The moons of the planets

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22th of October 2007

The planets of our solar system

Our solar system contains eight planets. Beginning with the closest one to the sun they are in order:

- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune

The moons in our solar system

- at least 166 known moons orbiting a planet
- amount varies intensely
- some planets don't have a moon
- to Jupiter (which has the most moons) belongs 63 of them

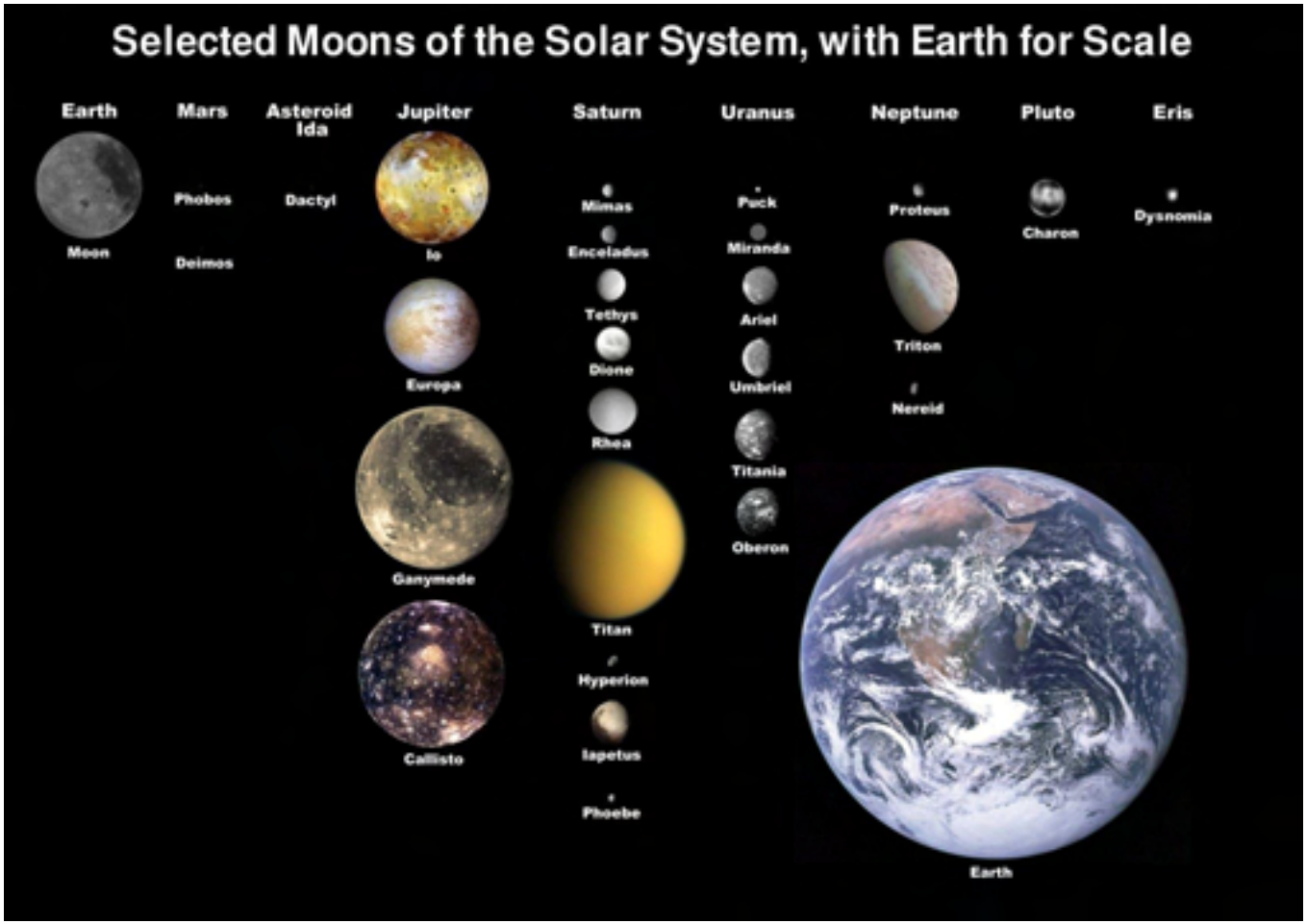
History

- The first known moon was Luna (Earth's Moon).
- 1610: Galilei discovered the first moons belonging to another planet (Jupiter): Io & Ganymede
- Nowadays, the 4 biggest moons of Jupiter are called 'Galilean moons'.
- This observation of objects, which are not orbiting the Earth was an argument for the heliocentric and against the geocentric philosophy.
- Christiaan Huygens was the first person, who discovered another moon (Titan, one of Saturn's moons) and called it a moon as well.
- $\Rightarrow$ relation between Saturn and Titan is the same like between Earth and Luna, the moon orbits its planet.

The amount of moons

Planet	Number of moons	some moons
Mercury	0	-
Venus	0	-
Earth	1	Luna
Mars	2	Phobos, Deimos
Jupiter	63	Io, Europa, Ganymede, Callisto
Saturn	60	Titan, Hyperion, Enceladus, Epimetheus, Janus
Uranus	27	Miranda, Ariel, Umbriel, Titania, Oberon
Neptune	13	Proteus, Triton

Some moons with Earth for scale



What is a moon?

A moon is a natural satellite in a solar system.
Definition:

- a celestial body or a galaxy, which revolves around a planet, a dwarf planet or other smaller objects like an asteroid for example
- the satellite follows the other object on its orbit around the central star of a solar system

Important facts about moons

inclination angular distance of the orbital plane of a moon relative to the planet's equatorial plane which it orbits

0° = orbit in the equatorial plane (direct motion)

90° = orbit in the polar orbit

180° = orbit in the equatorial plane (retrograde motion).

Important facts about moons

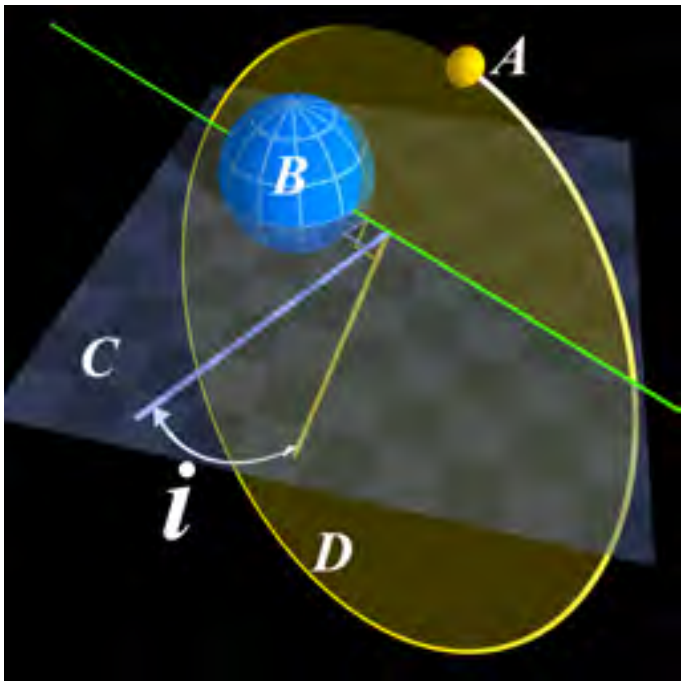


Figure: A=moon, B=planet, C=equatorial plane, D=orbital plane, i=inclination

Important facts about moons

direct (prograde) motion inclination of 0° to 90°

This signifies a moon orbiting its planet in the same direction as the planet orbits the sun.

retrograde motion inclination of 90° to 180°

So the moon orbits its planet in the contrary direction as the planet revolves around the sun.

Important facts about moons

regular satellite circular orbit and are all prograde

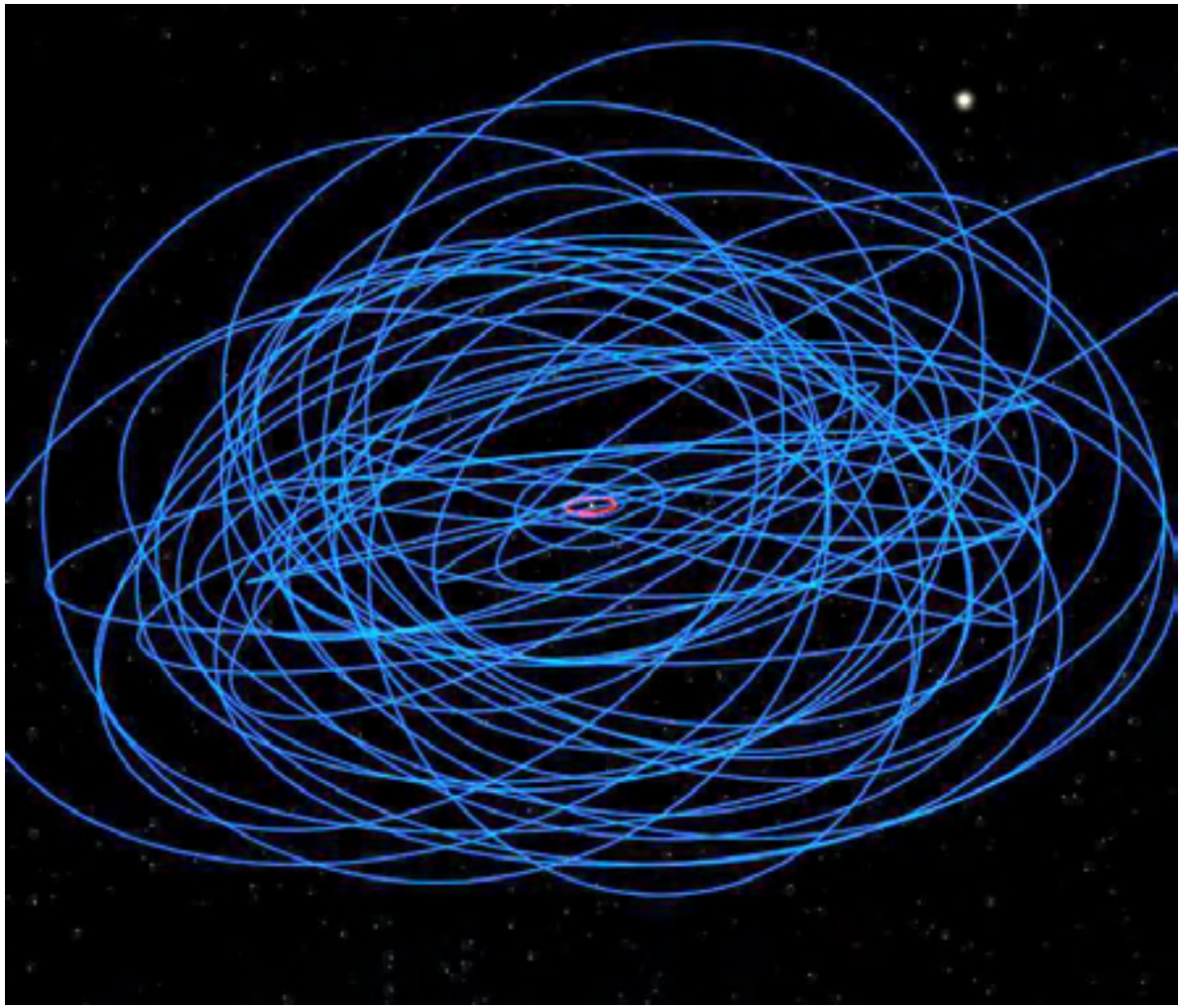
originated from the same collapsing region of the protoplanetary disk or results from a grand collision

irregular satellites do not have a circular orbit, they were probably asteroids captured by their planet

far enough from the planet so that the precision of their orbit is mostly controlled by the sun

retrograde motion in general, but there are moons with a direct motion

orbits of irregular satellites of Saturn



The Earth

The Earth

- Earth is the only planet with just one natural satellite, so Earth and Moon are the only double-planetary-system.
- Interesting: our moon has no real name. Most common: 'Moon' and 'Luna' (Latin name of the goddess of the moon).
- Up to now it is the only celestial body where humans have landed.
- Nowadays it has become a prime destination for many space projects.

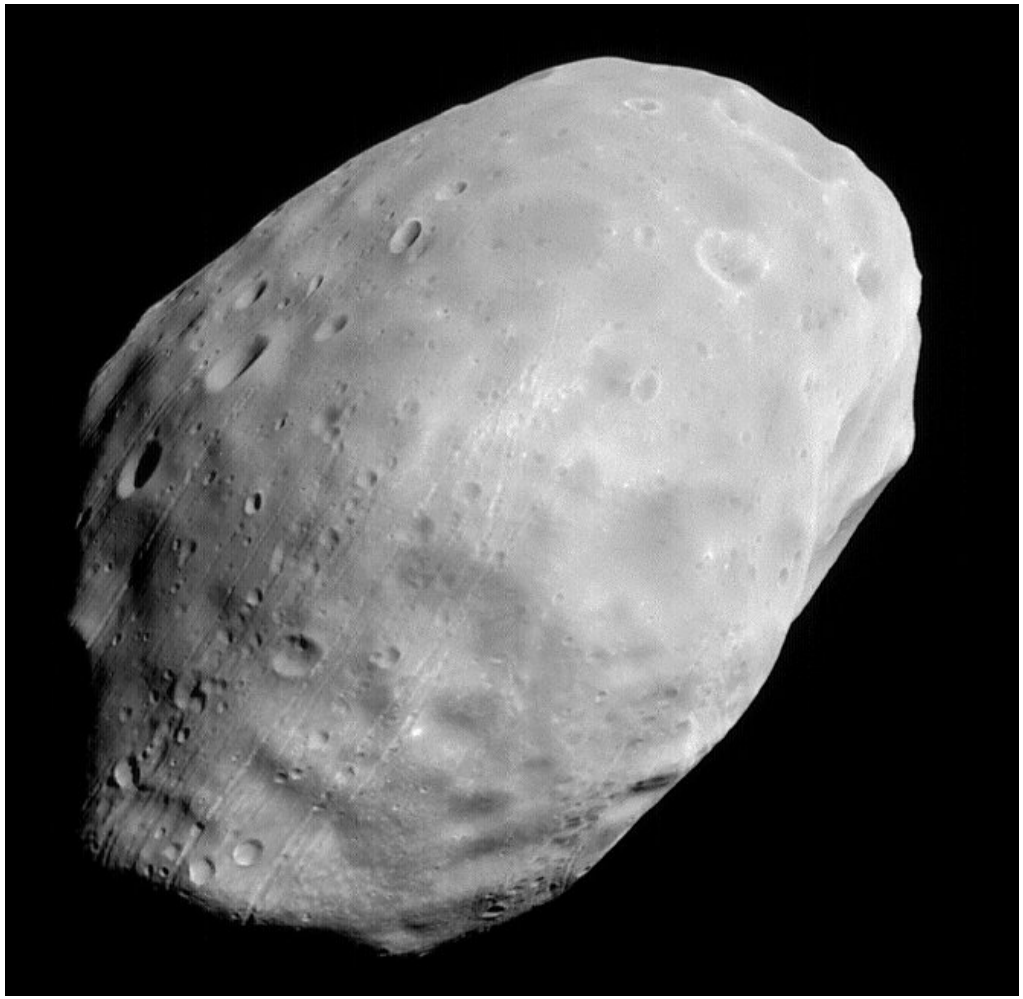
Luna

Luna

- fifth biggest moon in our solar system, average diameter of 3476km (about $\frac{1}{4}$ that of the Earth)
- gravitational acceleration is $1.62 \frac{m}{s^2}$
- average surface temperature is 274K
- orbits Earth in about 27 days, so once a month
- that is the origin of the name 'month'
- rotates at the same rate than it orbits $\Rightarrow$ we see only one side of Luna
- surface is heavily cratered; the largest impact crater, the Aitken basin, is also the largest known one in the entire solar system: diameter = 2240km, depth = 13km

Mars

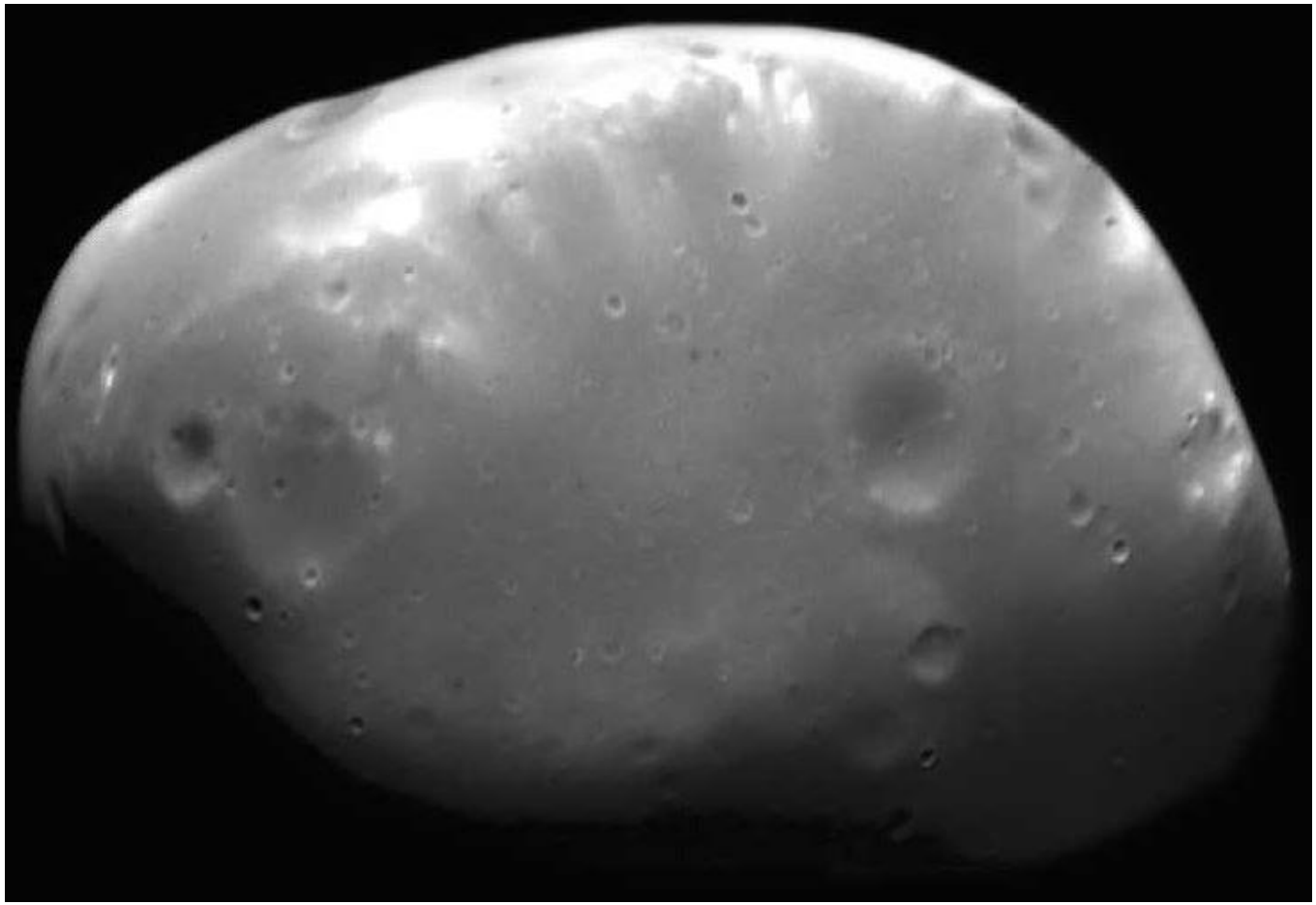
Phobos



Phobos

- the larger one of the two tiny moons
- irregular shaped and for this reason expected as a captured asteroid
- its surface shows a lot of craters
- retrograde moon, from Mars' surface you will see it rise in the West and set in the East
- orbit so close $\Rightarrow$ moves faster than Mars spins $\Rightarrow$ rises two times a day
- close orbit $\Rightarrow$ not visible at high latitudes from the surface of Mars $\Rightarrow$ moves below the horizon
- $\Rightarrow$ you can see a solar eclipse every time Phobos orbits Mars

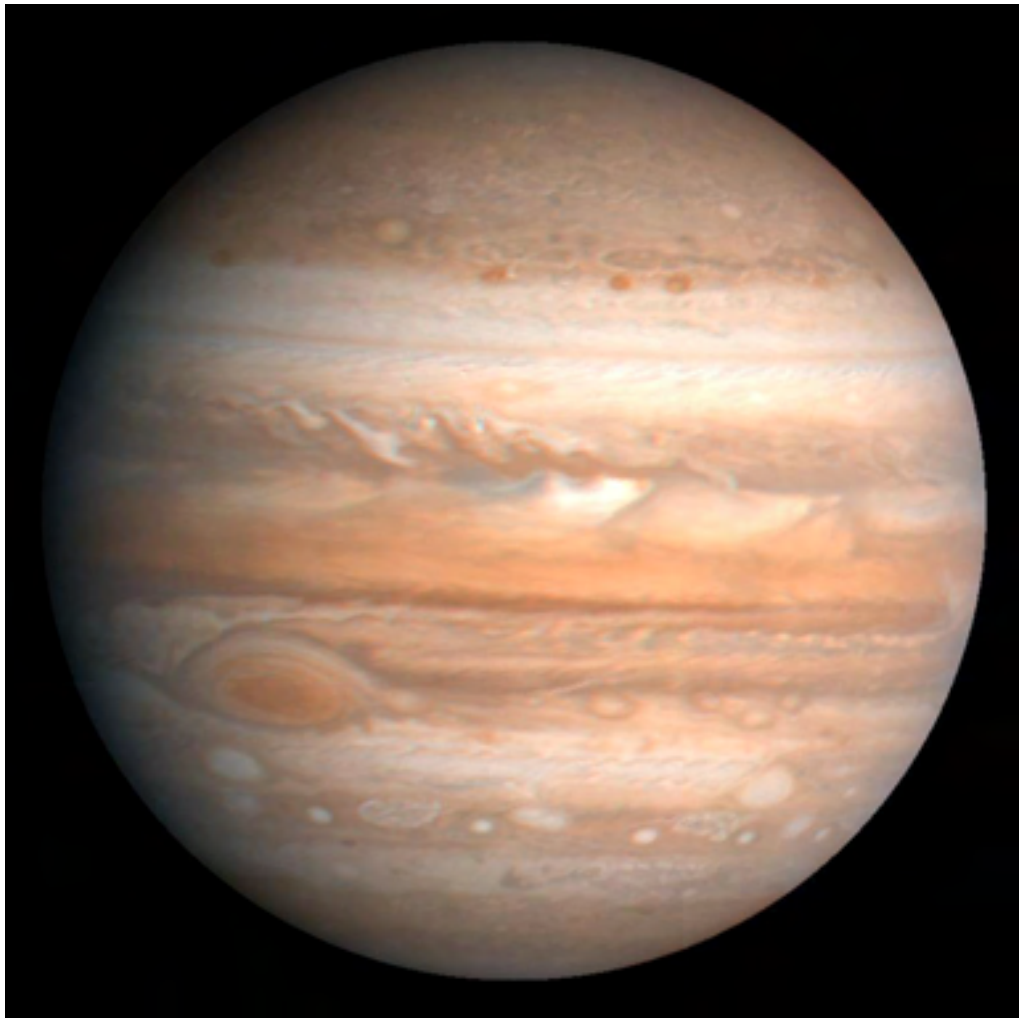
Deimos



Deimos

- also irregular shaped, possesses many craters
- one of the most gloomy celestial bodies
- so small that it seems not brighter to an observer on Mars than Venus does to one on the Earth

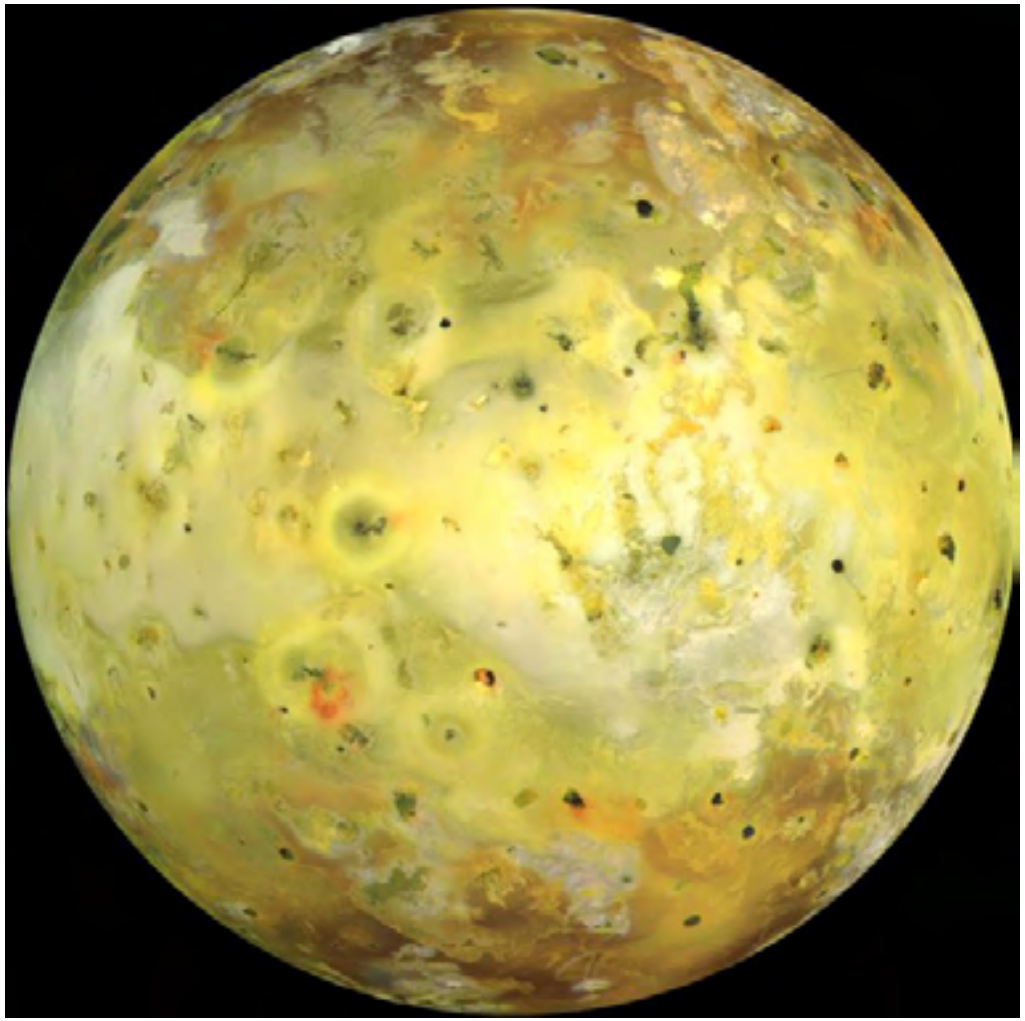
Jupiter



Jupiter

- the biggest planet with the most moons
- now following: the four biggest ones, the 'Galilean moons'

Io



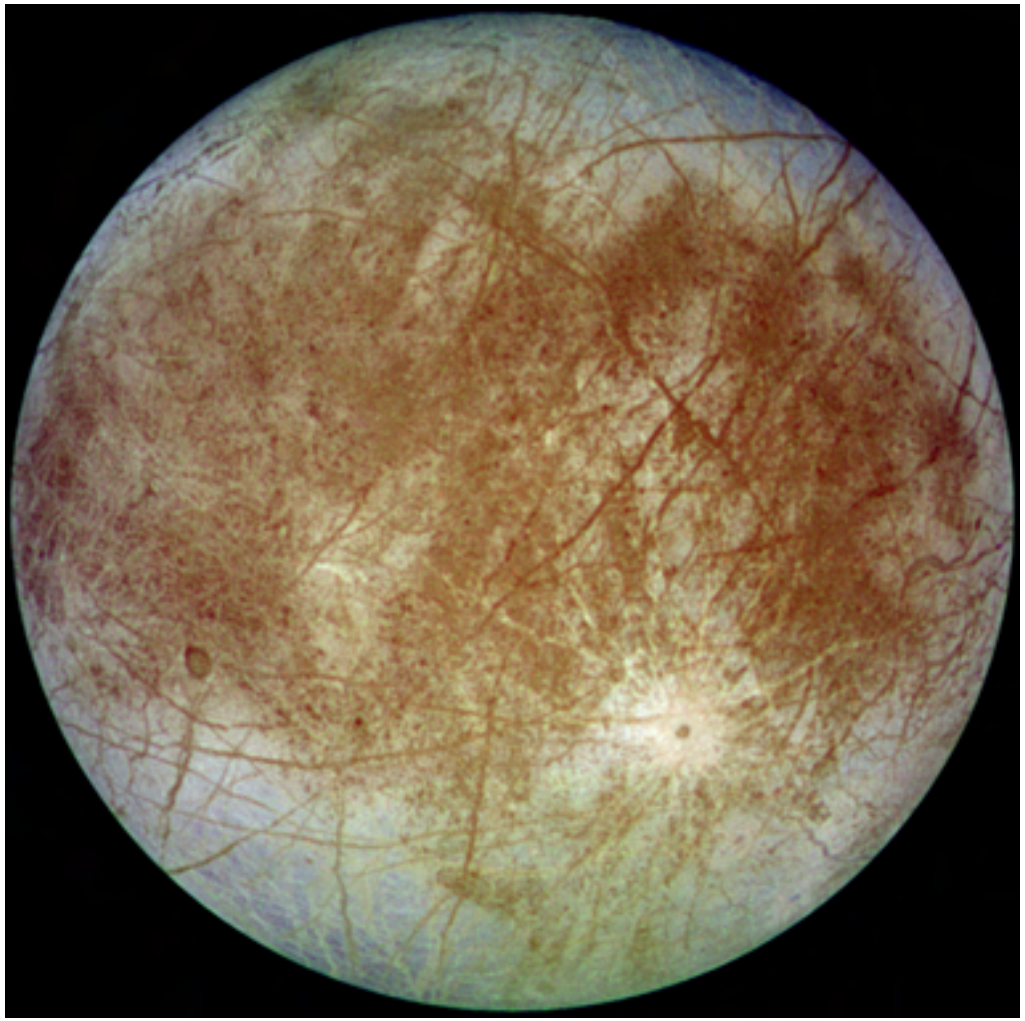
Io

- the most inner moon of Jupiter
- inclination is $0.04^\circ \Rightarrow$ orbit nearly in the equatorial plane of Jupiter
- the most volcanically active body
- practically no water unlike the other three Galilean moons
- very young surface with no craters caused by impacts
- many calderas with diameters up to 400km and a depth of several km

Io

- surface is caused by min. 300 active volcanoes
- raise clouds of dust, consisting mainly of sulfur, up to 300km
- sulfur compounds cover nearly the completely moon $\Rightarrow$ colorful surface
- average surface temperature = 130K, but it can reach temporary up to 1700K during a volcanic eruption
- energy caused by tidal forces between Jupiter and Io (1000 times bigger than between Earth and Moon) and its neighbor moons
- periods of these moons have a resonance so that Io oscillates and produces heat

Europa



Europa

- one of the brightest solar system bodies
- the most water holding body
- outer layer is a crust of ice(10-15 km thick)
- average surface temperatur between 50K and 110K
- expected a 90km deep ocean of fluid water beneath this crust that is heated by tidal forces
- thin atmosphere which contains also oxygen caused by the radiation of the sun (splits water)
- speculations about existence of life on Europa, but there is no evidence

Ganymede

Ganymede

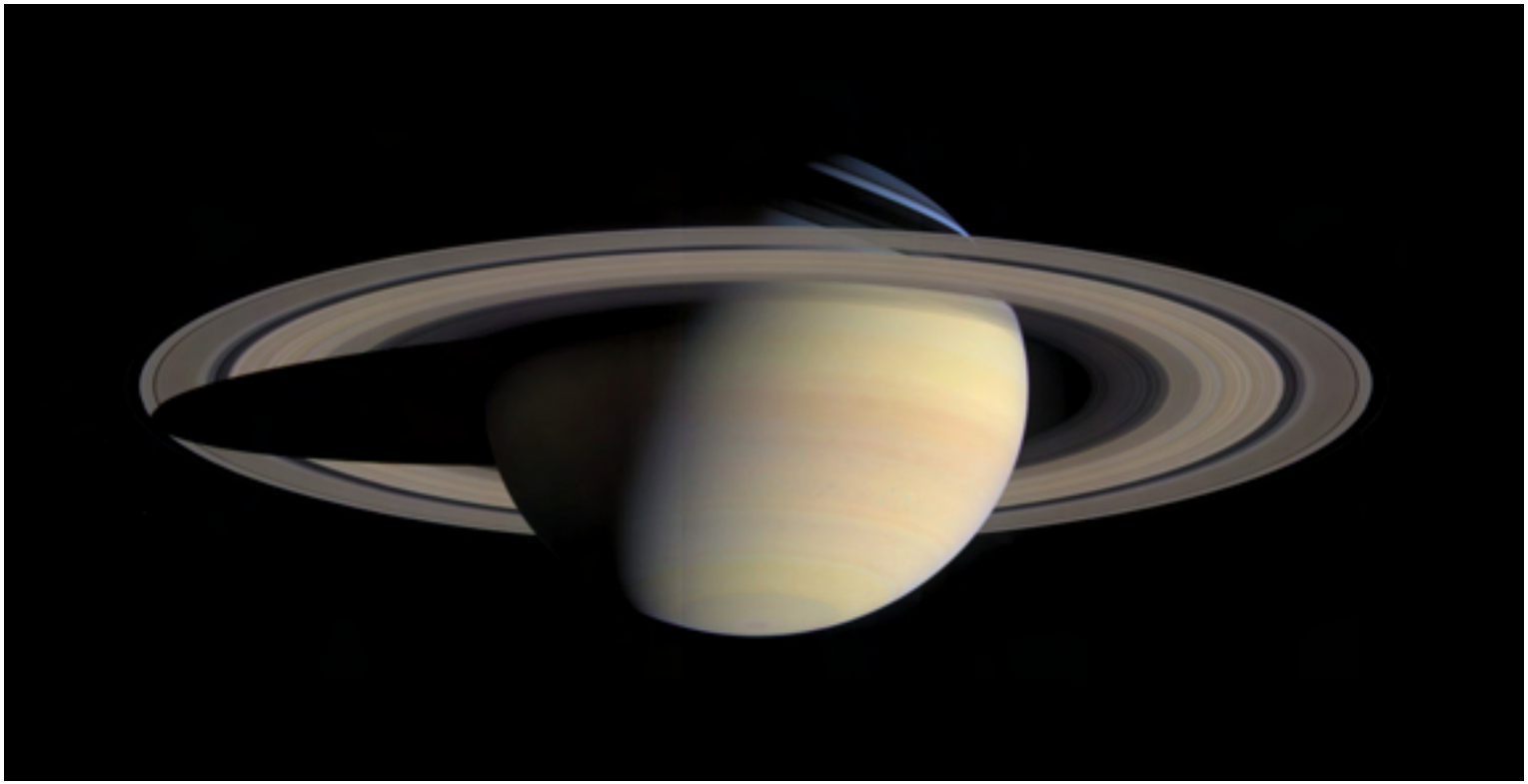
- the biggest moon in our solar system, diameter = 5262km
- surface can be separated in two disparated terrains:
- a very old and dark one which contains many impacts
- a younger and lighter one with rifts and faults
- two tectonic discs that moved independent from each other and causes long mountain ranges

Callisto

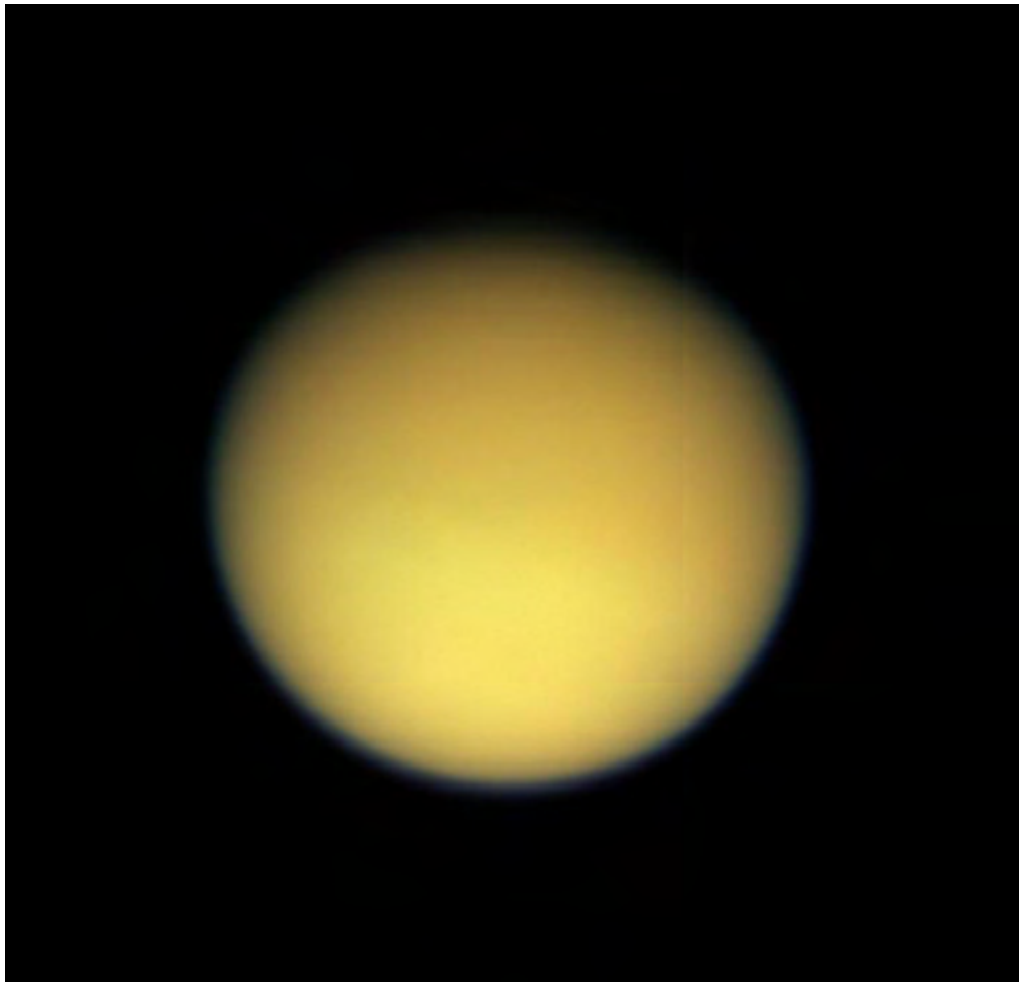
Callisto

- the most impact craters $\Rightarrow$ the oldest surface (four billion years old)
- consists mostly of ice and rocks which are jumbled together
- craters are very smooth $\Rightarrow$ the thick crust of ice relaxes the originally sharp-edged craters
- some bright craters that refers to a liquid ocean beneath
- $\Rightarrow$ after an impact, clear water could rise to the dusty surface, freeze and reflects more light

Saturn



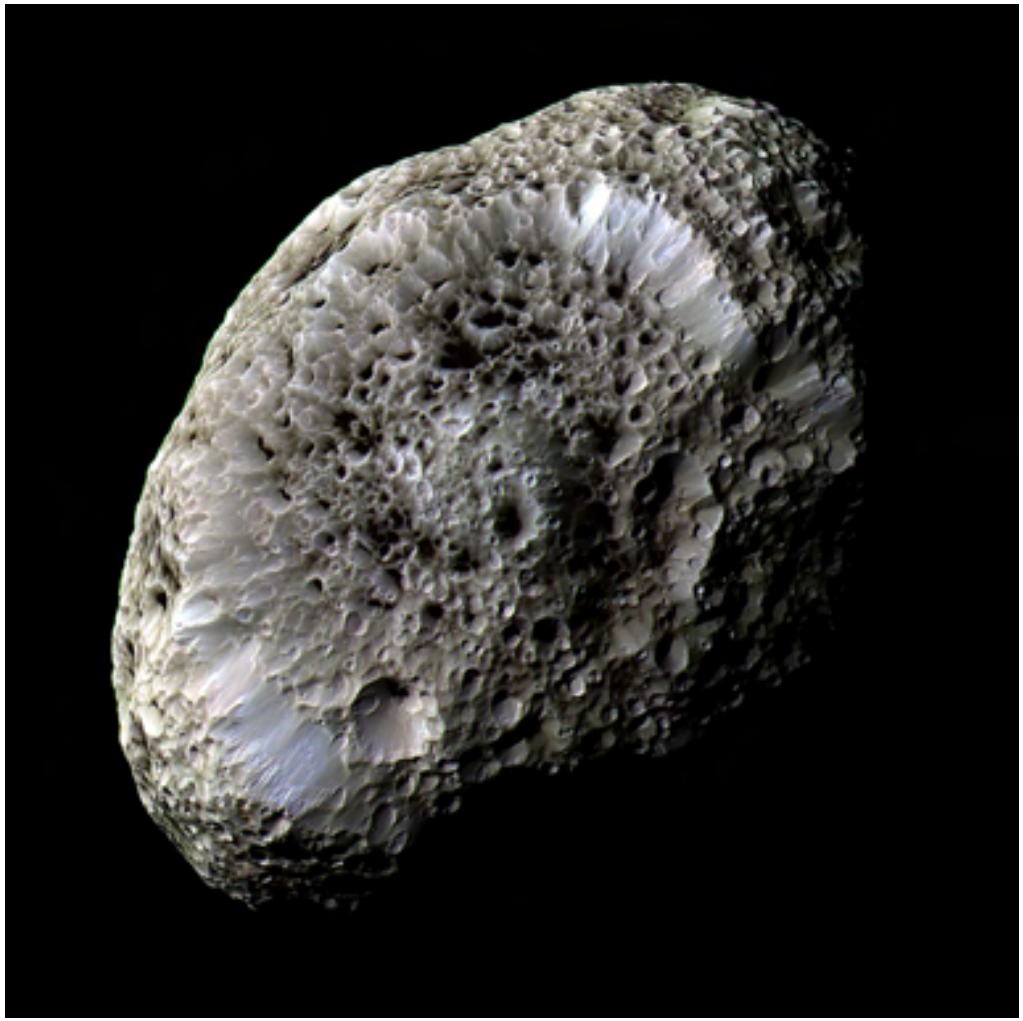
Titan



Titan

- the second biggest moon in the solar system and the only one with a dense atmosphere
- atmosphere is denser than on Earth, pressure near the surface is about 1.5bar (50% higher than on Earth)
- atmosphere consists mainly of nitrogen (at least 90%) and methane
- atmosphere rotates 5x faster than Titan ('super rotation') $\Rightarrow$ winds reach velocities of $400\frac{km}{h}$ in a height of 50km and decreases getting near to the surface
- weather processes similar to that on Earth earlier: clouds, rain of methane and ethane, rivers and lakes
- small size and slow rotation $\Rightarrow$ processes are much slower

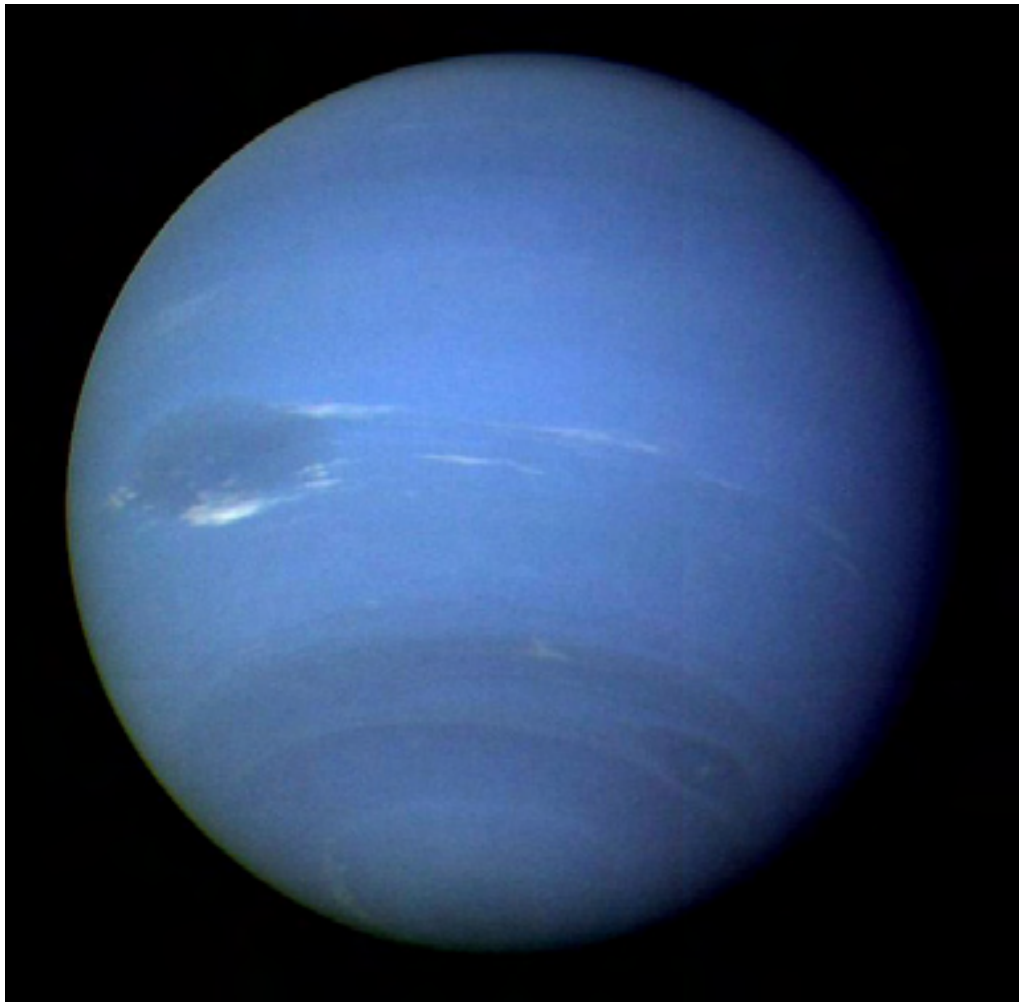
Hyperion



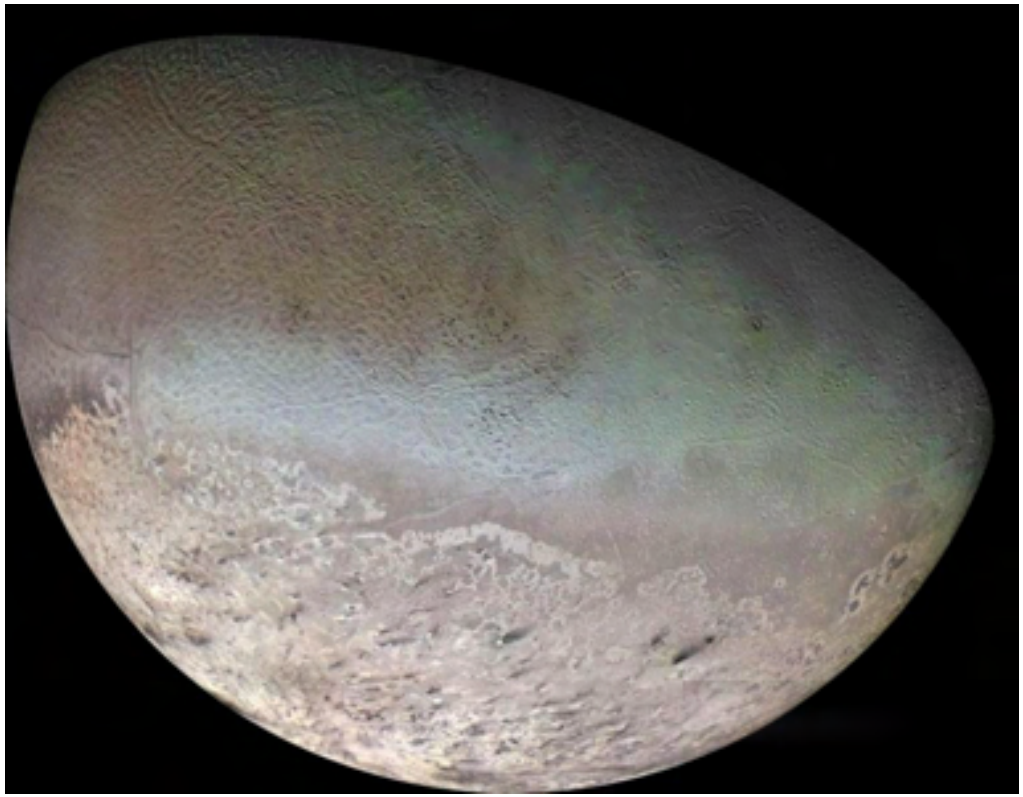
Hyperion

- for its size the most irregular formed body
- the biggest non-spherical moon with the most eccentric orbit of all regular moons
- velocity of rotation changes continually
- axis of rotation fluctuates unpredictable $\Rightarrow$ rotates totally chaotic

Neptune



Triton



Triton

- one of a few retrograde moons
- the poles will temporarily turn to the Sun with very long seasons
- at one pole there is winter for about 40 years
- low temperatures of only 34K, coldest place in the solar system

Thanks for your audience!