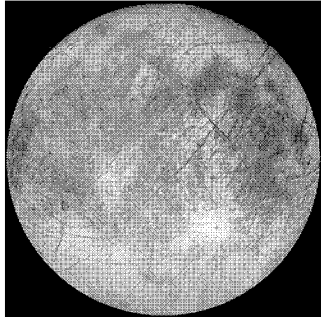


Tuesday, November 2
Life on Europa (?)



Life on Europa (?)
Key Concepts

1) The Galilean moons are internally heated by **tides** from Jupiter (closer to Jupiter = hotter).

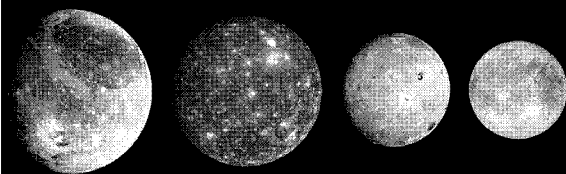
2) **Io**, the innermost moon, is tidally melted inside, making it volcanically hyperactive.



3) **Europa**, the next moon, may have tidally warmed liquid oceans (& possibly life).



The Galilean moons of Jupiter:



Ganymede
(5300 km)

Callisto
(4800 km)

Io
(3600 km)

Europa
(3100 km)



Moon (3500 km)

The Galilean moons orbit in the same direction around Jupiter, in nearly the same plane.

Orbital Periods:

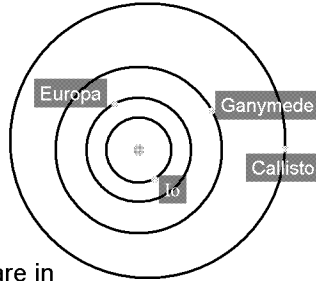
Io: 1.8 days

Europa: 3.6 days
(2 × Io's period)

Ganymede: 7.2 days
(4 × Io's period)

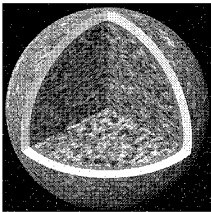
Callisto: 16.7 days

The 3 inner moons are in an **orbital resonance**.

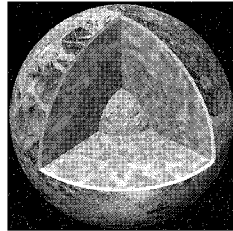


Ganymede & Callisto are big, low-density moons, made of mixed ice & rock.

Average densities less than 2 grams/cm³.



Callisto

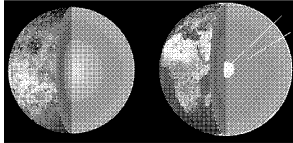


Ganymede

Geologically dead.

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

Venus & Earth have hot interiors:



Mercury & Mars (& our Moon) have cold interiors:



Mercury

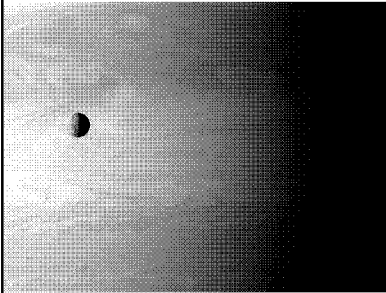


Moon

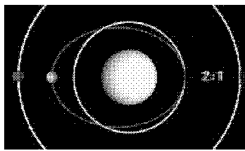


Mars

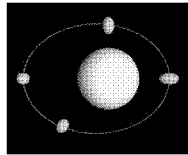
In the **Galilean moons**, internal heat is determined by **proximity to Jupiter**.



Innermost **Io** is the hottest.
Outermost **Callisto** is coldest.



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

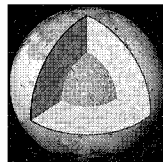


Near Jupiter: **Big** tidal bulges
Far away: **Small** tidal bulges

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

Io & Europa are high-density moons, made primarily of rock.

Average densities more than 3 grams/cm³.

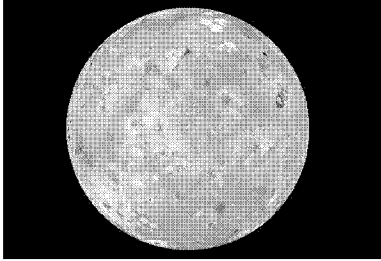


Io: Rocky crust, molten mantle & many active volcanoes.



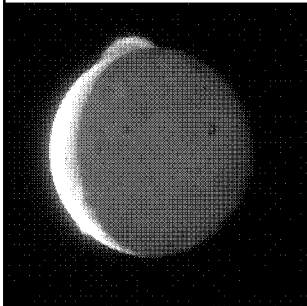
Europa: Icy lithosphere & rocky core.
Might have a deep-water ocean.

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

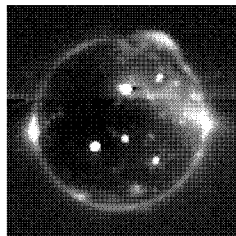


Interior: molten silicates & sulfur.
Surface: active eruptions & pools of molten sulfur.

Io's active volcanoes:



Tvashtar (2007 Feb 26)

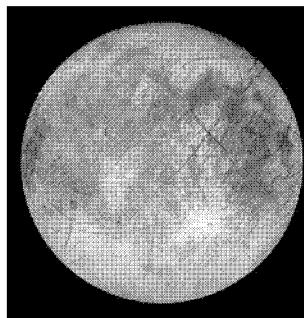


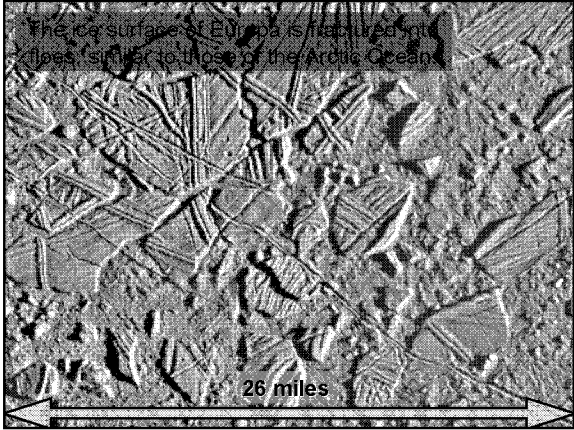
Io in eclipse, with volcanic hotspots (2007 Feb 27)

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

Scarcity of impact craters implies a young surface.

Surface is repaved by water squirting up through cracks in the ice.





Evidence for liquid water under Europa's ice:

Europa's young surface indicates frequent "repaving"
 with liquid water from below.

Chaotic & flooded terrains
 suggest an upwelling liquid.

Europa's magnetic field is caused by currents in an
 electrically conducting medium: a salty ocean?

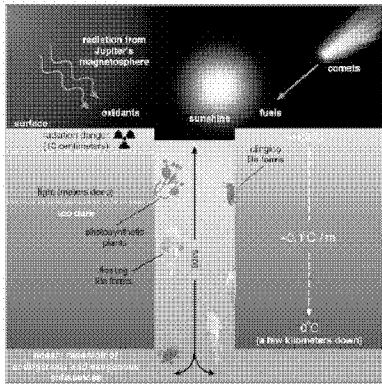
**Europa may be the most promising place
 to search for extraterrestrial life.**

It has many of the prerequisites:

- Source of heat (tidal flexing).
- Liquid water beneath the ice (?)
- Complex organic compounds.
- Shielding from UV light.

We might expect **anaerobic** life, like that near
 deep-sea volcanic vents on Earth.

Blatant speculation alert!



Tomorrow's Lecture:

Life on Titan (?)

This Week's Reading:

Chapters 9 & 10
