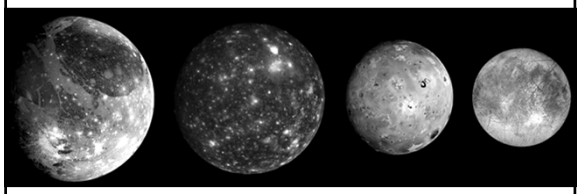
Lecture 28

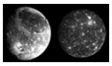
The Galilean Moons of Jupiter



Astronomy 141 – Winter 2012

This lecture is about the Galilean Moons of Jupiter.

The Galilean moons of Jupiter are heated by tides from Jupiter – closer moons are hotter.

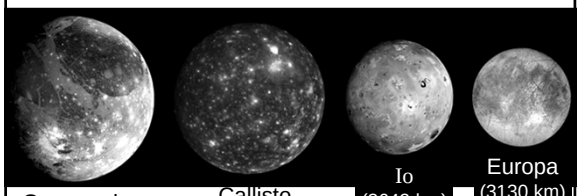


Ganymede and Callisto are old, geologically dead worlds: mostly ice mantles over rocky cores.

Innermost Io is tidally melted inside, making it the most volcanically active world in the Solar System.

Europa may have liquid water oceans beneath the ice, making it the most promising place to search for life.

The Galilean Moons of Jupiter



Ganymede (5262 km)

Callisto (4806 km)

Io (3642 km)

Europa (3130 km)

Moon (3474 km)

The Galilean Moons all orbit in the same direction around Jupiter. The inner 3 are on resonant orbits.

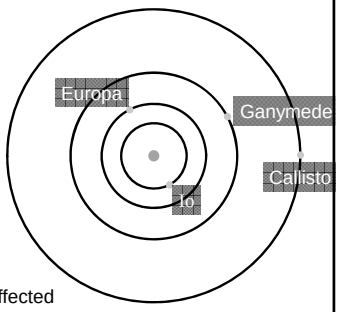
Orbital Periods:

Io: 1.8 days

Europa: 3.6 days
(*2 times Io's period*)

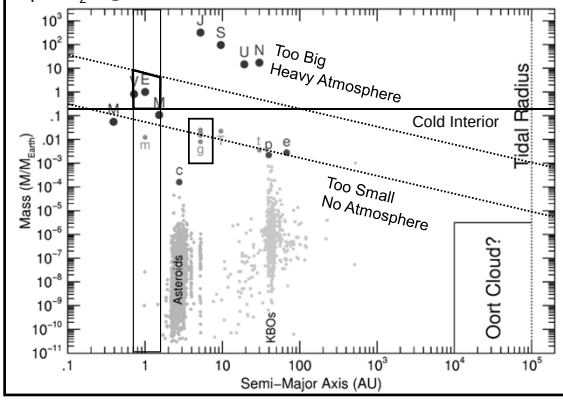
Ganymede: 7.2 days
(*4 times Io's period*)

Callisto: 16.7 days



Innermost are strongly affected by tides from Jupiter

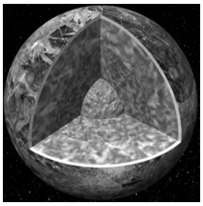
Liquid H_2O @ 1atm

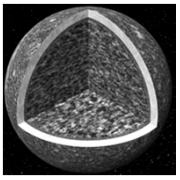


Ganymede & Callisto are mixed ice & rock, low-density moons.

Mean densities of 1.9 & 1.8 g/cc, respectively

Deep ice mantles over rocky/icy cores.


Ganymede

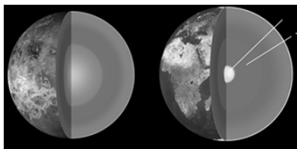

Callisto

Old, heavily cratered surfaces

They lack internal heat and are geologically inactive.

In the terrestrial planets, interior heat is determined by the planet's size.

Large Earth & Venus have hot interiors:

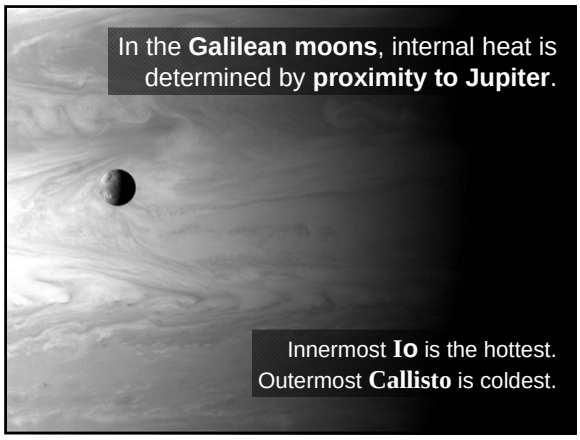


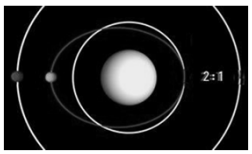
Smaller Mercury, Moon & Mars have cold interiors.


Mercury

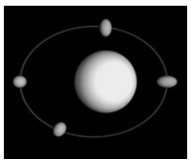

Moon


Mars





Io's orbit keeps changing, thanks to an orbital resonance with Europa.

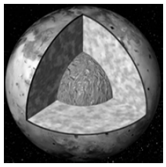


Near Jupiter: Big tidal bulges
Far away: Small tidal bulges

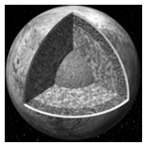
The rhythmic flexing of Io leads to tidal heating of its interior.

Io & Europa are mostly rocky, high-density moons.

Mean densities of 3.5 & 3.0 g/cc, respectively



Io: Rocky crust, molten mantle & many active volcanoes



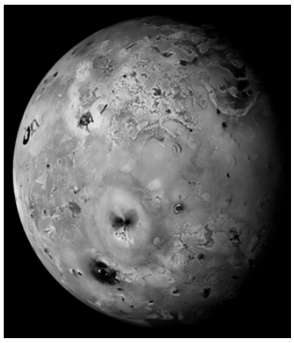
Europa: Icy lithosphere & rocky core. Might have a deep-water ocean.

The innermost moon, Io, is the most volcanically active world in the Solar System.

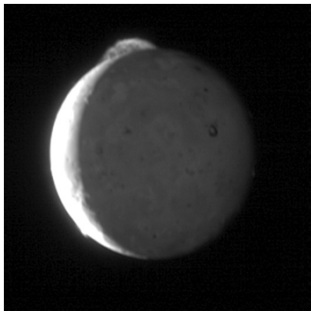
Hot, molten interior heated by tides from Jupiter.

Interior is molten silicates and sulfur.

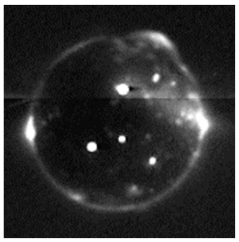
Active eruptions & pools of molten sulfur on its surface.



Io's active volcanoes

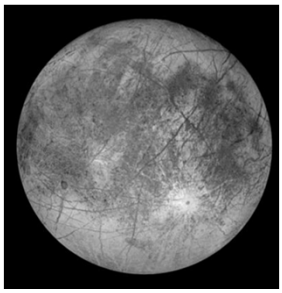


Tvashtar 2007 Feb 26
[New Horizons]



Io in eclipse, showing volcanic Hotspots 2007 Feb 27
[New Horizons]

Europa has a smooth, young icy surface covering a large rocky core.

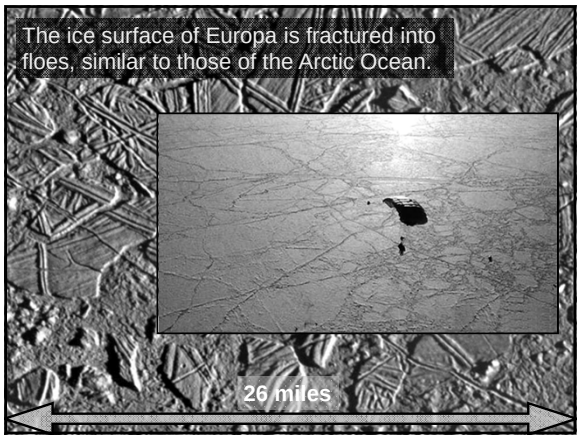


Composed of bright, shiny water ice.

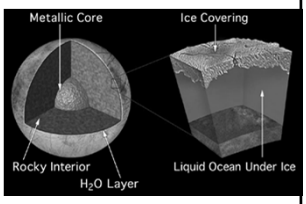
Very few impact craters implies a young surface

Repaved by water geysering through cracks in the ice.

Ice surface is fractured into ice rafts and floes a few kilometers across



Is there liquid water under Europa's ice?

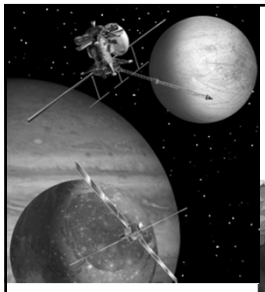


Young surface with few craters, recently repaved

Chaotic and flooded terrains suggestive of liquid upwelling from below.

Weak magnetic field caused by currents in an electrically conductive medium – a salty liquid water ocean?

Tidal heating calculations show sufficient heat to melt subsurface ice and keep it liquid.



Europa Jupiter System Mission

Joint US, Europe, Japan, Russia mission concept

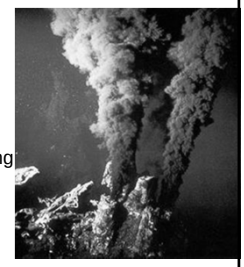
Possible 2020 launch

Europa CryoBot ice drill and HydroBot

Europa may be the most promising place to search in our Solar System for life beyond Earth.

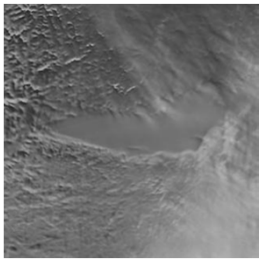
Has many of the pre-requisites:

- Source of heat (Jupiter tides)
- Liquid Water beneath the ice?
- Complex organics
- Ice and water provides UV shielding



Might expect anaerobic life, perhaps near volcanic vents like deep ocean extremophiles on Earth.

Lake Vostok Antarctica



A terrestrial analog of the Europa sub-ice oceans?