Saturn's Moons and Rings

- We have already discussed a few details of Saturn's ring system
- It is impossible to fully discuss the rings without mentioning the interactions with Saturn's many moons
- –
- The rings themselves may have been formed from a current or past moon

Ring Overview

- The rings were named alphabetically in order of discovery
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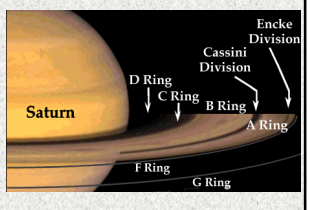
- The D ring is a faint ring close to Saturn's cloud tops
- The F and G rings and faint and narrow, outside the A ring
- The E ring is a large, low density ring in a more distant orbit around Saturn



What Creates the Rings?

- One clue to ring formation is where they are located compared to their host planet
- For each of the 4 outer planets, rings are usually not seen anywhere past about 2.4 times the planet's radius
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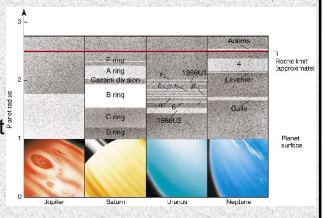

The Roche Limit

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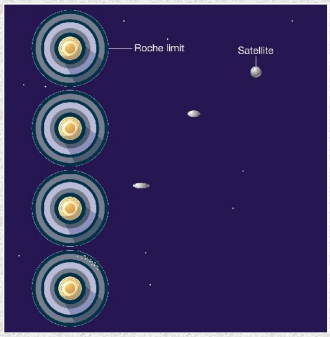

- Remember that gravity acts to squeeze moons that are close to the planet
- If the moon comes close enough, the moon is stretched to the point that it is destroyed

Ring Formation

- The fact that Saturn's rings are inside the Roche limit explains why they do not clump to form a new moon
- How did they form in the first place?
  - They could possibly be left over material from the formation of Saturn
  - –
  - A comet (like Shoemaker-Levy 9) could have come close to Saturn and broken up around the planet
  - An impact with one of Saturn's current or past moons may have generated the material in the rings

How Old Are The Rings?

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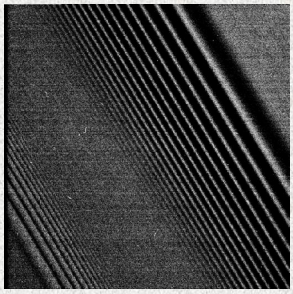

Disturbance waves in the A ring

- The rings are very bright, suggesting they haven't been covered by lots of interplanetary dust over time
- The interactions and disturbances in the rings suggest they are unstable, and shouldn't last more than a few hundred million years
- These points and others lead astronomer to believe the may be no older than 50 million years

Ring - Moon Interactions

- The spacing of Saturn's rings are based largely on interaction with different moons
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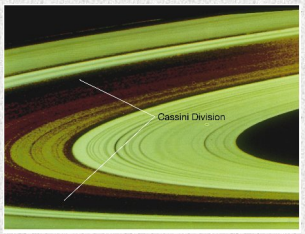
- In this case, particles in the Cassini Division are in a 2:1 resonance with the moon Mimas
- When Mimas and the particles 'sync up' in orbit, Mimas' gravity pulls on the particles and clears the gap



Shepherd Moons

- Close up images of the F ring showed a very narrow and braided structure
- Further analysis has revealed that this ring is controlled by the gravity of two nearby moons, Prometheus and Pandora
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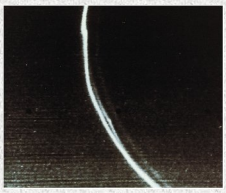
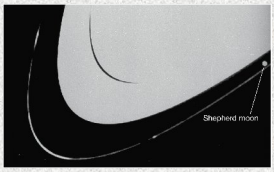
- Gravitational interactions keeps the F-ring narrow and confined





Herding the Rings

- The presence of a single moon in the rings acts to spread the particles out and create a gap
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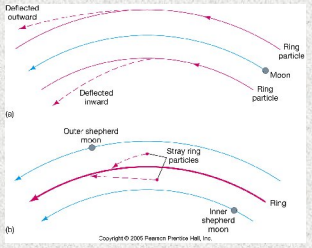
- These types of interactions change the structure of the ring system over long periods of time



The Source of the E-ring

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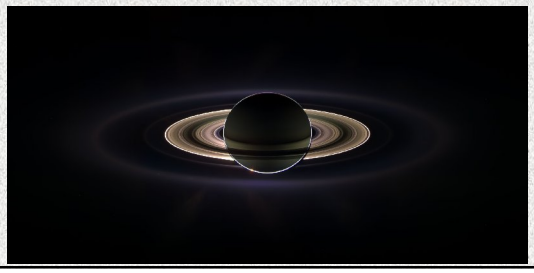
- Recent observations of Enceladus have revealed water volcanoes on its surface, which most likely provide the ice particles in the E-ring



Saturn's Moons

- Like Jupiter, the number of Saturn's moons continues to increase (currently in the 50's)
- Unlike Jupiter, Saturn's moons come in all sizes
  - Small (a few kilometers)
  - Medium (a few hundred kilometers)
  - Large (over a thousand kilometers)
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The Small Moons

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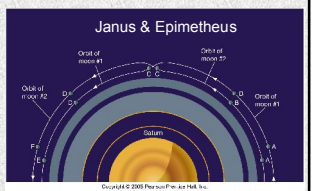
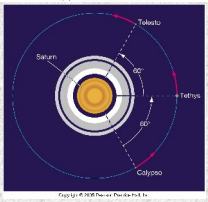
- Janus and Epimetheus actually trade orbits every time they pass each other
- The small moons Telesto and Calypso share an orbit with the larger Tethys
  - The two smaller moons lead and trail Tethys by 60º





Hyperion

- The small moon Hyperion is possibly the weirdest of Saturn's moons
- Influences with other moons cause it to 'tumble', never having a constant rotation speed or direction
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The Medium Moons

The Medium Moons

- The surfaces of Rhea, Iapetus, Tethys, and Dione resemble the surface of the Moon in many ways
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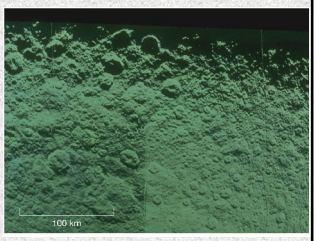
- On Dione, there is even some evidence of maria-like terrain meaning there may have one been volcanism of some sort



Craters on Rhea

Mimas

- The moon Mimas is dominated by a huge impact crater named Herschel
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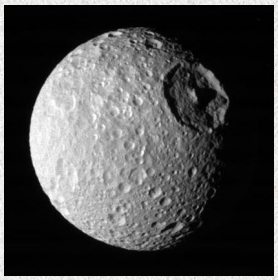
- The impact probably came close to destroying the moon
- The ejecta from this impact may be a possible source for the material in the rings



Enceladus

- The presence of the E-ring combined with the bright, smoothed surface suggested volcanism on Enceladus
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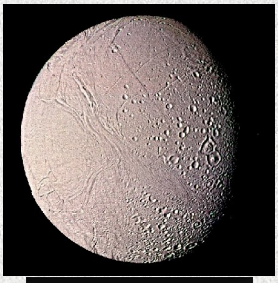
- Recent images from the Cassini mission revealed large plumes of water vapor erupting from a hot spot in the crust



The Large Moon - Titan

- Titan orbits Saturn at a distance of about 1.2 million kilometers
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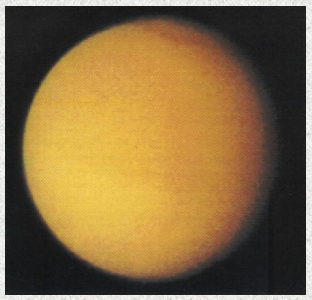
- Initial observations of Titan by the Voyager probes revealed a very thick atmosphere
- Neither probe was able to glimpse the surface



Titan's Atmosphere

- The top of Titan's atmosphere is a thin haze that is created by interactions with ultraviolet sunlight
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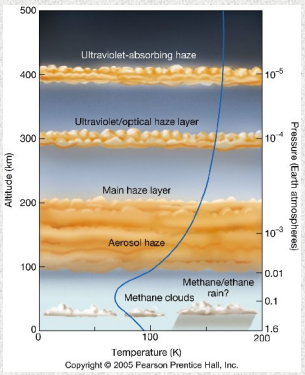
- It is made up of mainly nitrogen (>90%), some argon, methane, and traces of many other gases



Weather on Titan

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- This temperature is in just the right range that liquid methane should be abundant
- It is believed that methane on Titan acts much like water on Earth in terms of rain, lakes, oceans, and erosion

Titan's Surface

- The most detailed images of Titan's surface have come only in the past two years
- The Cassini-Huygens mission is designed to study Saturn, its rings, and its moons
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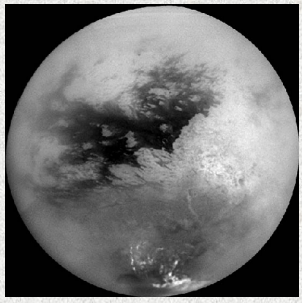
- These images from orbit reveal what may be large areas of liquid on the surface



The Huygens Lander

- The mission also included a lander which descended through the atmosphere and landed on the surface
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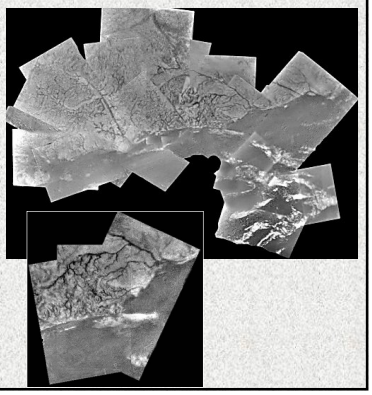
- Analysis is still being made on all the new data



Standing on Titan

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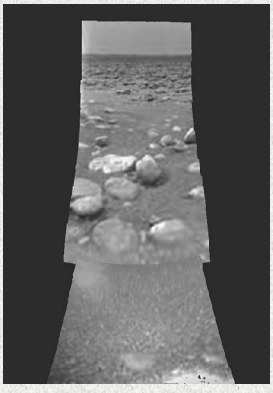
- The site was strewn with rounded rocks that appear to have been weathered by both wind and liquid
- Analysis of the surface material is still taking place



An Early Earth?

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- Many scientists believed the early Earth also contained an atmosphere and surface full of this 'chemical soup', which eventually spawned life
- Studying the chemical composition and reactions in Titan's atmosphere may give us insight into Earth's (and life's) early history