Tuesday, November 2

Life on Europa (?)

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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.

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

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

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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.

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**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:

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

Tvashlar (2007 Feb 26)

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?

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**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.
Tomorrow’s Lecture:
Life on Titan (?)

This Week’s Reading:
Chapters 9 & 10