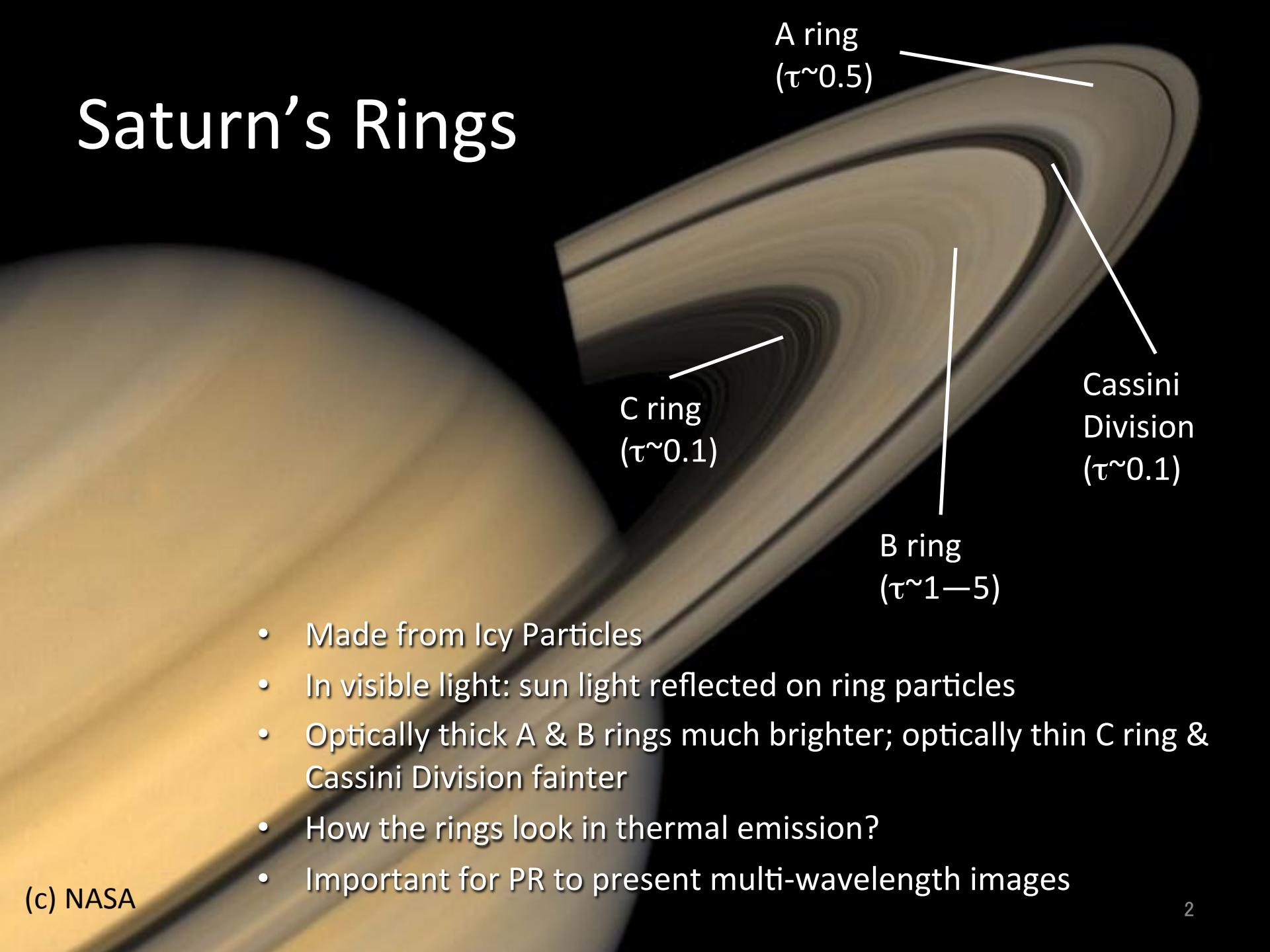
Saturn's Rings



- Made from Icy Particles
- In visible light: sun light reflected on ring particles
- Optically thick A & B rings much brighter; optically thin C ring & Cassini Division fainter
- How the rings look in thermal emission?
- Important for PR to present multi-wavelength images

(c) NASA

Data

- Observed in 2008/1/23 → unpublished
- MIR Camera COMICS on Subaru Telescope
- Multi-wavelength Imaging at 8.8, 9.7, 10.5, 11.7, 12.5, 17.7, 18.8, 20.5, 24.5 μm
- Retrieved from SMOKA (S07B-076, PI: Yanamandra-Fisher)
- Almost edge-on rings to observer/Sun

Epoch (UT)	r (au)	Δ (au)	B' (deg)	B (deg)	α (deg)
January 23, 2008	9.27	8.45	−8.7	−7.2	3.5

Sun-Saturn

Solar El. (above ring plane)

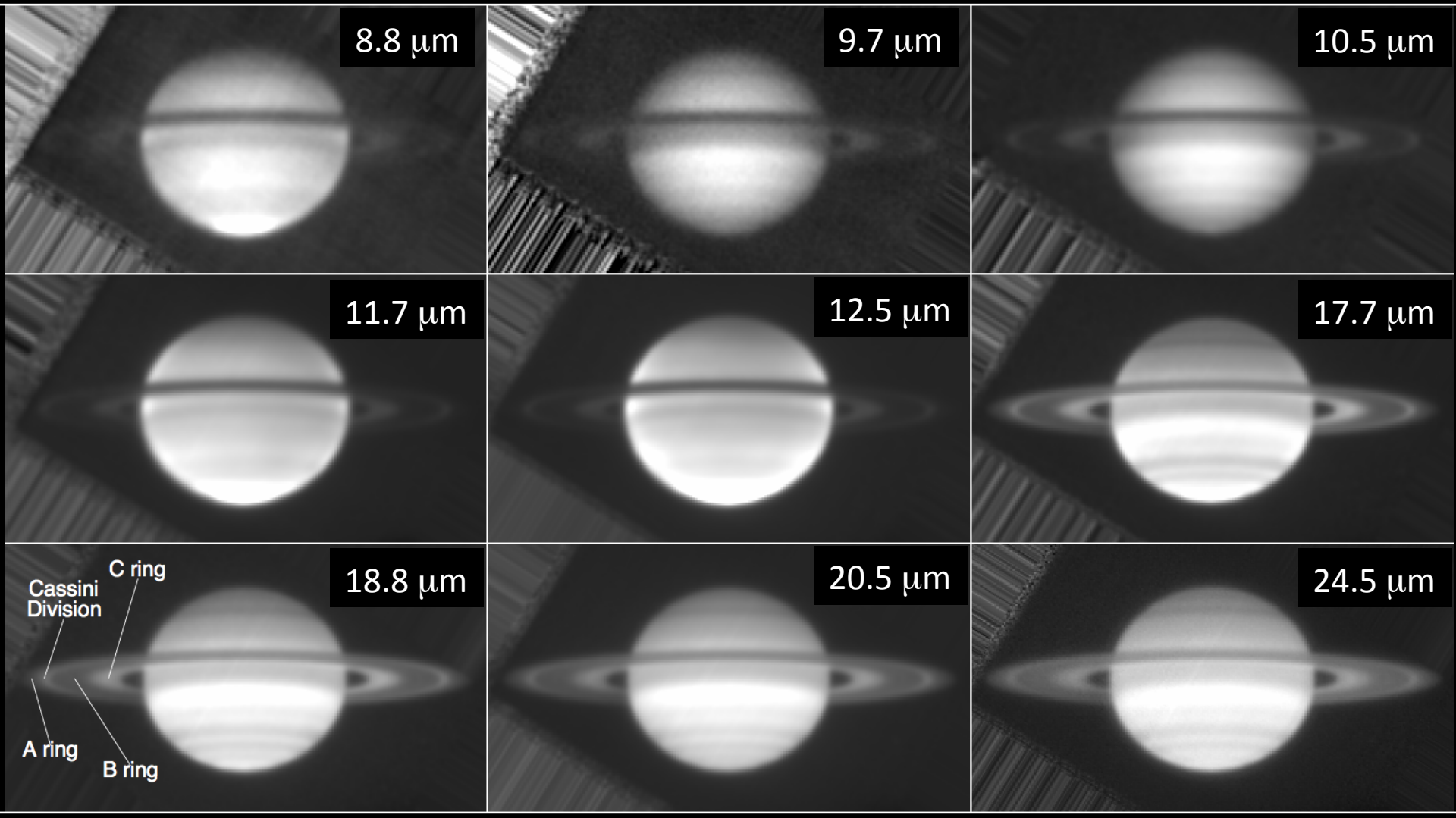
Phase Ang.

Earth-Saturn

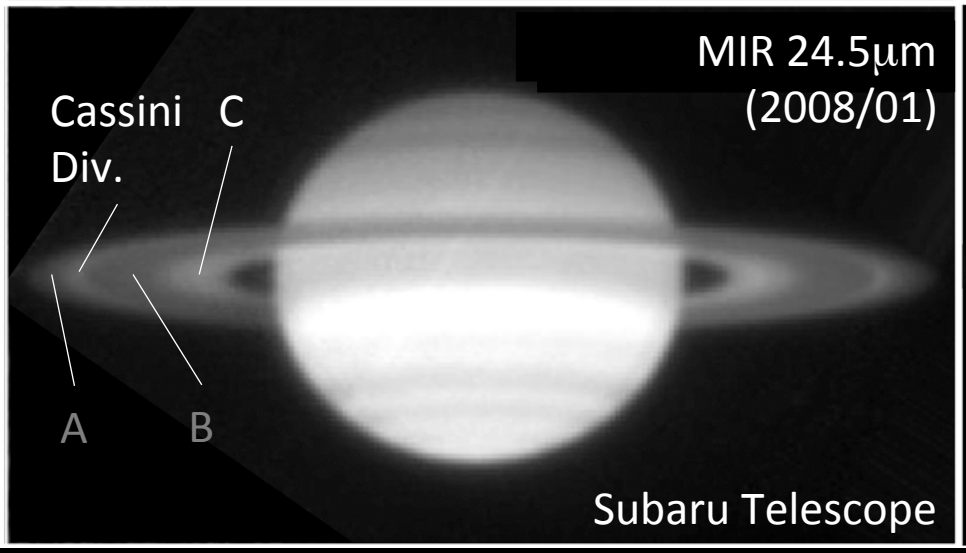
Earth El.

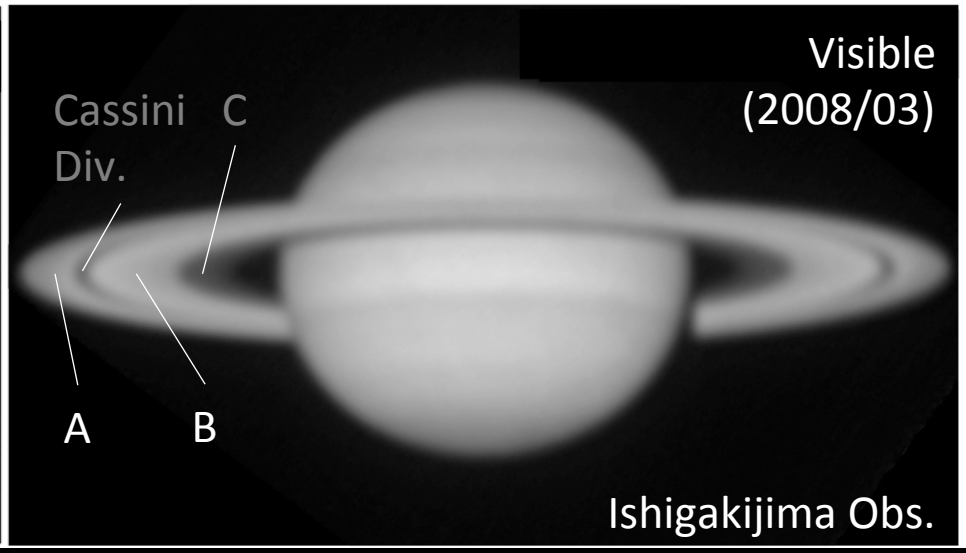
Ring Brightness

Spatial Res: 0.38-0.67” = a few 1000 km
(**Highest-ever in MIR from ground**)



Comparison w/ visible image

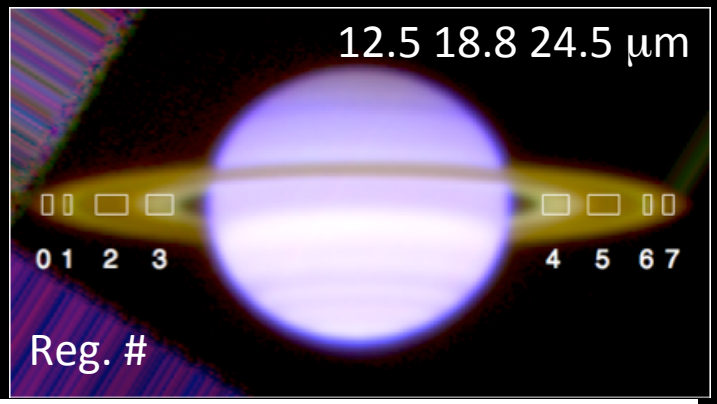




- Compared with visible image by Ishigakijima Obs.
- Ring brightness contrasts in MIR and visible are the inverse
- C ring and Cassini Div. are brighter than B and A rings in MIR while C rings and Cassini Div. are always fainter in visible

SEDs of Rings

- Blackbody peaking at > 25 μm
- No significant dust features



Reg. 0 (A Ring East)
T = 78 K

Reg. 1 (B ring East)
T = 91 K

Reg. 2 (CD East)
T = 82 K

Reg. 3 (C ring East)
T = 97 K

Reg. 4 (C ring West)
T = 100 K

Reg. 5 (B ring West)
T = 84 K

Reg. 6 (CD West)
T = 93 K

Reg. 7 (A ring West)
T = 80 K

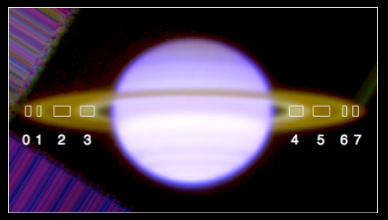
Surface Brightness (Jy arcsec^{-2})

Wavelength (μm)

Ring Temperatures

- Assuming blackbody (& τ from stellar occultation → filling factor β=1-exp(-τ/sin|B|)) → Physical ring temperatures

Region	Ring	T by COMICS (K)					
		τ = 0.05	0.1	0.2	0.5	1	2
0	A ring (East)	–	–	80	**78**	78	–
1	Cassini Division (East)	97	**91**	87	–	–	–
2	B ring (East)	–	–	–	82	**82**	82
3	C ring (East)	102	**97**	92	–	–	–
4	C ring (West)	105	**100**	95	–	–	–
5	B ring (West)	–	–	–	84	**84**	84
6	Cassini Division (West)	99	**93**	89	–	–	–
7	A ring (West)	–	–	82	**80**	80	–



Morning

Evening

- West (evening) side warmer than east (morning) side in each ring
- C ring & Cassini Div. warmer than B, A rings
- Higher temperatures in C ring and Cassini Div. overcome low filling factors, achieving brighter MIR emission in 2008
- Are C ring & Cassini Div. ALWAYS brighter?

Variation from 2005 to 2008

- Compared with data in 2005 April, when ring opening was larger

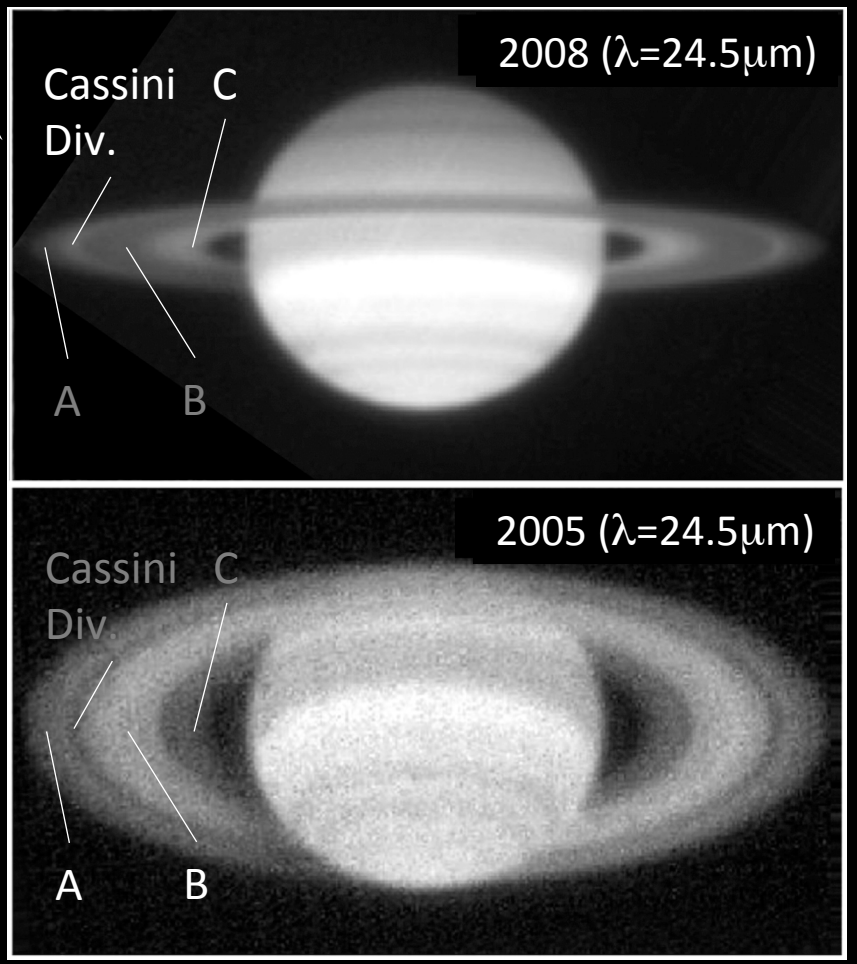
Epoch (UT)	r (au)	Δ (au)	B' (deg)	B (deg)	α (deg)
January 23, 2008	9.27	8.45	−8.7	−7.2	3.5
April 30, 2005	9.07	9.33	−21.9	−23.6	6.1

(above ring plane)

Solar El. Earth El.

- Contrast reversed in 2005-2008
- Particle temperatures and filling factors depend on opening angle

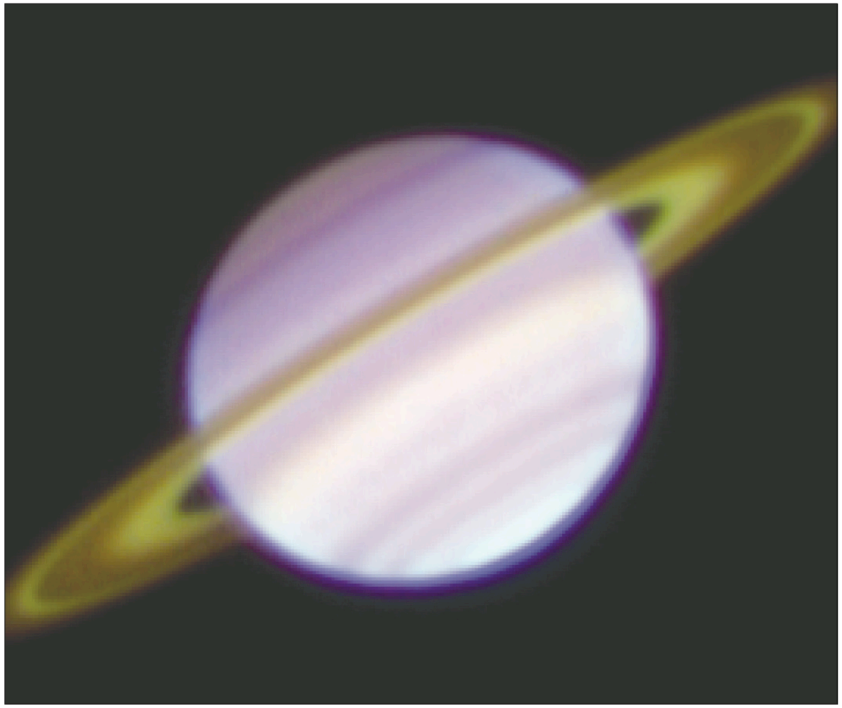
- Larger opening angle makes larger contrast in filling factors
- C ring & CD fainter



(See Fujiwara et al. 2017 A&A for quantitative discussion)

Summery

- MIR image of Saturn from Archival Data (SMOKA)
- Measurement of Ring Brightness & Temperatures (Highest-ever spatial resolution from the ground)
  - C ring and Cassini Div. were warmer than B and A rings
- In 2008 C ring and Cassini Div. were brighter than B and A rings (opposite contrast to visible light)
- MIR Brightness Contrast became inverse from 2005 to 2008
- Scientific Publication led by Public Information Activities



An infrared image of Saturn taken with the Subaru Telescope. COURTESY PHOTO

Subaru takes infrared image of Saturn

WEST HAWAII TODAY

HILO — Astronomers are seeing Saturn's rings in a whole new light.

A team of researchers using the Subaru Telescope atop Mauna Kea recently measured the brightness and temperature of the planet's rings using infrared images taken in 2008.

They are the highest resolution images from a ground-based telescope, according to the observatory.

The images revealed the Cassini Division, a wide dark area in between rings, and the C ring were brighter than other rings in mid-infrared light, the opposite of what is seen in visible light.

Subaru spokesman Hideaki Fujiwara said that means that particles in those rings, while less reflective, are better at absorbing heat from the sun and helps researchers better understand their composition.

He said Mauna Kea is particularly good for viewing mid-infrared light because of its low humidity.

- Local Newspaper in Big Island
- Chance to explain how Maunakea is special for infrared observations

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