

Cassini: The Grand Finale

August 30, 2017

Host: Brooks Mitchell, STAR_Net Education Coordinator

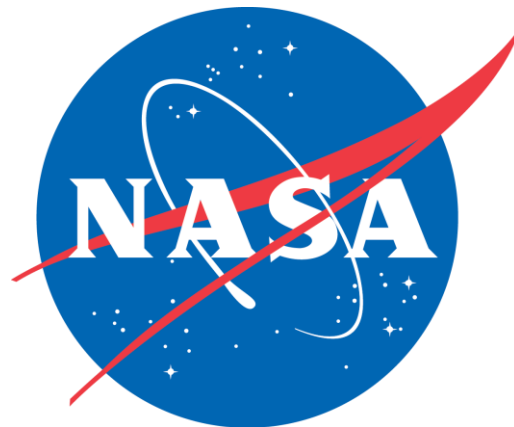
Presenter: Colin Mitchell, Space Science Institute
Researcher for the Cassini Mission



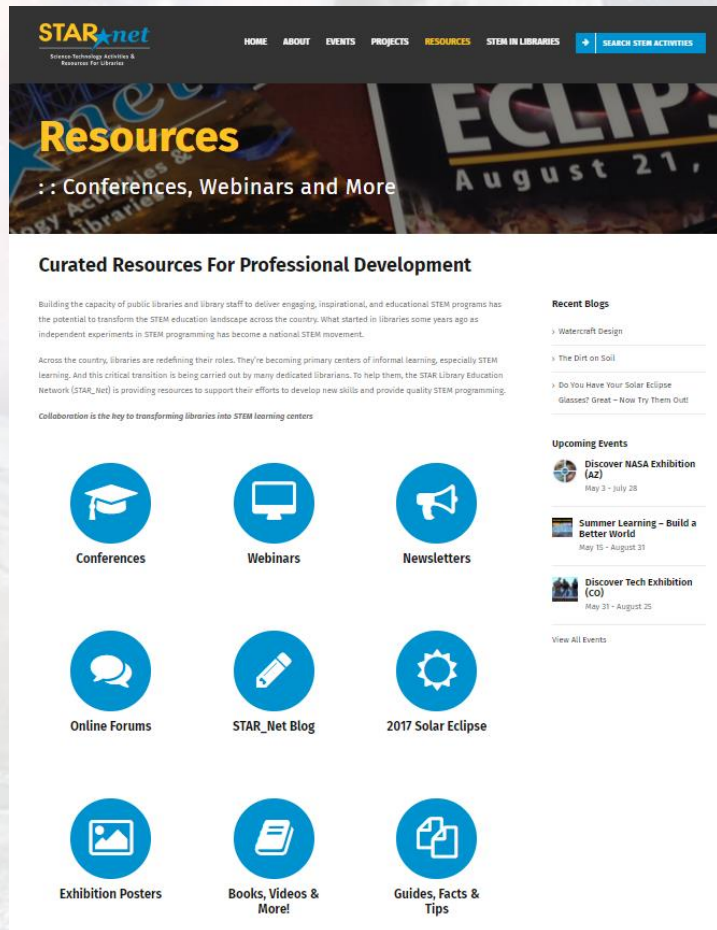
Audio problems? Click and highlight the  button at the top of your screen. You can also click “Meeting” > “Audio Setup Wizard”. You will not need microphone capabilities.



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Science-Technology Activities &
Resources For Libraries

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Resources

:: Conferences, Webinars and More

Curated Resources For Professional Development

Building the capacity of public libraries and library staff to deliver engaging, inspirational, and educational STEM programs has the potential to transform the STEM education landscape across the country. What started in libraries some years ago as independent experiments in STEM programming has become a national STEM movement.

Across the country, libraries are redefining their roles. They're becoming primary centers of informal learning, especially STEM learning. And this critical transition is being carried out by many dedicated librarians. To help them, the STAR Library Education Network (STAR_Net) is providing resources to support their efforts to develop new skills and provide quality STEM programming.

Collaboration is the key to transforming libraries into STEM learning centers



Conferences



Webinars



Newsletters



Online Forums



STAR_Net Blog



2017 Solar Eclipse



Exhibition Posters



Books, Videos & More!



Guides, Facts & Tips

Recent Blogs

- Watercraft Design
- The Dirt on Soil
- Do You Have Your Solar Eclipse Glasses? Great - Now Try Them Out!

Upcoming Events

- Discover NASA Exhibition (AZ)
May 3 - July 28
- Summer Learning - Build a Better World
May 15 - August 31
- Discover Tech Exhibition (CO)
May 31 - August 25

[View All Events](#)

Professional development resources, including webinars, newsletters, blogs, forums, videos, and much more!

Professional Development Resources

Upcoming Webinars [Out-of-This-World Activities](#)

- **September 13th at 1:00 p.m. (MT)**

[Celebrate Afterschool Partnerships with the Annual Lights on Afterschool!](#)

- **September 9th at 1:00 p.m. (MT)**

[International Observe the Moon Night](#)

- **October 4th at 2:00 p.m. (MT)**

How-To Videos for Activities

[Scale Model of Sun and Earth](#)

Upcoming Conferences

[ARSL, ASTC, and more!](#)

Archived Webinars

[Busy? See what you missed!](#)

STEM ACTIVITY Clearinghouse

STEM Activity Clearinghouse





Home > Collections > 2017 Total Solar Eclipse

ATTRIBUTES

Content Area

- ☐ Earth Science (0)
- ☐ Astronomy and Space (0)
- ☐ Chemistry (0)
- ☐ Physics (0)
- ☐ Engineering (0)
- ☐ Mathematics (0)
- ☐ Technology and Computing (0)
- ☐ Health Science (0)

Age Group

- ☐ Family (0)
- ☐ Infant (0-2) (0)
- ☐ Pre-K (0)
- ☐ Early Elementary (0)
- ☐ Upper Elementary (0)
- ☐ Tweens (9-12) (0)
- ☐ Teens (0)
- ☐ Adults (0)

Time to Complete Activity

- ☐ Under 10 minutes (0)
- ☐ 10-20 minutes (0)
- ☐ 20-40 minutes (0)
- ☐ 40 minutes to 1 hour (0)
- ☐ 1-2 hours (0)
- ☐ 2-4 hours (0)
- ☐ Long Duration (days to months) (0)

2017 TOTAL SOLAR ECLIPSE

There are 7 items.

Showing 1 - 7 of 7 items



How Big, How Far, How Hot, How Old?

This is an activity about scale. Participants will arrange imagery of Earth and many other space objects in order of their size from smallest to largest, their distance from Earth's surface, their temperature from coolest to hottest, and/or their age from youngest to oldest.

[Open Activity](#)

[Report broken link](#)

Content Area

Earth Science
Astronomy and Space

Age Group

Family
Upper Elementary
Tweens (9-12)

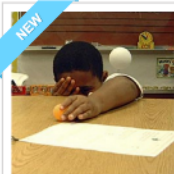
Time to Complete Activity

10-20 minutes

Difficulty Level (by content)

Medium

[View Details](#)



How Can the Little Moon Hide the Giant Sun?

This is an activity exploring the concept that distance affects how we perceive an object's size, specifically pertaining to the size of the Sun and the Moon as seen from Earth.

[Open Activity](#)

[Report broken link](#)

Content Area

Earth Science
Astronomy and Space

Age Group

Early Elementary
Upper Elementary

Time to Complete Activity

40 minutes to 1 hour

Difficulty Level (by content)

Easy

For example:
[DIY Sun Cookies](#)



Reminders

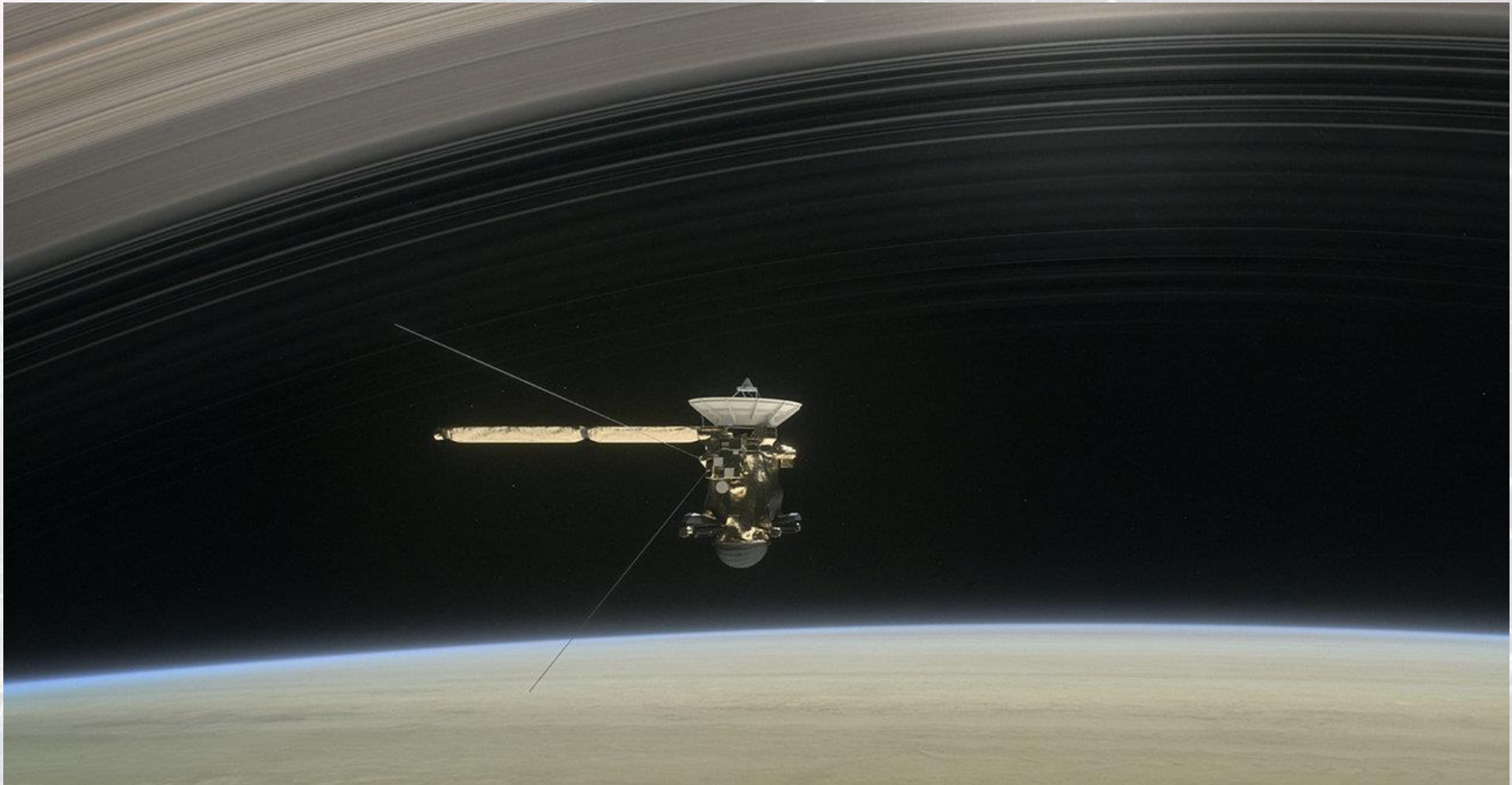
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Cassini Mission to Saturn: The Grand Finale



Make a CD Saturn



Dr. Colin Mitchell

Research associate within the Cassini Imaging Central Laboratory for Operations (CICLOPS), working on analyzing Cassini Saturn ring images, as well as helping plan Cassini's mission and calibrating the Imaging Science Subsystem (ISS) instrument.

Engaged in the study of the electromagnetic effects in Saturn's rings

- In particular, he is studying the Saturn B ring spokes to study their dynamics and link to the planet's magnetic field

Received his Bachelor's degree from Colorado State University in 1999 and his Doctorate from the University of Colorado in 2006.

Cassini Mission Finale

Colin Mitchell
Carolyn Porco
Cassini Team
August, 2017



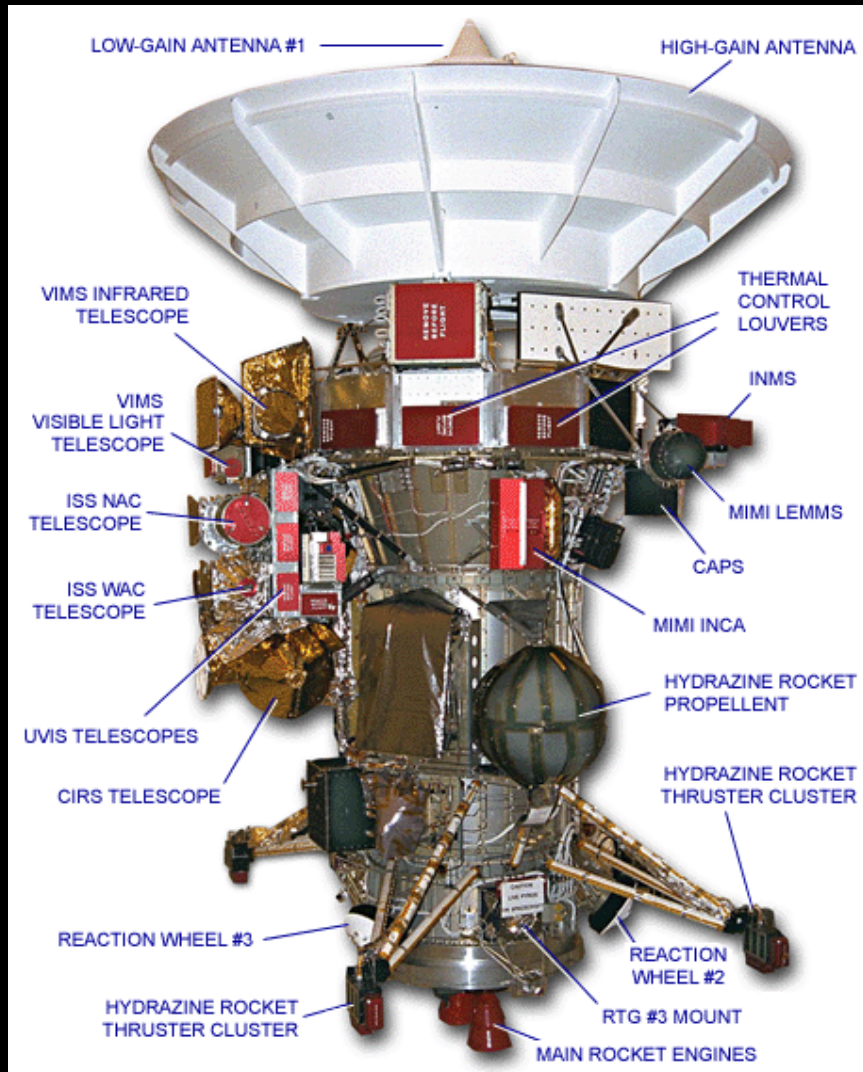
CICLOPS

CASSINI IMAGING

CENTRAL LABORATORY FOR OPERATIONS



Cassini's Instruments



ISS - IR to UV Imaging (Photometry)

VIMS - Visible and IR Mapping Spectrometer

UVIS - UV Imaging Spectrograph

CIRS - Composite IR Spectrometer

RSS - Radio Science

Radar - Radar

RPWS - Plasma Waves

MIMI - Magnetosphere Imaging

CAPS - Plasma Spectrometer

INMS - Ion and Neutral Mass Spectrometer

MAG - Magnetometer

CDA - Cosmic Dust Analyzer

Cassini Orbiter & Huygens Probe



Cassini Spacecraft Specs

- Height: 6.8 m (22 ft)
- Diameter: 4 m (13 ft)
- Mass: 2125 kg (2.8 tons)
(fueled+probe): 5574 kg (6 tons)
- Power: 875 Watts at Launch
670 Watts currently
- .5 GB recorder
- Huygens Probe:
320 kg (~700 lbs)

Timetable

Launched in October, 1997
(Titan IVB)

Multiple Flybys of other planets
(2 Venus, 1 Earth, 1 Jupiter)

Arrived July, 2004

Finished Prime Mission July, 2008

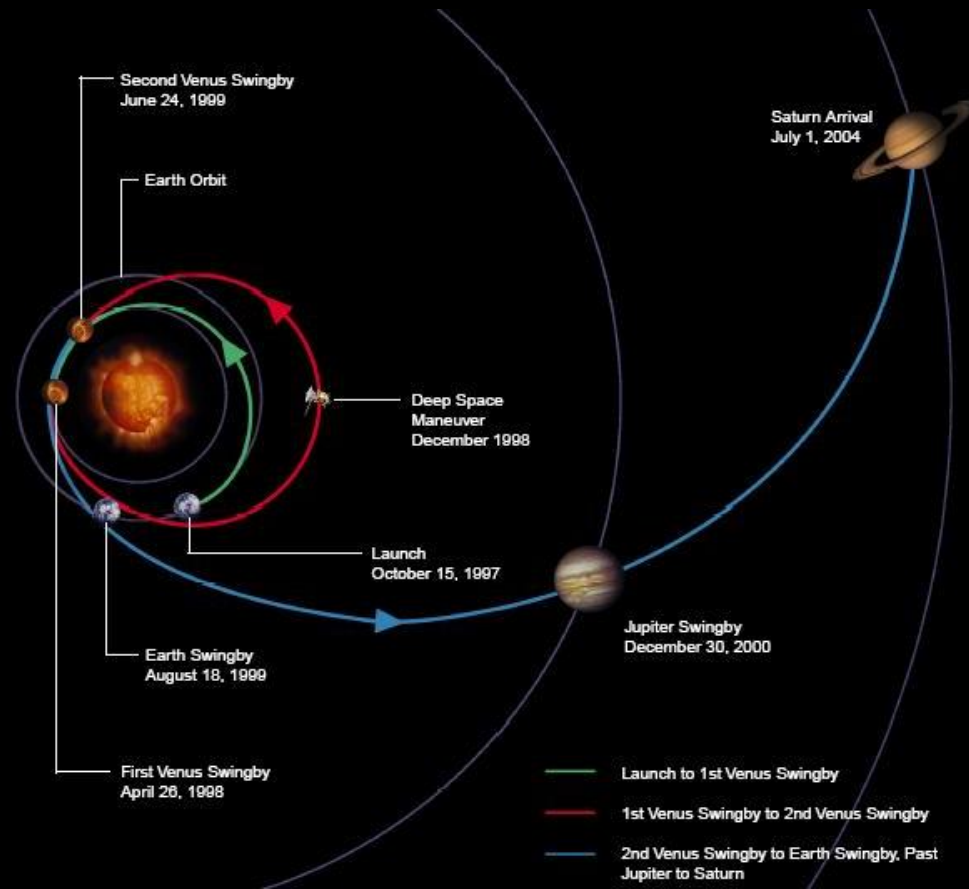
Finished Equinox Mission July, 2010

Solstice Mission currently ongoing.

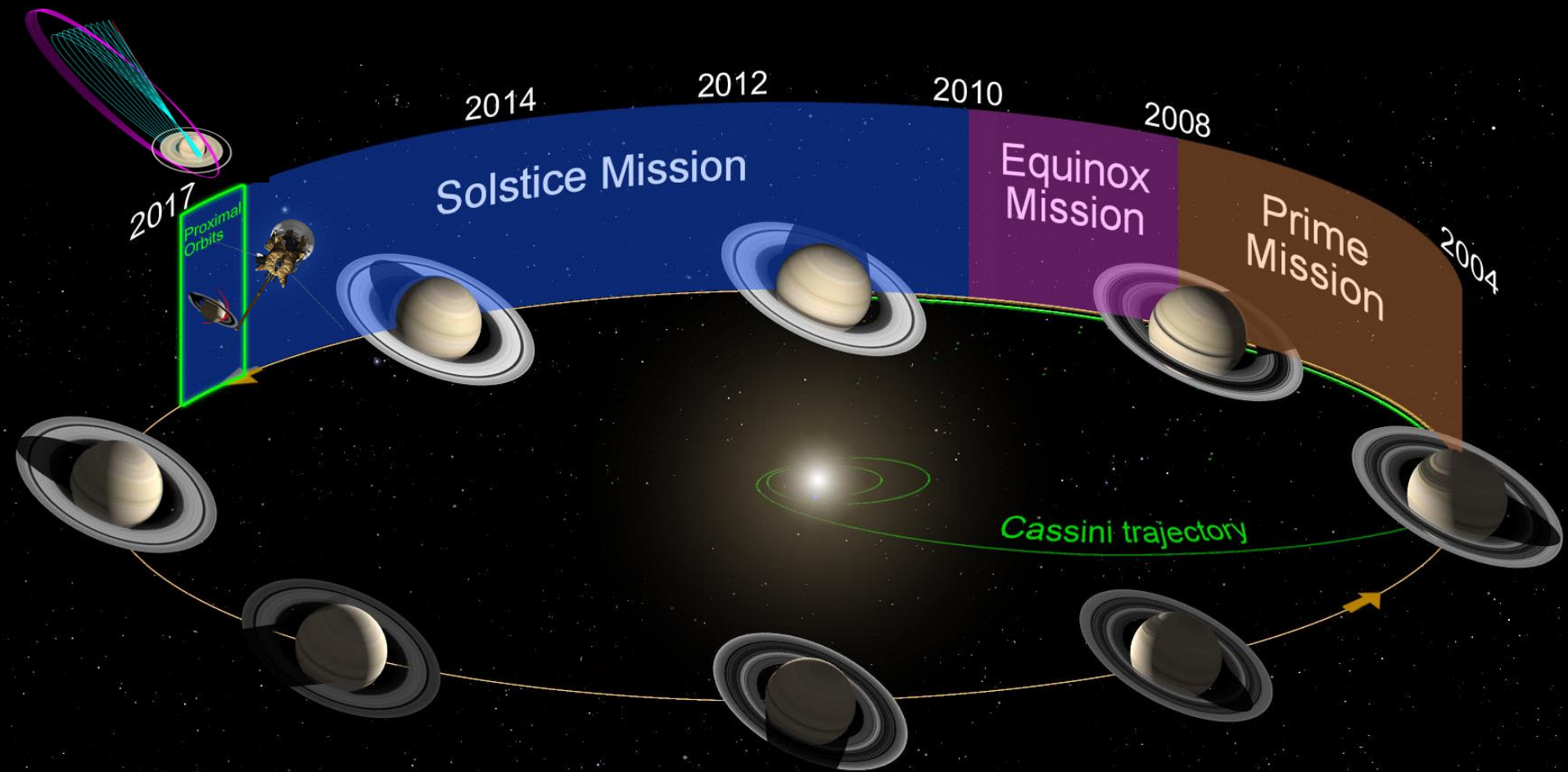
End of Mission September 15, 2017



Launched on October 15, 1997 from KSC



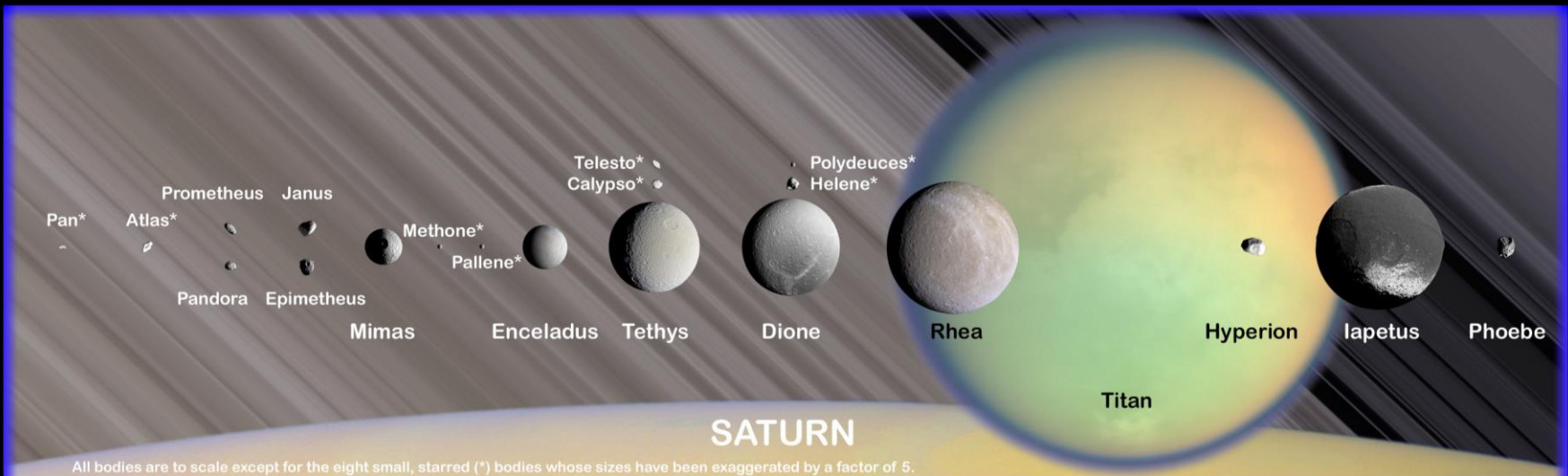
Cassini-Huygens Mission Overview



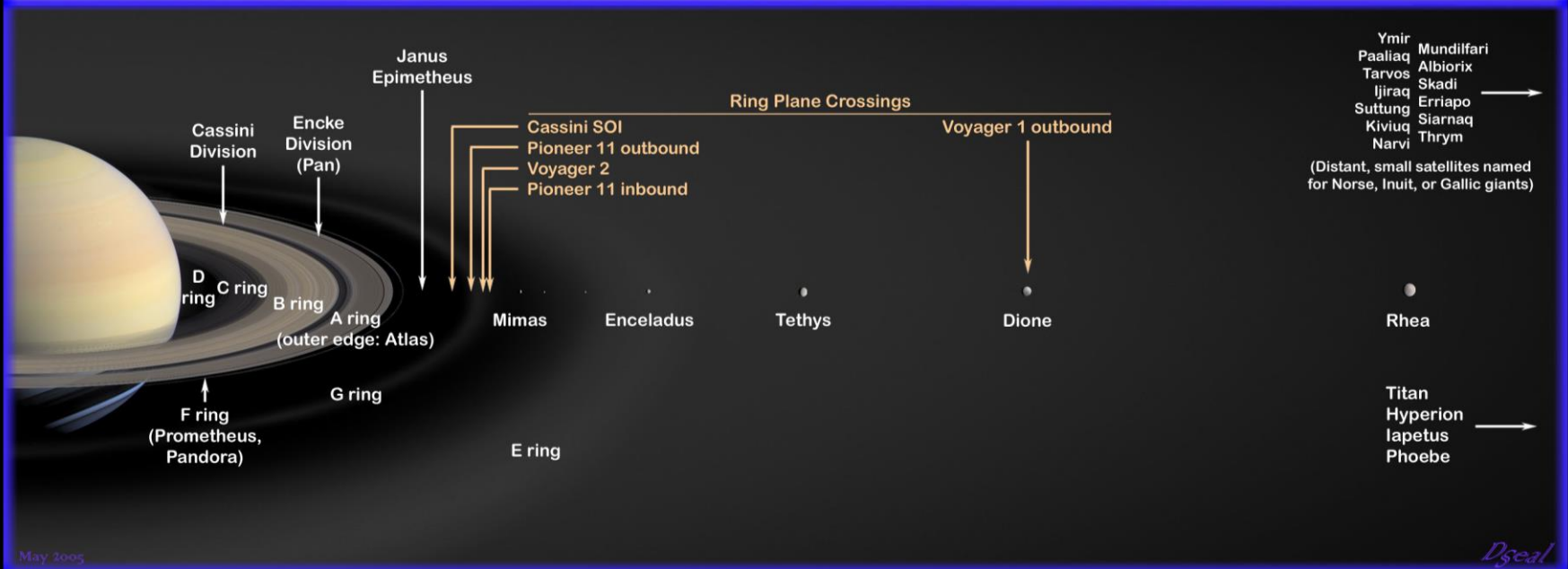
Eclipse Mosaics



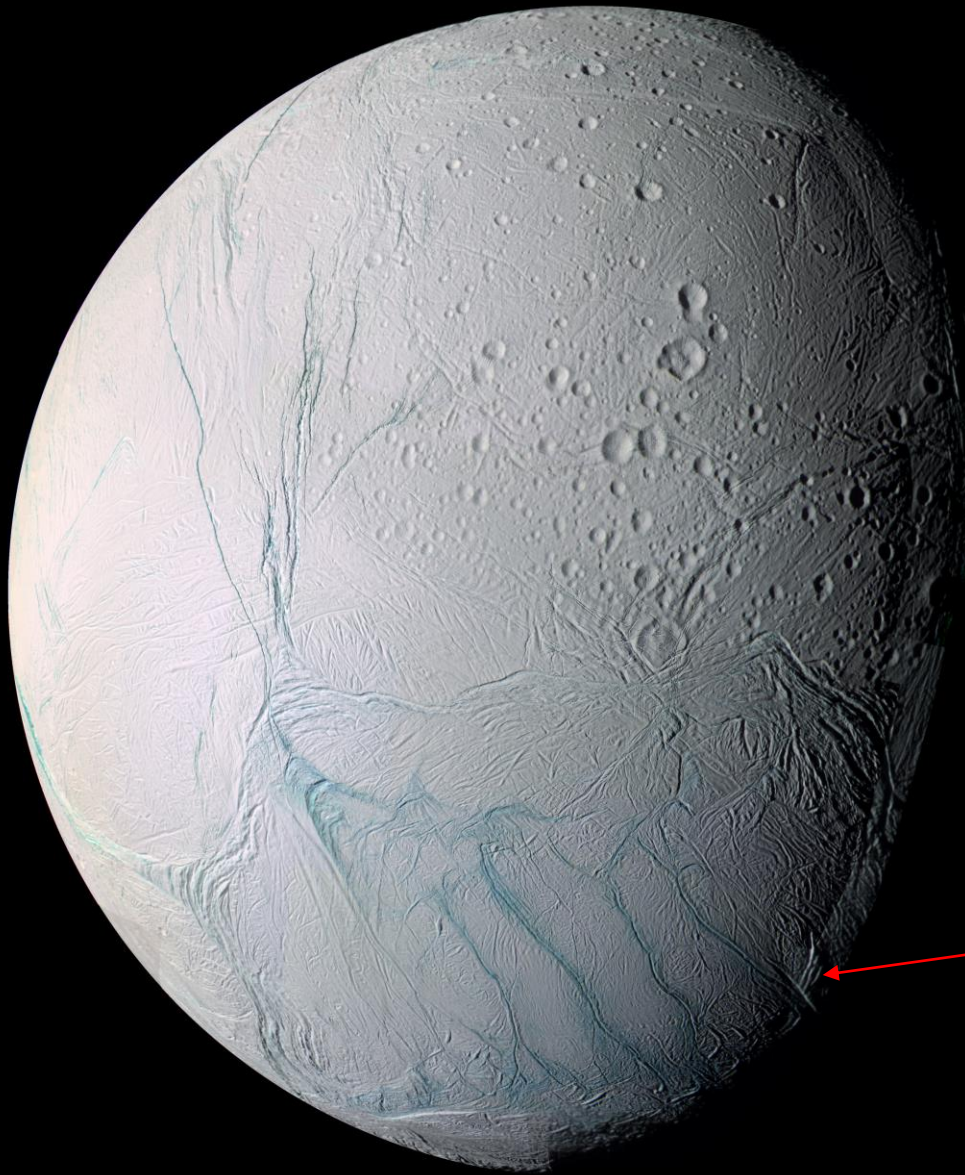
Saturnian Satellites and Rings



All bodies are to scale except for the eight small, starred (*) bodies whose sizes have been exaggerated by a factor of 5.



Enceladus

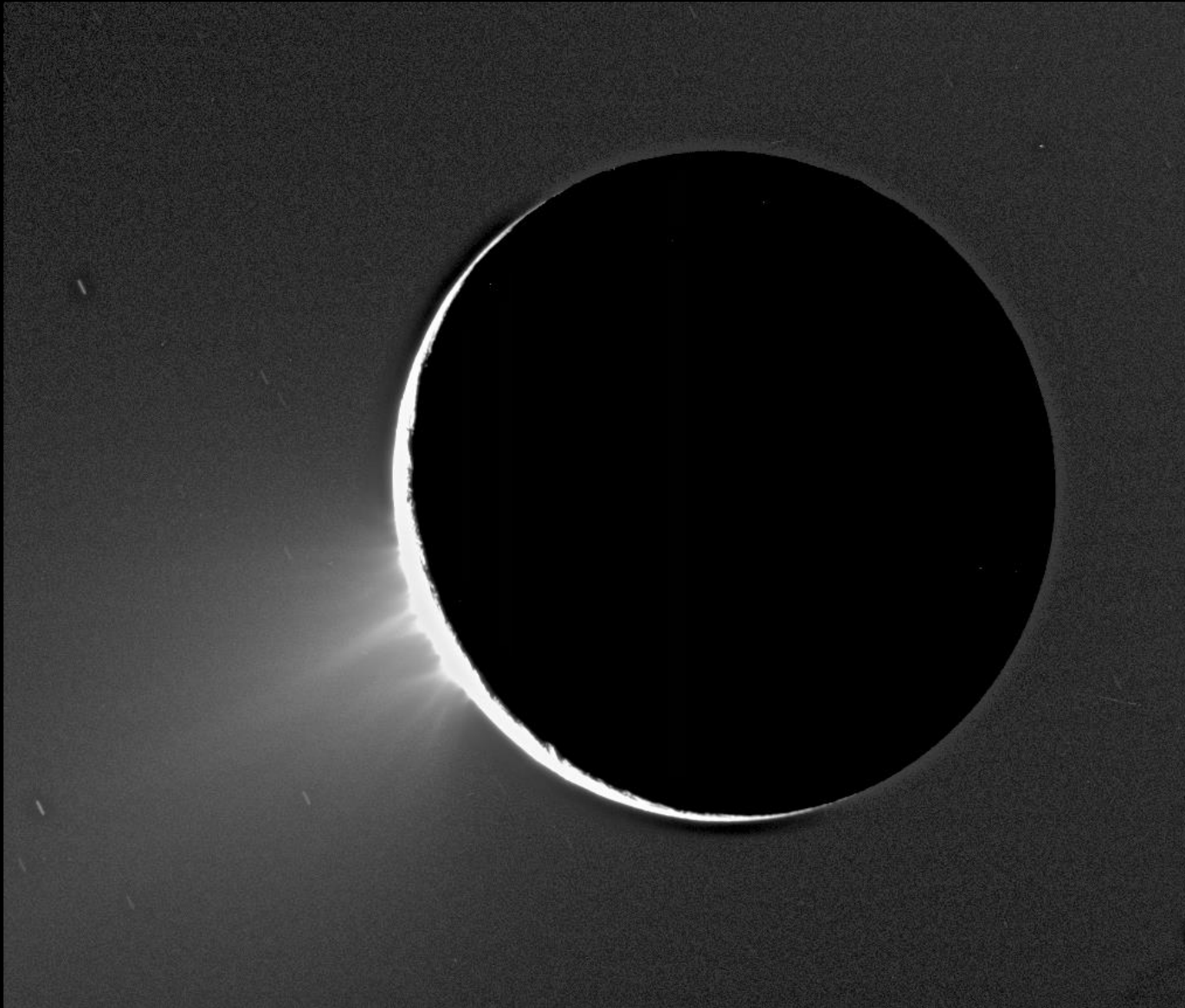


VERY reflective
(Albedo ~ 80%)

“Tiger Stripes”

Diameter ~ 505 km

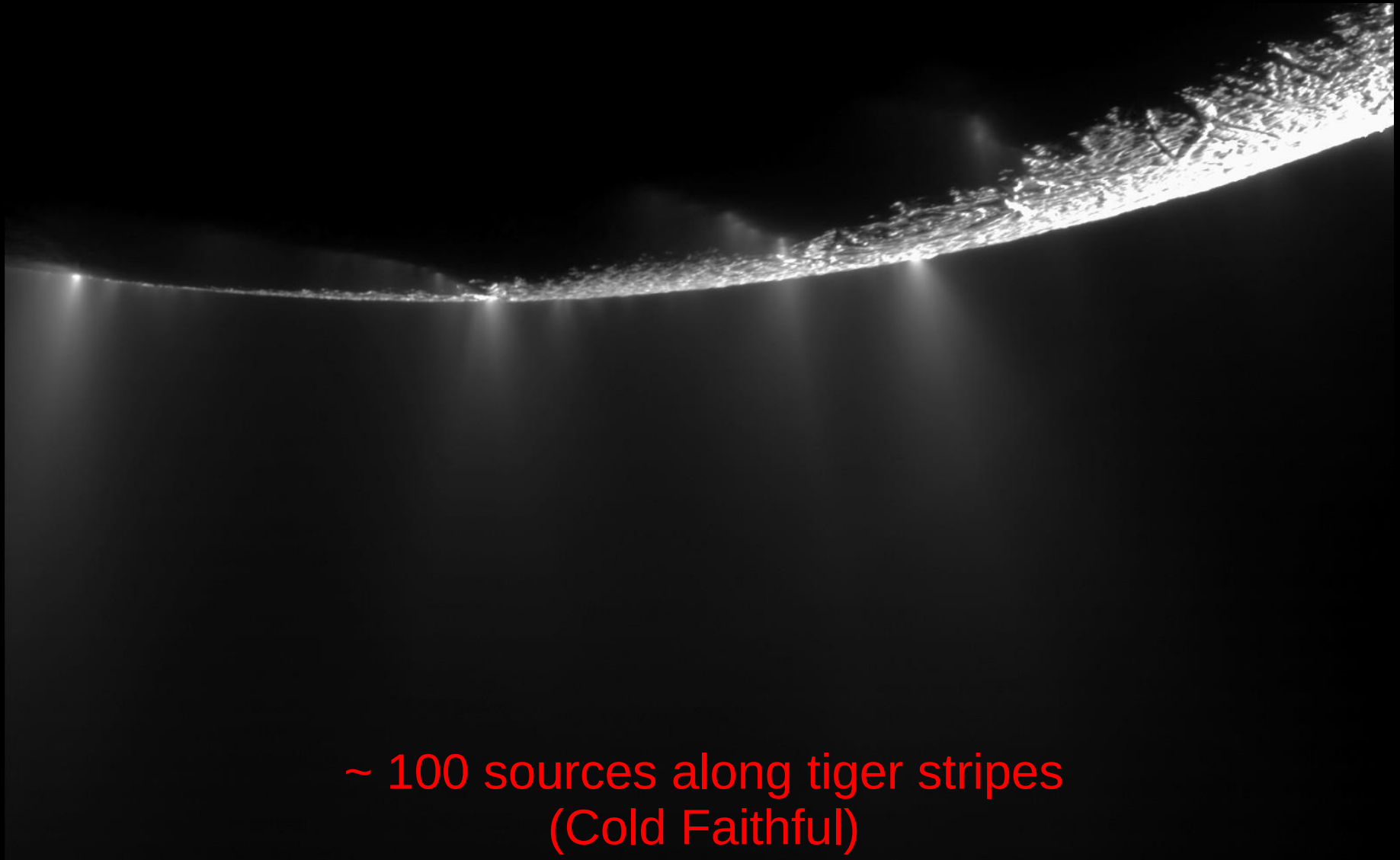
Enceladus Plume



Water ice

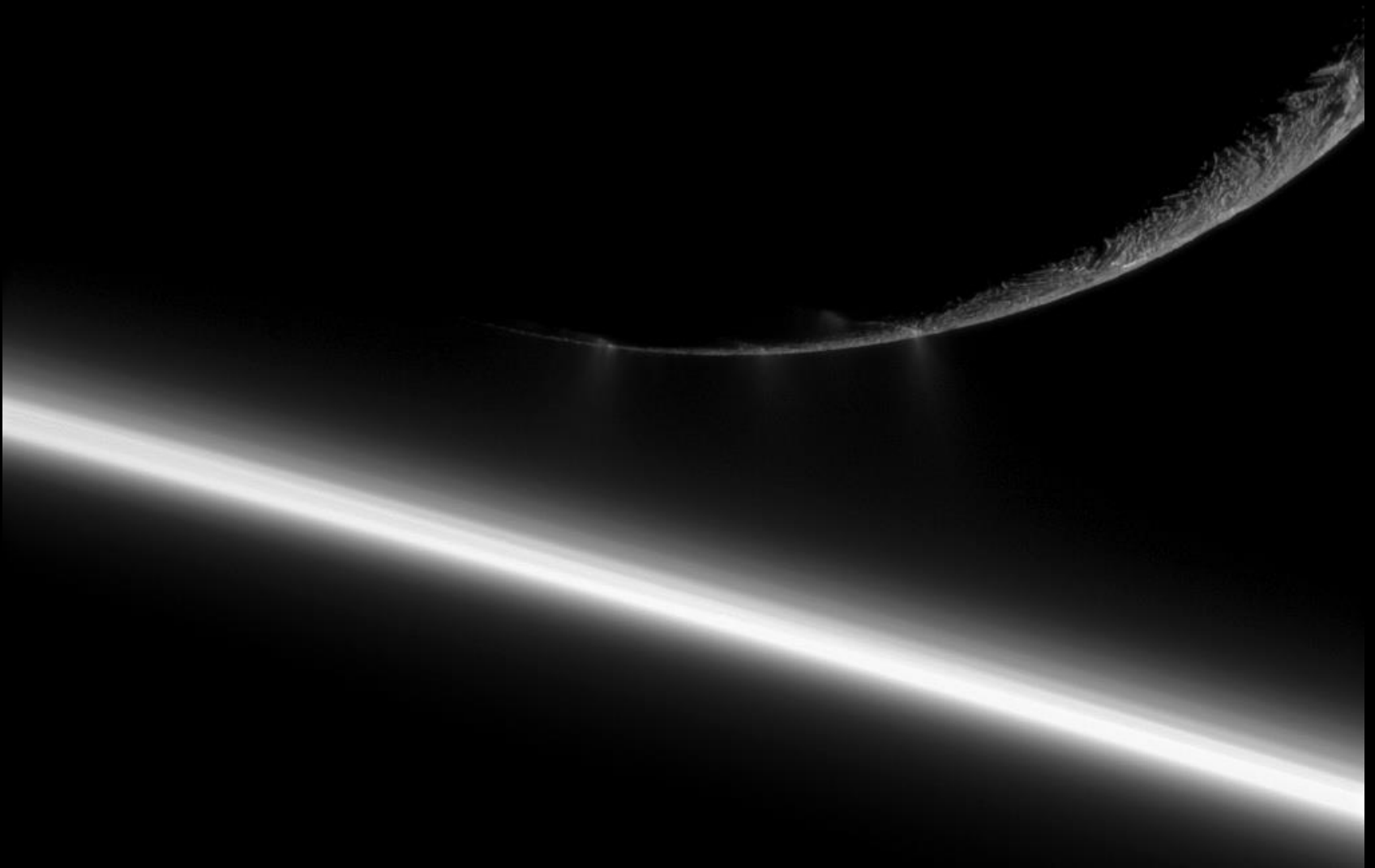
Particles
~ 1 micron
(10^{-6} meters)

Enceladus Plume



~ 100 sources along tiger stripes
(Cold Faithful)

Enceladus Plume



Closest View

South Polar Region

Near terminator

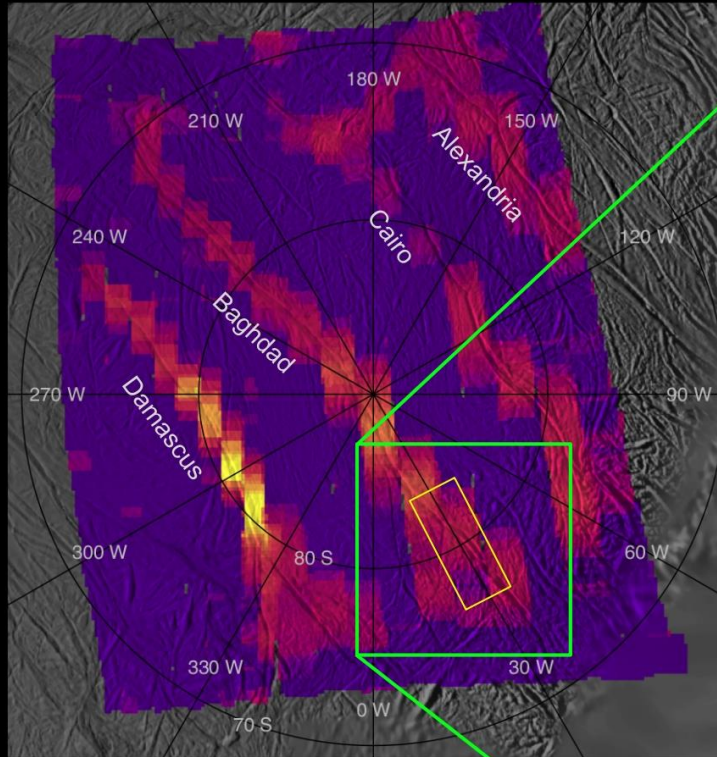
Many boulders

13 m per pixel

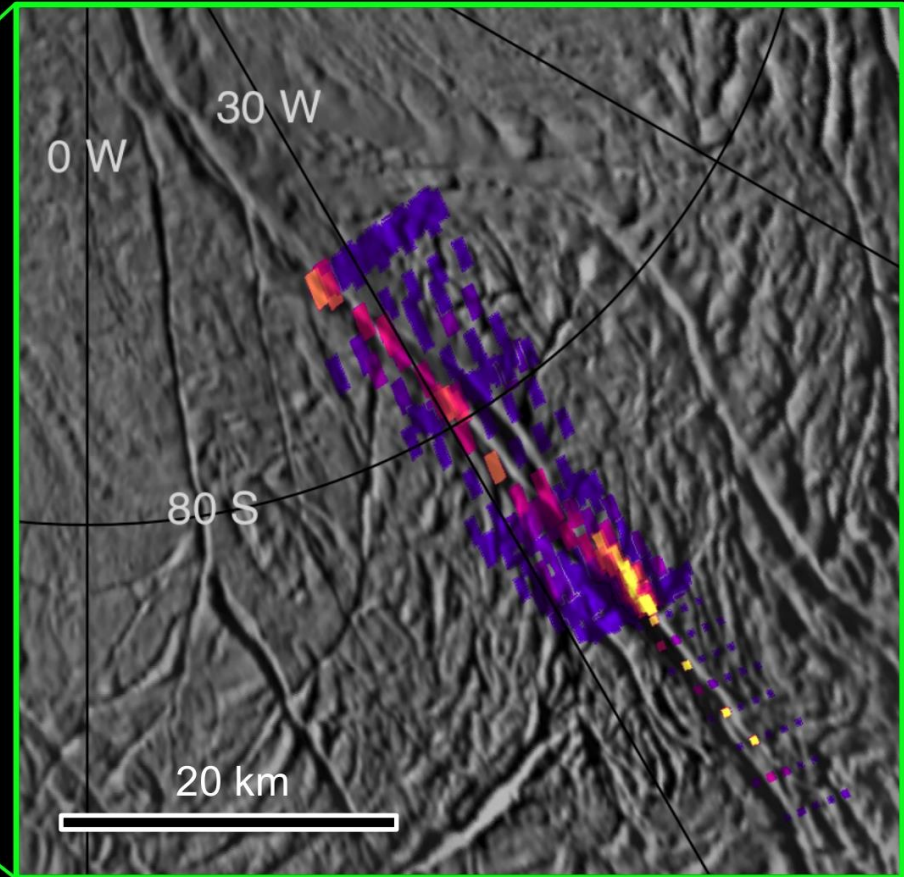


Warm Tiger Stripes

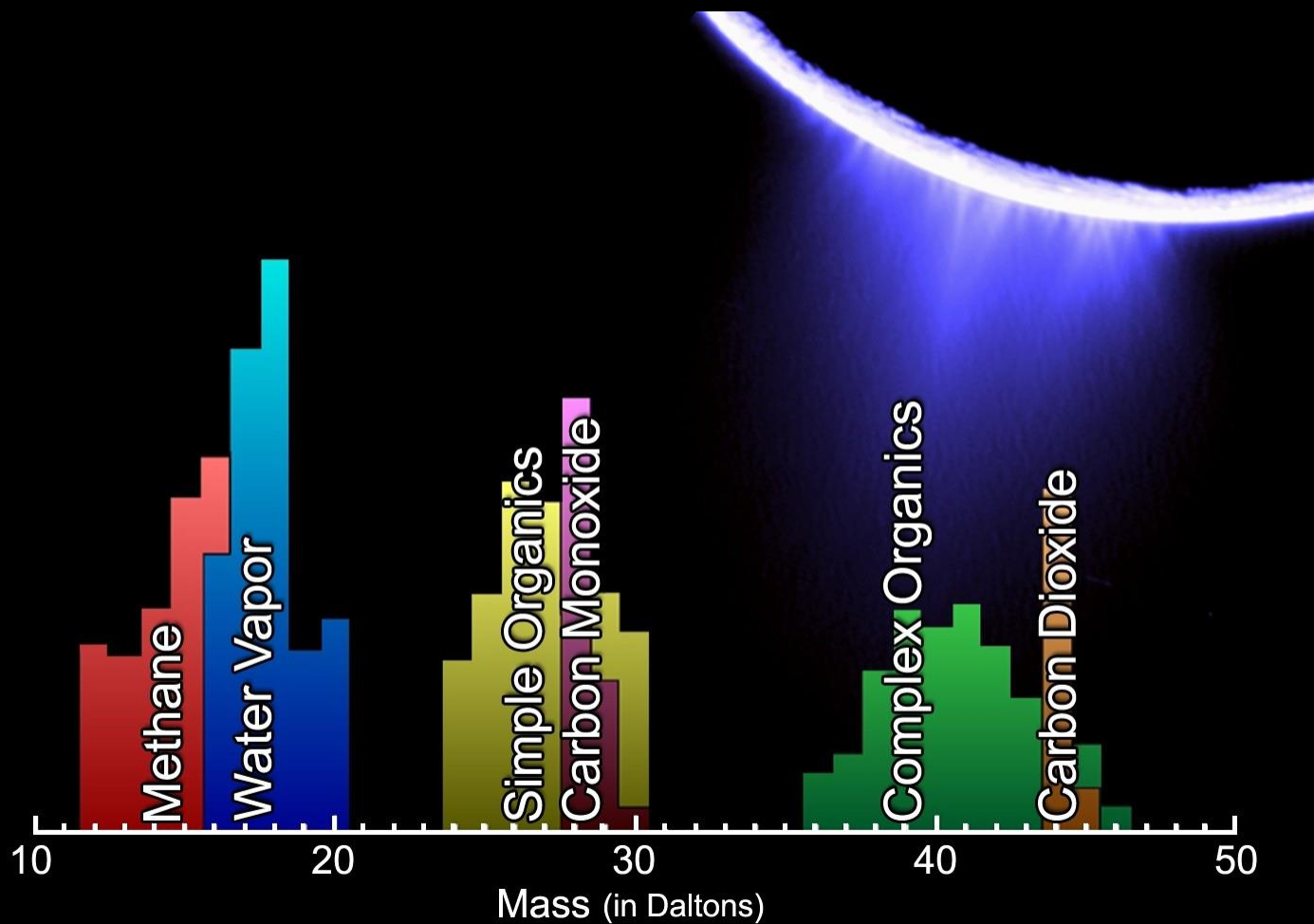
March 2008 CIRS map



November 2009 CIRS map

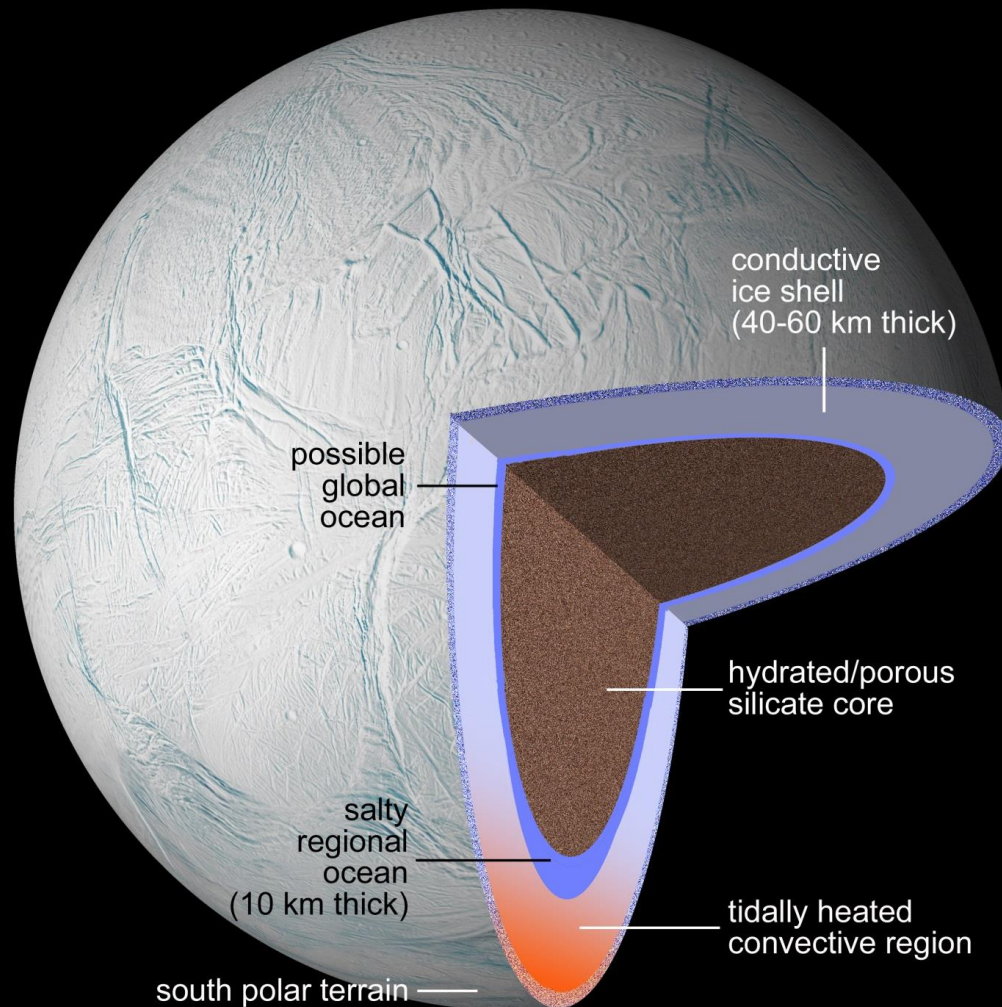


CIRS

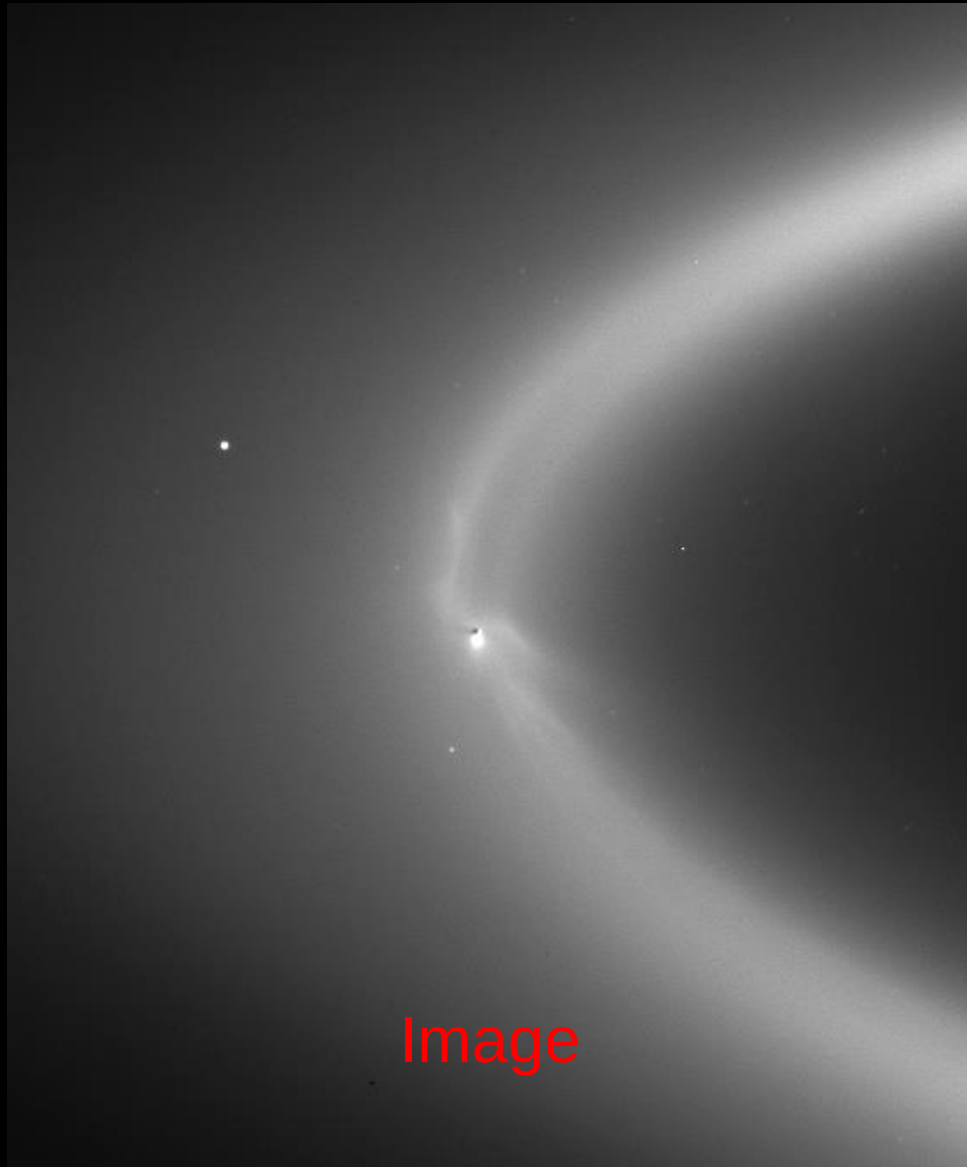


INMS Data

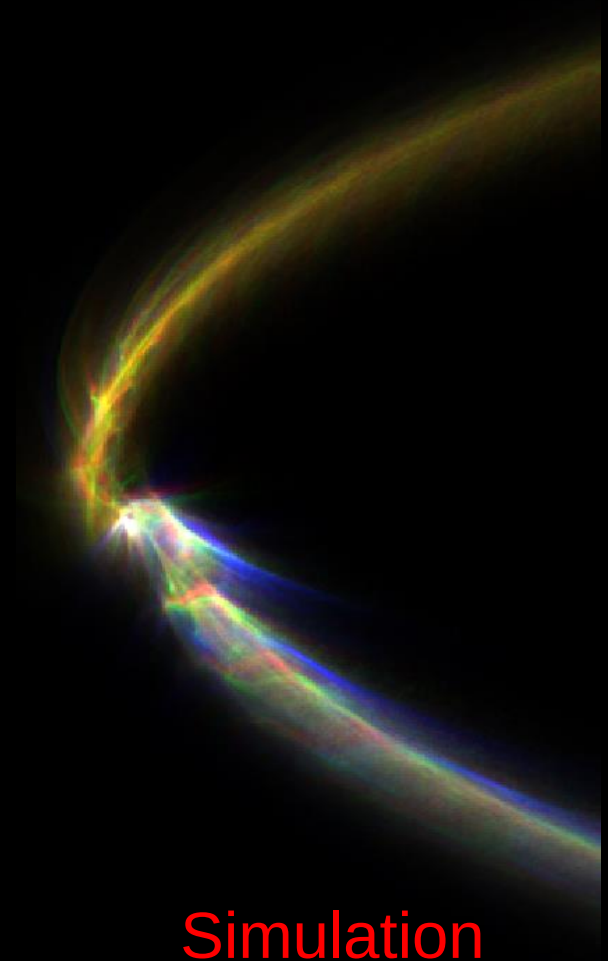
Enceladus's Interior



Feeding the E Ring

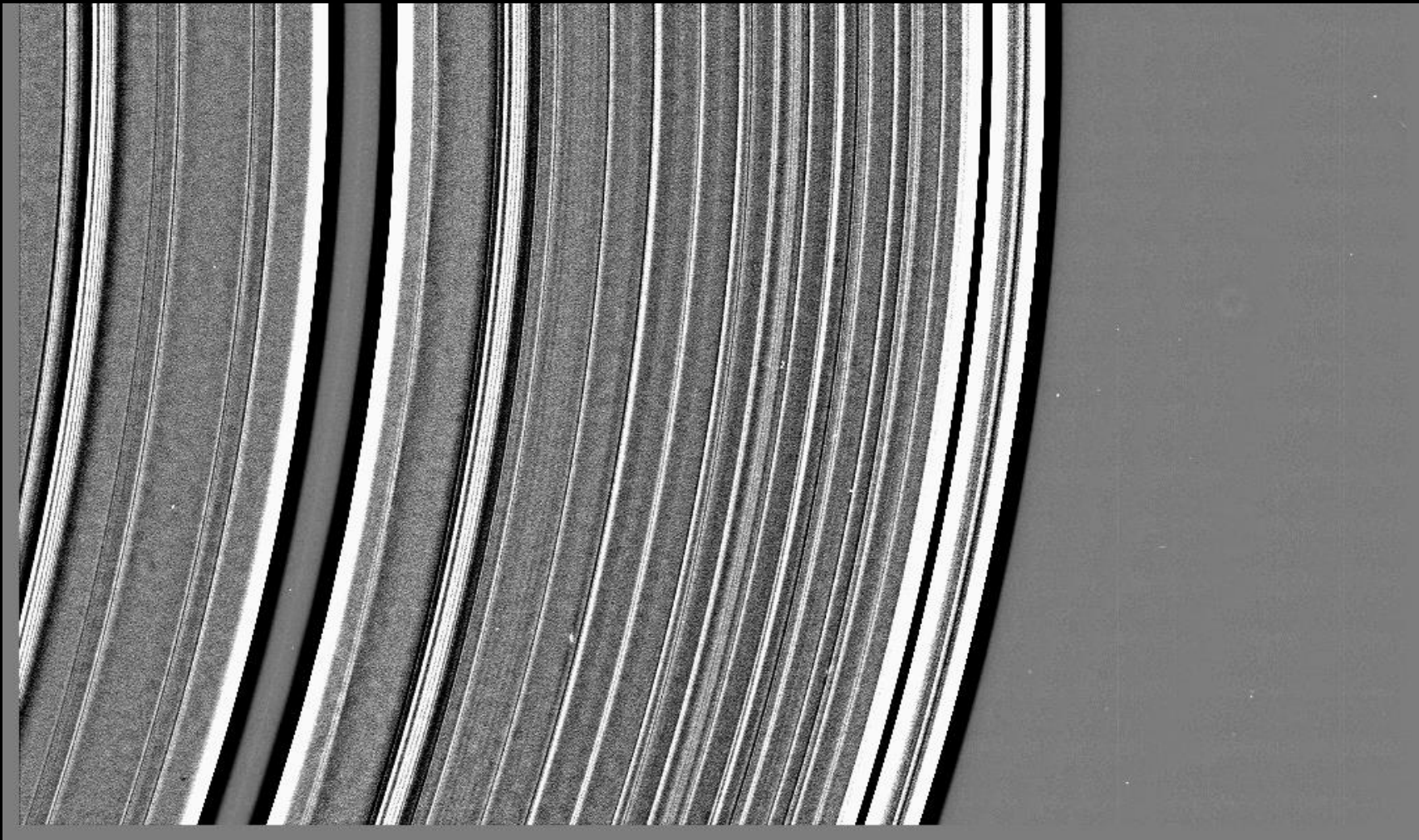


Image

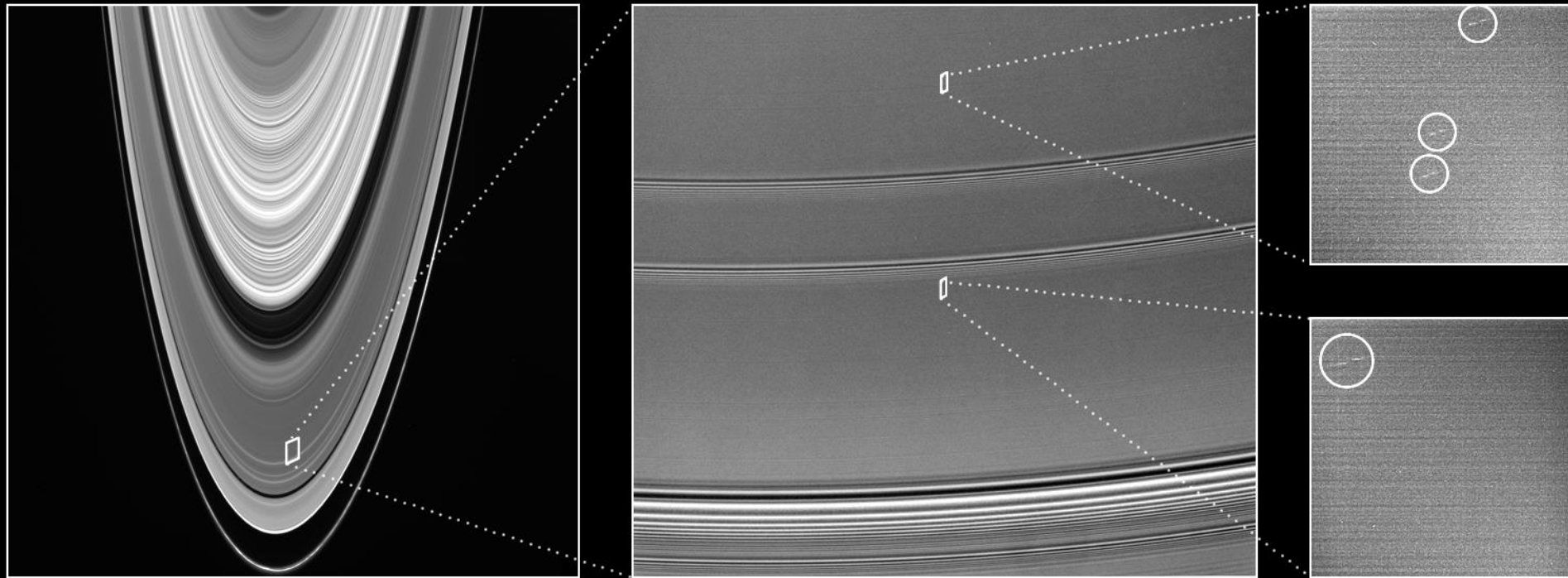


Simulation

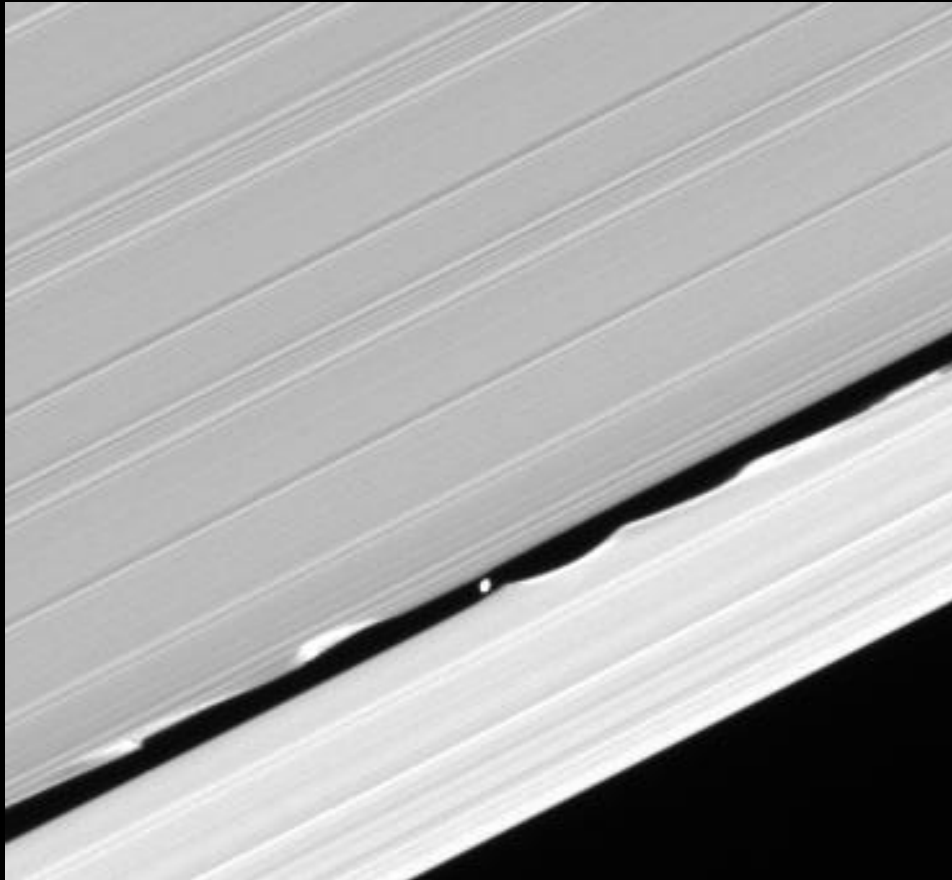
Propellers



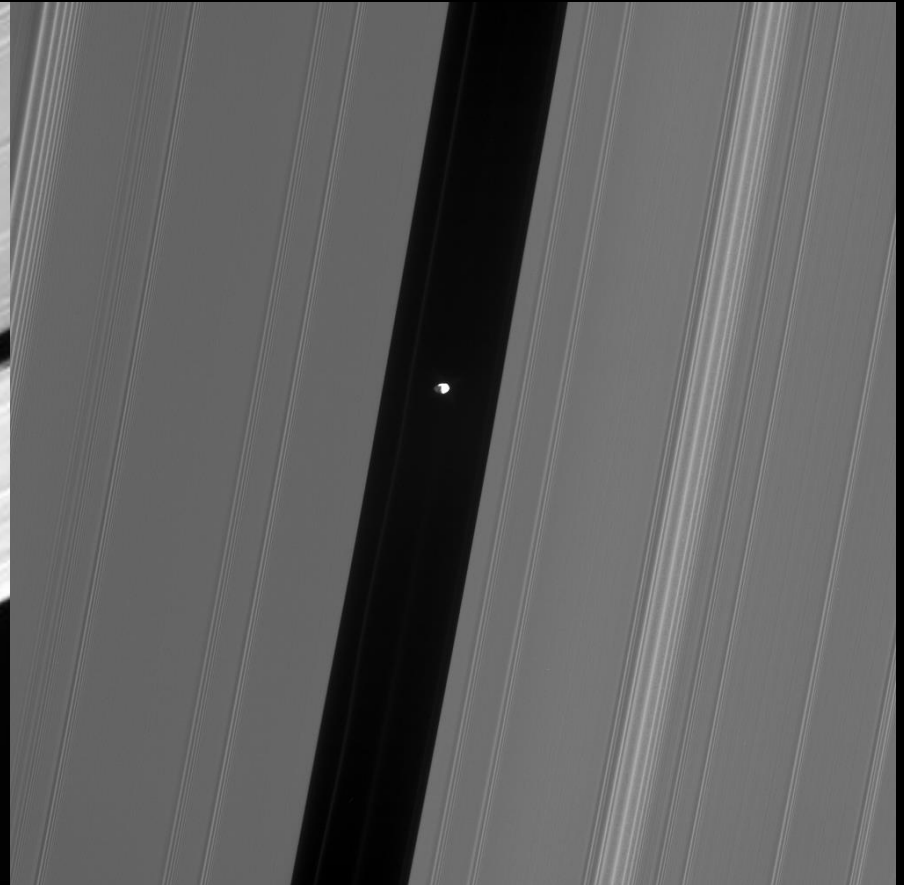
Propellers



A Ring Moons

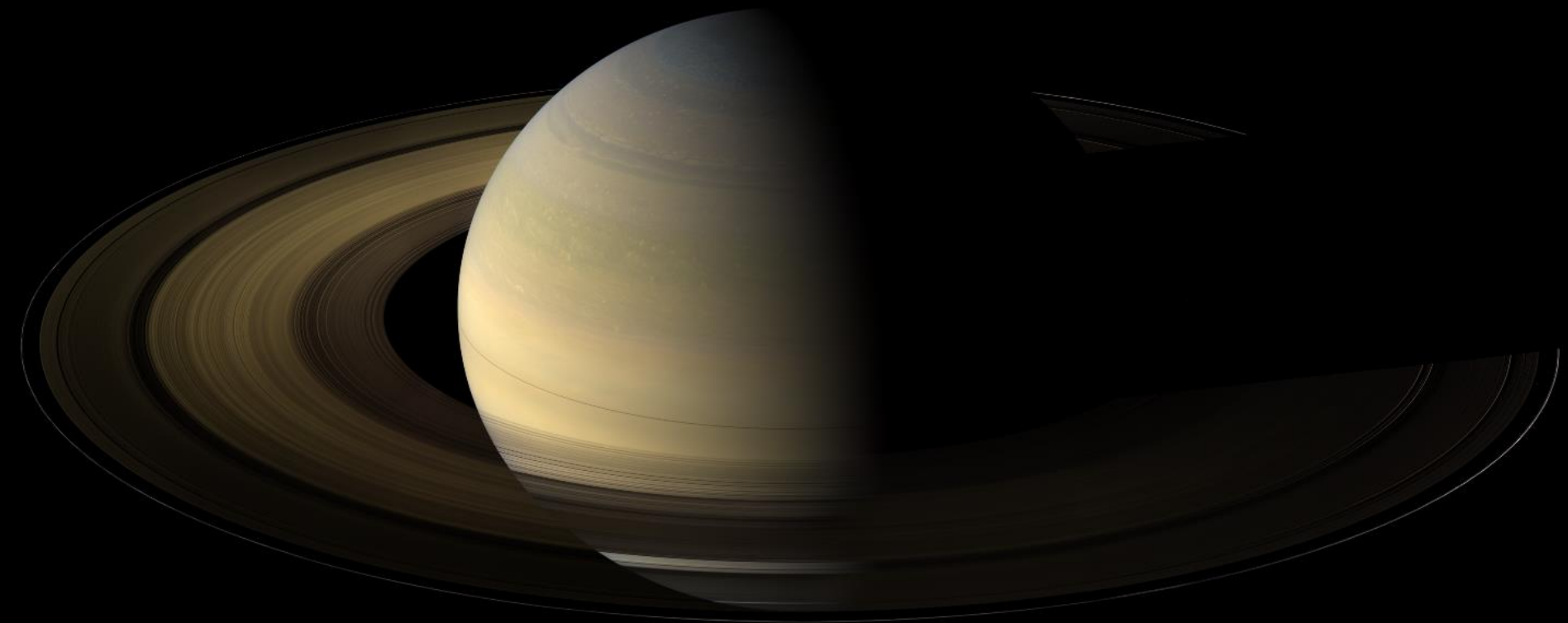


Daphnis ~ 8 km
Keeler Gap

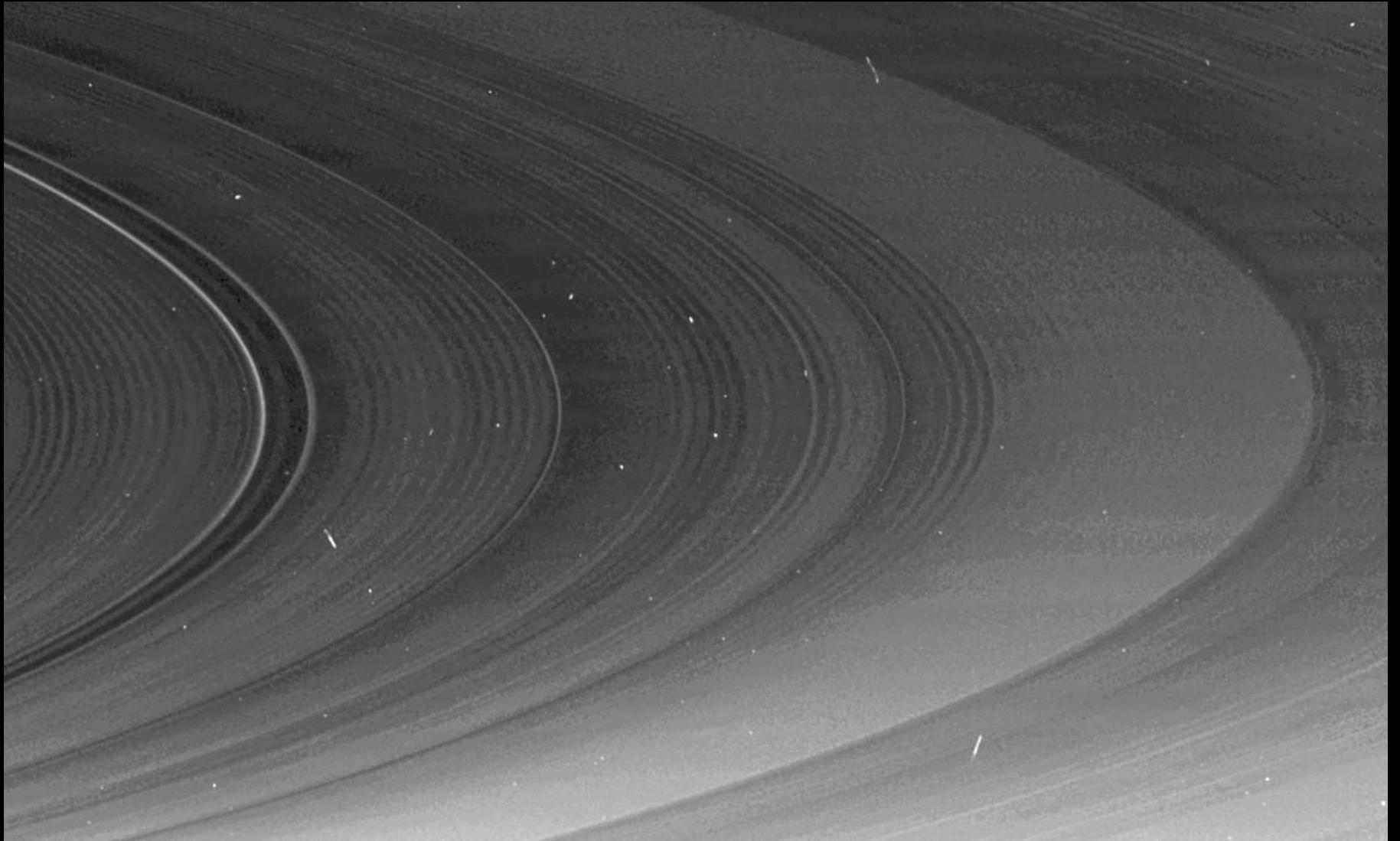


Pan ~ 28 km
Encke Gap

Equinox Mosaic

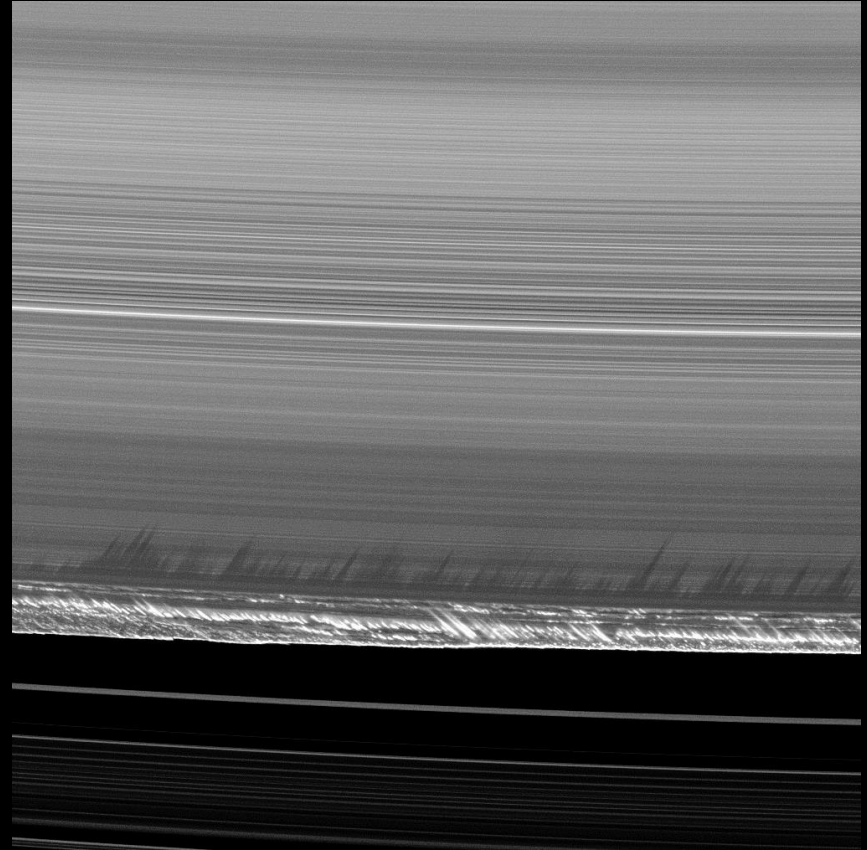
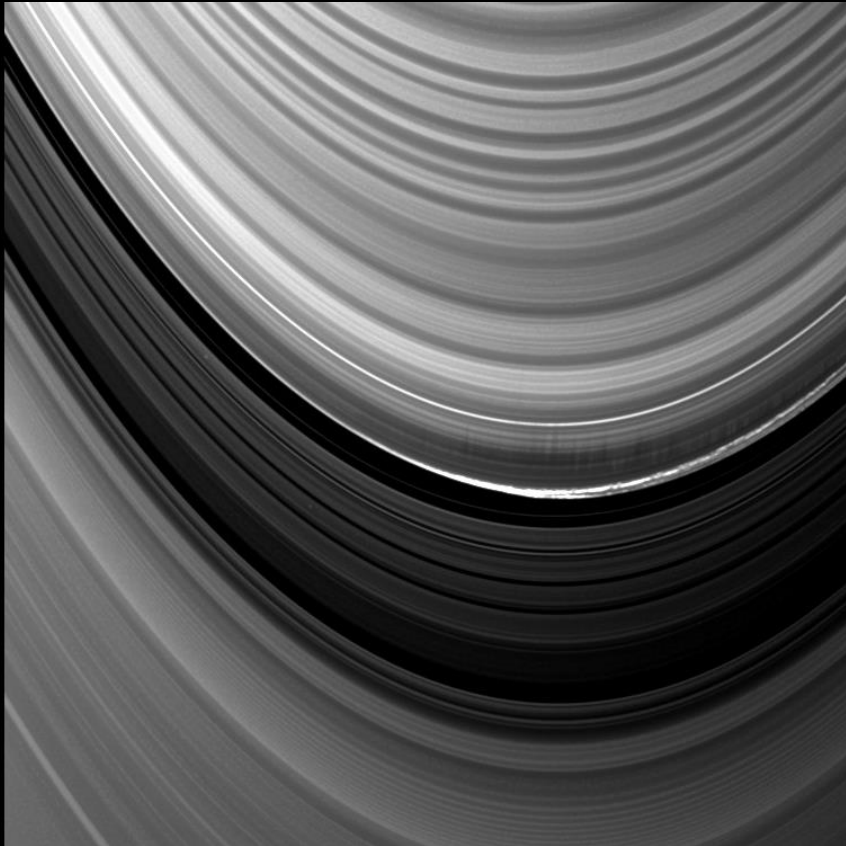


Ring Ripples



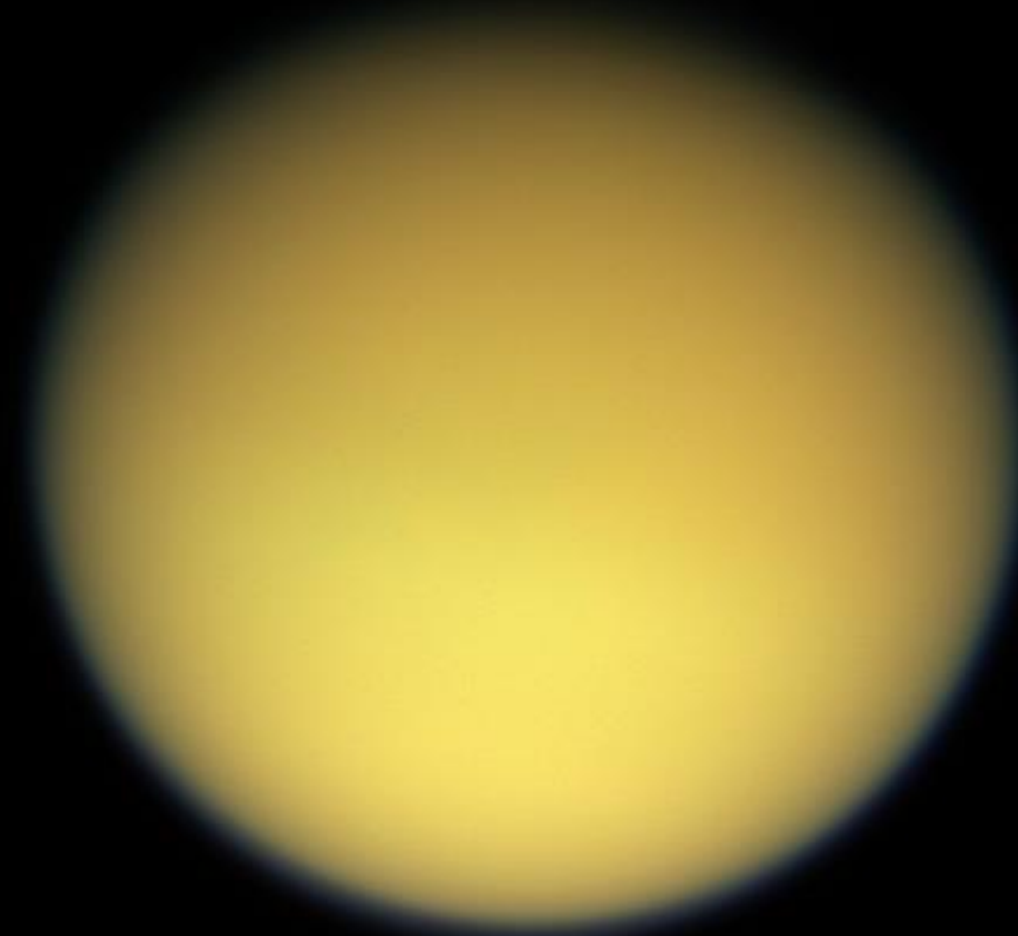
D and C ring corrugations

Mountains on the Edge



~3.5 km high

Titan seen by Voyager 2



Thick haze

Surface invisible

Liquids on surface?

5150 km

(Moon is 3475 km)

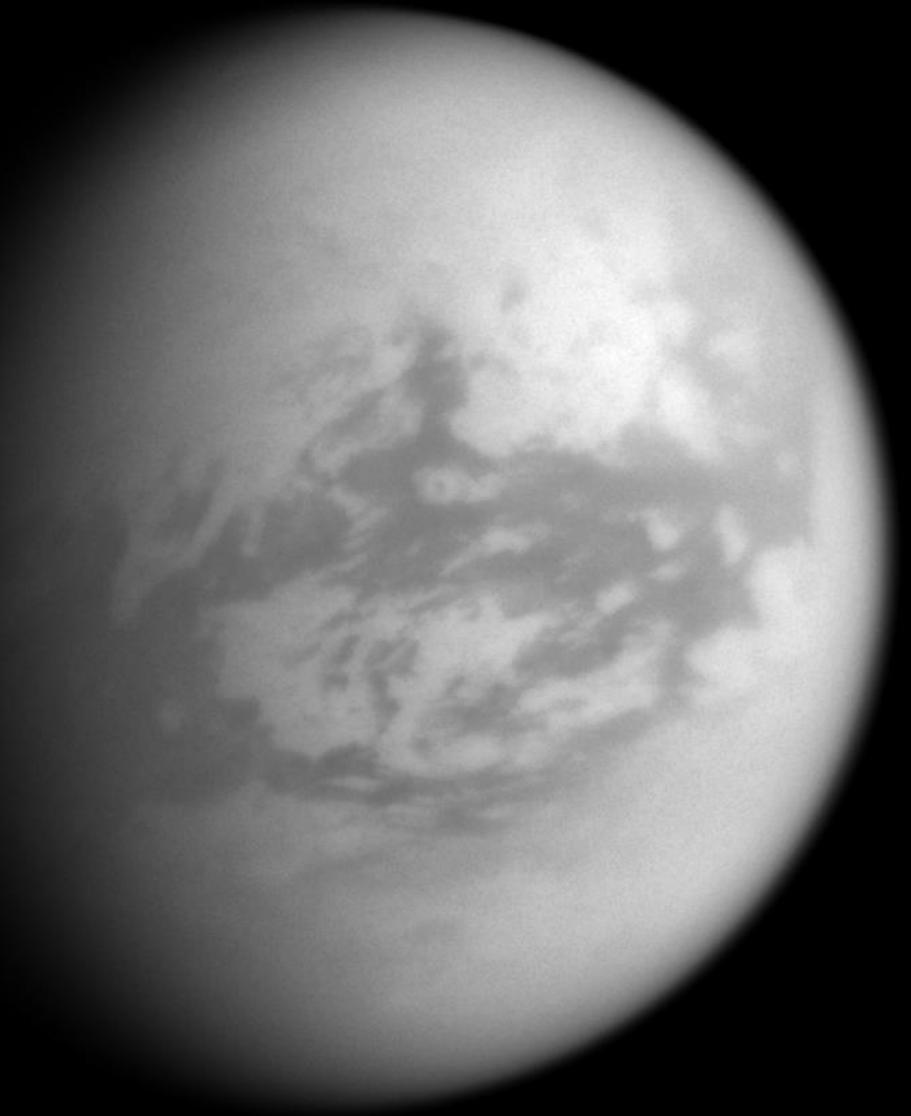
Titan seen by Cassini

Cassini's filters can
see through the haze

Dark and bright terrain

Few craters

Lakes



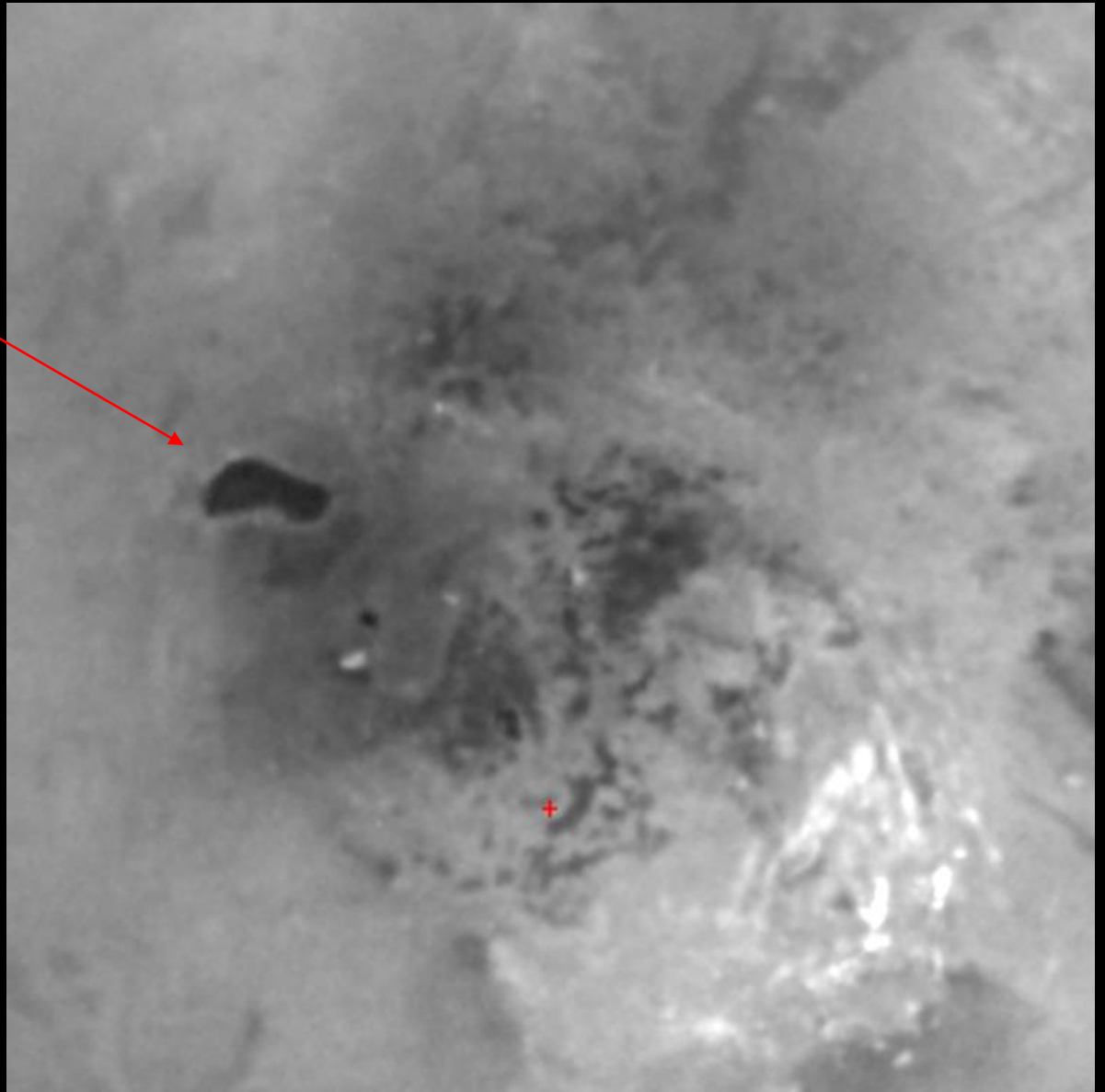
Titan South Pole

ISS Imaging

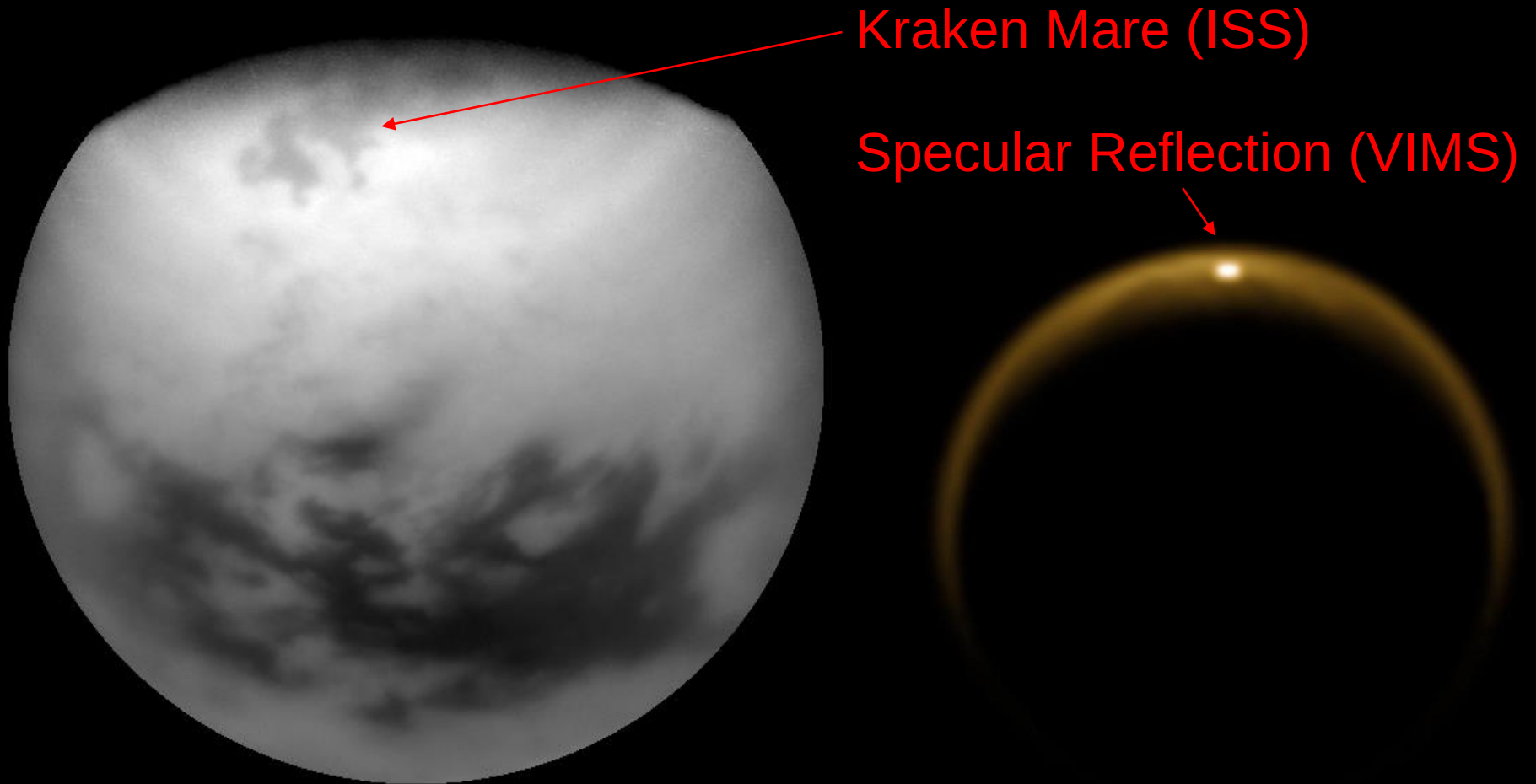
Ontario Lacus
240 x 80 km

Suspiciously
lake-like feature

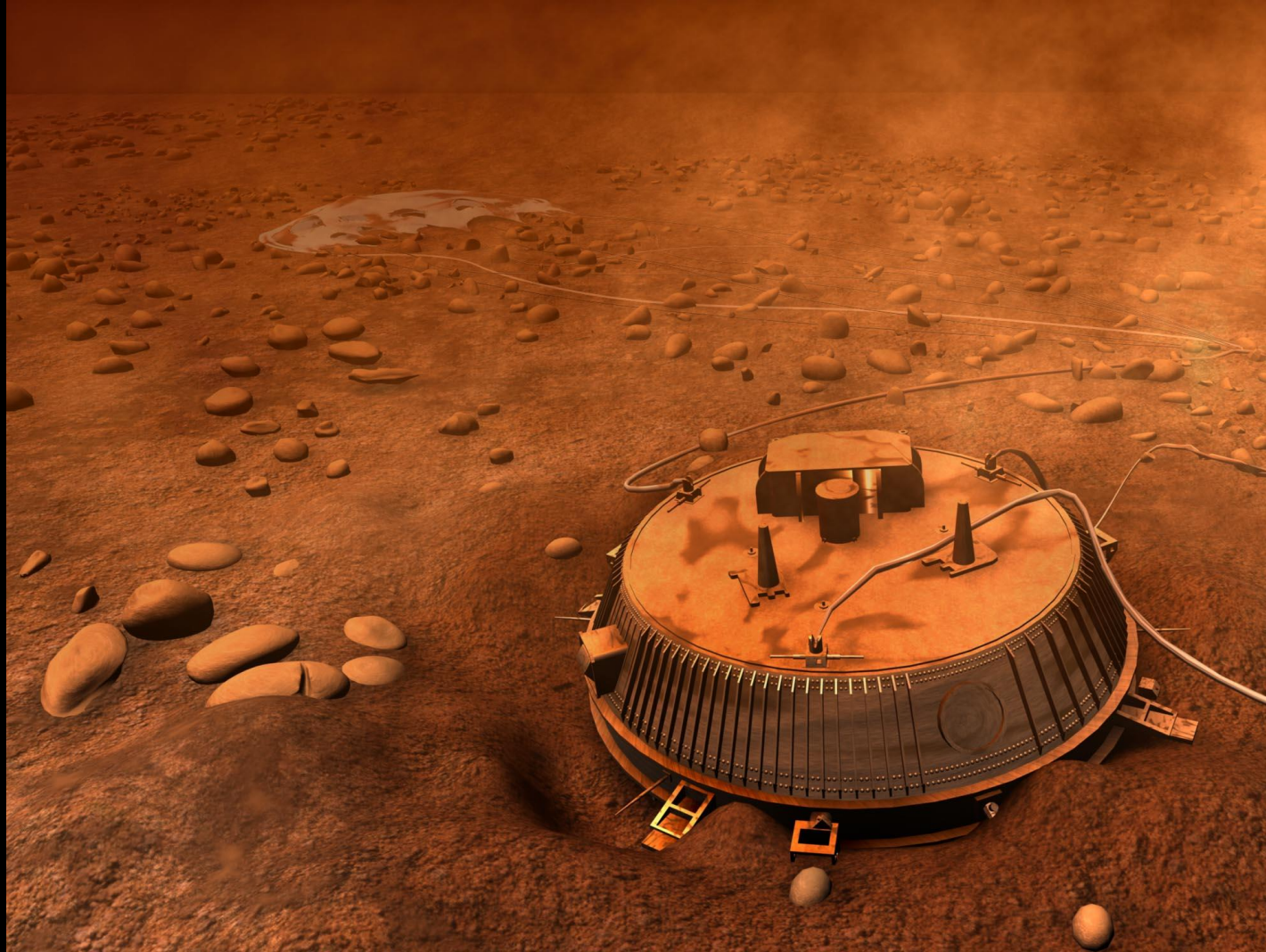
VIMS:
Liquid Ethane



Titan North Pole



Huygens



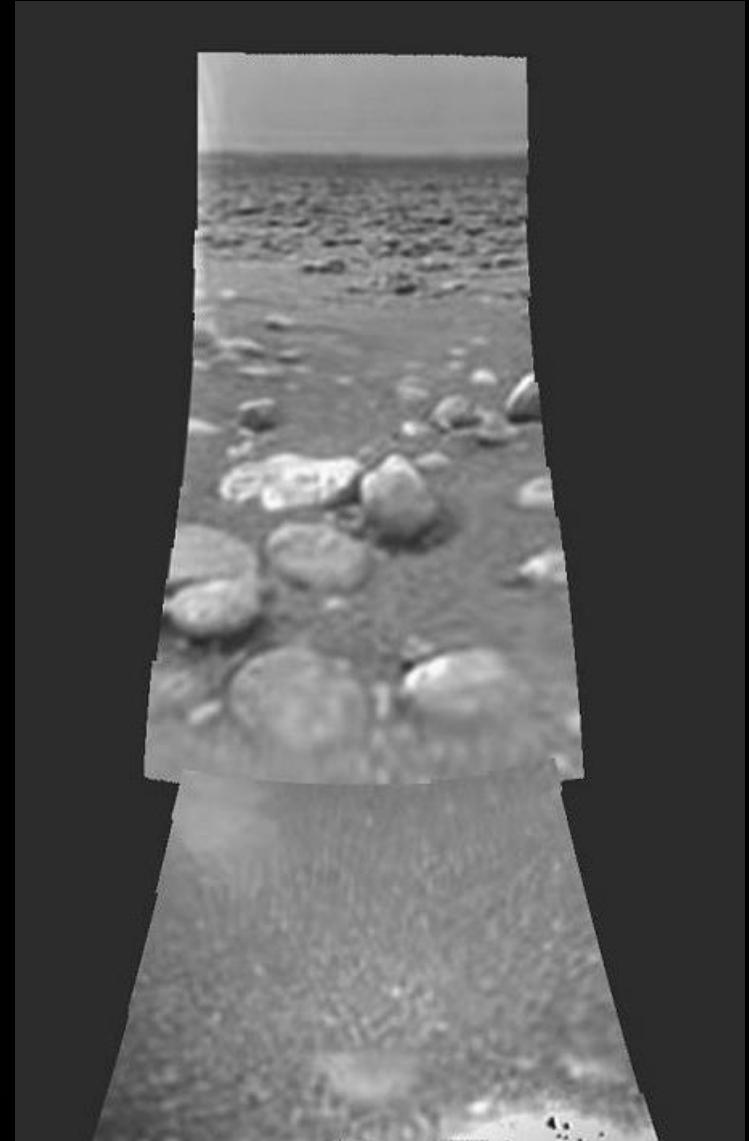
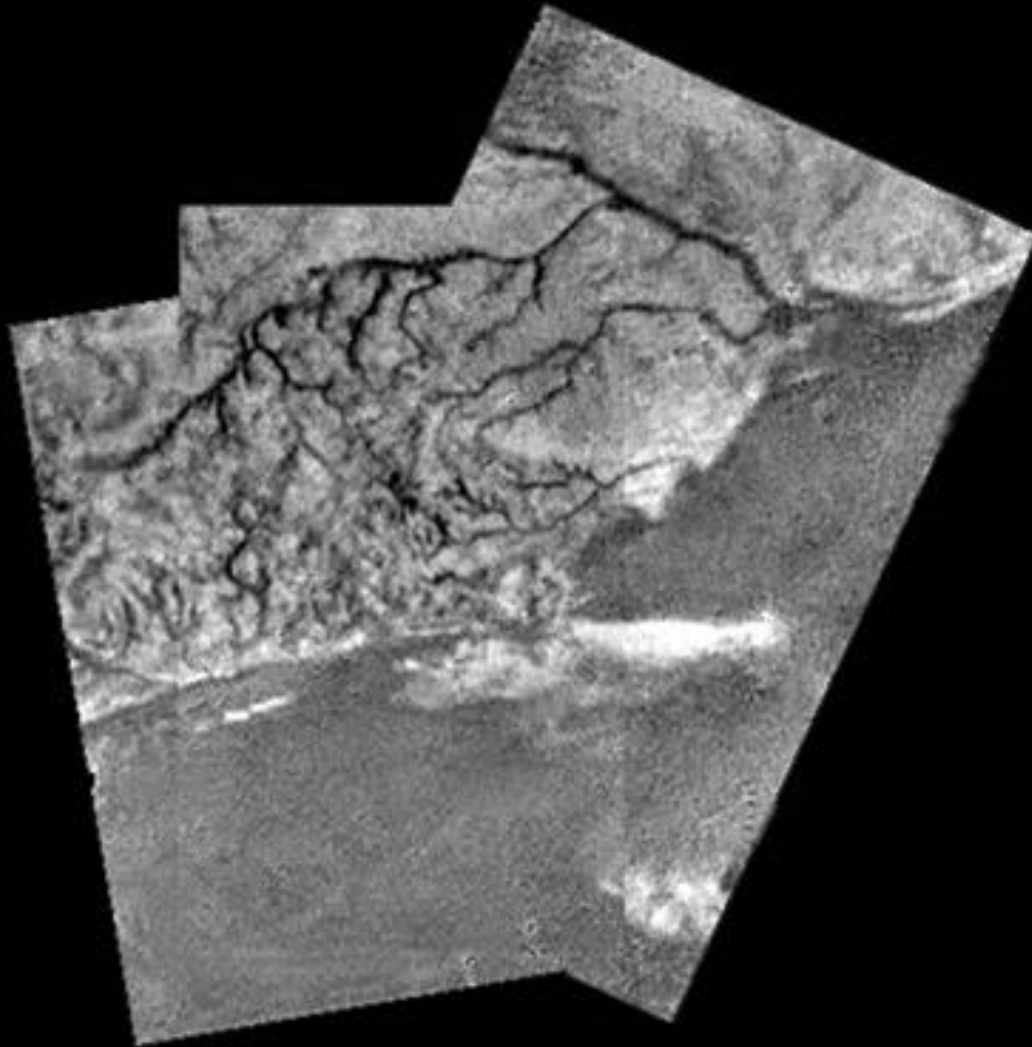
Artist
Concept: ESA

Titan seen by Huygens ~30k feet



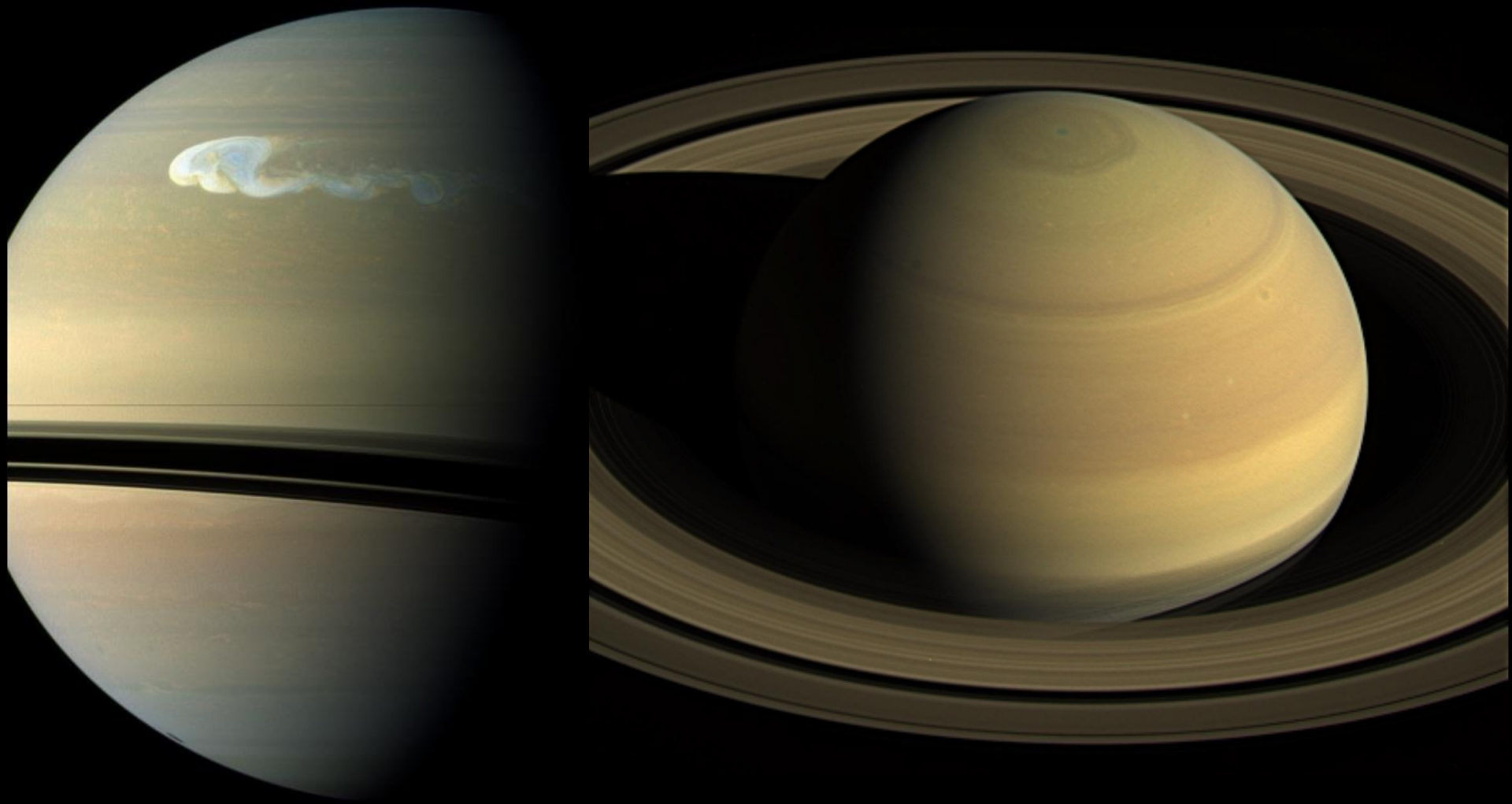
Images: ESA

Titan seen by Huygens



Images: ESA

Saturn Storm and Vortex



Storm was early (predicted around 2020)

End of Mission

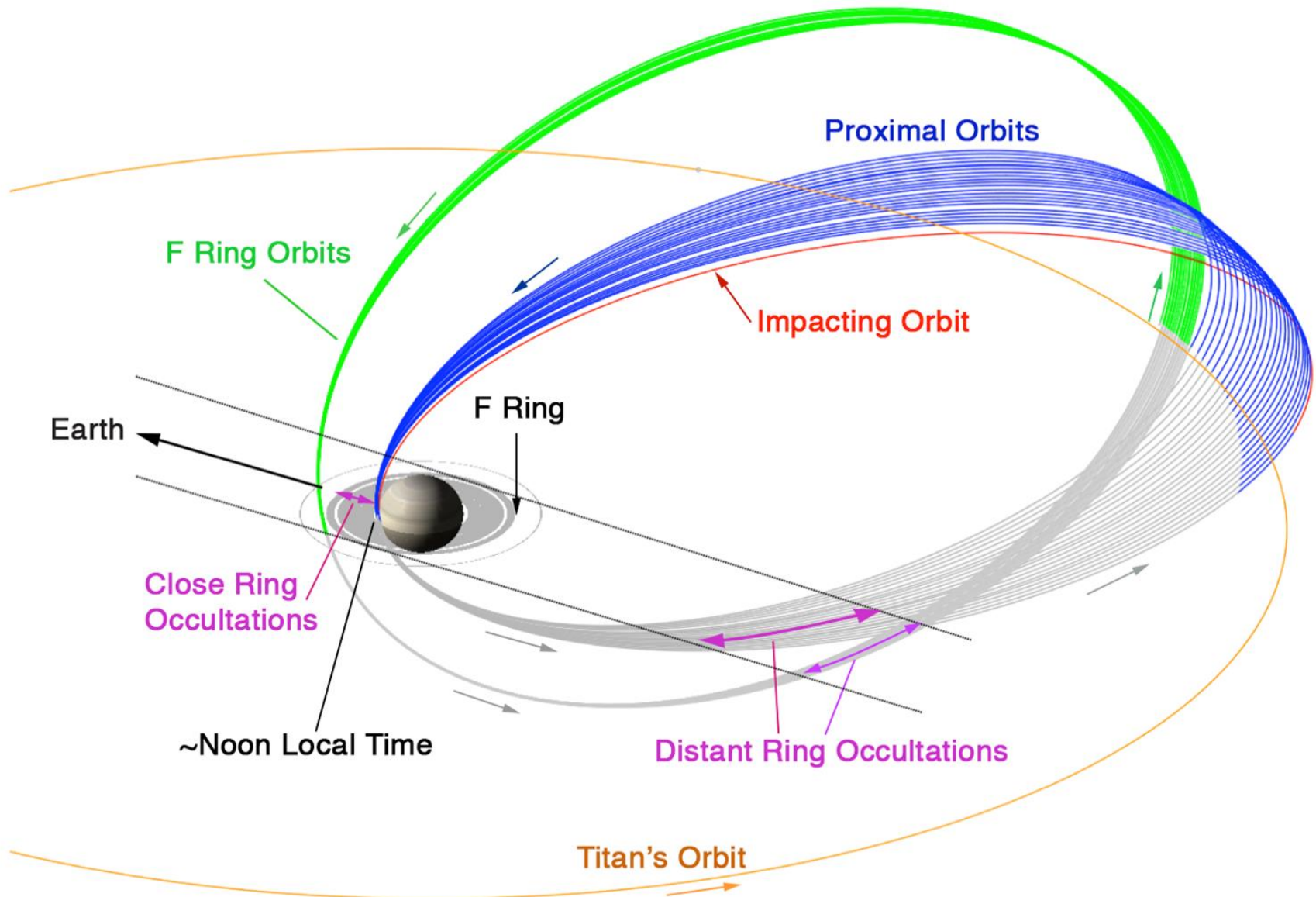
F ring orbits
(Nov 2016 – Apr 2017)

Proximal orbits
(Apr 2017 – Sep 2017)
Great Imaging
Gravity data

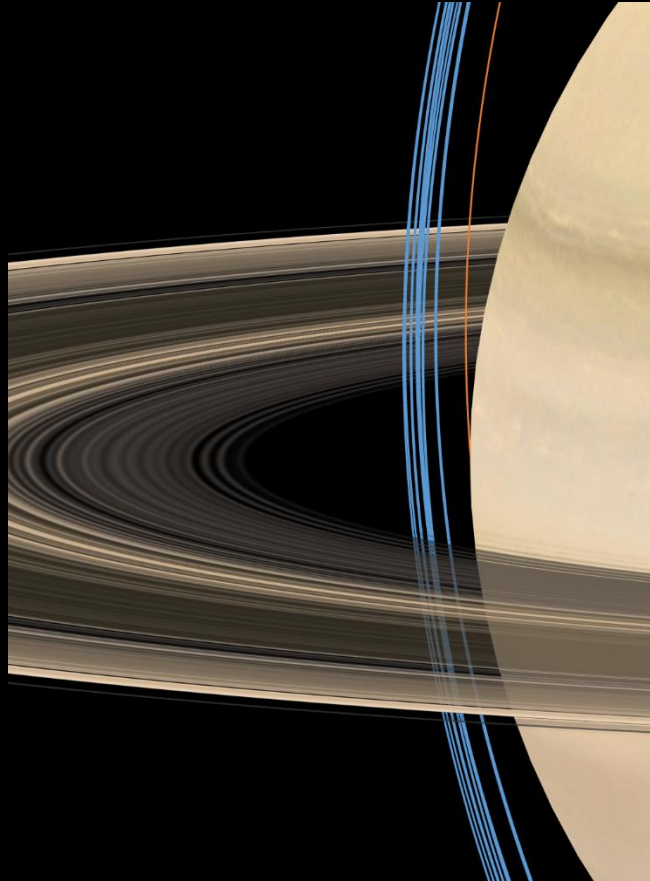
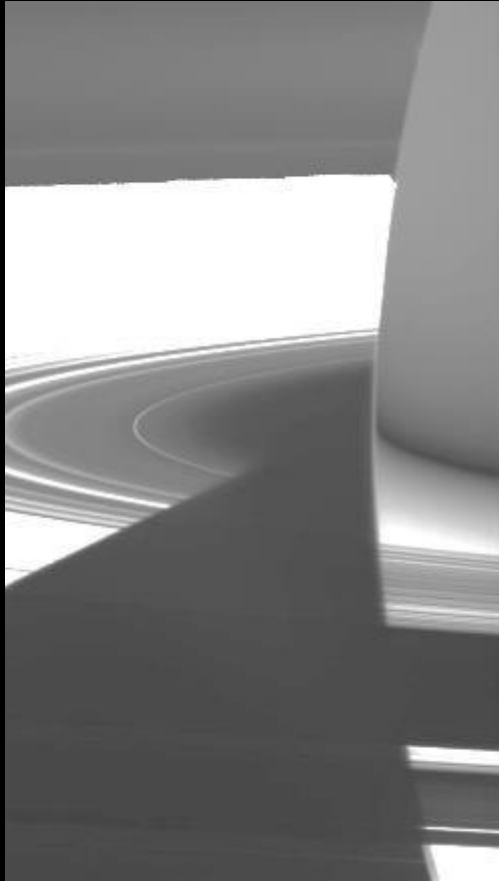
Burn up Sep 15, 2017



Final Orbits



Proximal Orbits



Juno-like orbits

Gravitational Field
measurements

Saturn internal
structure

B Ring mass

Magnetic Field

CICLOPS



CASSINI IMAGING

CENTRAL LABORATORY FOR OPERATIONS

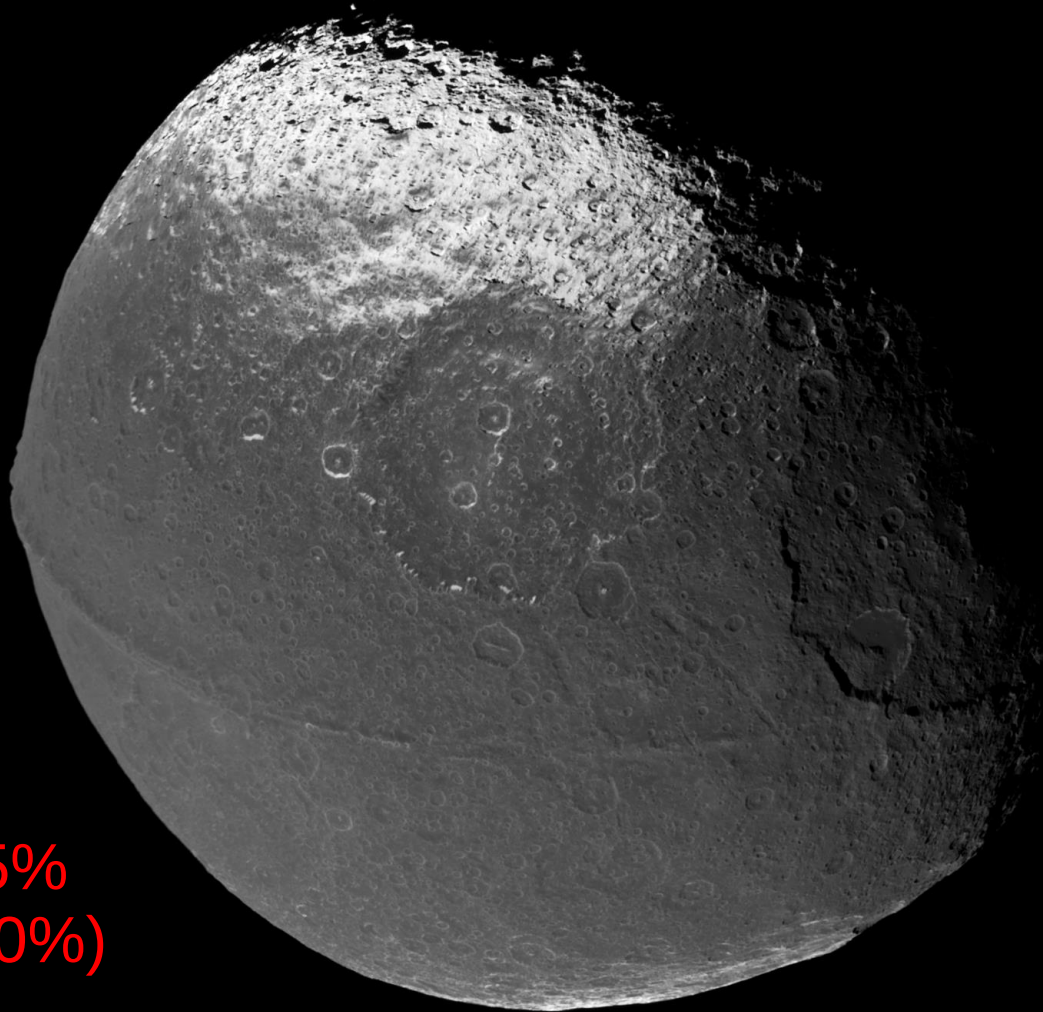
www.ciclops.org

colin.cassini@gmail.com

Extra Slides

If time permits!

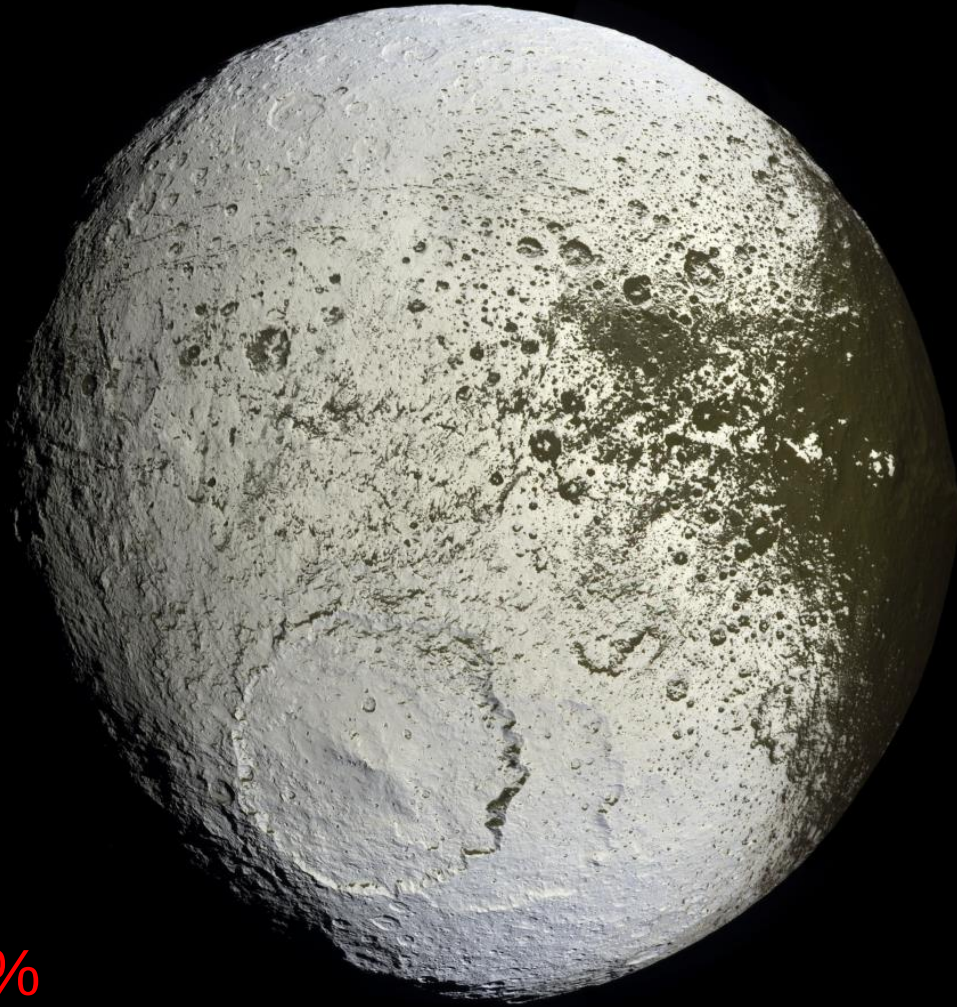
Iapetus Dark Hemisphere



Albedo ~ 5%
(Moon ~ 10%)

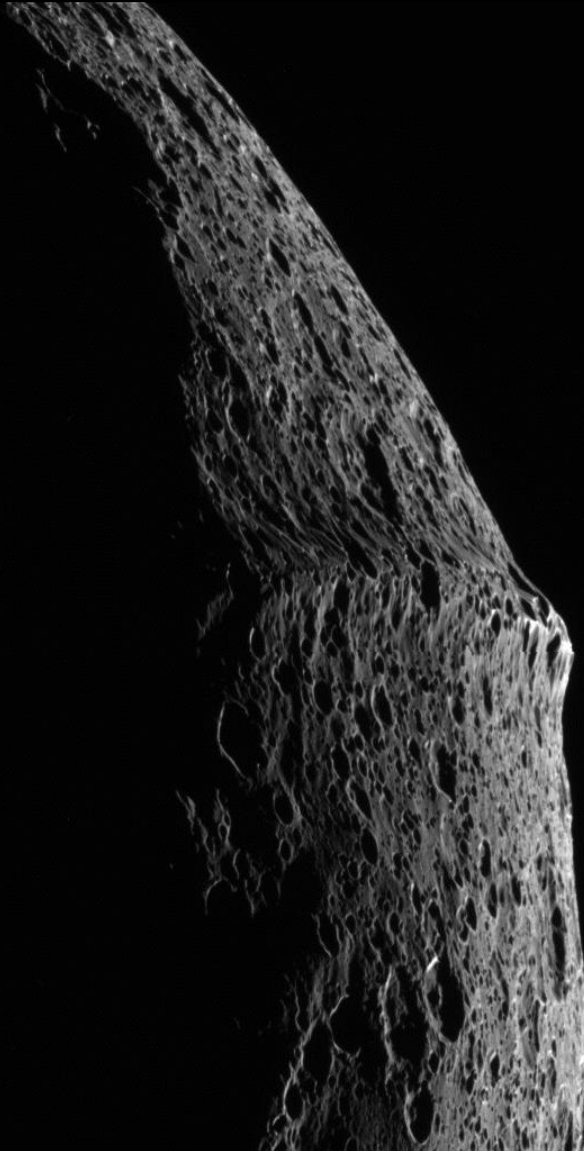
1450 km

Iapetus Bright Hemisphere



Albedo ~ 40%

Iapetus Ridge



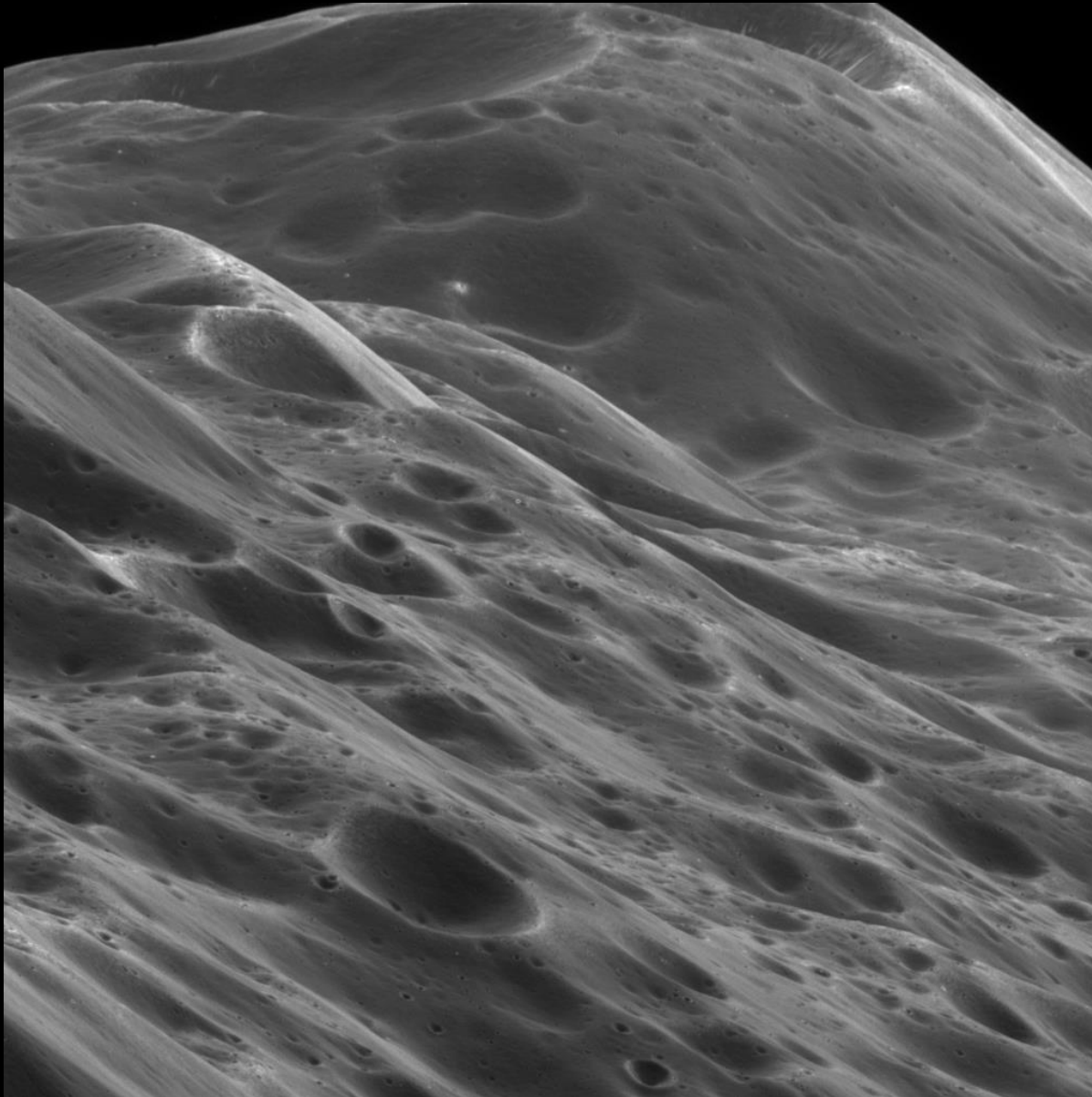
13 km high by 20 km wide

Collapsed ring?

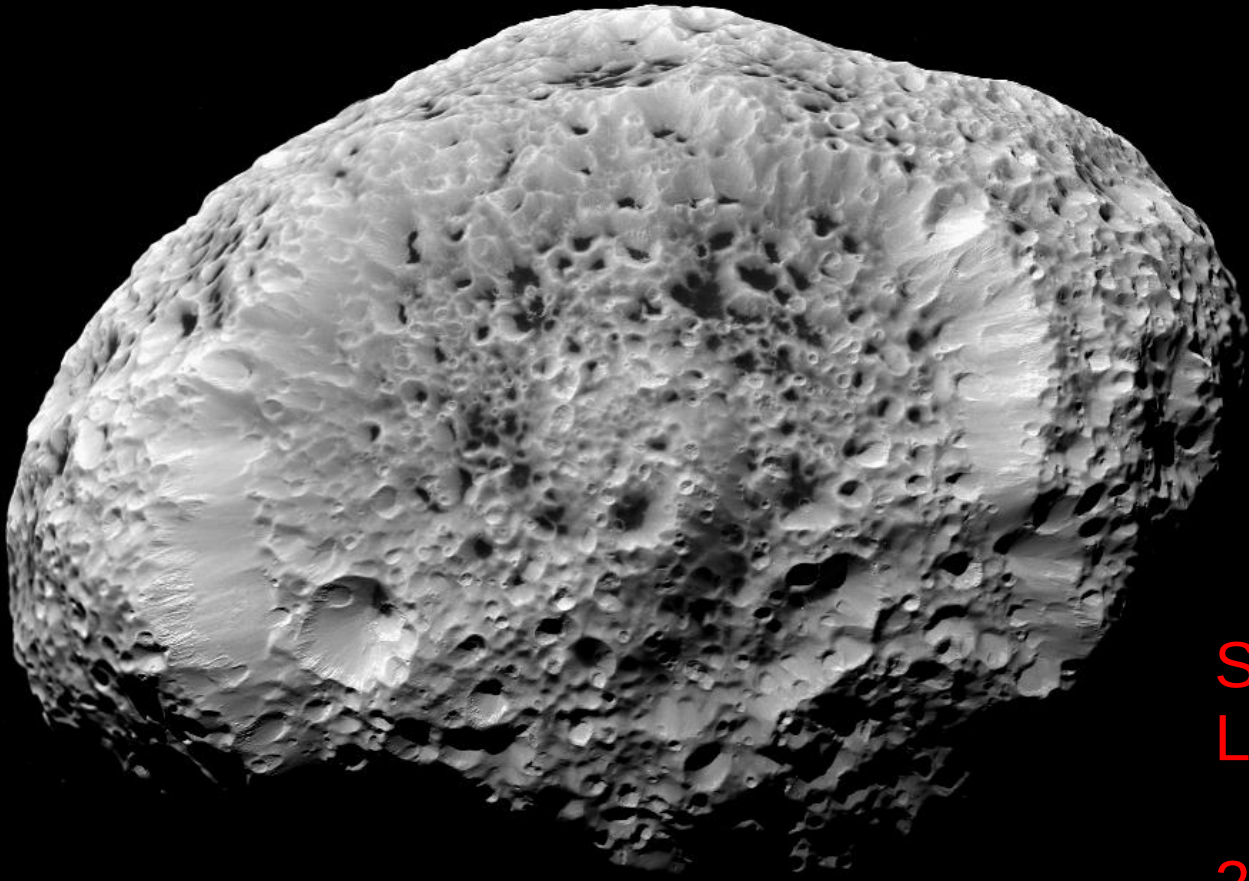
Cooling feature?

Upwelling?

Iapetus Ridge Close Up



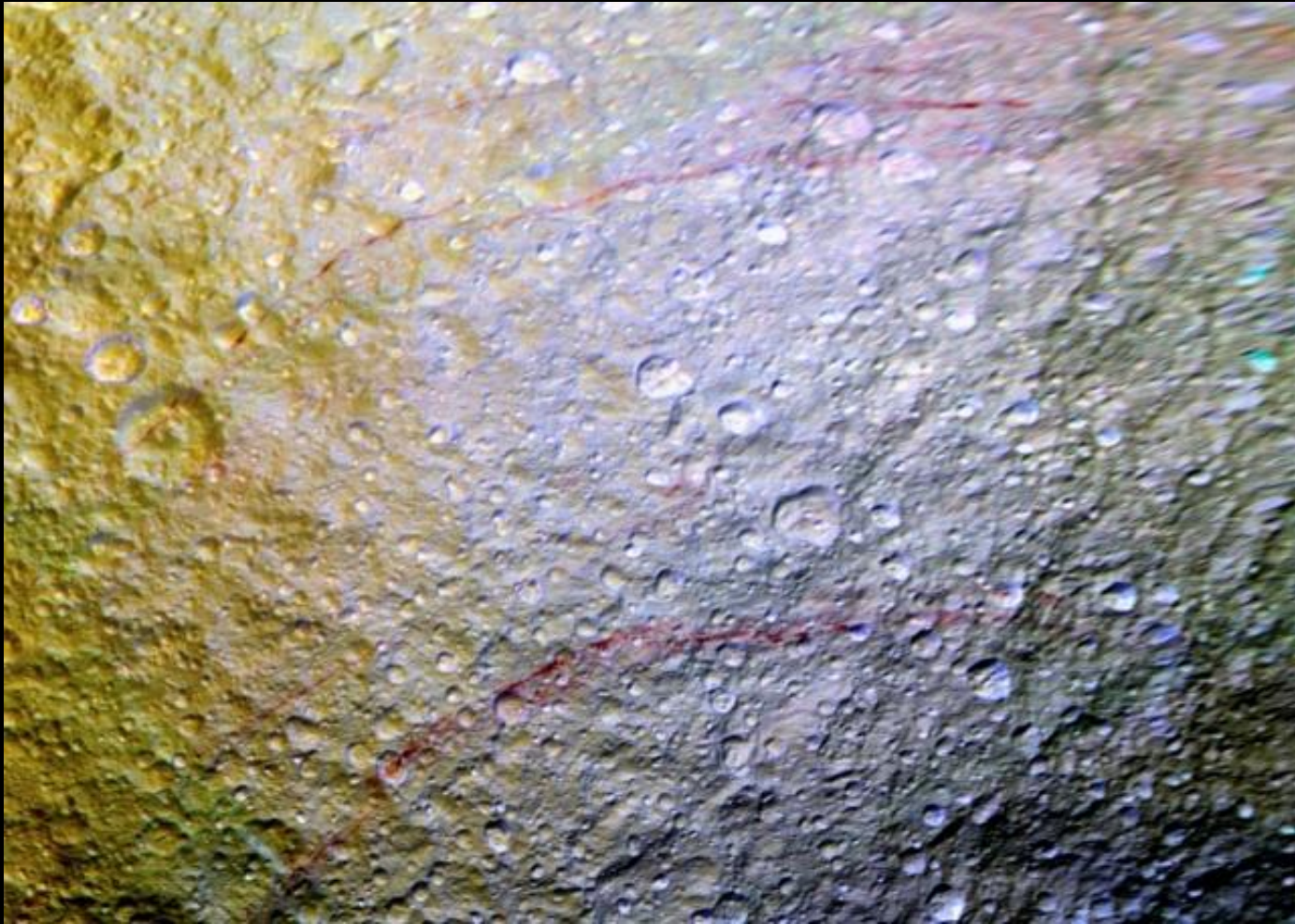
Hyperion



Spongy Appearance
Low Density

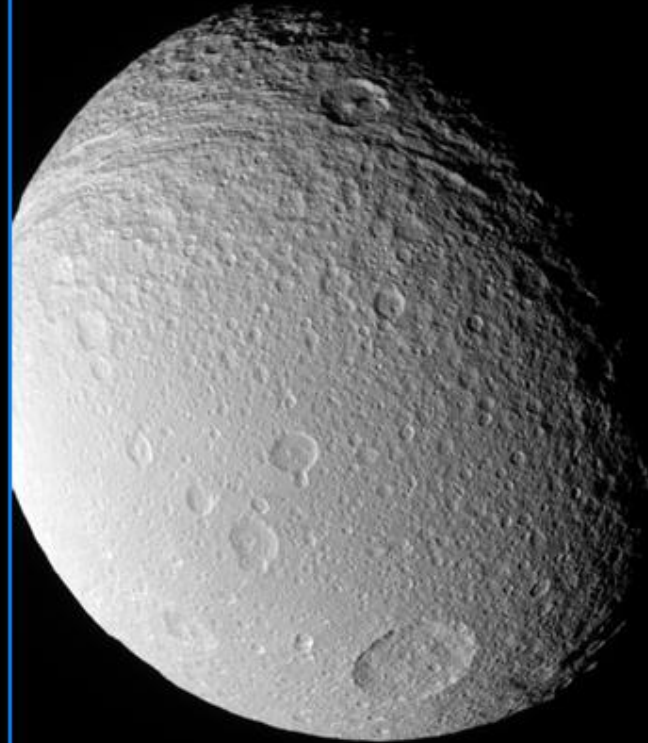
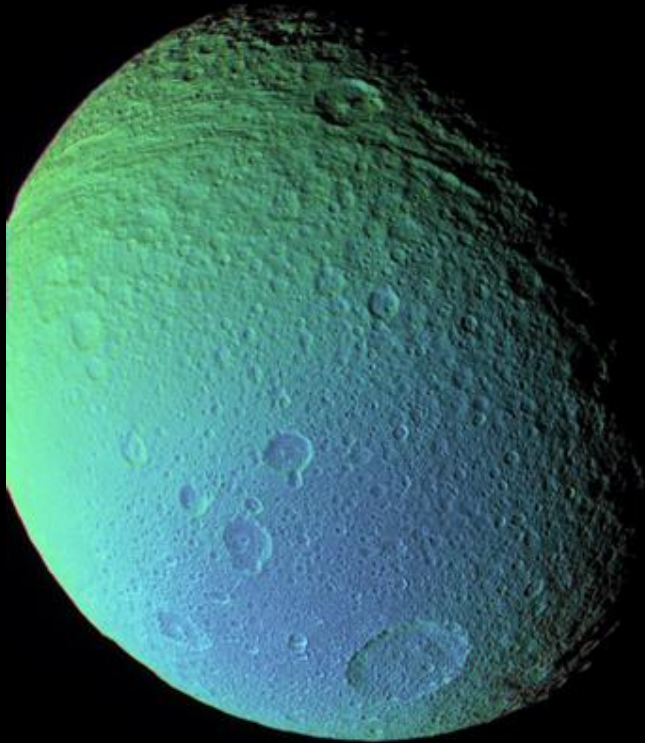
270 km

Tethys Streaks

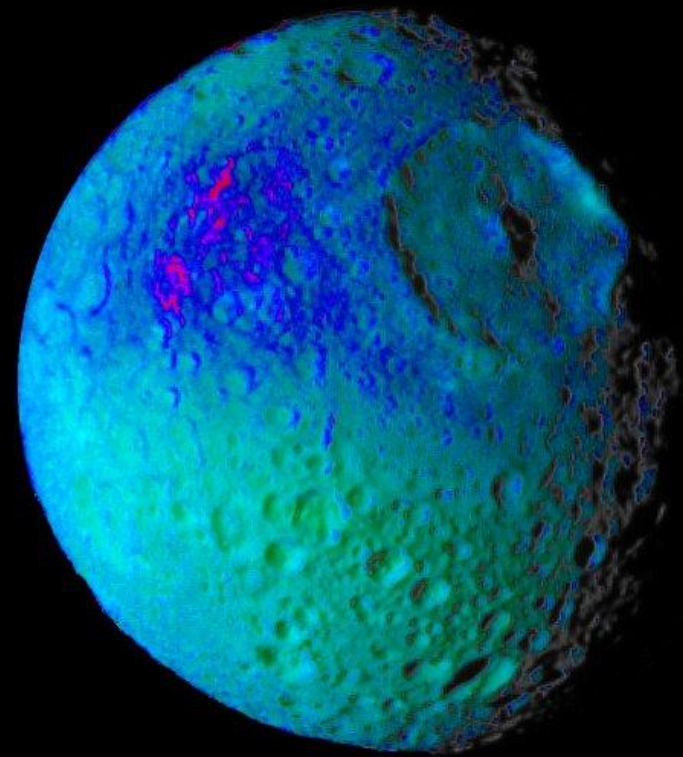


- Red streaks

Tethys

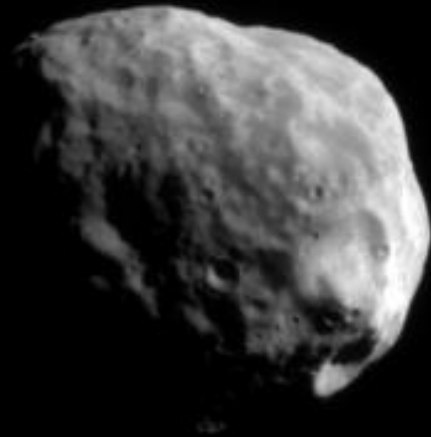


Mimas



395 km

Janus and Epimetheus



Nearly same orbit
“Coorbital”

Swap places every 4 years

Janus: 180km



Epimetheus: 115 km

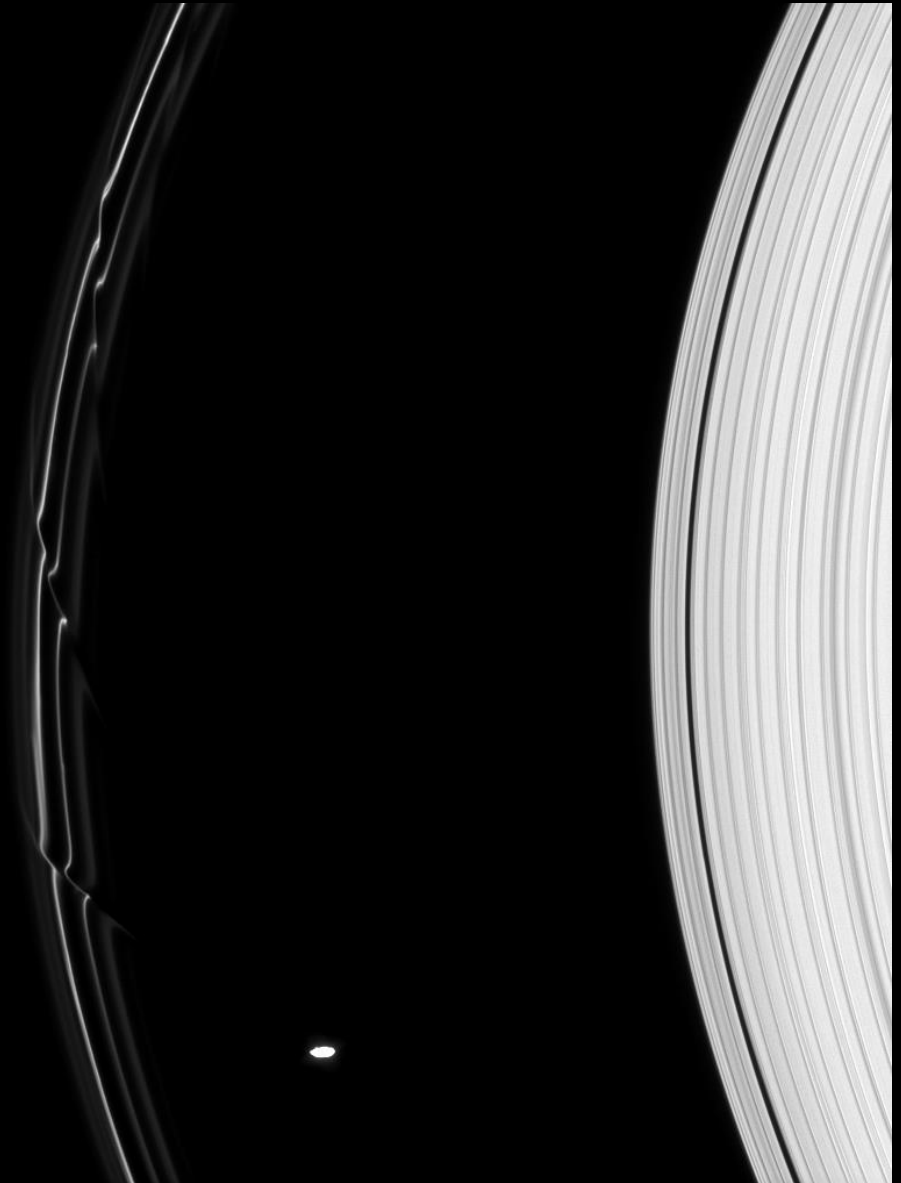
F Ring



F Ring and Prometheus

Inner Satellite:
Prometheus
85 km

Outer Satellite:
Pandora
80 km

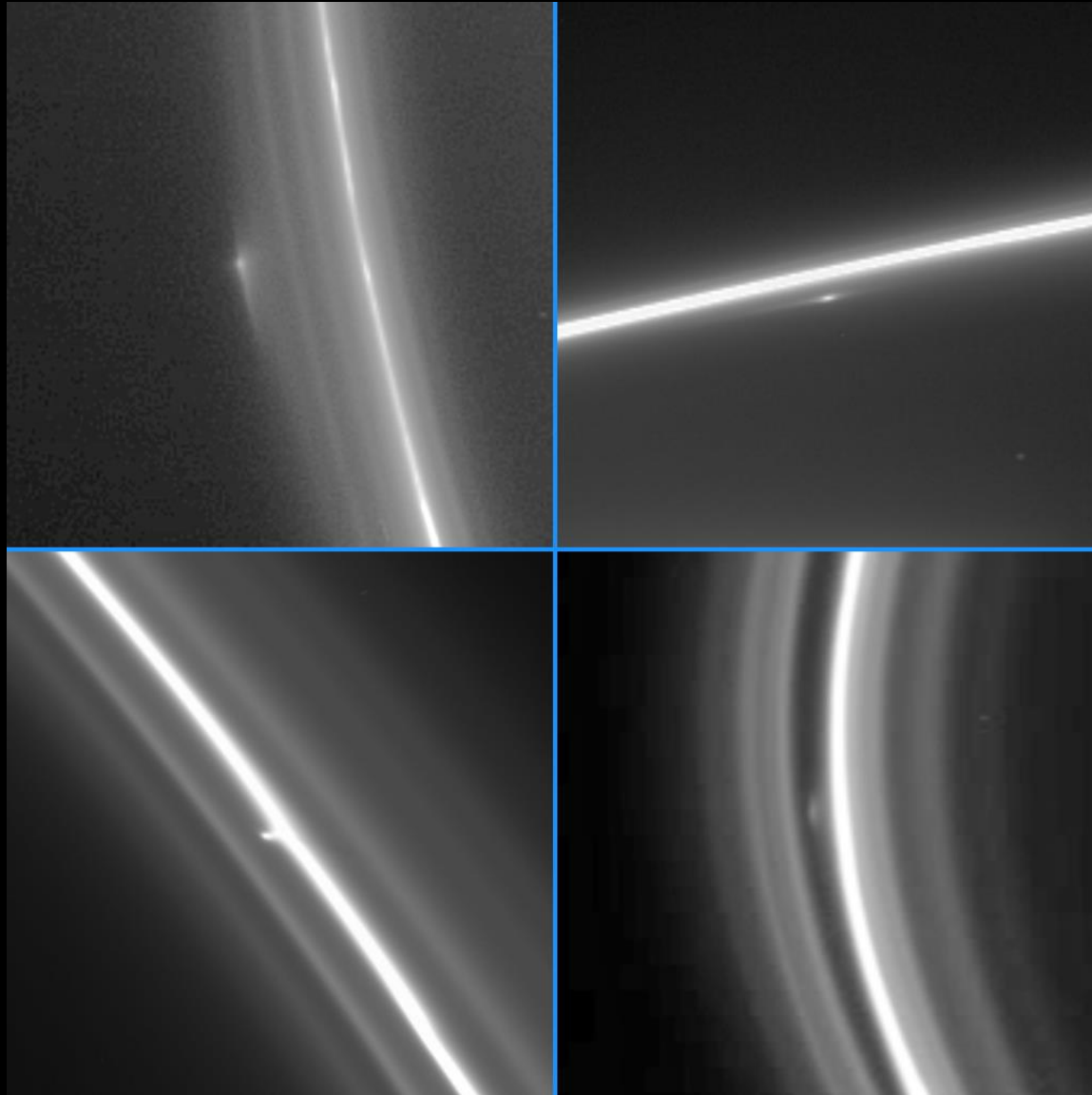


F Ring Gores



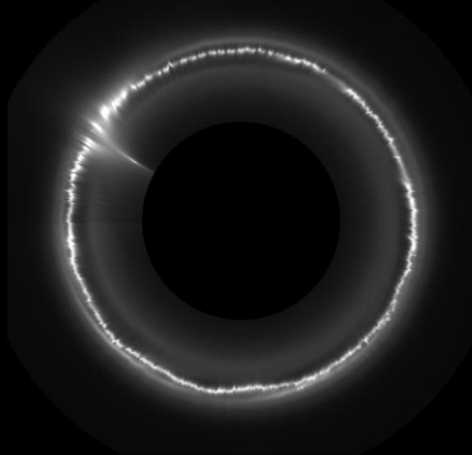
Perturbations due
to Prometheus

F Ring Clumps

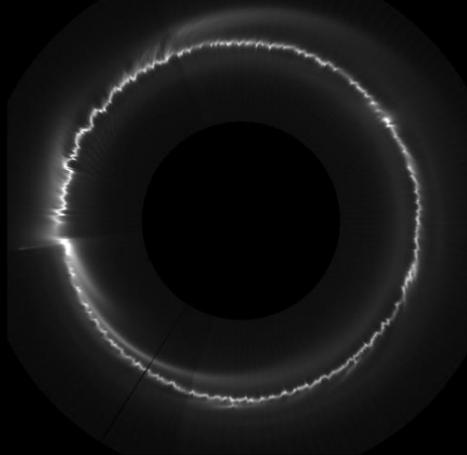


F Ring Mosaics

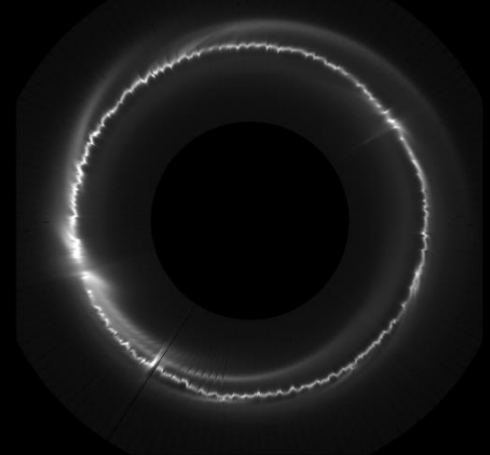
2006 Dec 23



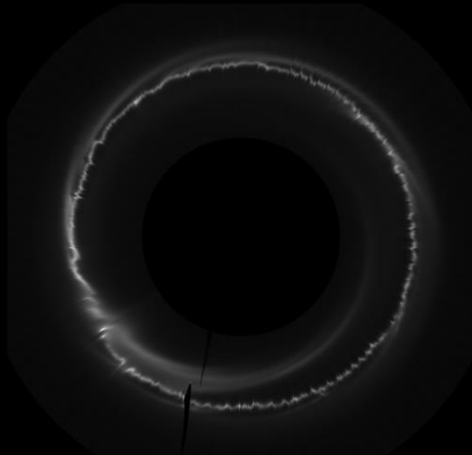
2007 Feb 27



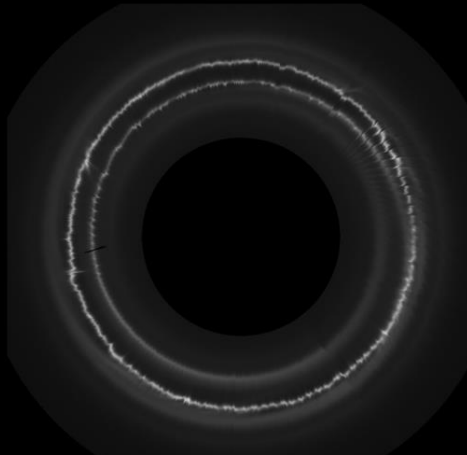
2007 Mar 17



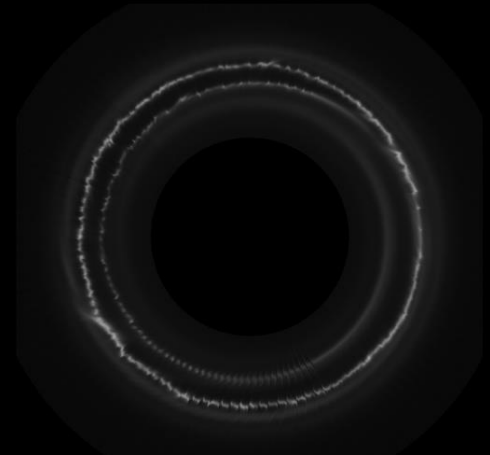
2007 Apr 18



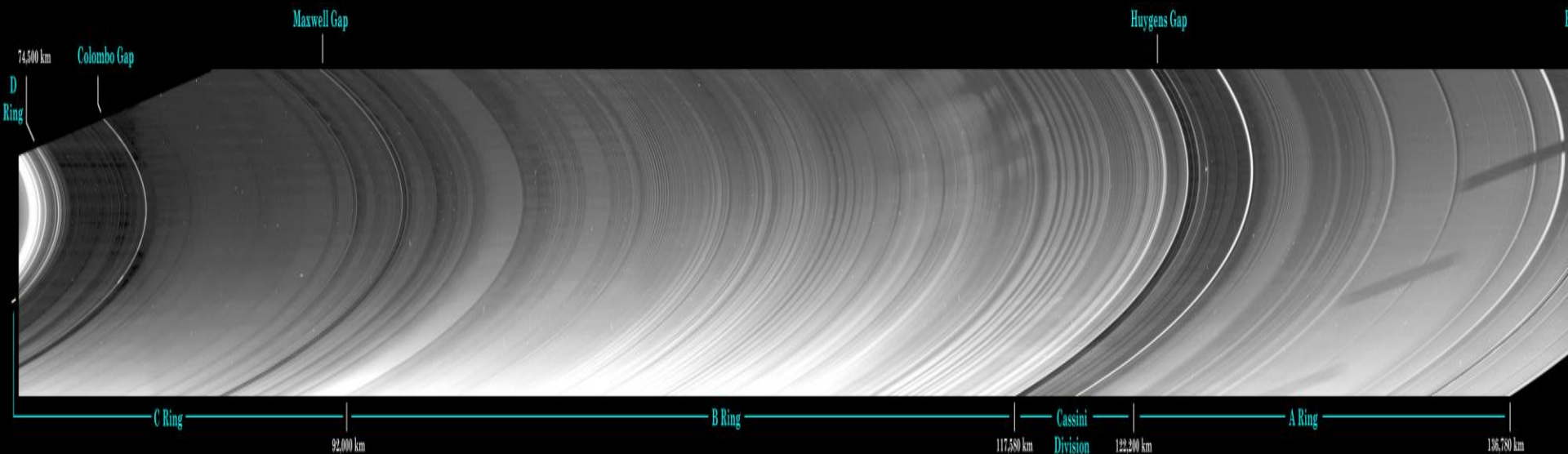
2008 Jan 7



2008 Feb 24

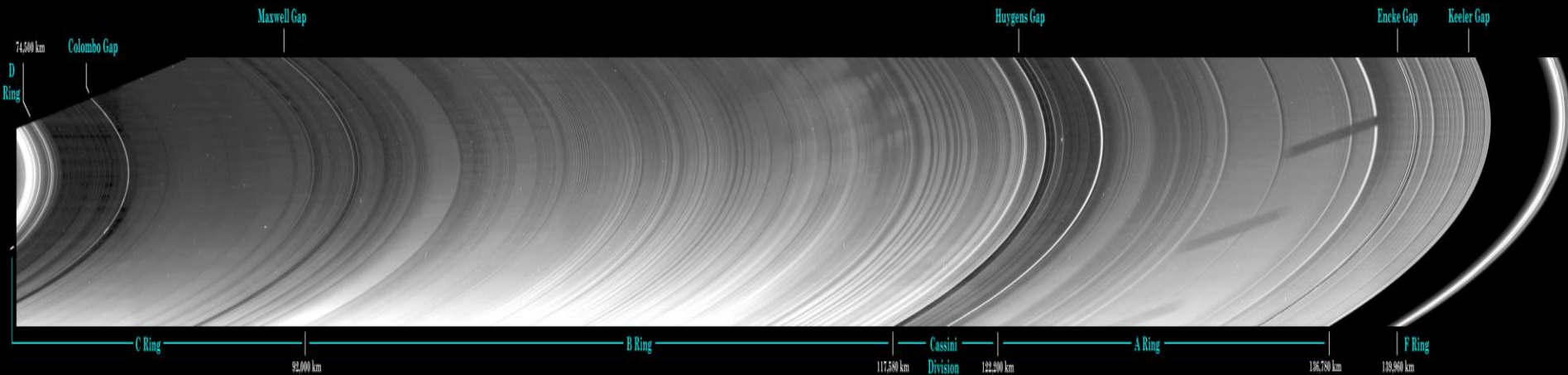


Equinox Ring Scan



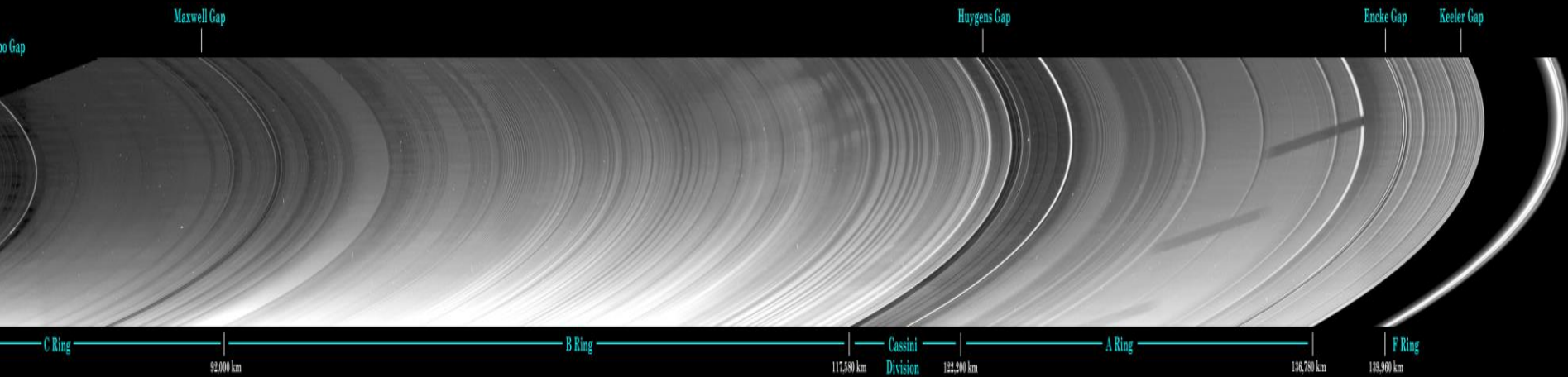
Gap edges
Ringlets in gaps

Equinox Ring Scan



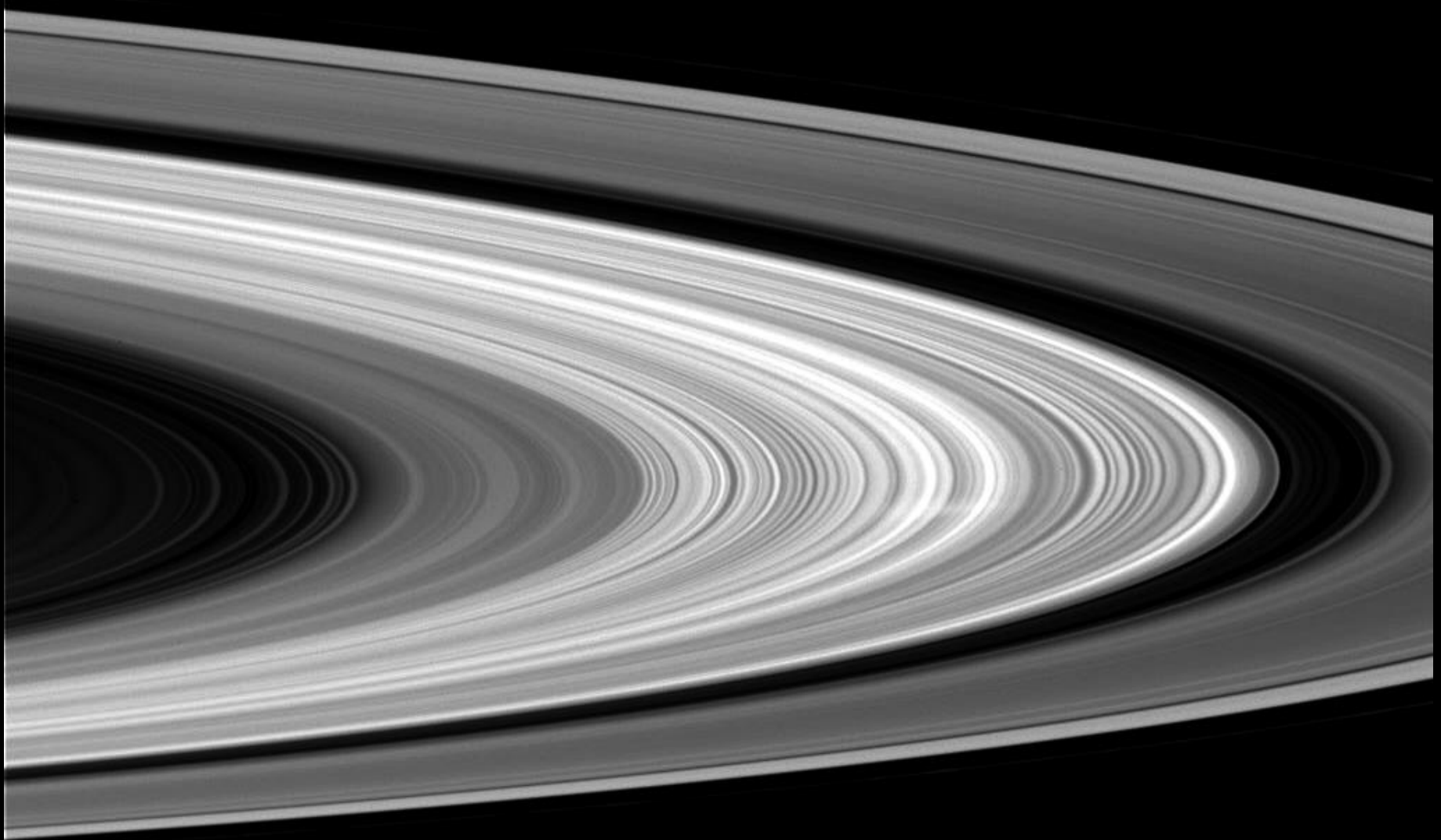
Resonance with Mimas at B ring edge
Spokes

Equinox

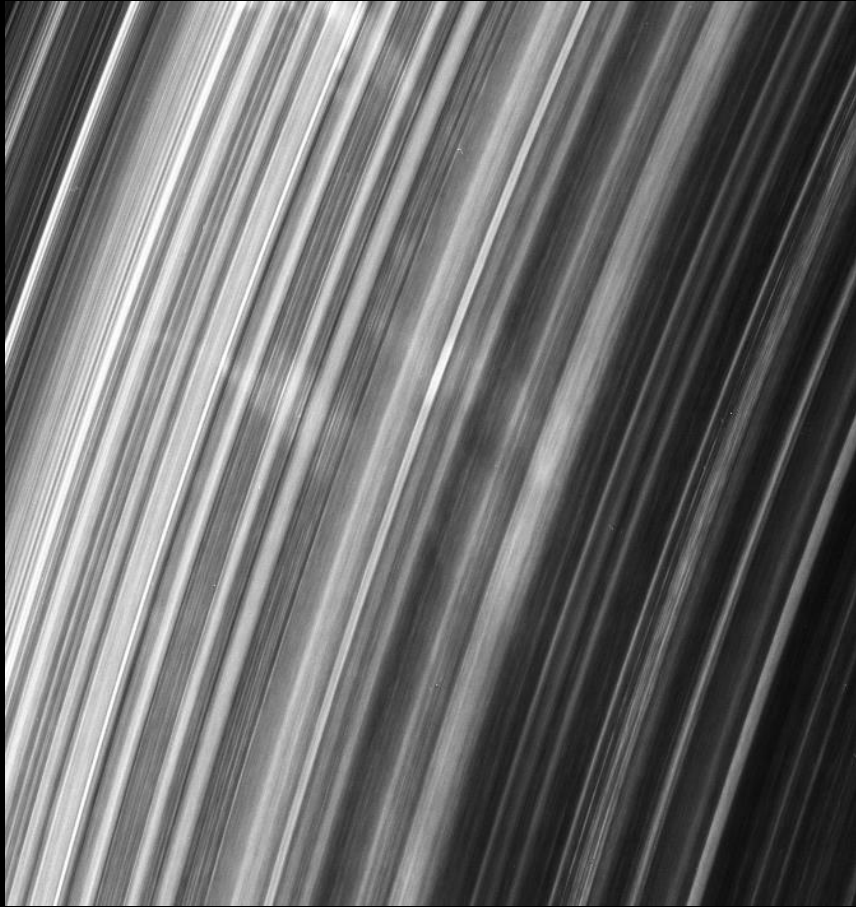


Ringlet
Bending Waves
Density Waves

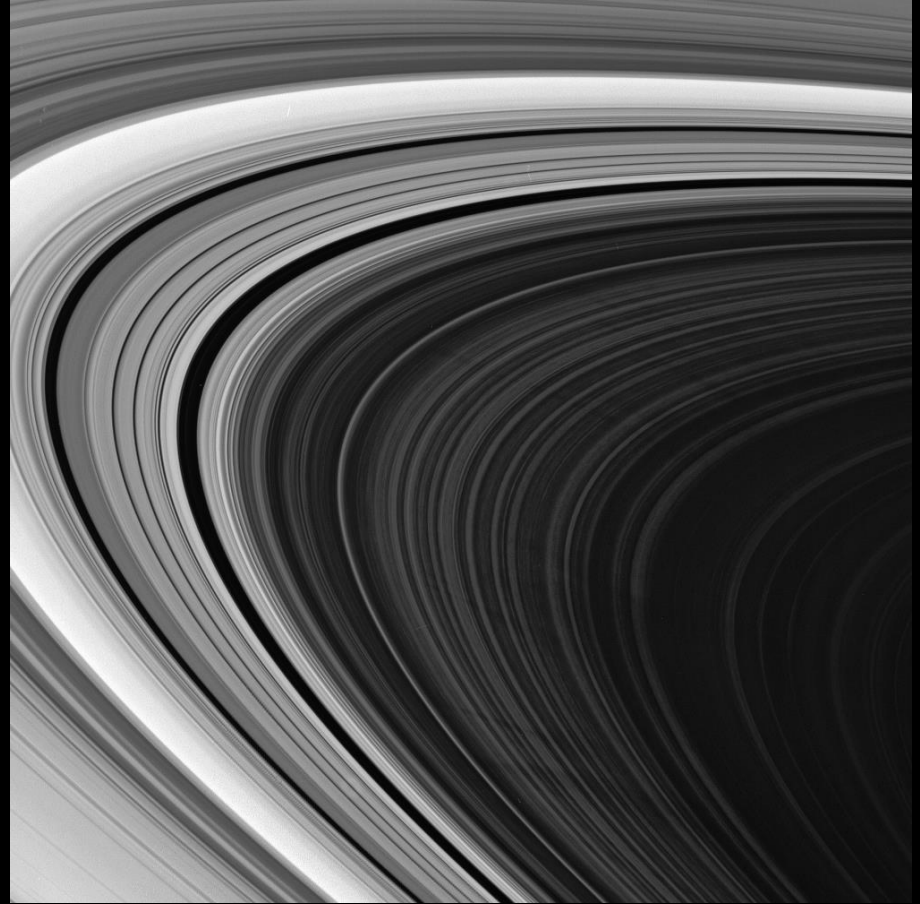
Spokes in the B Ring



Contrast Phase Dependence

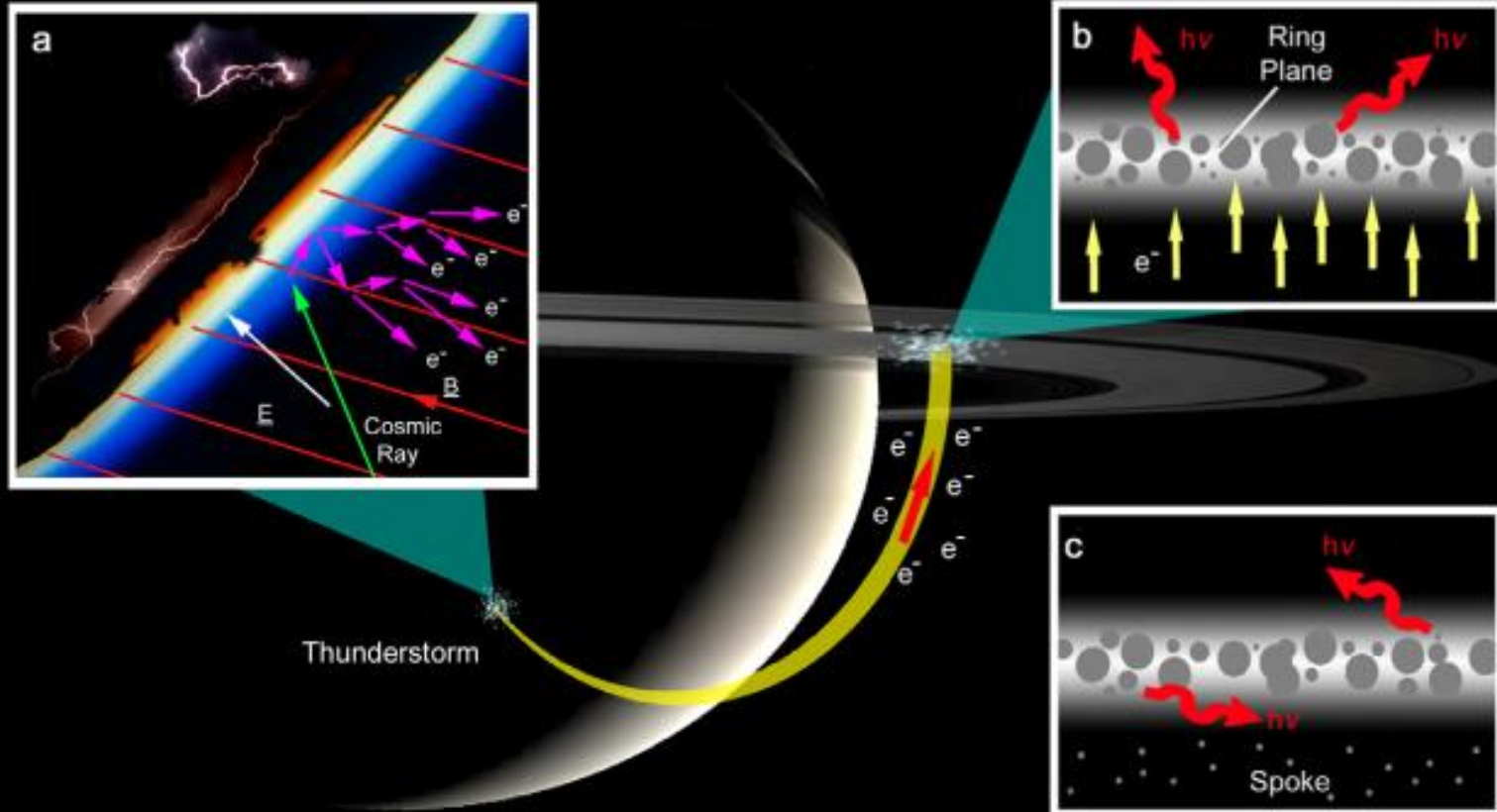


High Phase



Low Phase

Lightning the Cause?



Jones et al. 2006

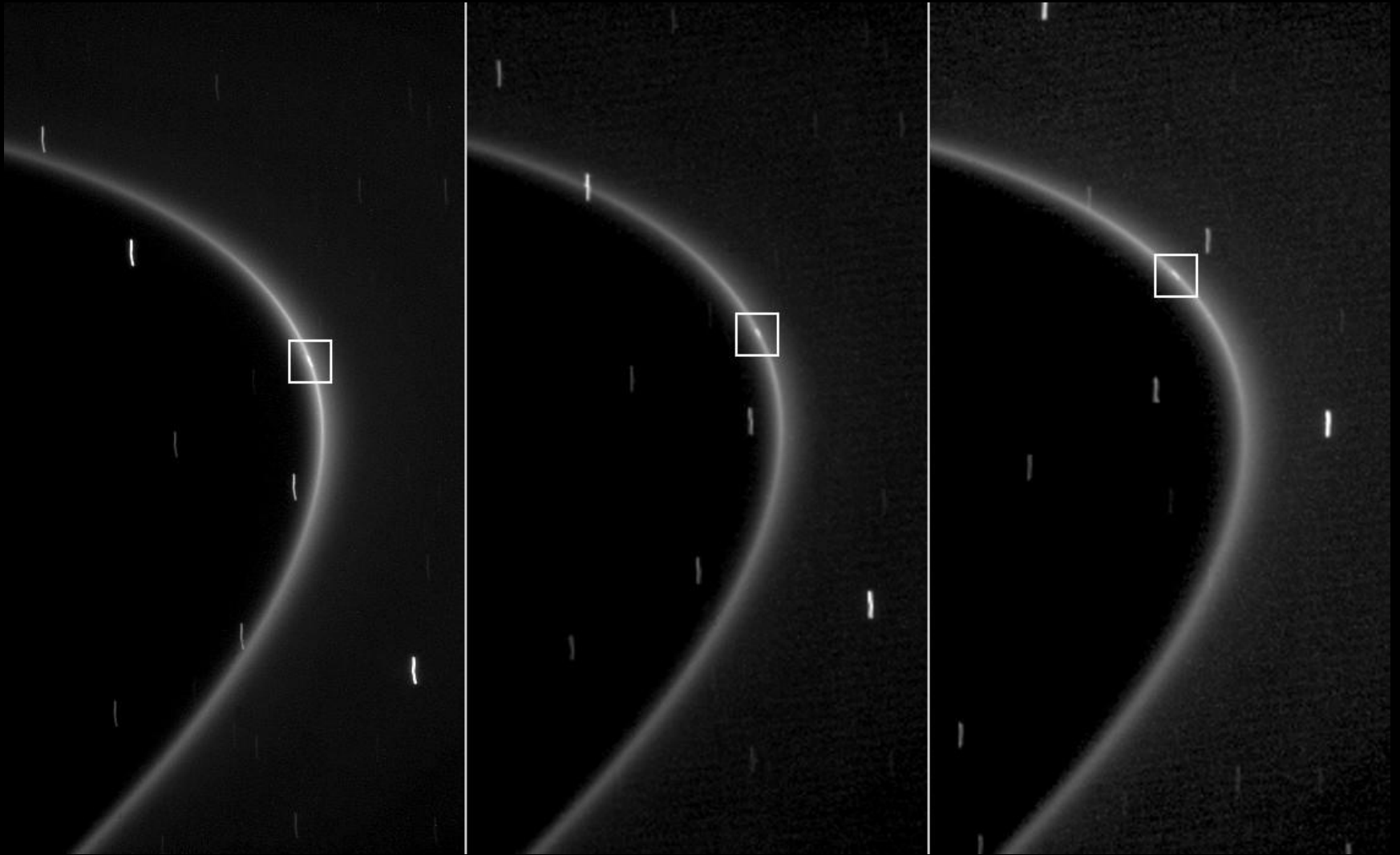
G Ring Arc



Similar to
Neptune's
arcs

Resonance
with Mimas
(7:6)

G Ring moonlet (Aegaeon)



Source of the G Ring?

Titan seen by Huygens

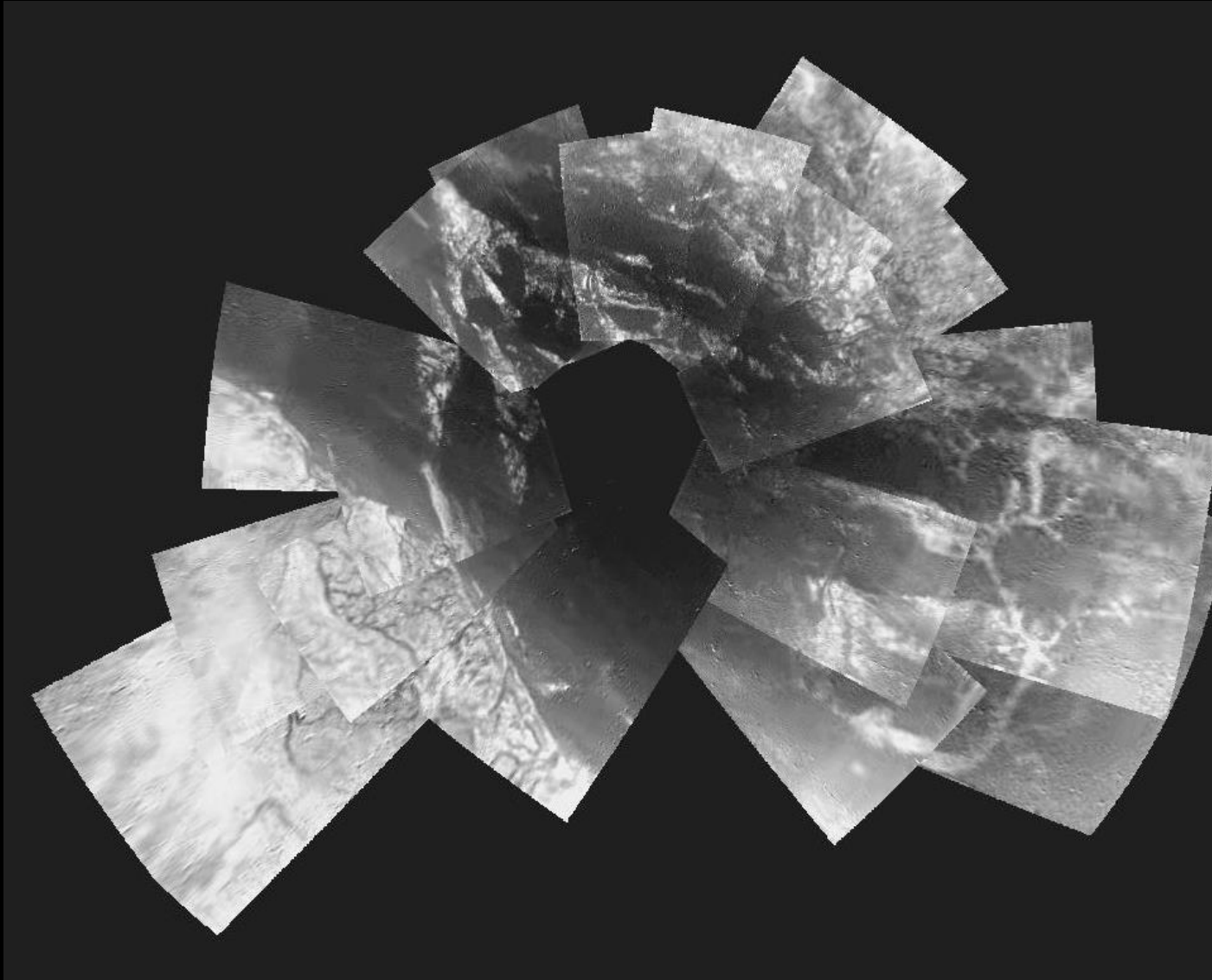


Photo: ESA

Reminders

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