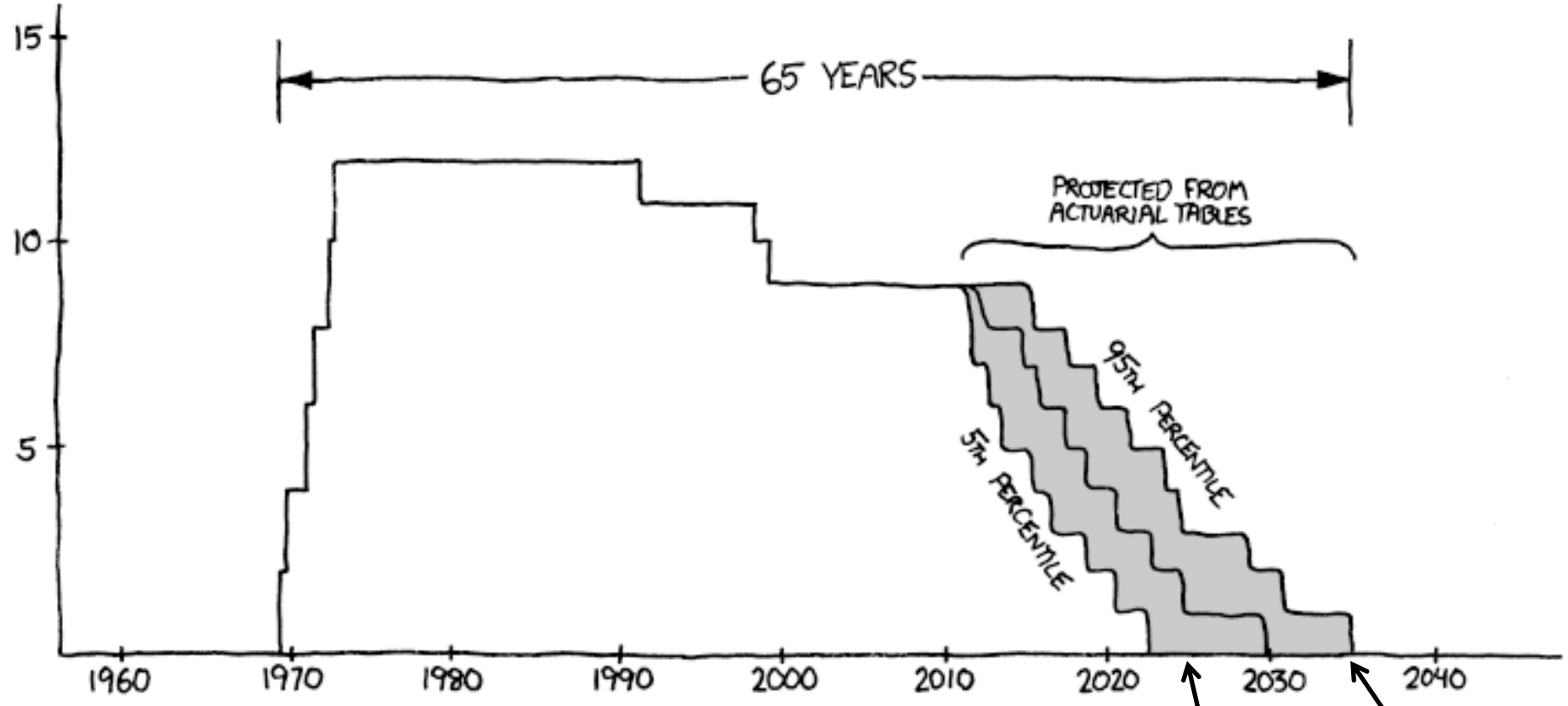
Are we a multi-planet species or not?



NUMBER OF LIVING HUMANS WHO HAVE WALKED ON ANOTHER WORLD

http://xkcd.com/893

asteroid?

Mars orbit?

Later this Fall: Observatory Night

Where: Roof of Howey Physics building

When: Sep. 26th – W

Oct. 24th – W

Sep. 24th – M

Oct. 22nd – M

What time: TBA,

after dark!

Thanks to
Dr. Jim Sowell !

Survey of the Solar System

The Sun

Giant Planets

Terrestrial Planets

Minor Planets

Satellite/Ring Systems

Satellites

All but two planets (Mercury & Venus) have satellites, as do several asteroids and minor planets

The giant planets have tens of satellites each

Have a broad spectrum of variability

Satellites

Giant Planet Satellite Systems:

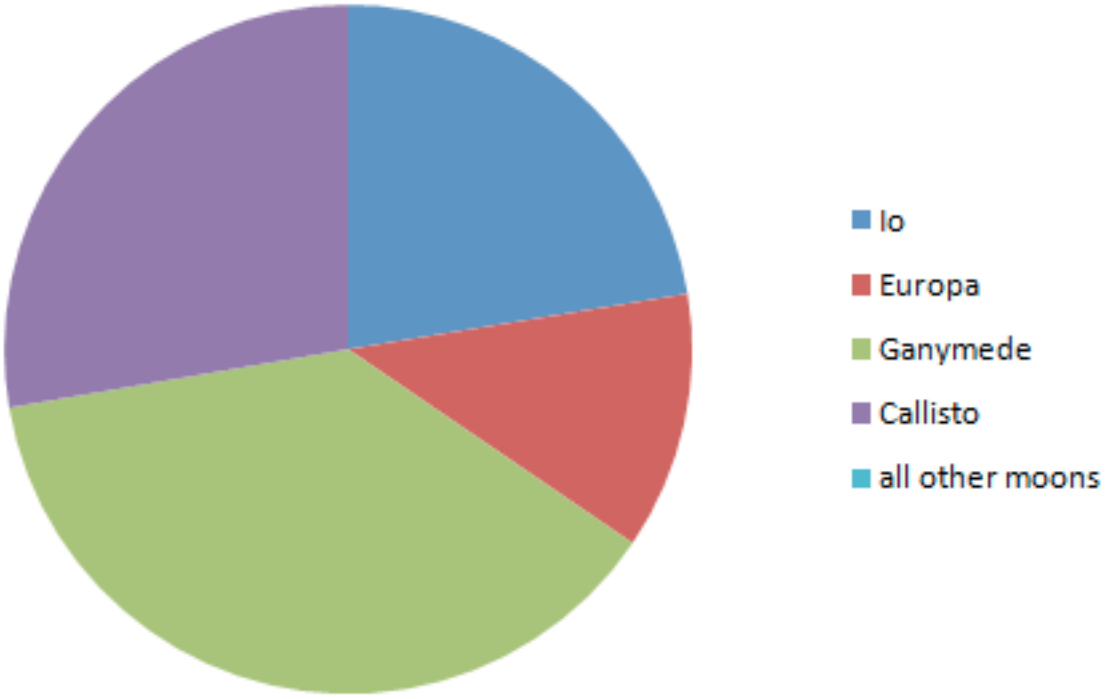
Tens of moons (J–66, S–62, U–27, N–13)

Inner moons in prograde orbits about planet and close to the equatorial plane with low eccentricity

Distant moons can orbit in any direction, at any inclination and with extreme eccentricity

Photo by Jan Sandberg

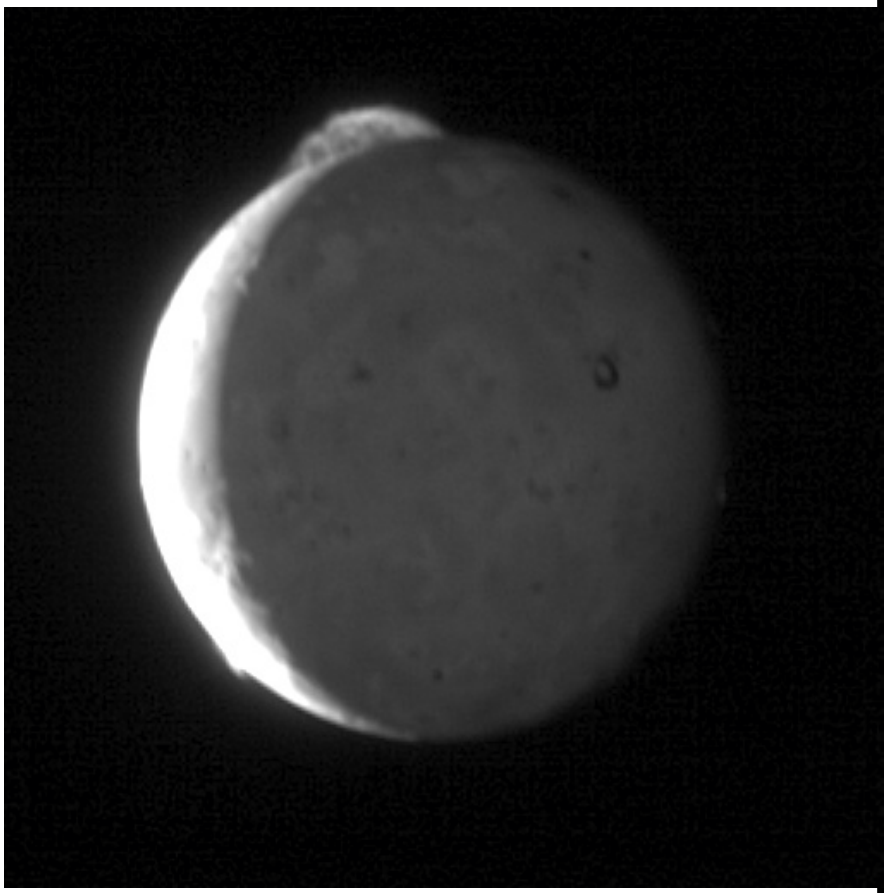
Not all moons carry equal weight…



Satellites

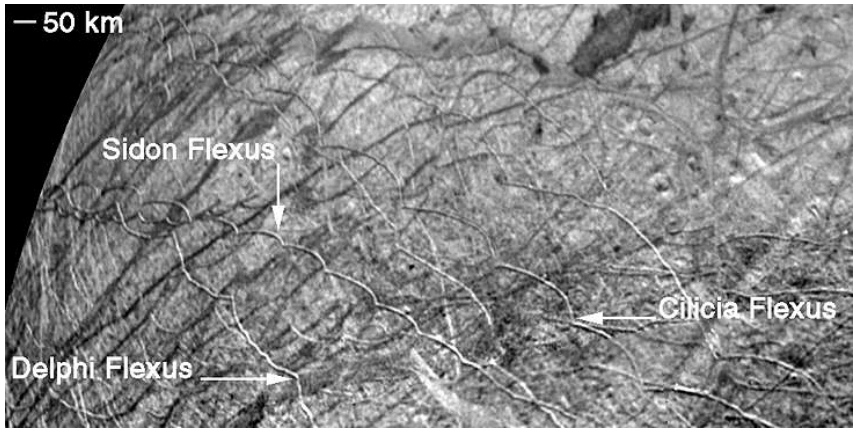
Giant Planet Satellite Systems:

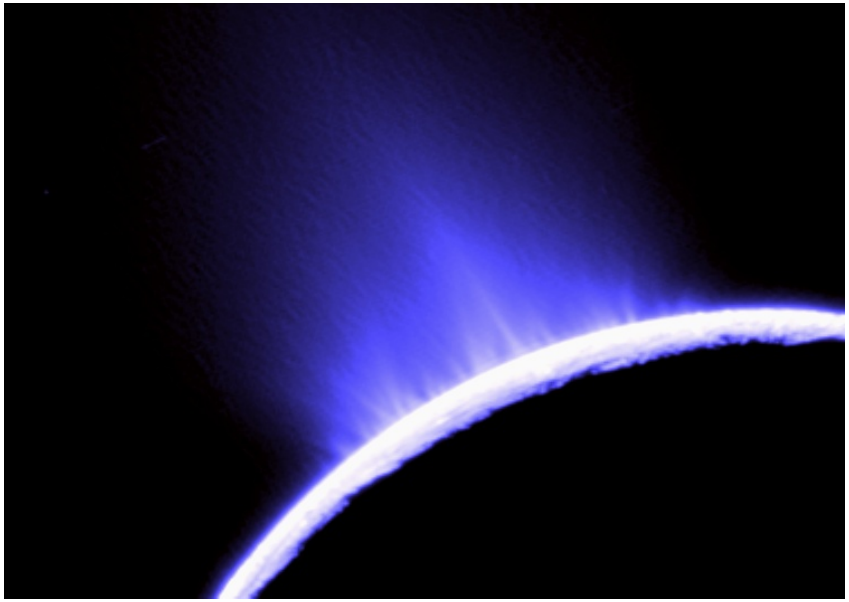
Tidal forces due to orbital eccentricity and changing gravity from other moons can generate significant interior heat for moons



Satellites

- Giant Planet Satellite Systems:
- Tidal heat could potentially be translated to driving volcanic activity, heating a subsurface layer, etc.



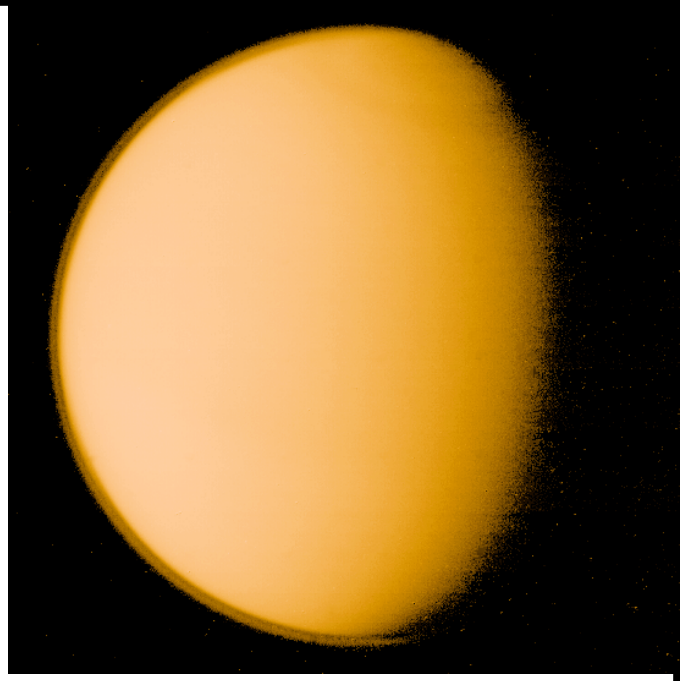


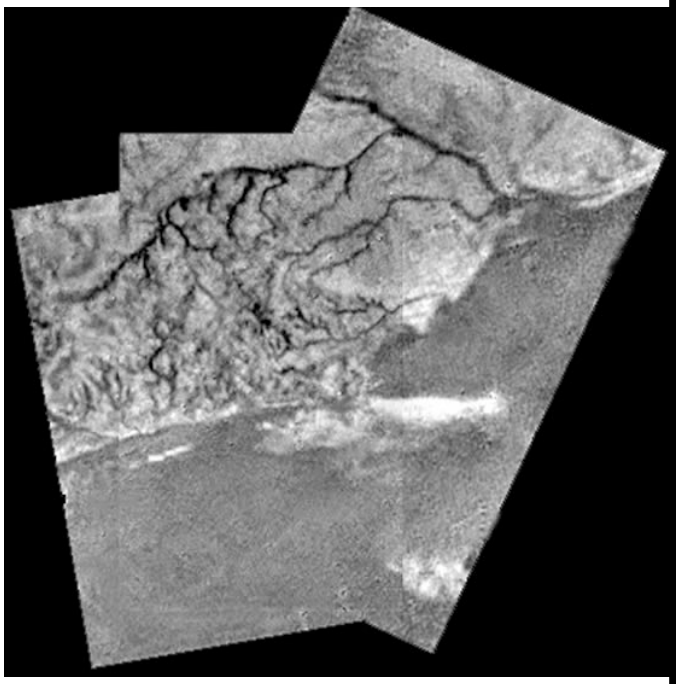
Satellites

Giant Planet Satellite Systems:

Diffuse atmospheres have been detected at several moons, including: Io, Ganymede, Enceladus

Titan's atmosphere is thicker than Earth's



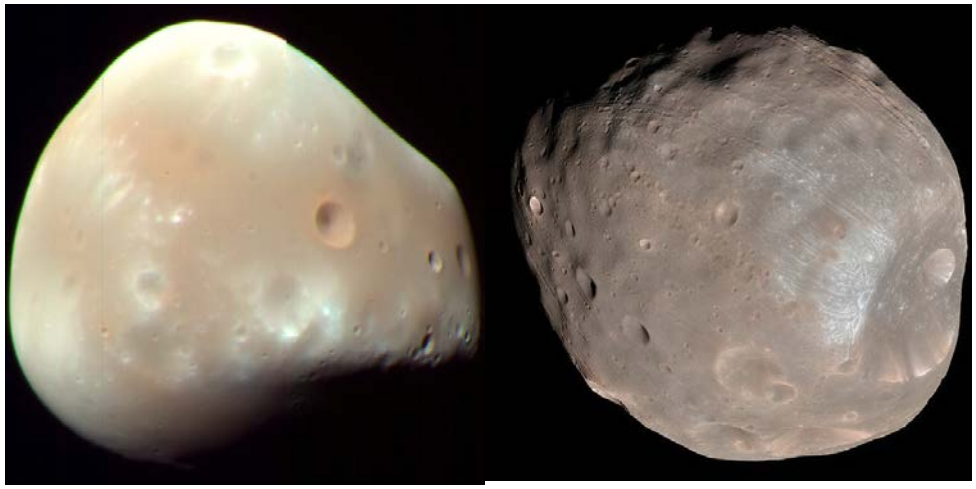


Satellites

Terrestrial Moons:

Earth's moon thought to be from a large impactor early in the solar system's history

Mars's two moons appear to be captured asteroids likely from the nearby asteroid belt.



Deimos & Phobos from MRO

Satellite Sizes

- Pluto and Earth have largest moons relative to their size; both are likely formed from the impact of secondary planetesimals
- Ganymede and Titan are larger than Mercury
- Smallest moons are ~ km in size

Earth and Moon
from Messenger spacecraft

Ring Systems

- Only giant planets have confirmed ring systems
- Generally thought to reside within a few radii of the planet (but recent observations show otherwise!)
- Characteristics are quite variable between systems (e.g., Neptune arcs), raising many questions with respect to ring formation, life expectancy, and evolution.

Ring Systems

Saturn:

Most observed and dynamic of the ring systems

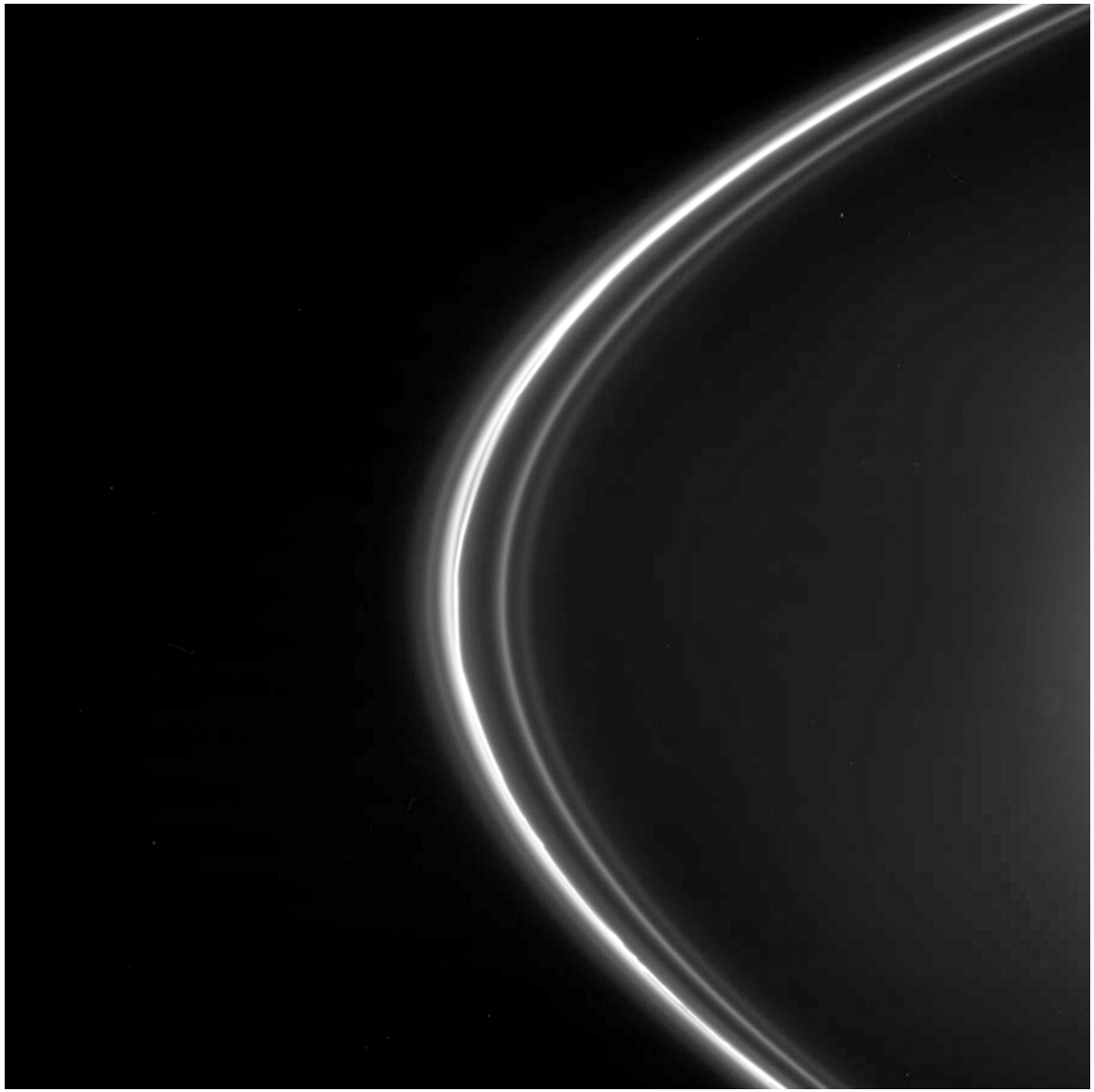
Ring particles are made nearly entirely of water ice, with some dust and other chemicals

Sun eclipsed by Saturn from Cassini

Ring Systems

Saturn:

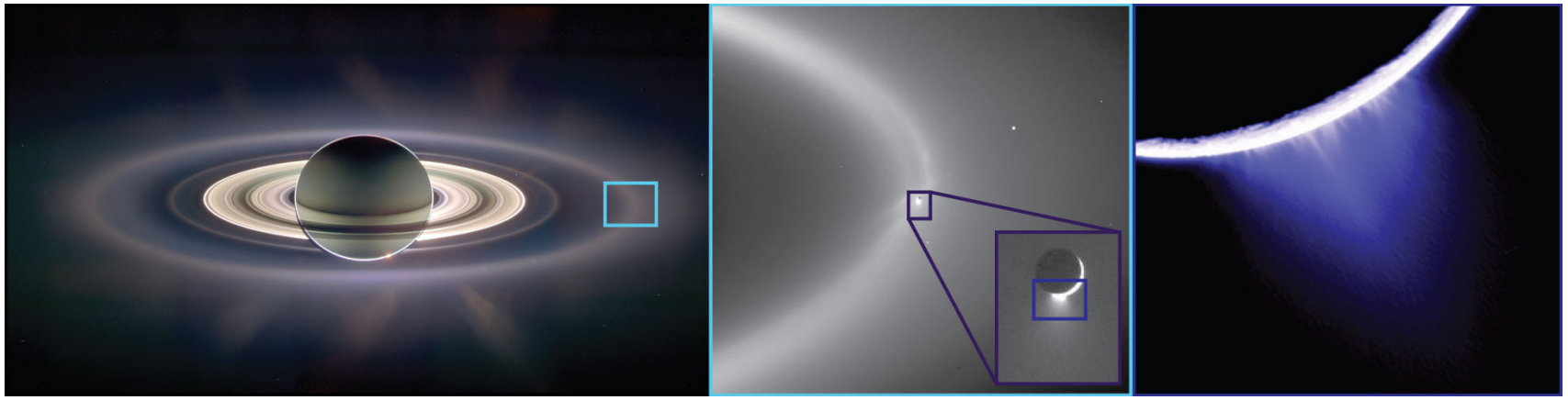
Rings dynamically shaped by moons causing waves, channels, gaps, etc.



Ring Systems

Saturn:

E Ring sourced from cryovolcanism on the moon Enceladus

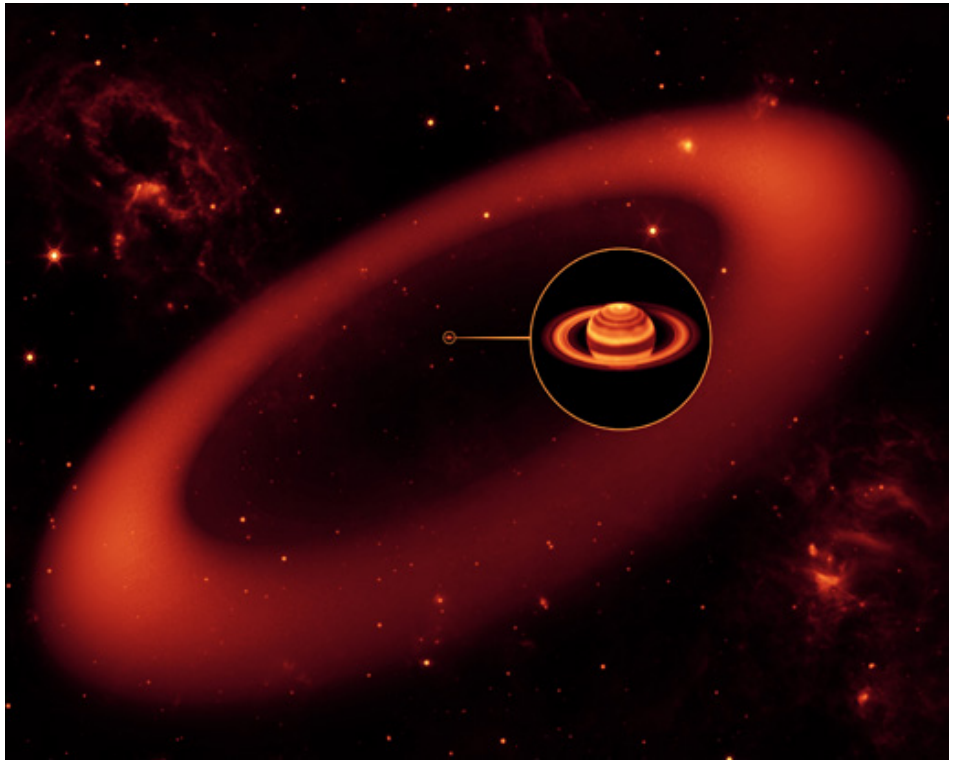


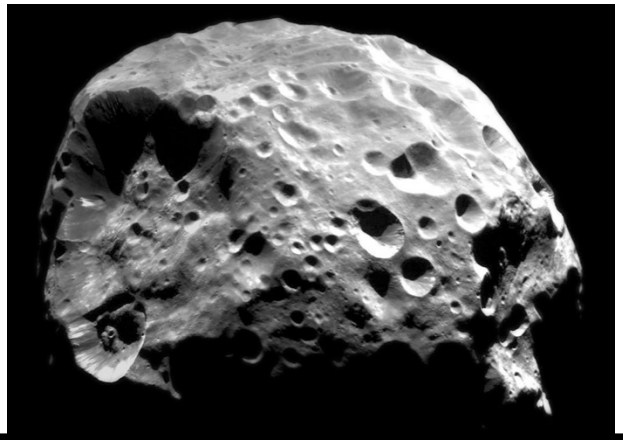
Ring Systems

Saturn:

Latest ring discovery by Spitzer Space Telescope: ring orbiting at 100 R_s and tilted 27º from inner ring plane

Corresponds to orbit of irregular moon Phoebe





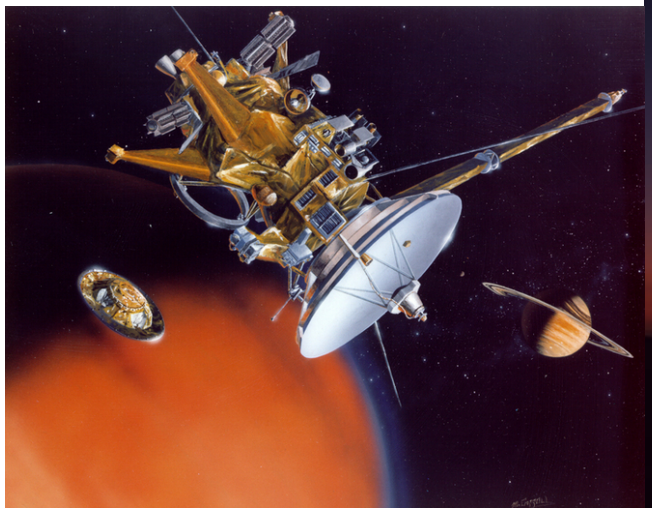
Observables vs. Inferables

Observations

Remote Sensing

In Situ

Inferring Properties

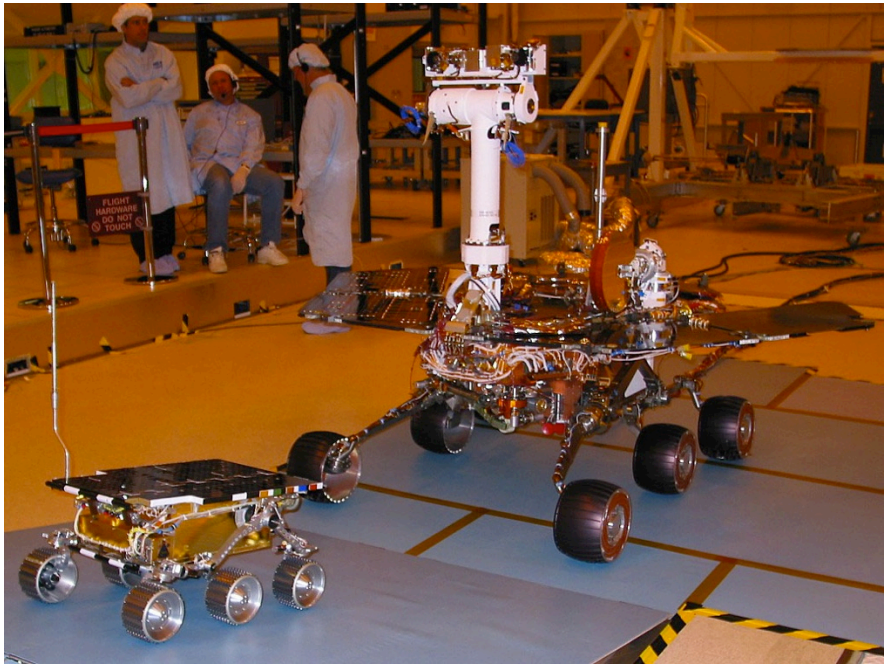


Hubble
Cassini
Keck

Planetary Properties

Orbit
Mass
Size
Rotation
Shape
Temperature
Magnetic Field
Surface Composition
Surface Structure

Bulk Composition
Interior Structure



Mars rovers: Sojourner and MER

Observations

Remote Sensing:

Can be Earth-based or satellite-based

Generally refers to studying distal phenomenon by observing the electromagnetic spectrum emitted/ perturbed that propagates to the observer (I.e. to a telescope, camera, antenna, etc).

Observations

In Situ:

Observations made by the observer or via spacecraft/rockets/balloons/rovers of their local environment

Can serve to observe properties such as composition, magnetic field, neutral/ plasma populations and energy, dust; can also calibrate remote sensing observations

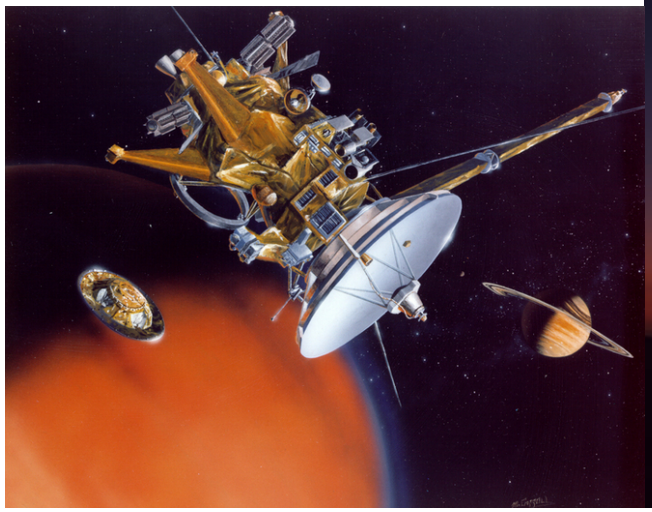
Observables vs. Inferables

Observations

Remote Sensing

In Situ

Inferring Properties

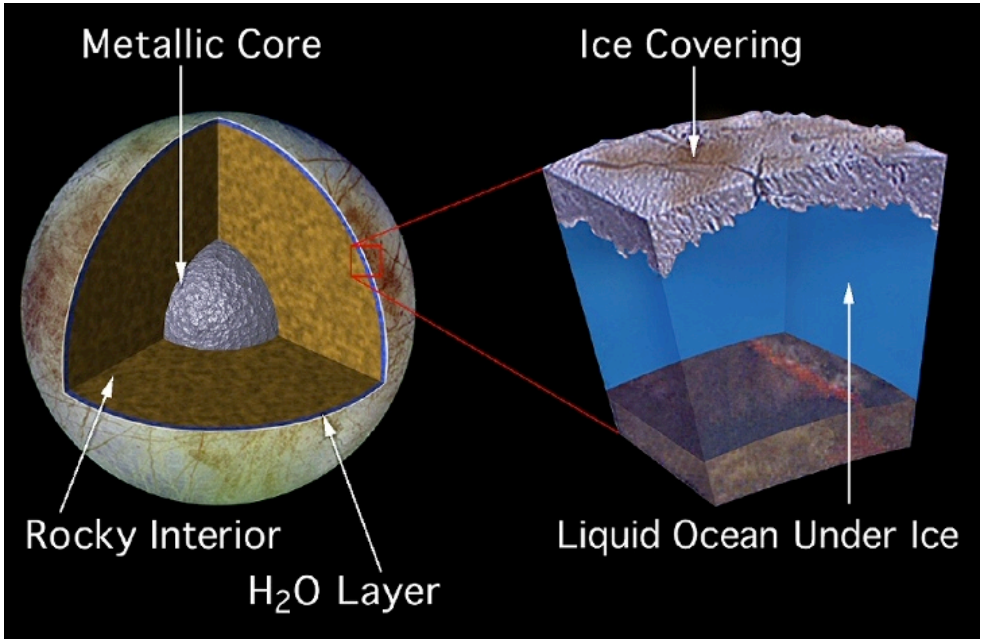


Hubble
Cassini/Huygens
Keck

Planetary Properties

Orbit
Mass
Size
Rotation
Shape
Temperature
Magnetic Field
Surface Composition
Surface Structure

Bulk Composition
Interior Structure



Inferred Quantities

Several characteristics can be determined from a combination of observations and theory constrained by those observations

Examples include internal structure and existence of a subsurface ocean to name a few…