Announcements

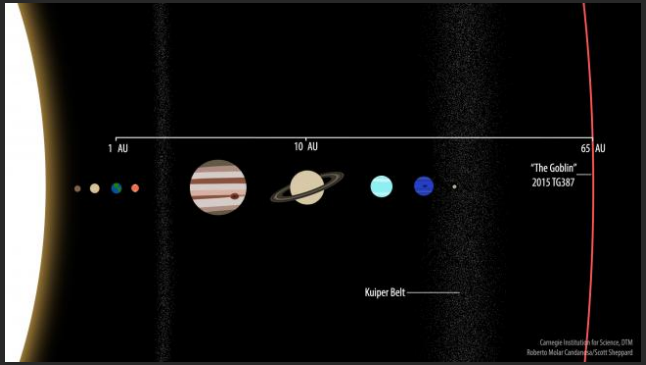
- WebWorK due on Wednesday
- Lab Group B tonight!
  - Largely computer based, so feel free to bring your laptops
- Latest grade reports posted
- Polling: `rembold-class.ddns.net`

The Sky Tonight

- Bright ISS crossings
  - Tonight at 8:36 to the NW
  - Tomorrow at 8:29 to the NW
- Bright Iridium Flares
  - REALLY bright one this morning at 6:04
  - Another very bright one tomorrow morning at 5:58:23, low to the North
  - A fairly bright one at 7:31:22pm about 53° above the horizon to the SSE
- Fun fact: The APOD for yesterday was the Scale of the Universe applet we played with on the first day!

THE GOBLIN!

- New dwarf planet!
- Originally seen around Halloween
- Hugely elliptical orbit
  - Closest about 65 AU
  - Furthest about 2300 AU



Review Question

Why does Jupiter has such extreme weather?

A. Because it is very massive
B. Because it is gravitationally perturbed by Saturn
C. Because its size makes it more heavily influenced by the solar wind
D. Because it rotates very fast

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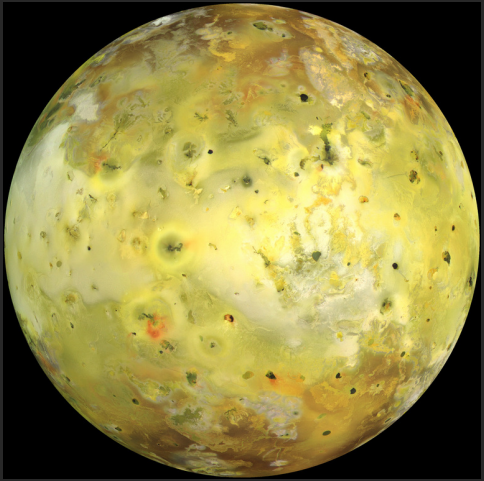
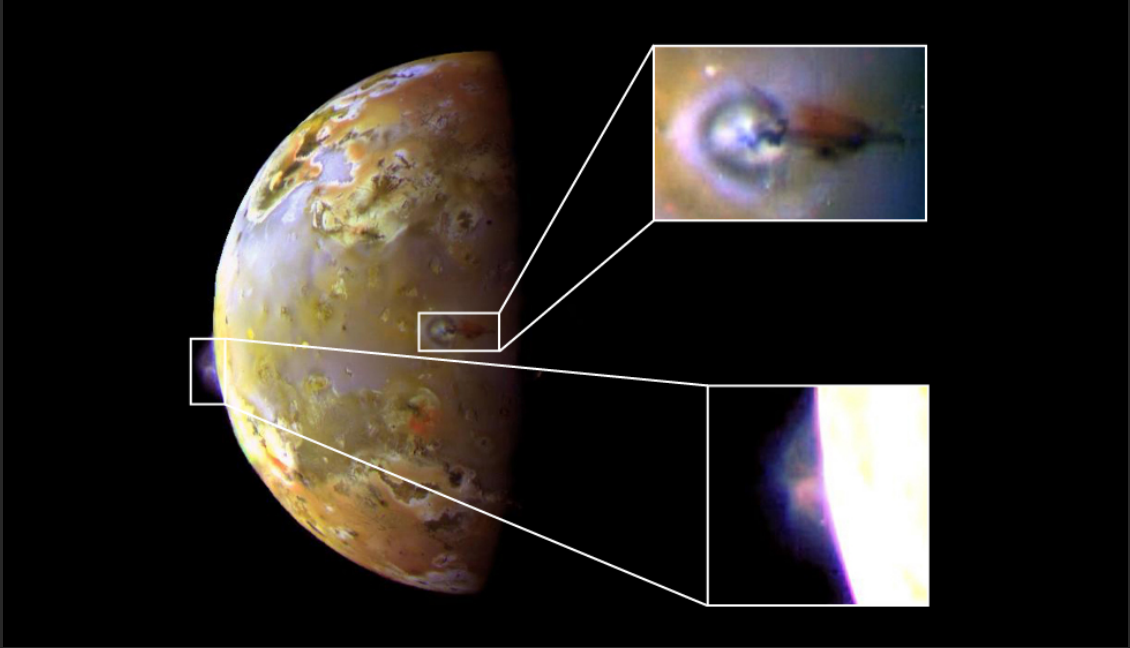
Let's Talk Moons

- Commonly called planetary satellites
- A large variety of sizes and shapes
  - Jupiter: 67
  - Saturn: 62
  - Uranus: 27
  - Neptune: 14
- We'll look at the biggies

Galilean Moons: Io

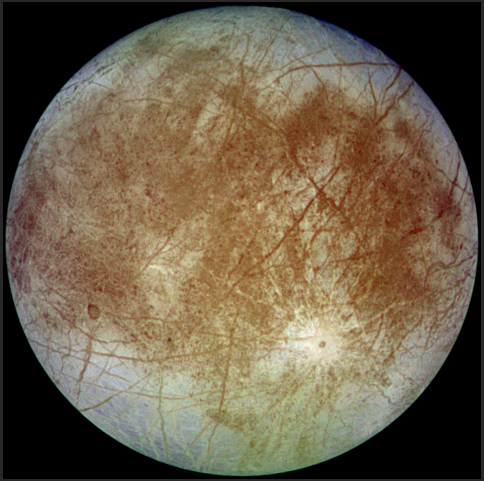
- 3rd largest $\approx$ Moon sized
- Extremely volcanically active
- Why still so hot?
- Forces from Jupiter and the other moons squeeze and stretch the planet





Galilean Moons: Europa

- Smallest of the Galilean moons
- Covered in water ice!
- May hide liquid water oceans inside
- Life?



Galilean Moons: Ganymede

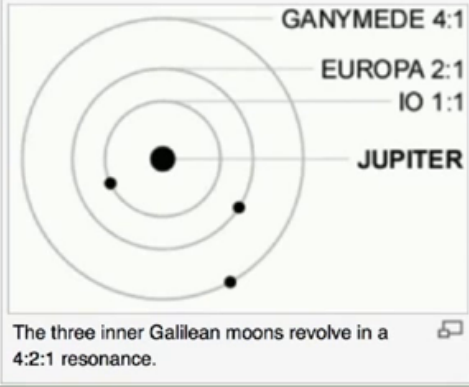
- Largest moon is Solar System
- Larger than Mercury!
- Water ice on surface
- Subsurface ocean?

Galilean Moons: Callisto

- Furthest from Jupiter
- Second largest
- Largely cratered
- Potentially also has a subsurface ocean?

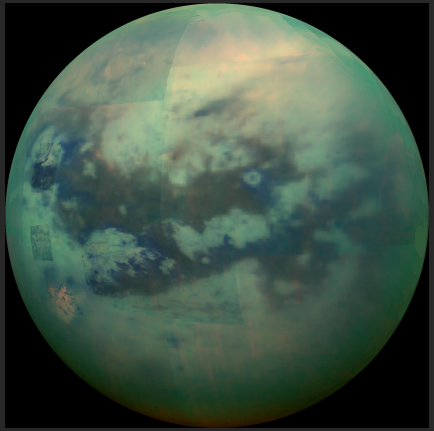
Orbital Resonance

- The Galilean moons influence each others orbits
- Locked in a 1:2:4 resonance



The Titan

- Largest moon of Saturn, second largest in the Solar System
- Has a thick atmosphere
- Atmosphere largely Nitrogen, methane and ethane
- Greenhouse has slight warming, but still cold (-180 °C)
- Geologically active
- Chemistry produced organic chemicals
- Huygens probe:
  - River valley's and shorelines
  - Crust hard but a bit squishy
  - Ice boulders rounded by erosion
- Many similarities to Earth, but with liquid methane instead of water



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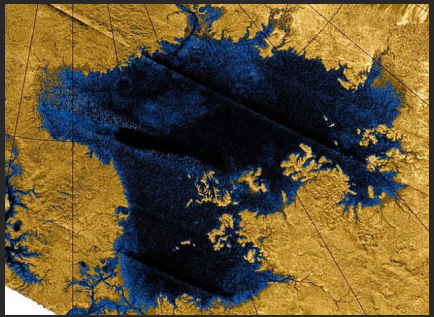
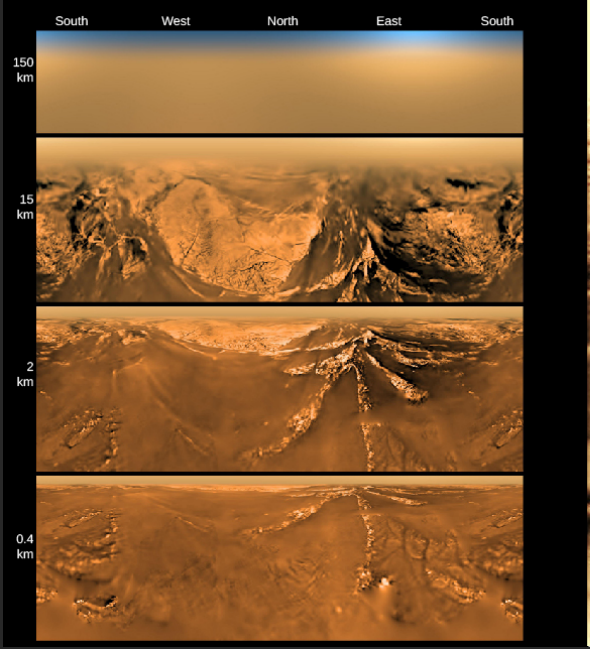
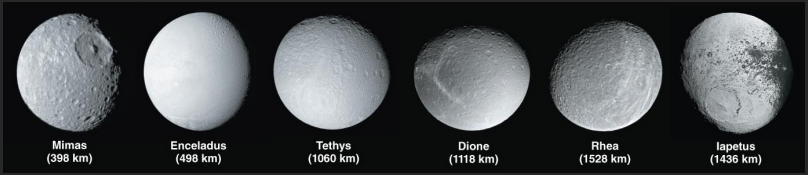



South
West
North
East
South
150 km
15 km
2 km
0.4 km

Further large moons

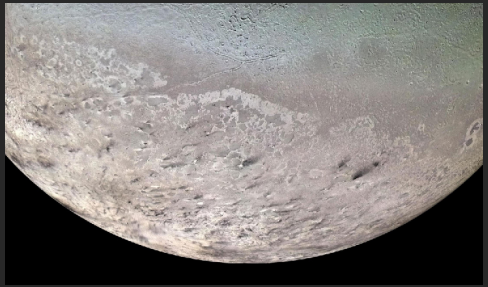
- Saturn:



- Uranus
  - 5 medium-sized moons
  - At least 3 geologically active
  - Miranda:
    - Smallest, but with huge tectonic features and few craters

Triton

- Geologically active
- Backward rotation
- Captured from a binary?



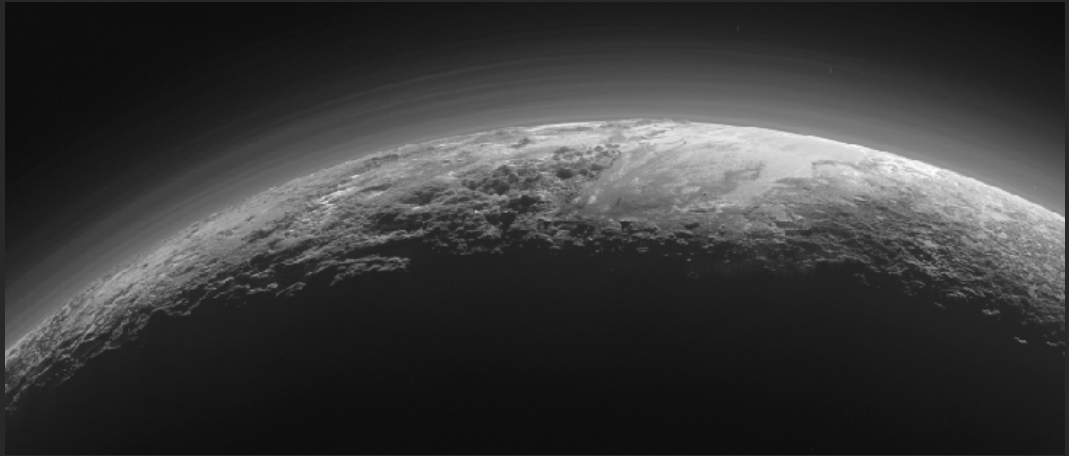
Hot and Bothered

- We know internal temperature is related to:
  - Size of object
  - Distance from Sun
- Why then are so many of the jovian moons geologically active, when they are barely bigger than our geologically dead moon?
  - Tidal Heating
  - Hydrocarbons boil and become liquid easier than rock and metal
  - "Ice geology" possible at lower temperatures than "Rock geology"

Pluto

- Systematically search for
  - Was very mildly perturbing Uranus's orbit
  - Hypothesized to be much larger than it ended up being
- Originally thought to be Earth sized
  - Only the discovery of its moon Charon in 1978 let us realize otherwise
- Charon itself is half the size of Pluto

Pluto Terrain Variation

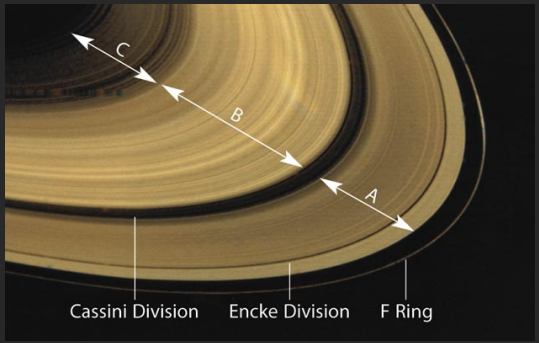


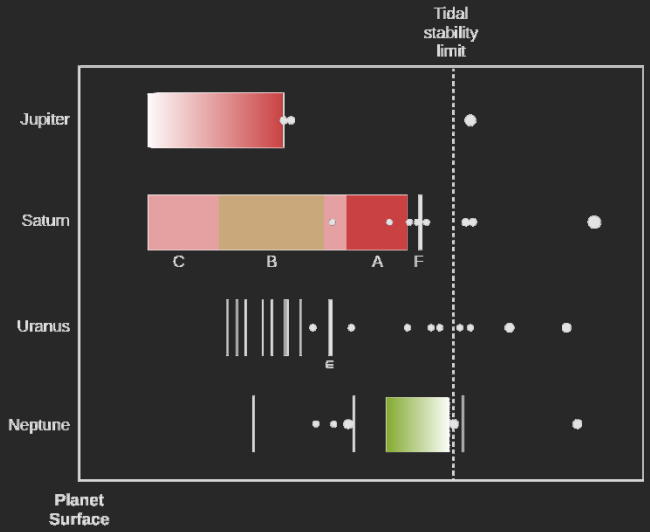
Pluto Terrain Variation

Put a Ring on It

- Saturn the most popular, but all jovian systems have rings
- Largely comprised of dust and reflective ices
- Saturn just has an more dust and more reflective ices to make them so obvious

Features and Formation



- What causes gaps?
  - Small moons can "clear a lane" as they orbit in the rings
  - Gap moons or "Shepard moons"
  - Repeated tugs from more distance moons
    - Cassini division from Mimas
- Why do they exist?
  - Likely not leftover from planet formation
  - Need to be replenished
  - Dust/Ice formed from bits being slowly blasted off nearby moons?

Ring Stability