Rings, Moons and Pluto

September 30, 2002

1) Introduction
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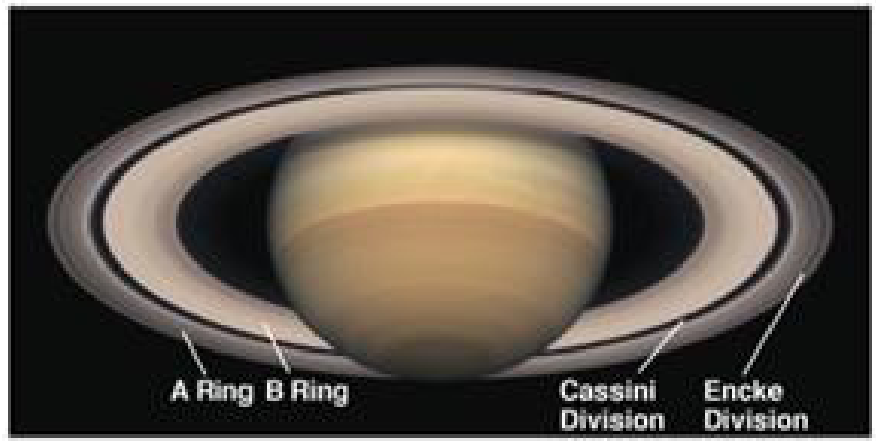
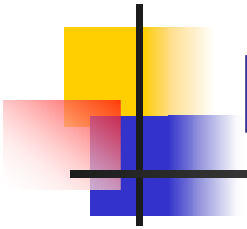




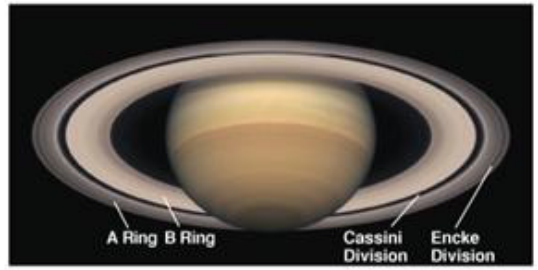
Review

- Outer Planets
  - Interior/Exterior
  - Gas Giants
    - Jupiter & Saturn
  - Ice Giants
    - Uranus & Neptune
- Tides
  - Forces
  - Tidal Resonances

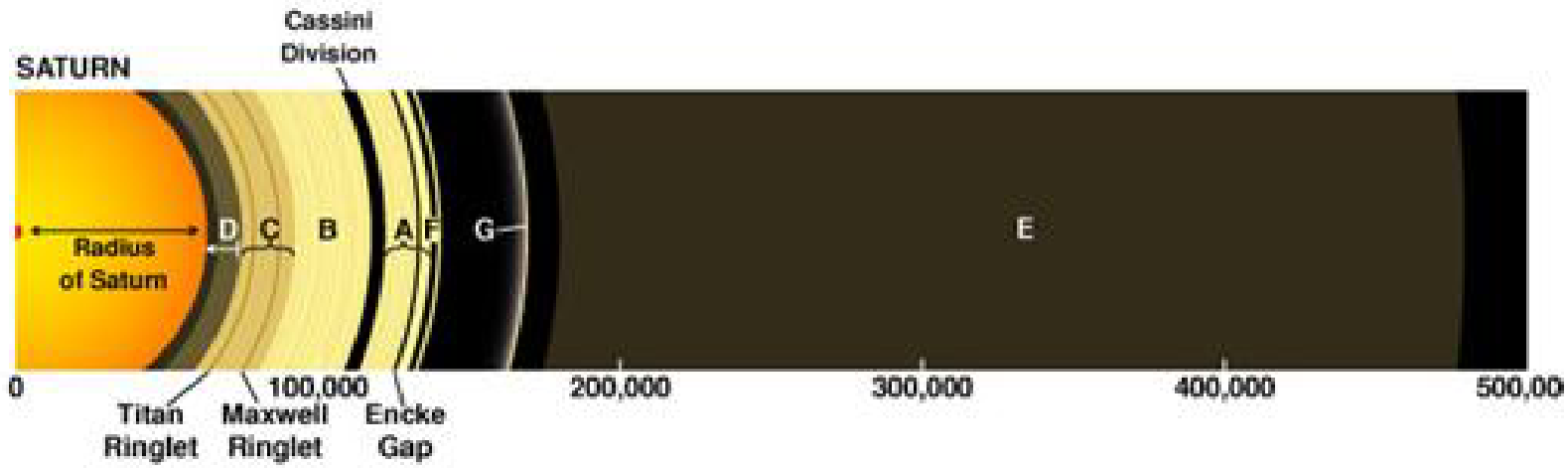
Rings

- All of the gas giants have rings
- Composed of lots of small particles
  - From tiny moons to dust
- Orbit planet because of its gravity
- Vary in thickness, density, material
- Contain structure
  - Divisions
  - Arcs
  - Spokes

Saturn's Rings



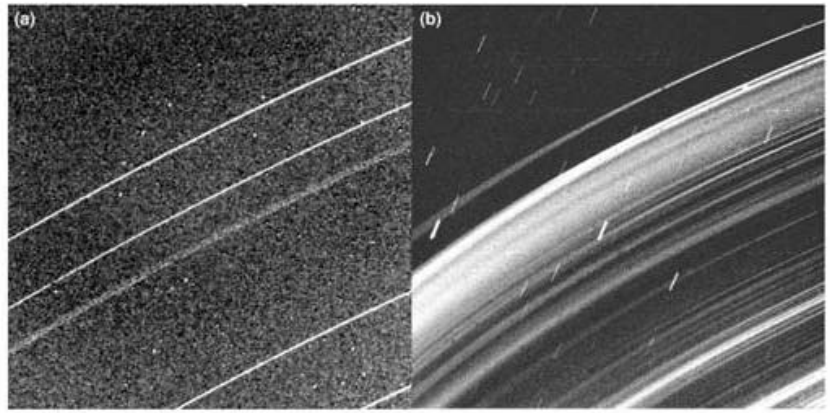
- Complicated, intense ring system
  - Ring A – bright, narrow, with gaps
  - Ring B – very wide with no gaps
  - Rings C&D – close to the planet
  - Rings E&G – very large, diffuse outer rings
- Cassini Division – separates the A&B rings



Other Rings

- Jupiter
  - best seen lit from behind
  - diffuse
- Uranus
  - 10 narrow rings
  - one wide ring close to planet
- Neptune
  - 3 narrow, 3 wide
  - arc-like segments within rings

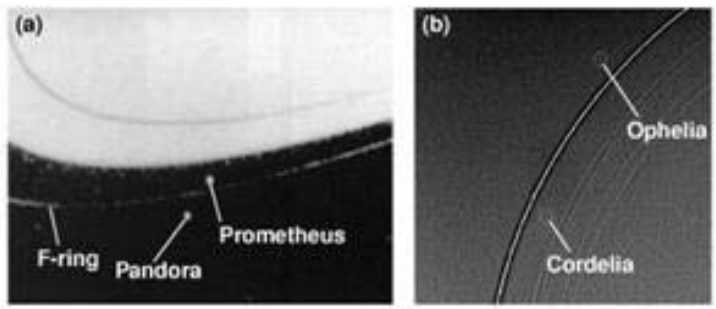
Ring Material



- Different rings, different materials, different appearance
  - Rings made of ice appear bright (reflect light)
  - Rings made of dust are visible when backlit
  - Dark, dim rings made of heavier materials, carbon and silicon
- Ring material comes from moons and comets
  - Material released from moons (volcanic plumes)
  - Material from moons and comets which break apart in giant planets gravitational field
- How do we know this
  - Saturn's rings are composed of materials similar to its moons
  - Rings of Uranus and Neptune are similar to material of carbon rich comets

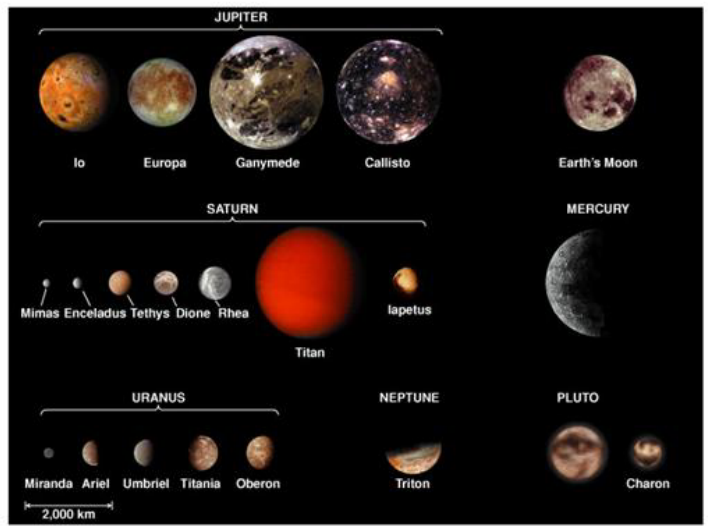
Ring Stability

- Rings want to spread out and disappear
- Can be held together by gravity and collisions
  - Temporary
- Can be held together by moons
  - Remember shepherd moons in *To Boldly Go*



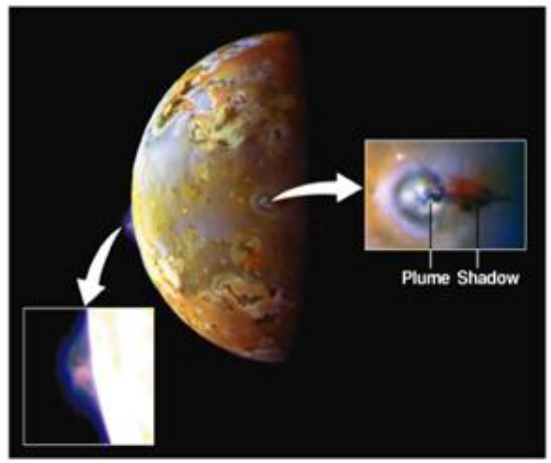
Moons

- There are more than 90 moons – mostly in the outer Solar System
  - Only 3 around the inner planets, Earth & Mars (2)
  - Wide range of sizes
  - Generally low mass and little or noatmosphere
- Categories – Geological Activity
  - Currently active (confirmed)
  - May be active
  - Probably was active at one time
  - Dead Moons

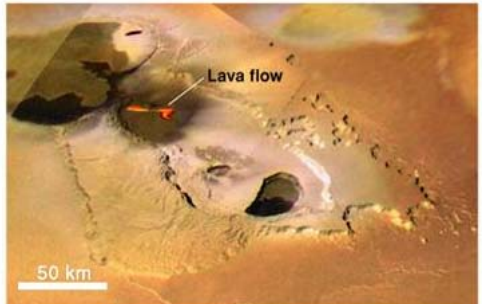


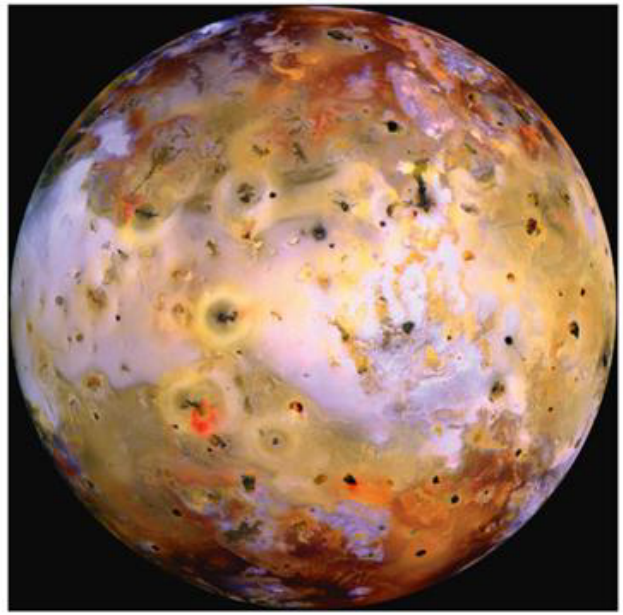
Determining Geological Activity

- Several ways to determine geological activity
- Appearance of surface
  - no craters means the surface has been recently "smoothed" – probably volcanic/tectonic
  - lots of craters mean no recent geological activity
- Observation of volcanic plumes
  - Seen by Voyager on Io and Triton
  - Remember *To Boldly Go*?



Io

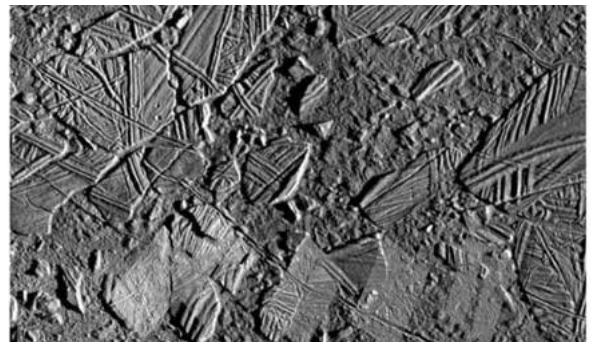




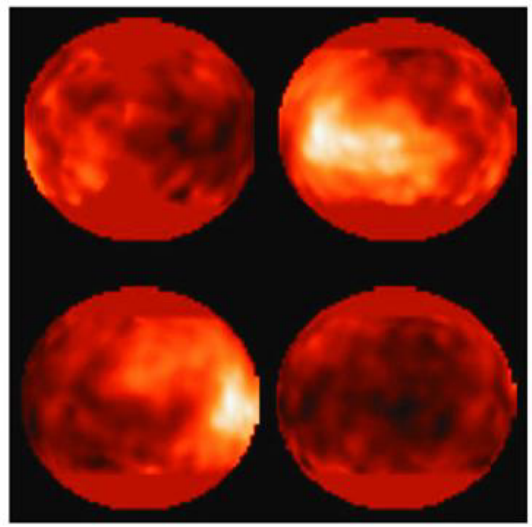
- Moon of Jupiter
  - Very close to Jupiter
  - Tidal forces heat the interior
- Very volcanically active
  - Most volcanically active object in the Solar System
  - Several plumes observed by Voyager
  - More than 300 volcanic sites have been identified
  - Probably has turned itself inside out at least once

May Be Active

- No observed activity, but evidence of activity at one time
  - less craters, more smooth surfaces

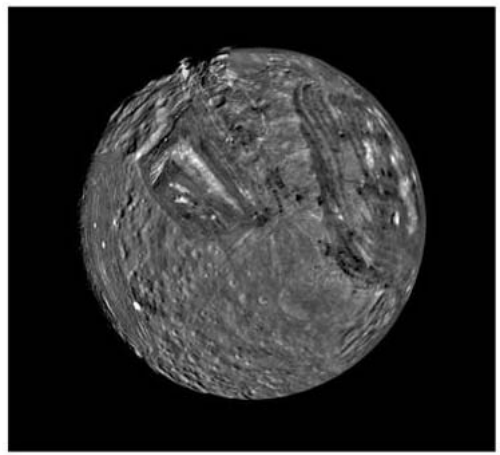


- Europa (Jupiter)
  - rock with icy crust
  - may contain liquid water below surface
  - evidence of internal heating
- Titan (Saturn)
  - dense atmosphere (35% denser than Earth's)
  - evidence of water ice and liquid methane



Active in the Past

- Evidence of past geological activity, but not recent
  - some reshaped surfaces, but lots of craters
  - can be volcanic, tectonic or ice flow
- Ganymede (Jupiter)
  - largest moon in the Solar System
  - intense tectonic activity in the past
- Tethys & Mimas (Saturn)
- Dione & Rhea (Mars)
- Miranda & Ariel (Uranus)

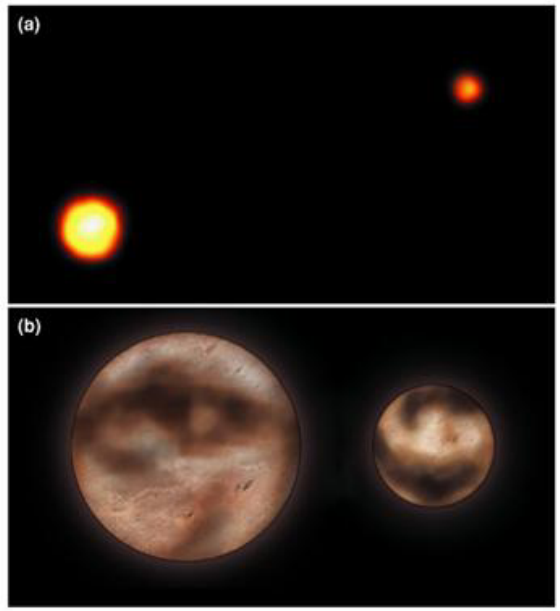


Dead Moons

- No signs of geological activity since formation
  - lots of craters
- Include:
  - irregular moons
    - often captured or remnants of older moons
  - Callisto (Saturn)
    - confusing data on formation/history
  - Umbriel (Uranus)
    - why wasn't it active?

Pluto

- Farthest of the planets (most of the time)
  - Occasionally is closer than Neptune (elliptical orbit)
- Orbit takes 248 Earth years
- Charon
  - Moon with 1/2 mass of Pluto
  - Pluto and Charon are tidal locked
- Mass of Pluto + Charon is 1/418th that of Earth
  - Rock, ice and methane
  - Similar to Europa
- Like other objects in Kuiper Belt…
  - Today, would not be classified a planet

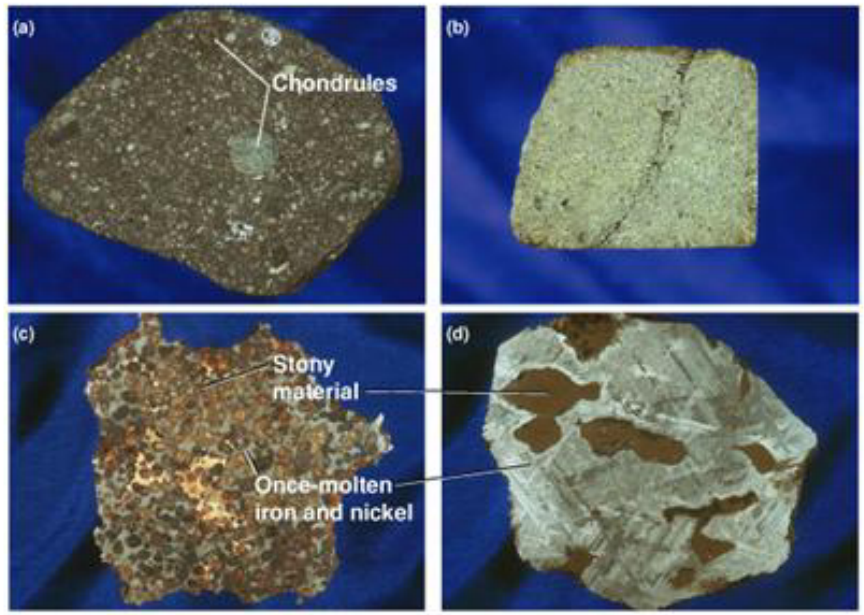


Other Bodies

- The solar system contains a number of other small bodies
- Planetesimals from the formation of the Solar System which did not become part of a planet or moon
  - or pieces of a planet or moon which have broken apart
- Comets
  - icy objects from the far outer solar system
- Asteroids
  - rocky planetesimals from the inner solar system
- Meteors
  - pieces of comets or asteroids which fall to Earth

Meteors

- Parts of the Solar System that come to us
  - some of the most studied astronomical objects
- Categories
  - stony meteorites
  - iron meteorites
  - stony-iron meteorites
  - category depends upon source of meteor



Asteroids

- Classification depends upon formation
- C-type
  - cooled without differentiation
  - snapshot of material of early Solar System
- S-type
  - differentiated – iron core, silicate crust
- M-type
  - iron core without crust