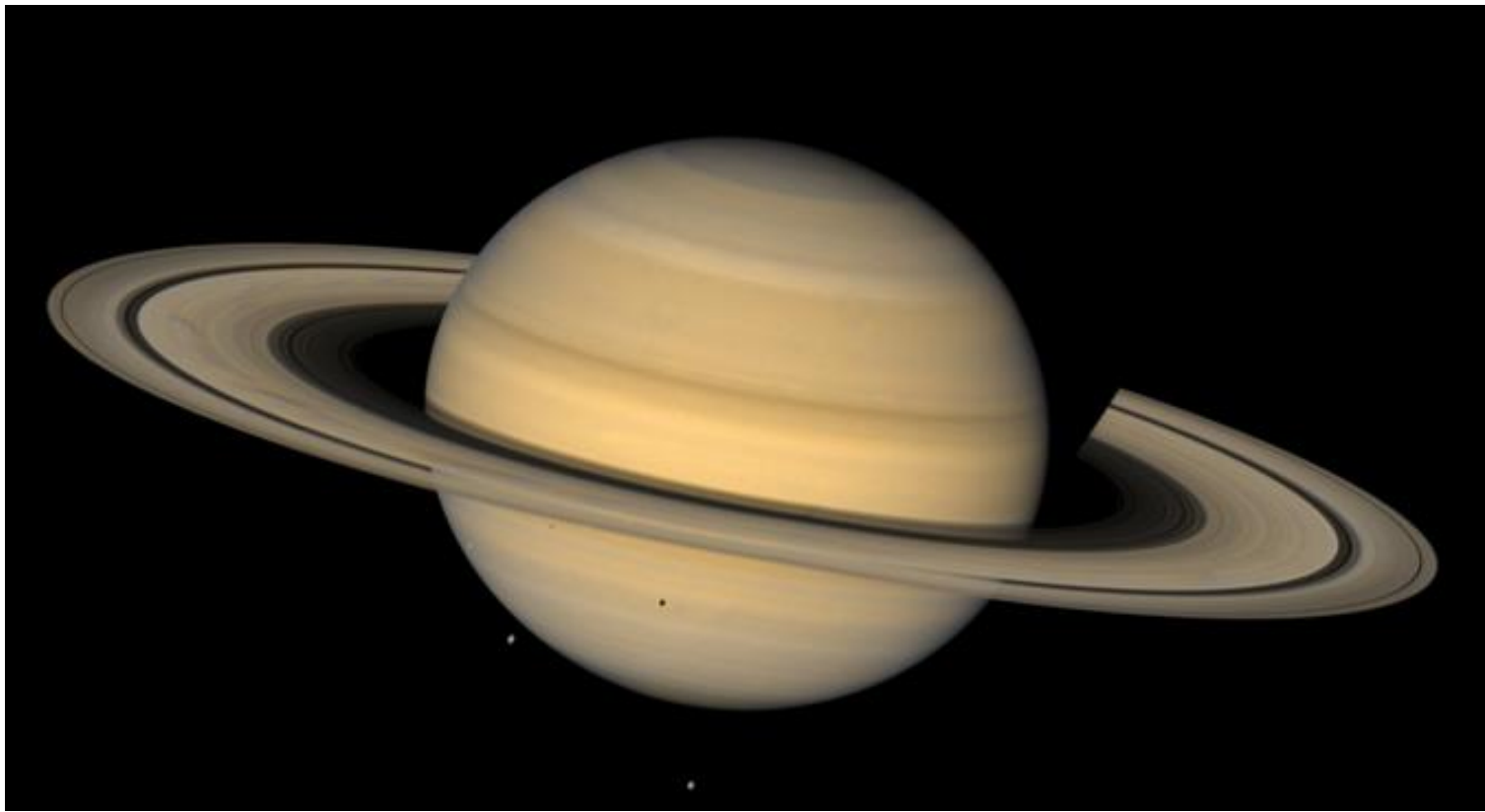


# Lesson 11

# Saturn

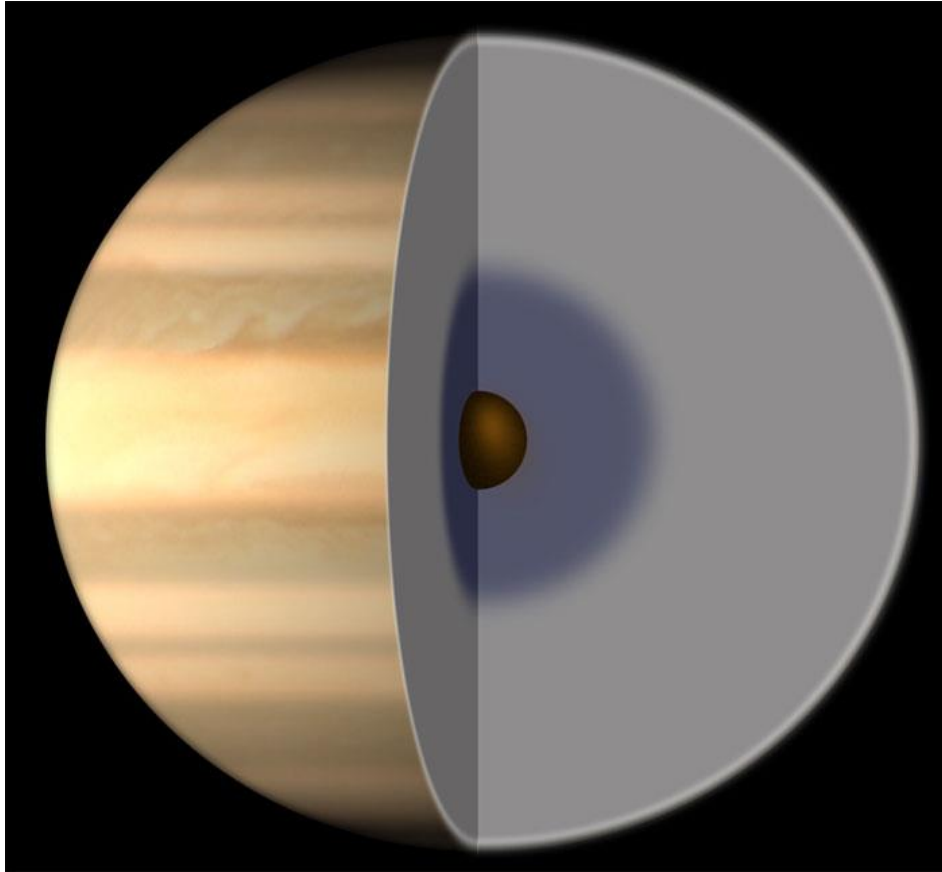
# Saturn

- Sixth planet from the sun.
- Equatorial diameter =  $1.21 \times 10^5$  km
- Planetary mass =  $5.69 \times 10^{26}$  kg
- Bulk density =  $0.69$  g/cm<sup>3</sup>
- Mean orbital radius =  $1.43 \times 10^9$  km (9.5 AU)
- Orbital period = 29.5 years
- Rotational period = 10.67 hours
- Axial tilt =  $26^\circ$
- 82 moons (2016)
- Largest ring system (Galileo 1610)



Saturn has the lowest bulk density of all of the Jovian planets ( $0.69 \text{ g/cm}^3$ ) and has the most ellipsoidal shape due to its fast rotation and low density. Saturn has no solid surface so the atmosphere bulges outward at the equator.

Saturn's structure is similar to Jupiter's.

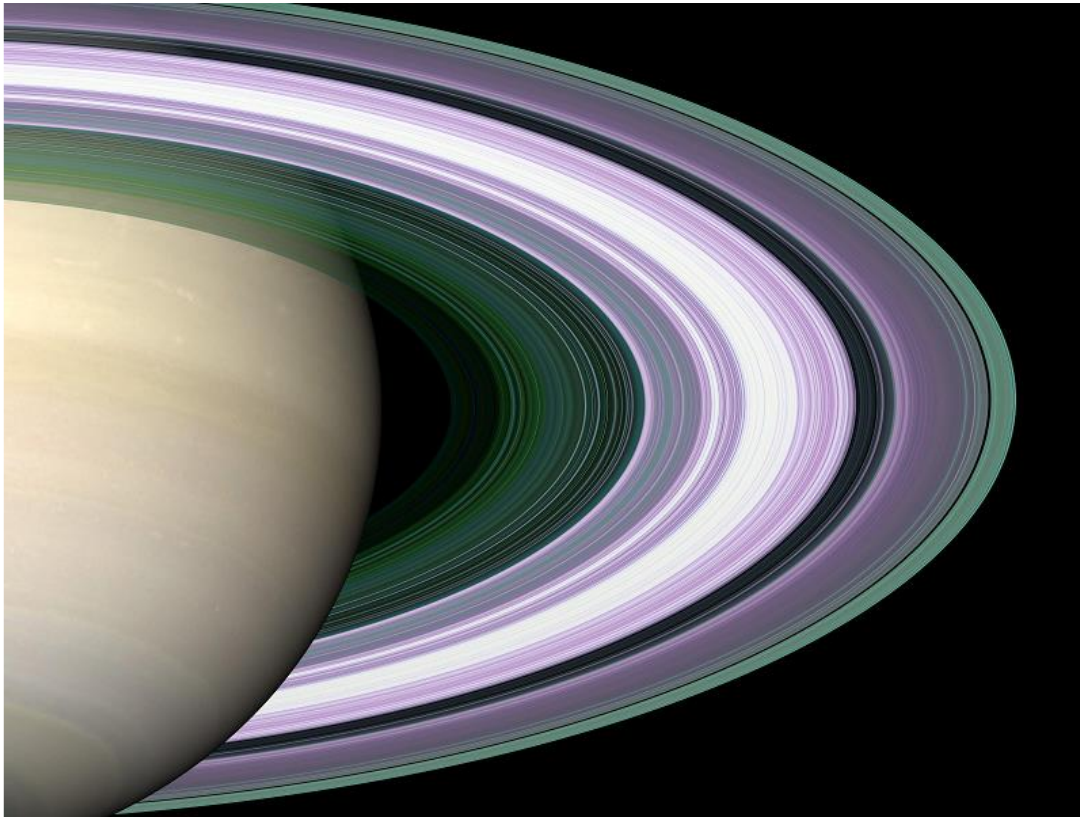


Sulfurous, hydrocarbon and ammonia clouds in upper atmosphere.

Very large molecular hydrogen and Helium gas atmospheres. A very large zone of liquid below the atmosphere. The mantle part of Saturn is metallic hydrogen “mantle”.

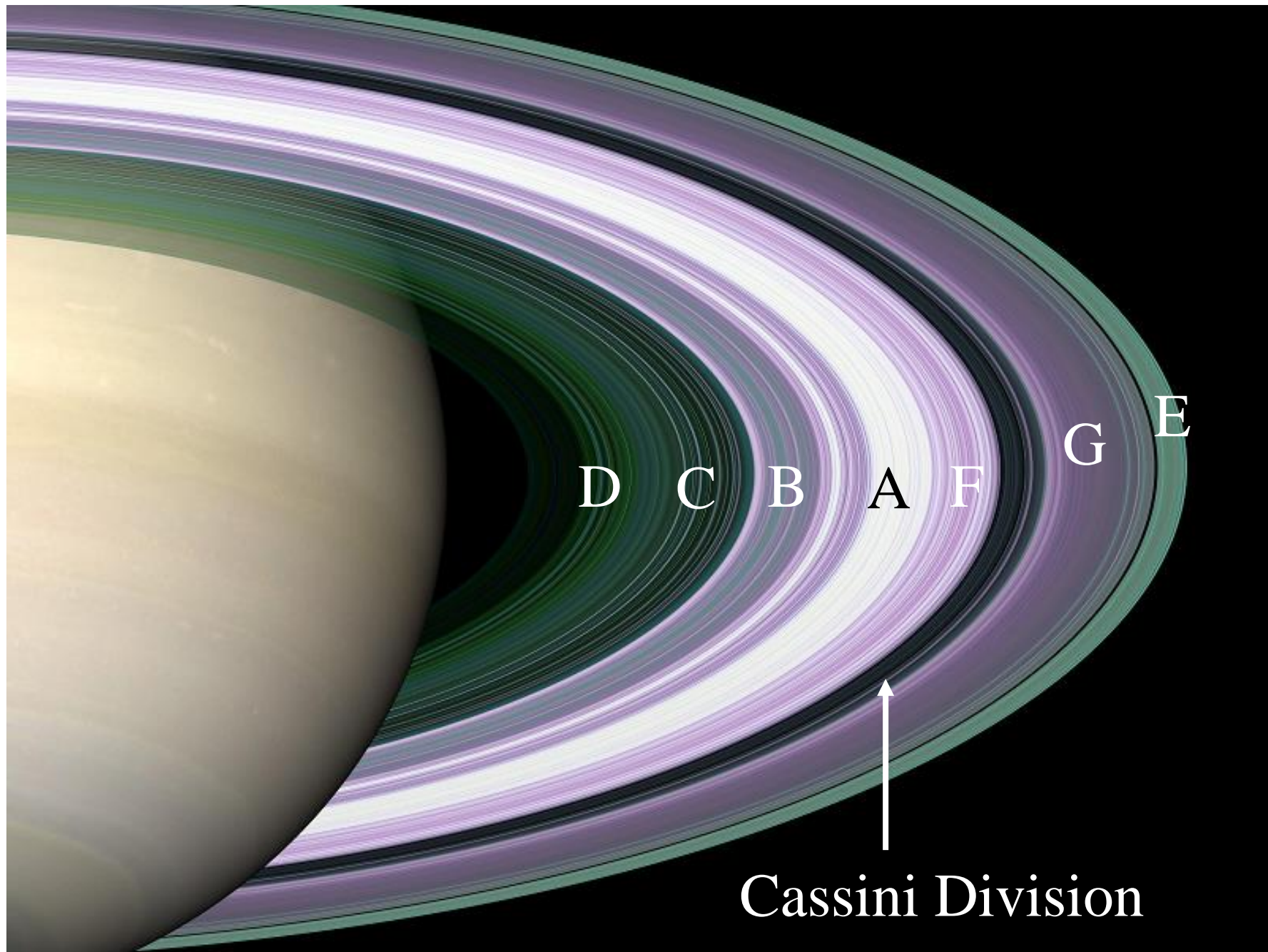
Small rocky and icy core.

Saturn appears to have **seven ring bands** when viewed from afar. There are thousands of ringlets or smaller rings within the larger rings (using visible imaging and false color).

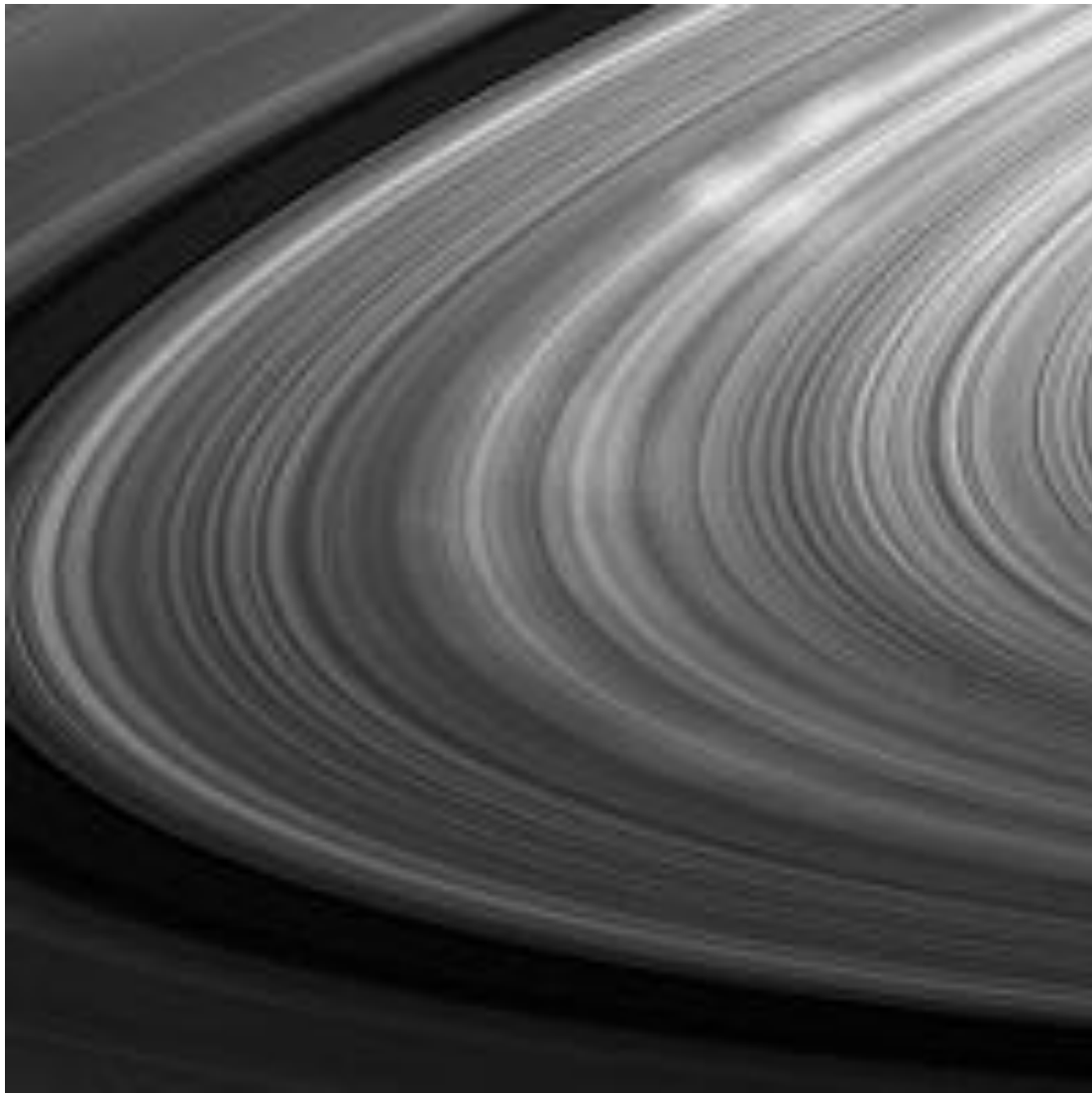


The rings align with Saturn's equator.

The rings lie inside the **Roche Limit**.

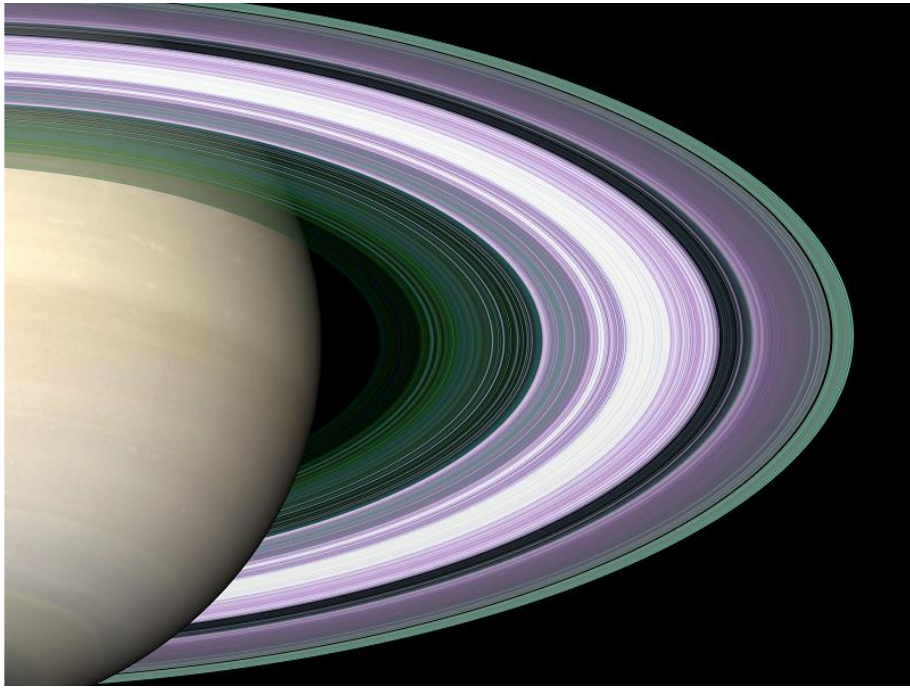






The materials in the rings orbit Saturn. The materials move at different speeds as a function of distance from Saturn.

Material closer to Saturn orbits faster than material farther from Saturn.



The debris inside the rings is mostly dust and small ice crystals. A little of the mass is small icy asteroids the size of mountains. Shepherd moons also are found in the rings.

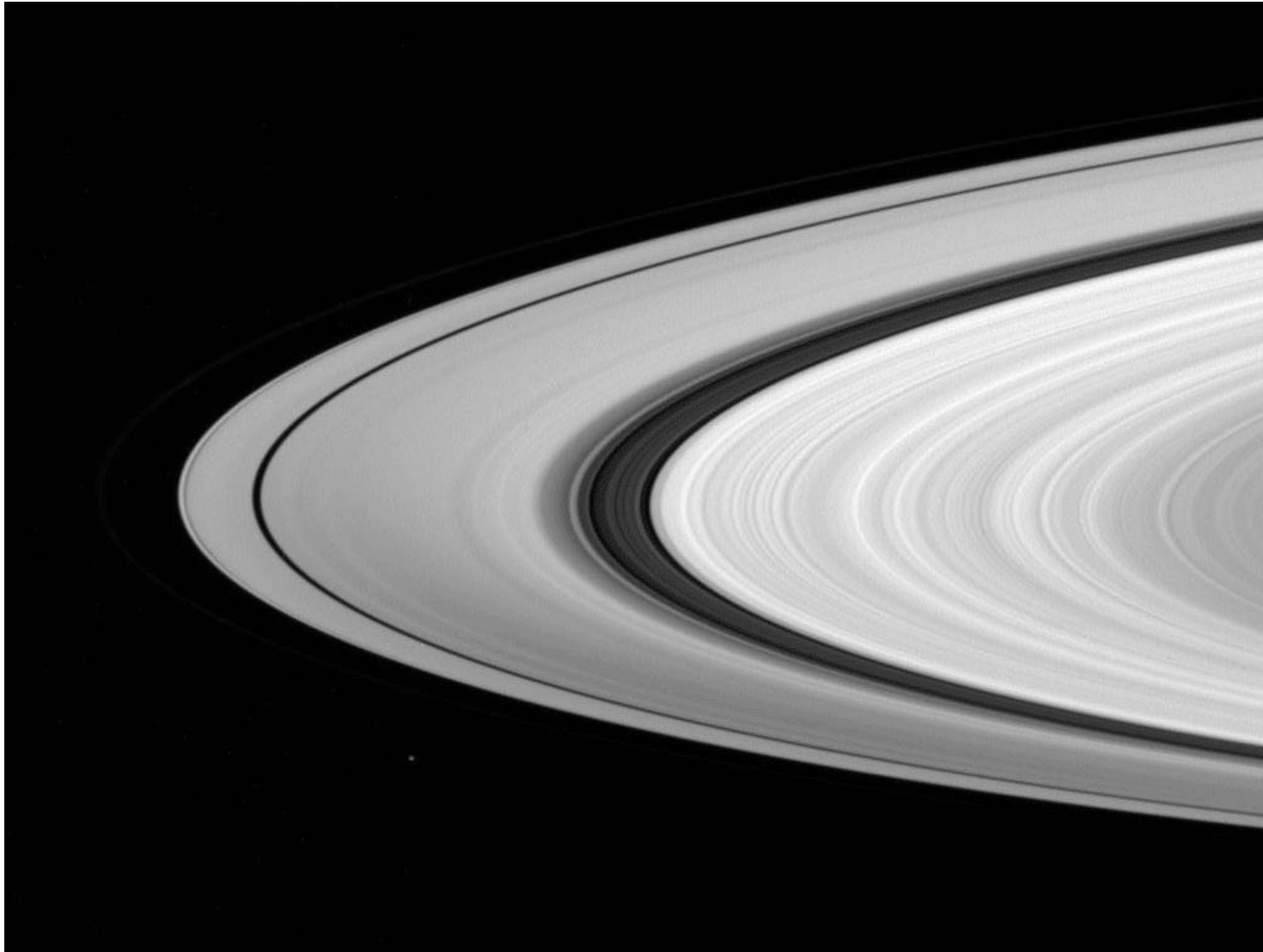
The brightness and reflectivity of the rings is due to composition.

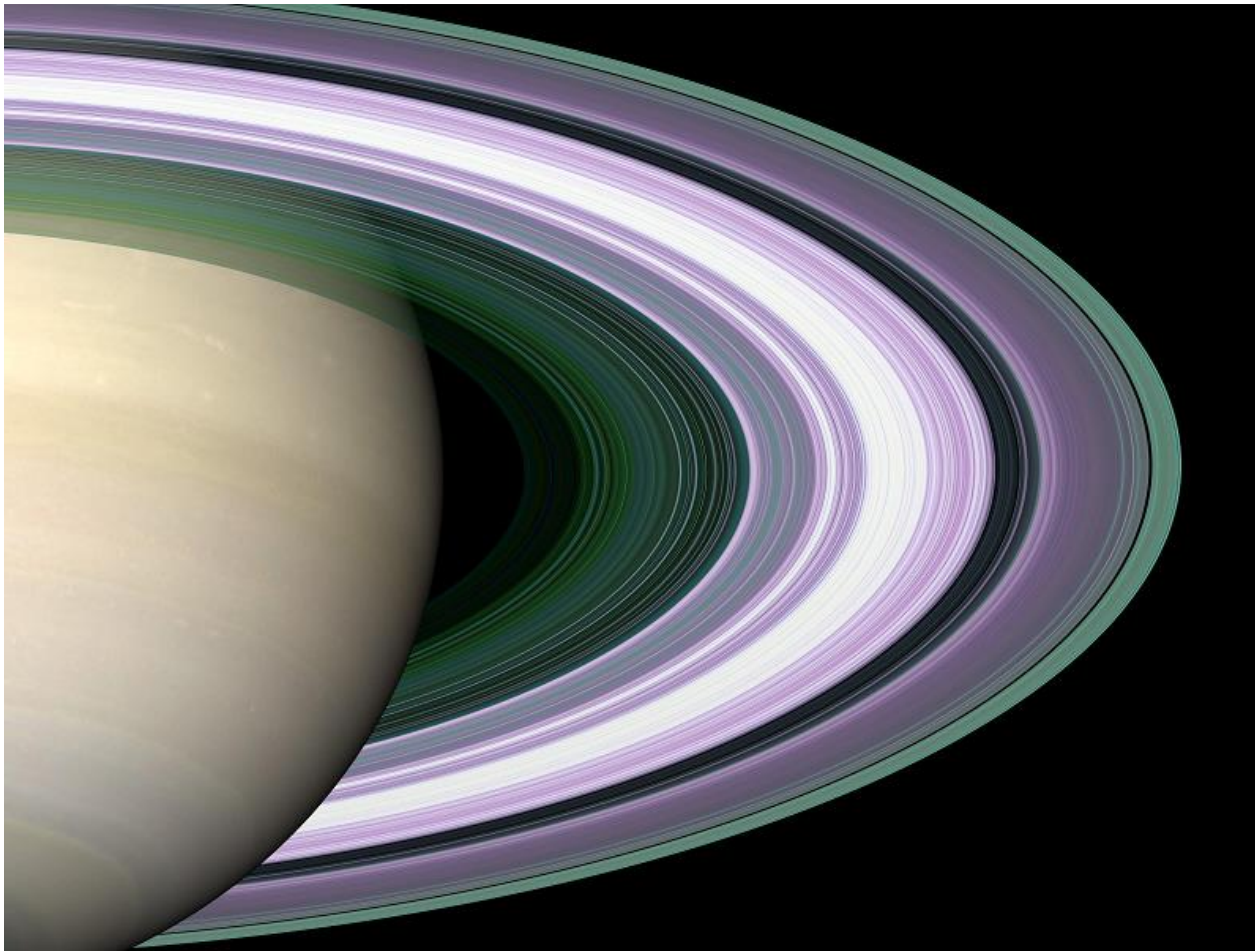
Icy particles = whiter and more reflective.

Dusty particles = darker and less reflective

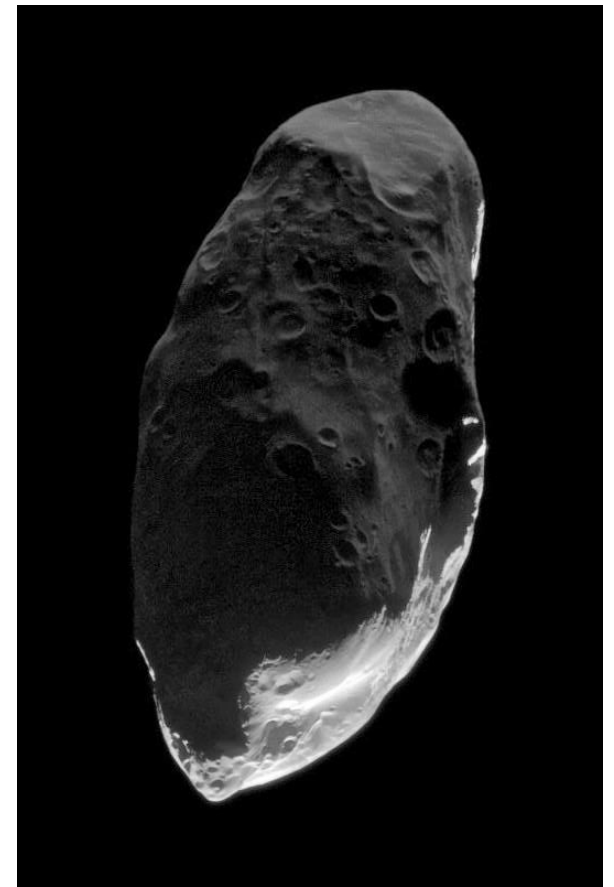
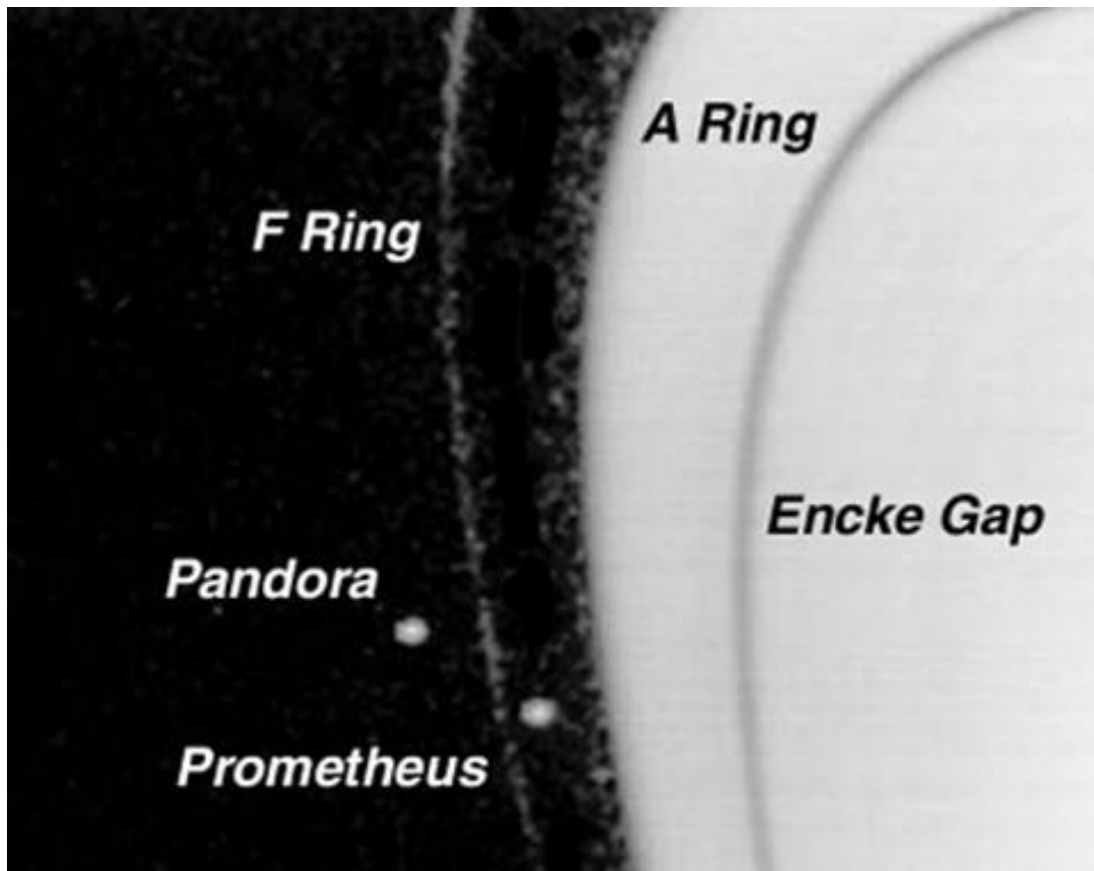


The rings are very thin, only 100-1000 meters thick. The width of the entire ring system is 270,000 km.



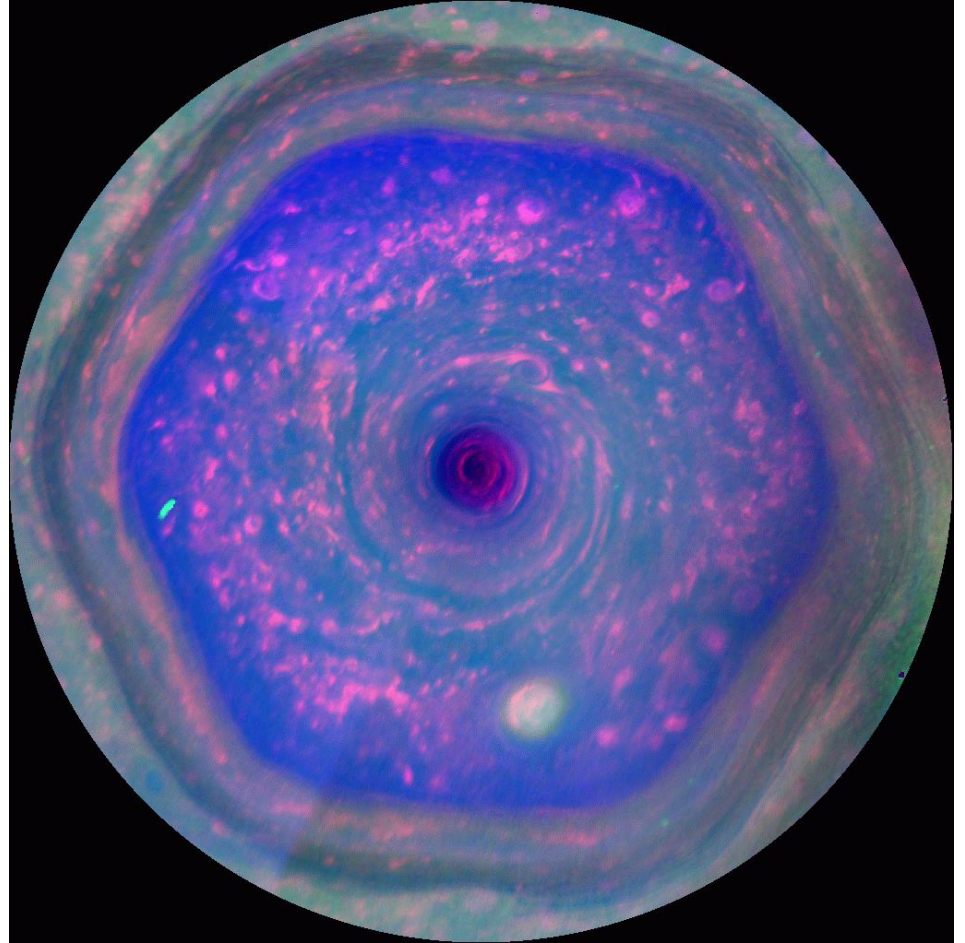
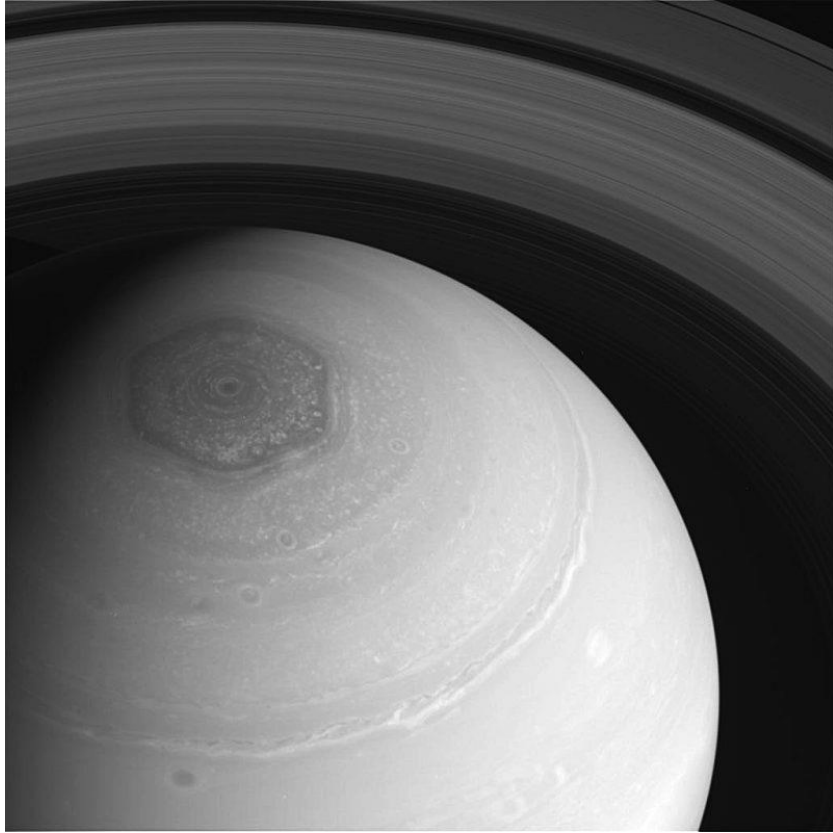


**Cassini division** is the wide “dark colored” gap between the inner rings and the outer rings. ~4800 km wide



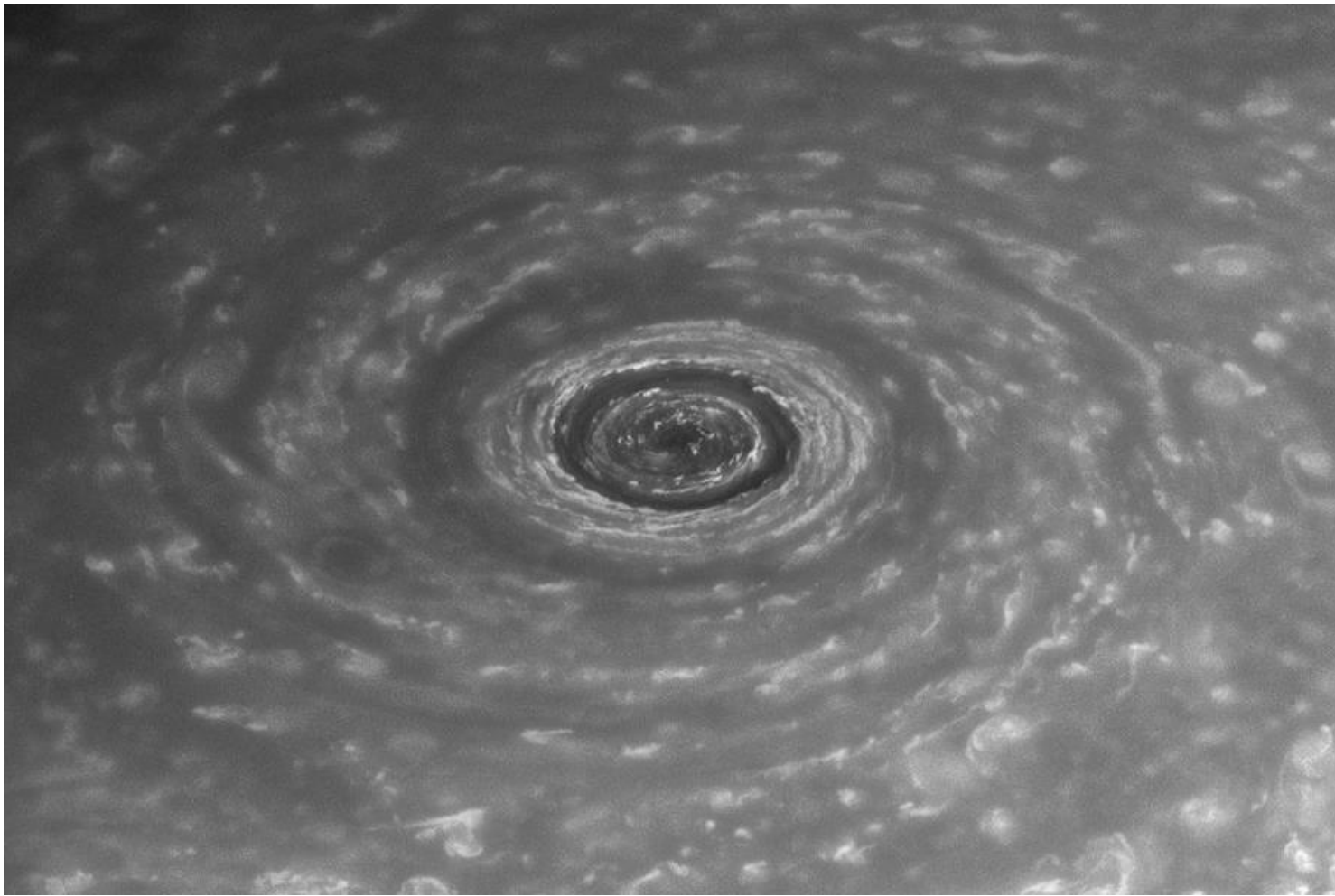
**Shepherd moons** are very small moons (captured comets or asteroids) orbit their planet near the edge of the ring systems. Their gravity stabilizes the ring system and keeps the ring particles confined to the rings.

Saturn's **North pole** has a very large **hexagon-shaped** polar vortex surrounded by 220 km/hr upper atmospheric winds.

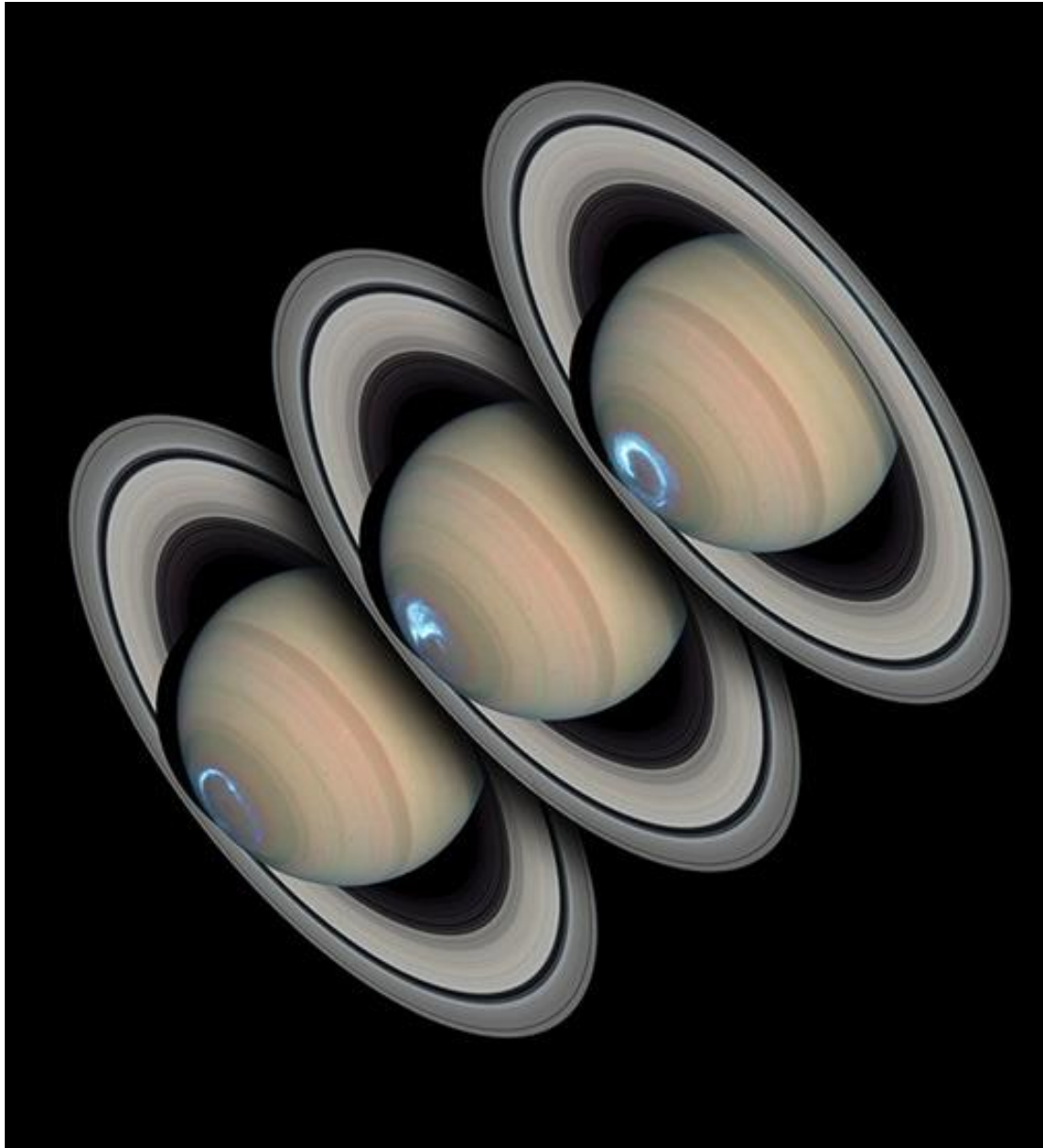


It changes color and size over time.





Saturn's **south pole** has a towering rotating storm and well-developed eyewall. A hurricane that is fixed over the south pole.

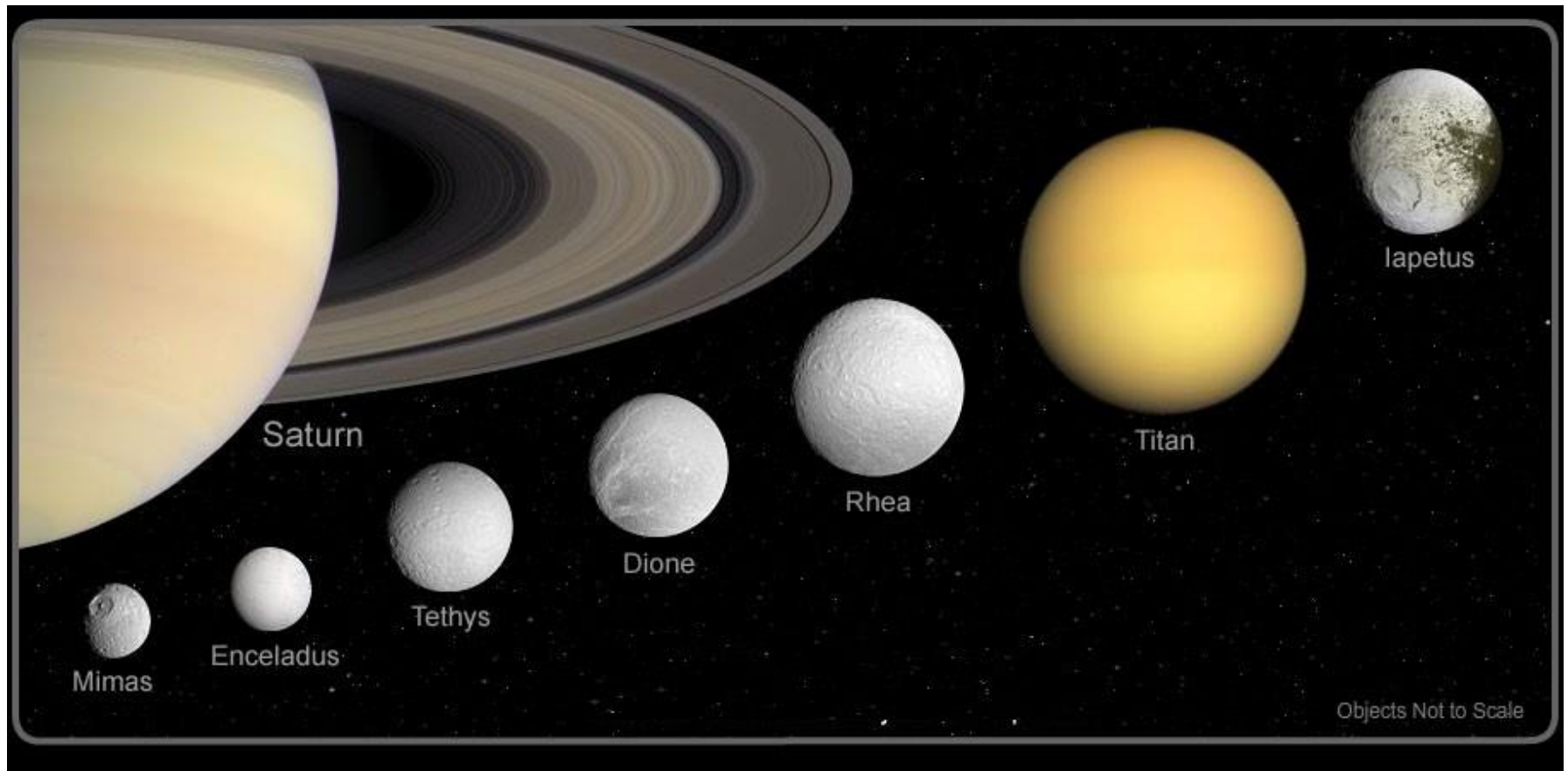


Saturn's south pole also has geomagnetic storms caused by solar wind particles streaming down into Saturn's atmosphere.

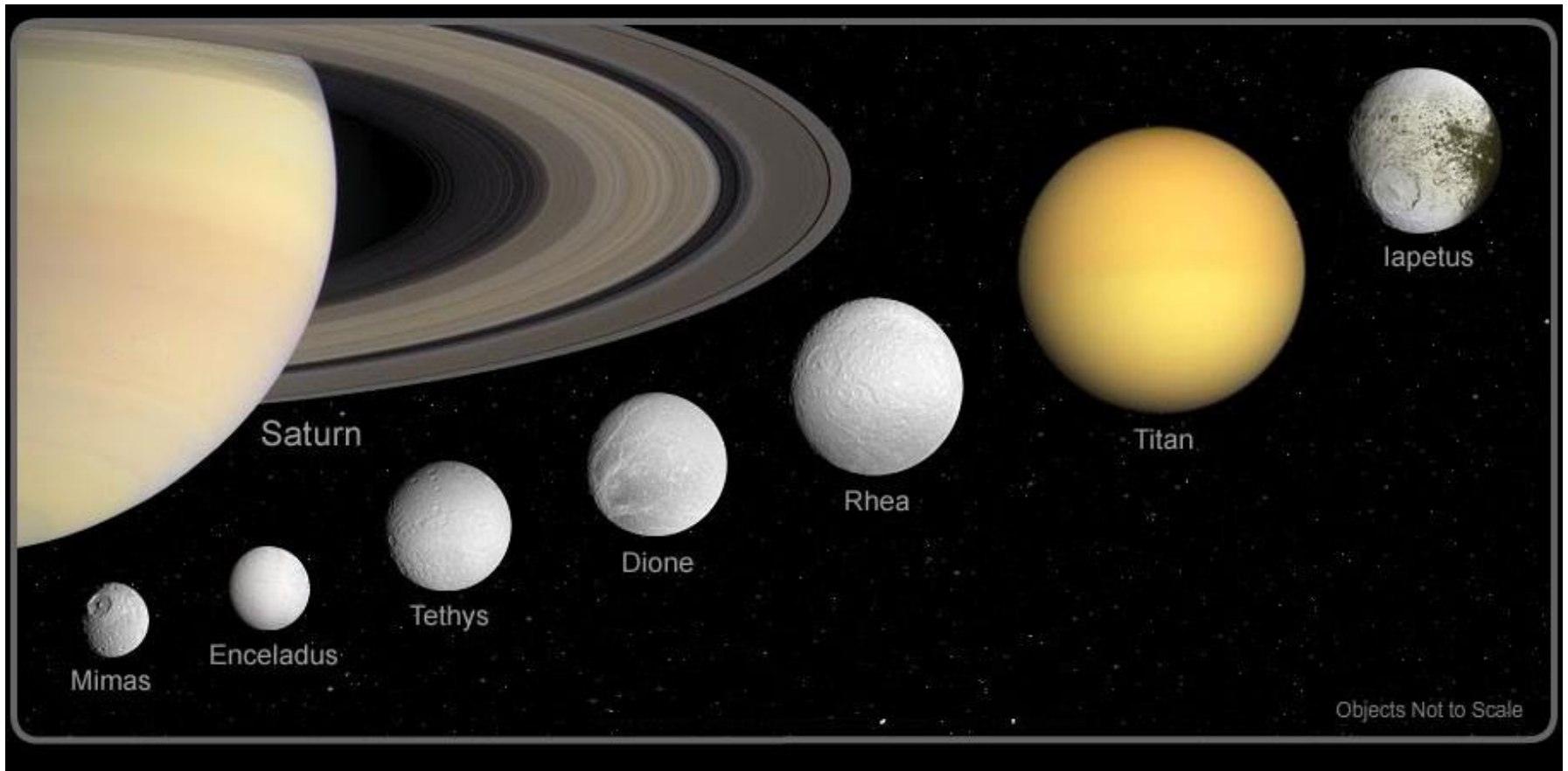
The aurora were viewed in ultraviolet.



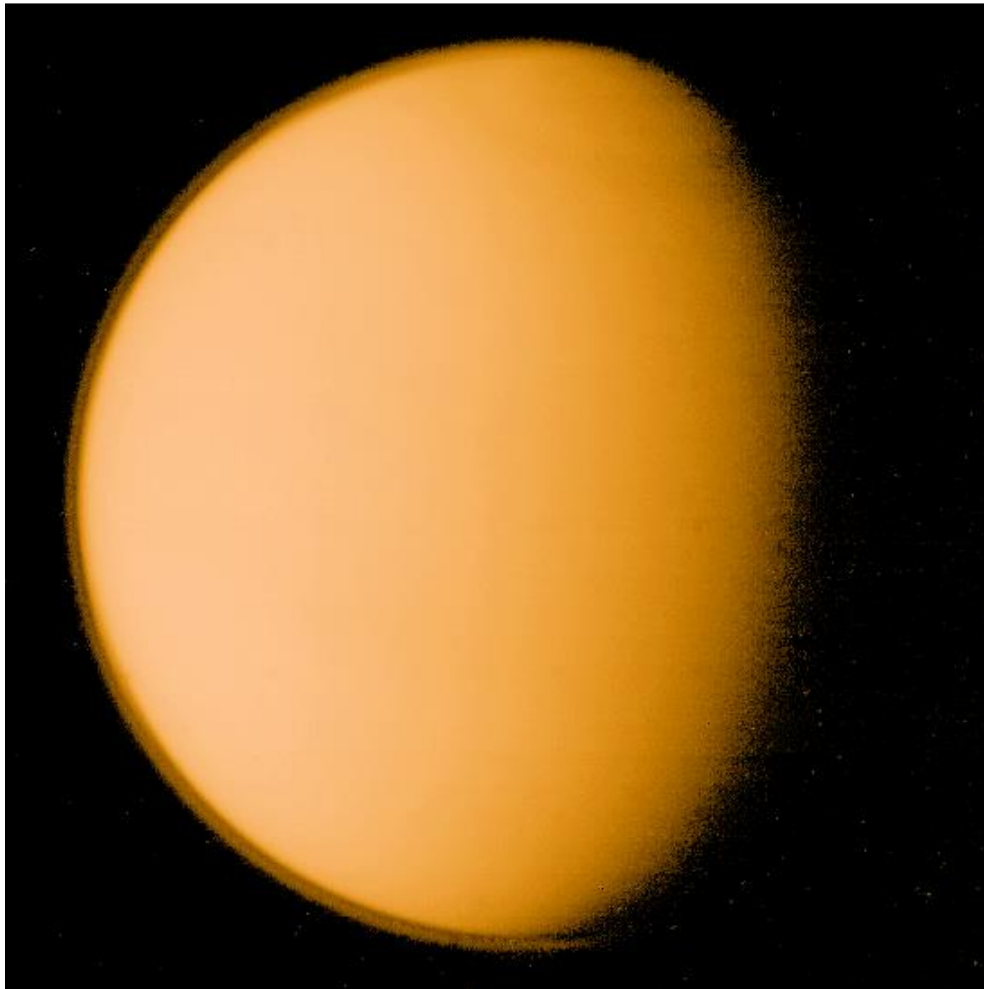
Saturn has 7 larger spherical ice moons that are of significant size. Titan is Saturn's largest moon and the 2<sup>nd</sup> largest moon in the solar system. Most of the other moons are < 100 km in diameter (captured comets, captured asteroids, or failed moons).



The largest moons are approximately 75% frozen water ice and other volatile ices by mass, with small rocky and metal cores. The lighter reflective surfaces is frozen water ice.

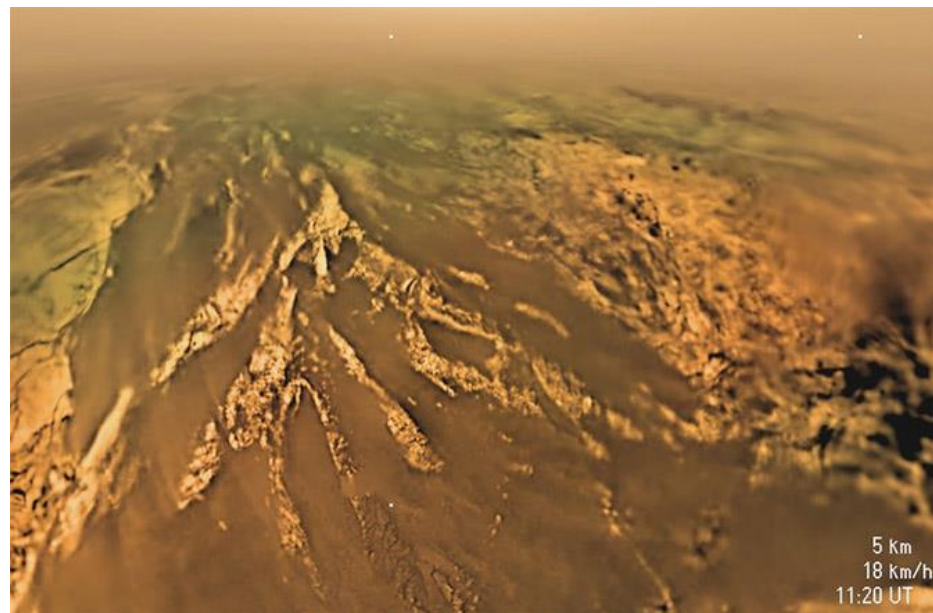
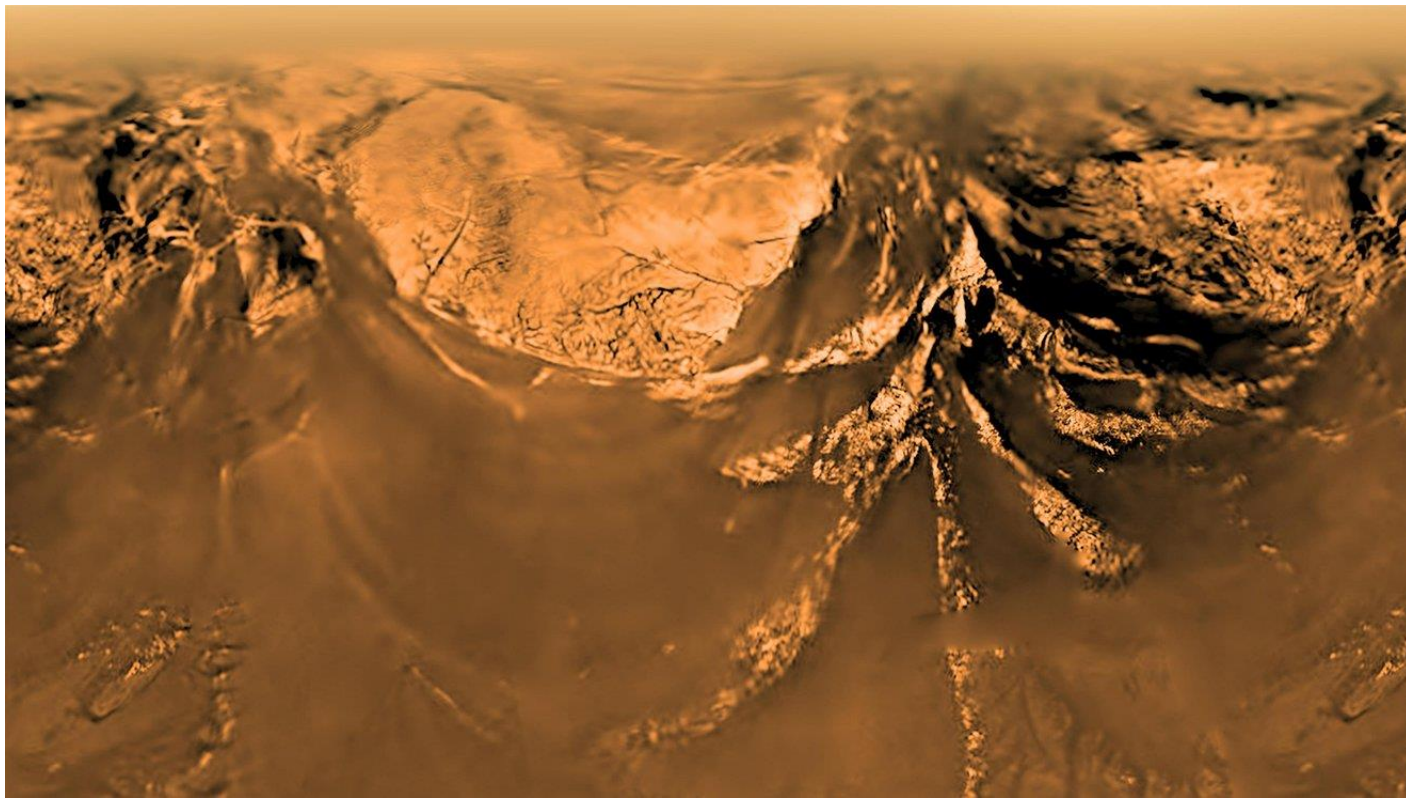


**Titan** is Saturn's largest moon. Titan is the only moon in the solar system with a significant atmosphere. Titan's relatively large mass and very cold temperatures hold the atmosphere close to the moon's surface.

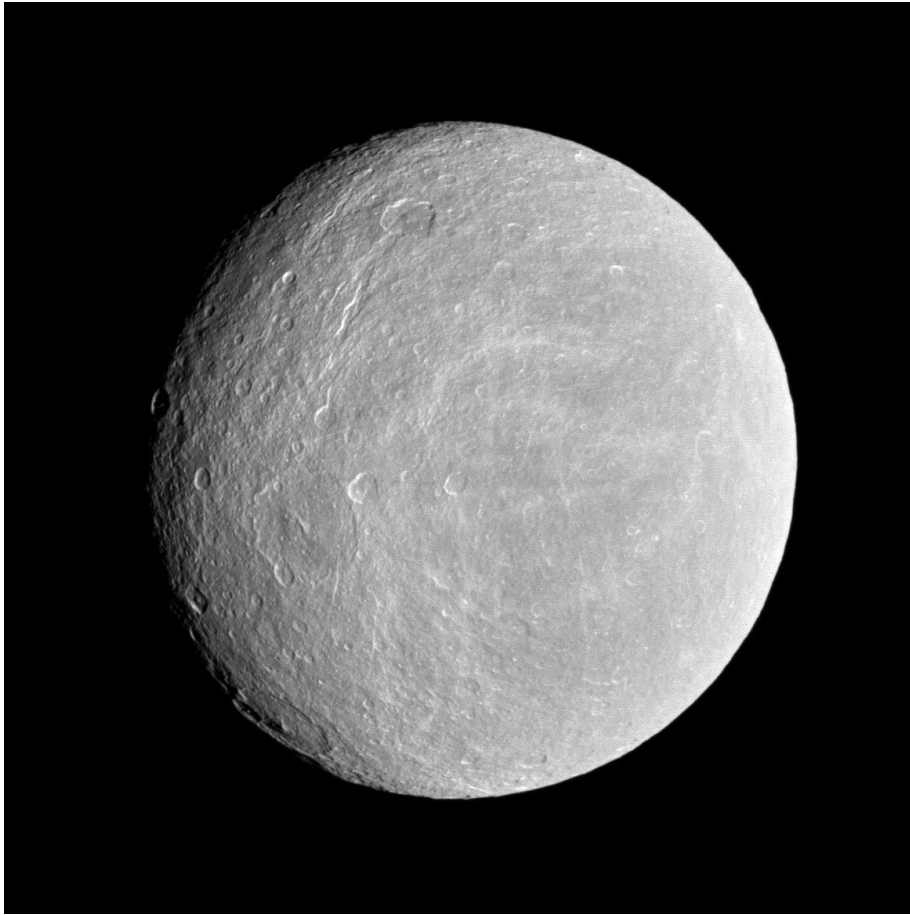


The atmosphere is 98% nitrogen gas with clouds made of methane, ethane, and hydrocarbons. The rain is methane.



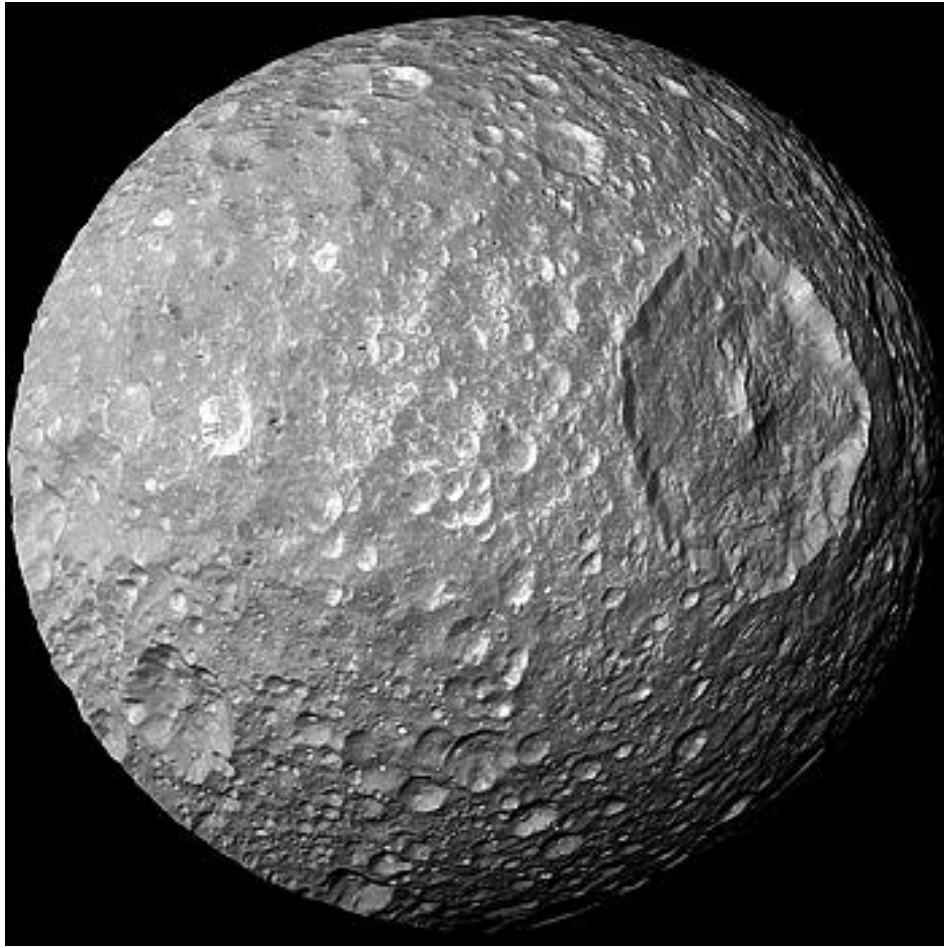


Titan's icy surface  $-179^{\circ}\text{C}$ .  
It is a slushy frozen hydrocarbon landscape, with icy mountains, lakes and rivers filled with liquid methane.



Rhea is Saturn's 2<sup>nd</sup> largest moon. It has only 1/3 the diameter of Titan and 1/10 the mass of Titan.

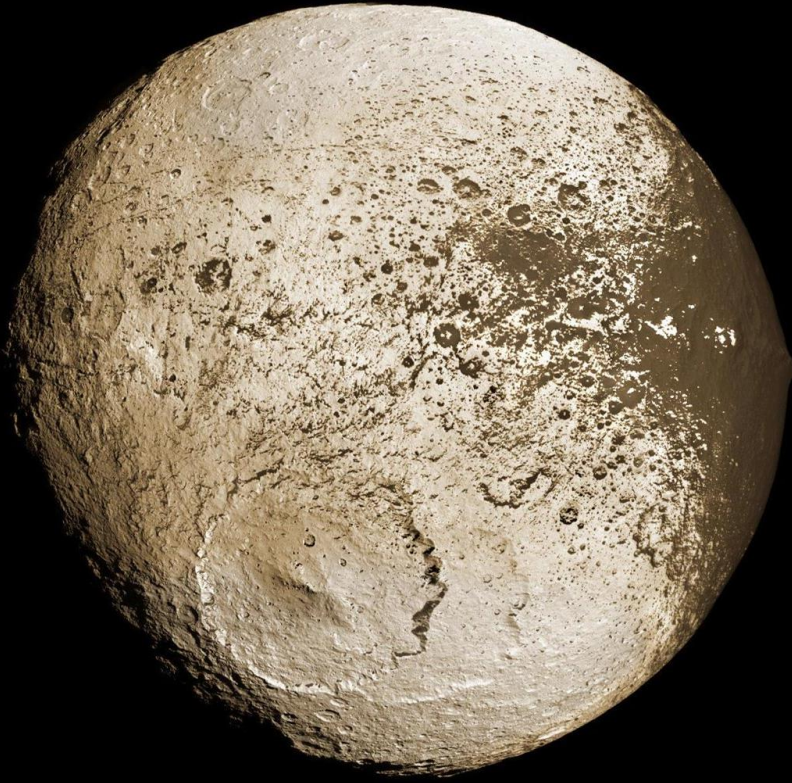
Rhea has a very faint system of small rings around it.



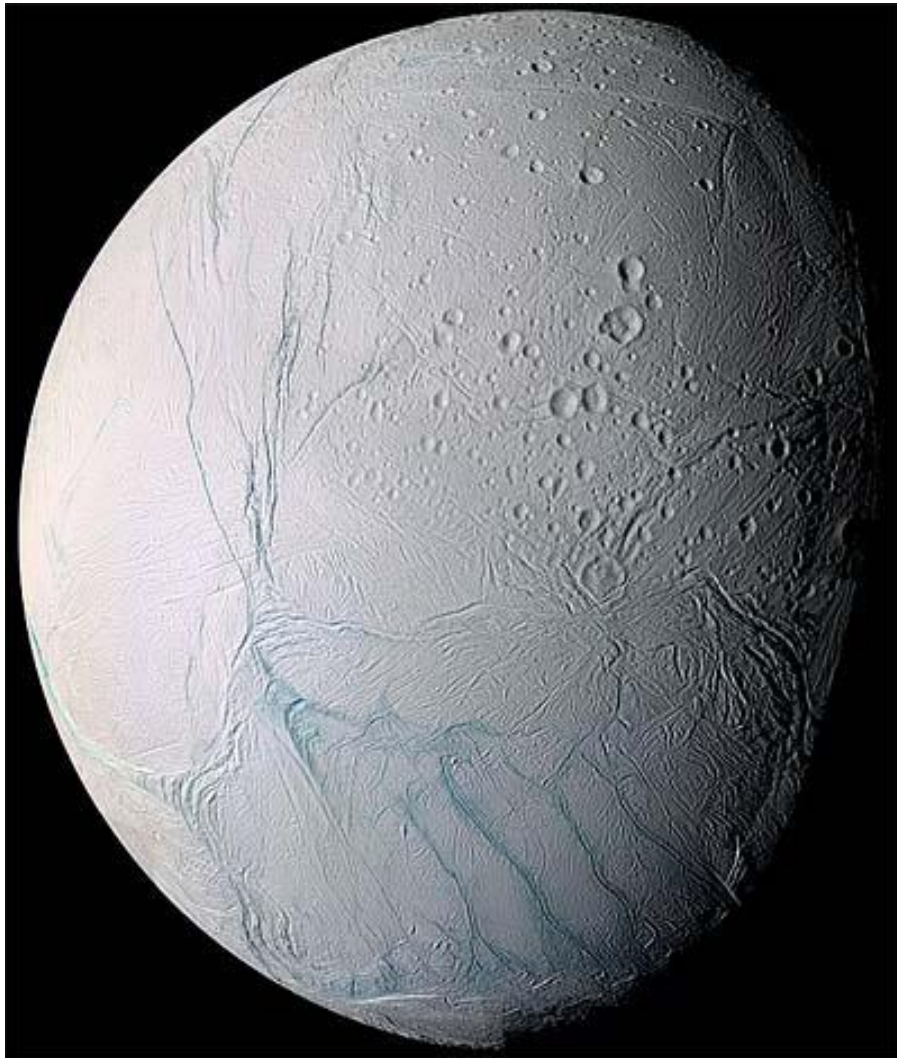
**Mimas** is the 7<sup>th</sup> largest of Saturn's moons. The Herschel impact crater is approximately 130 km wide. Mimas resembles the Deathstar space station from the Star Wars movies.



**Iapetus** is the 3<sup>rd</sup> largest of Saturn's moons. Iapetus has white, reflective areas made of water ice crust. There are extensive dark areas.



The dark areas are thought to be darker gases and dust flying off a smaller nearby moon. Iapetus in its orbit sweeps up this material and it collects on its surface. Alternatively, the darker color may be “deeper” darker ice that is exposed when sunlight heats up the daytime surface, causing the lighter water ice to sublime away.



Enceladus is the 6<sup>th</sup> largest moon of Saturn. It orbits Saturn the 2<sup>nd</sup> closest. Enceladus's smooth white crust is frozen water ice. There is thought to be a warm liquid water layer beneath the crust.

Enceladus has dozens of active cryovolcanoes. These are volcanoes and geysers that eject liquid water, water ice, and dust. Enceladus's interior is heated by tidal deformation—Saturn's gravity is squeezing and stretching Enceladus. The friction from the ice rubbing against each other creates the heat that makes the volcanism.

