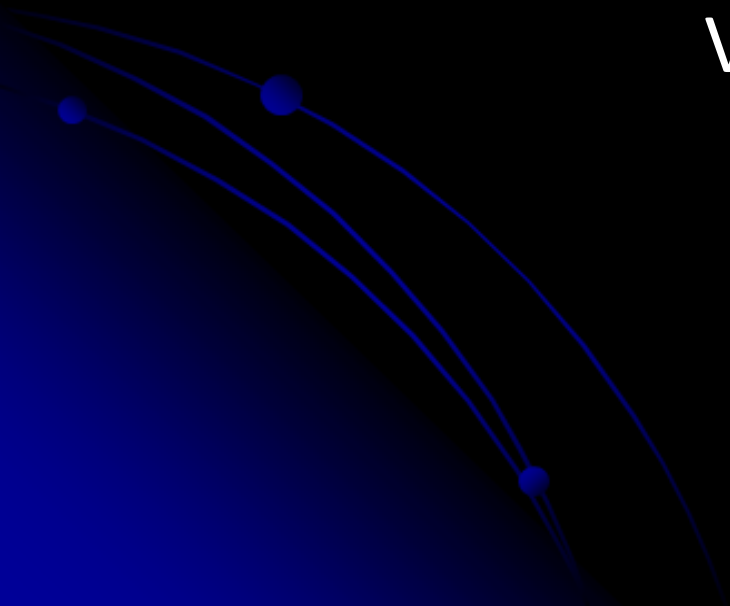


Terrestrial Bodies of the Solar System

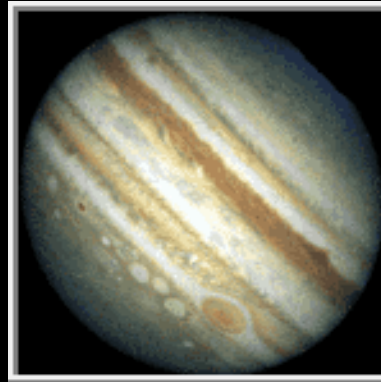
Valerie Rapson



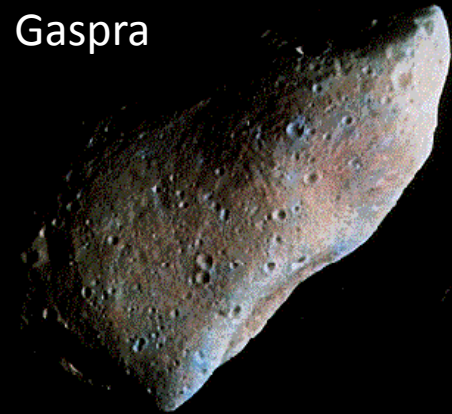
March 22, 2012

Terrestrial Bodies

- Many different bodies in the Solar System



Gaspra

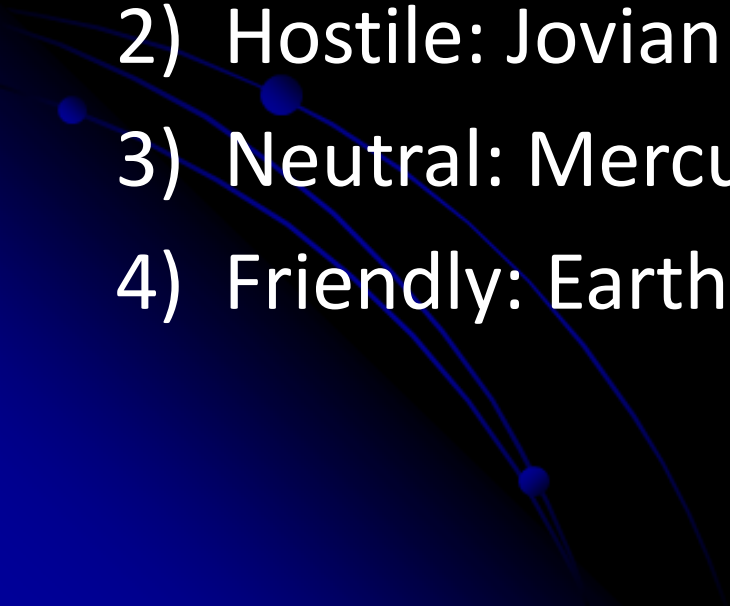


- **Terrestrial** bodies are those with solid surfaces on which one could stand

Terrestrial Bodies

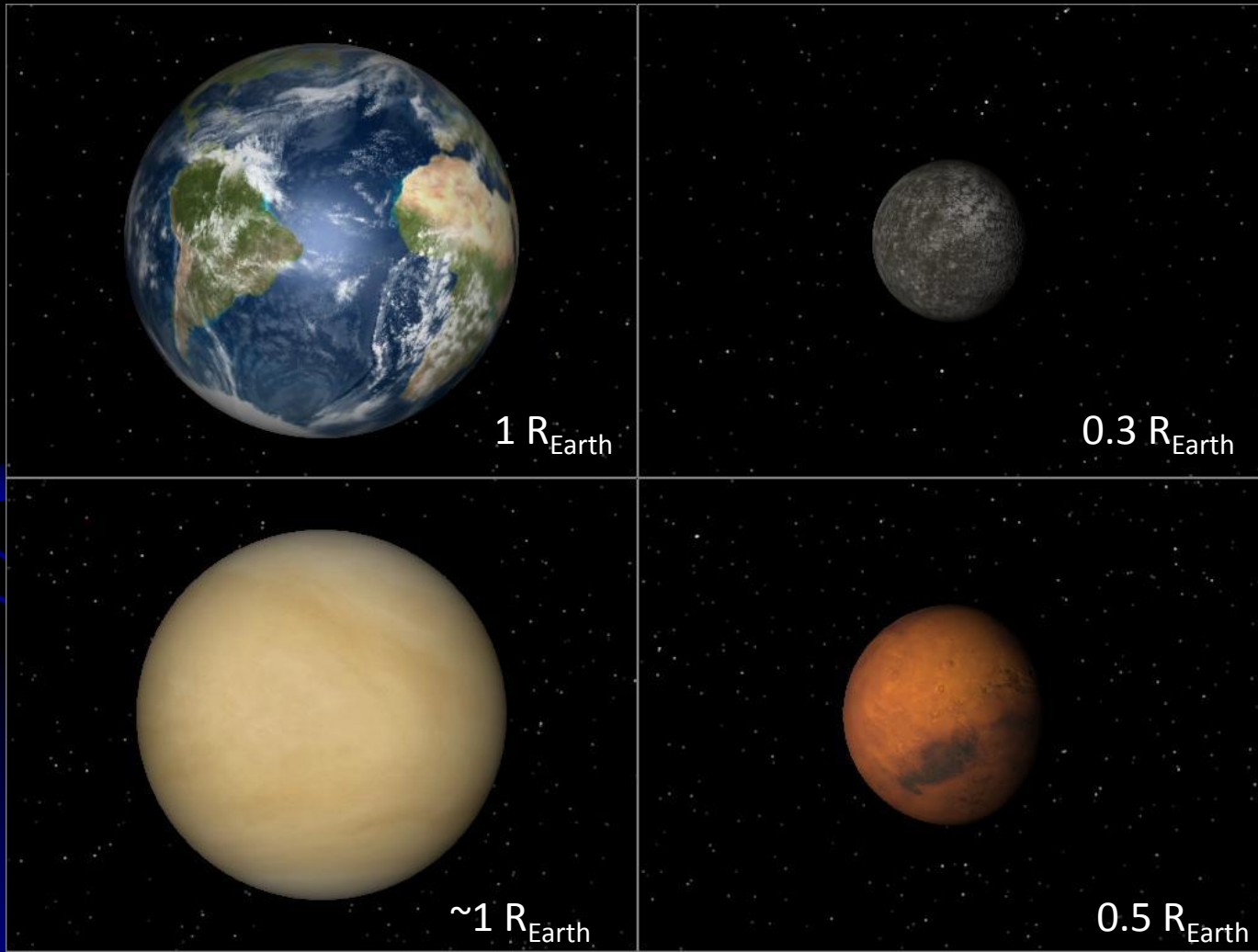
Usually discussed Sun outward....

We will consider in terms of hospitality to
Humans:

- 1) Ultra-hostile: Venus
 - 2) Hostile: Jovian Moons
 - 3) Neutral: Mercury, Moon
 - 4) Friendly: Earth, Mars, Titan
- 

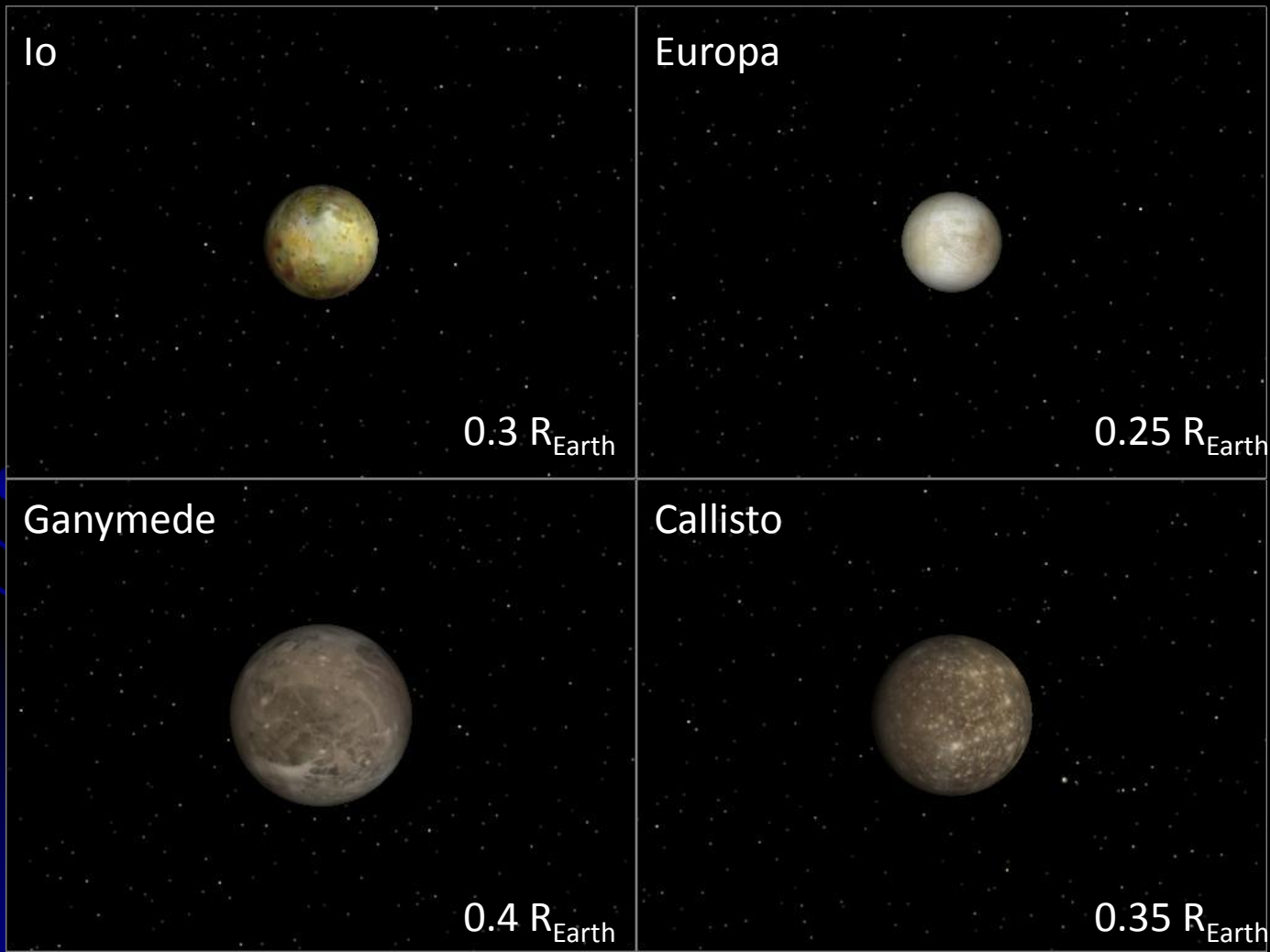
Terrestrial Planets to Scale

All viewed from 53,000km



Terrestrial Planets to Scale

All viewed from 53,000km



Terrestrial Planets to Scale

All viewed from 53,000km



Ultra-Hostile Venus



Distance: ~0.72 AU to Sun

Temp: 740 Celsius

Volcanically Active

Very thick atmosphere!

Surface pressure: 90 Earth atm

Composition

96% carbon dioxide

3.5% nitrogen

water vapor

sulfuric acid

hydrochloric acid

hydrofluoric acid

Venus

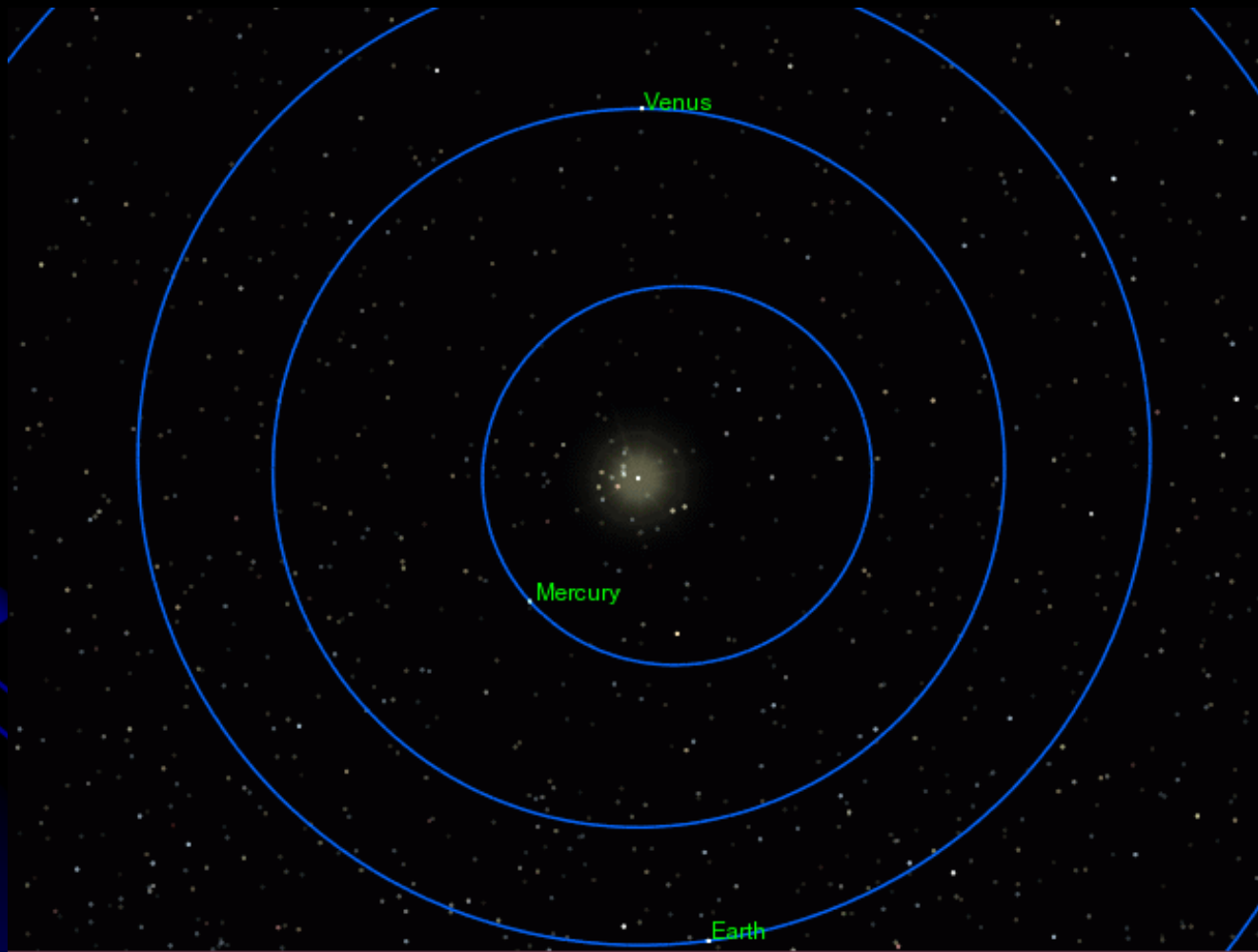


Taken by: Pioneer Spacecraft



**Surface of Venus
Taken by: Magellan**

Why is Venus So Hot?



It's closer to the sun...

Why is Venus So Hot?

The orbital radius of Earth is 1.0 AU

The orbital radius of Venus is 0.72 AU

The intensity of light from the Sun (or any source) decreases as the inverse square of the distance.

$$\frac{\text{Intensity}(R_2)}{\text{Intensity}(R_1)} = \frac{R_1^2}{R_2^2} \Rightarrow I(\text{Venus}) = 1.9 I(\text{Earth})$$

Q: How much stronger is sunlight at the distance of Venus than at the distance of Earth?

Could that explain the enormous difference in temperature?

Why is Venus So Hot?



Transmits visible and near-IR, traps mid-IR

Extreme heat

- At 700+ Celsius, nothing can survive!
- Metals such as lead, tin and zinc will melt



Soviet Venera 9, 10 and 13 soft landed on Venus and survived for only a few minutes

Galilean Moons



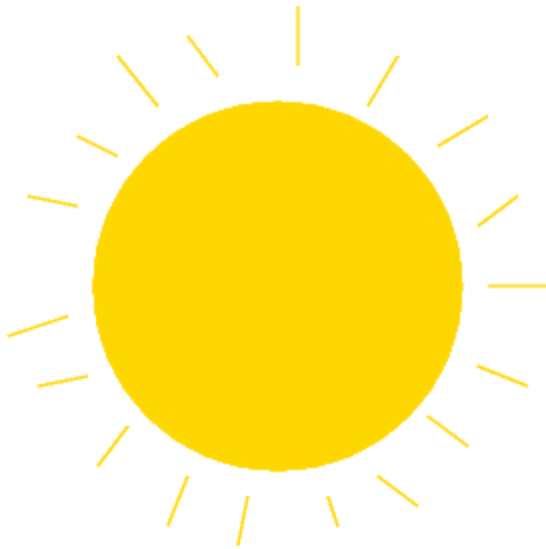
Amalthea

Composed of:
Oxygen
Carbon
Silicon
Hydrogen compounds

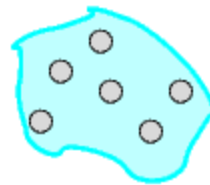
Little refractory elements!

Why?

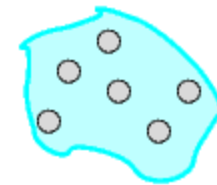
Early Solar System



hot

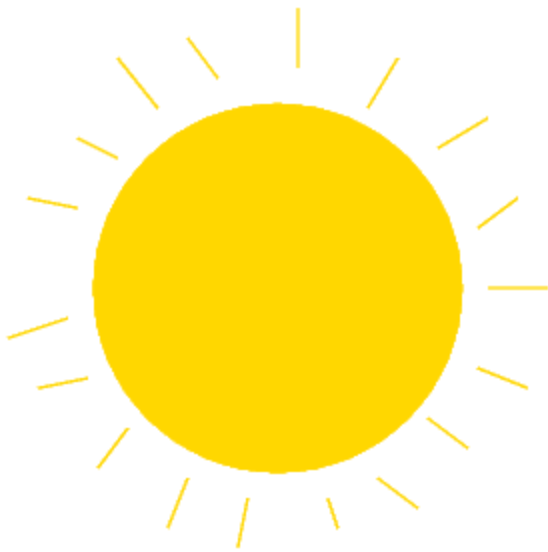


cool

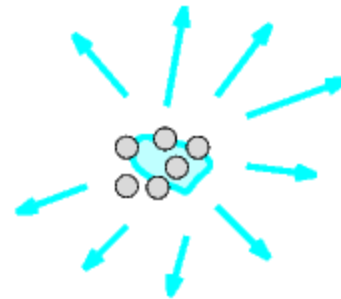


**Start with two clouds of gas and dust,
one close to Sun and one far from Sun**

Early Solar System



hot

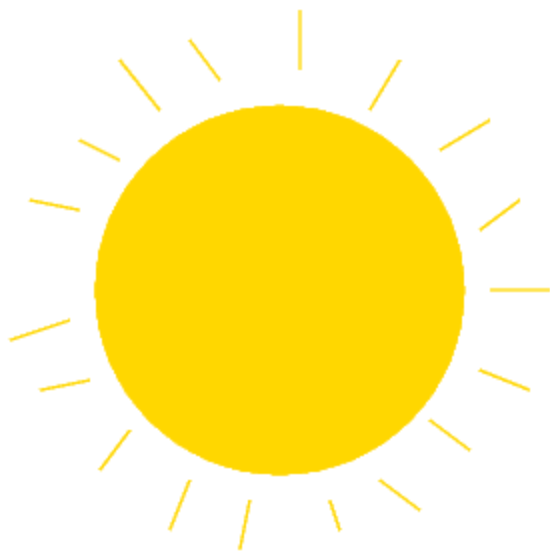


cool



Most of the gas and volatiles are lost from the inner cloud before it collapses, but the outer cloud retains almost all its gas

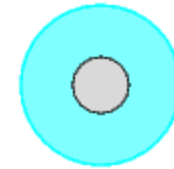
Early Solar System



hot



cool



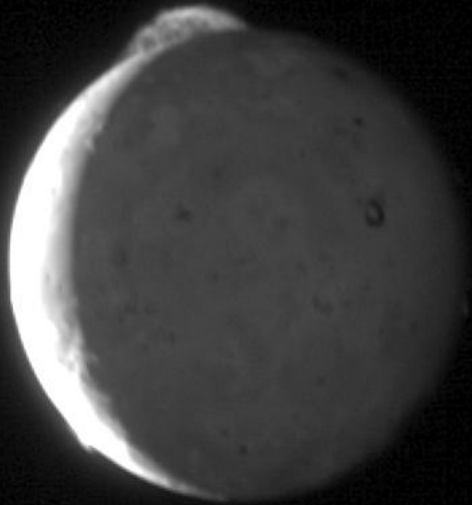
Inner planets end up being mostly the (originally uncommon) refractory material, outer planets end up being mostly the (originally common) volatiles.

Outer planets and moons are less dense

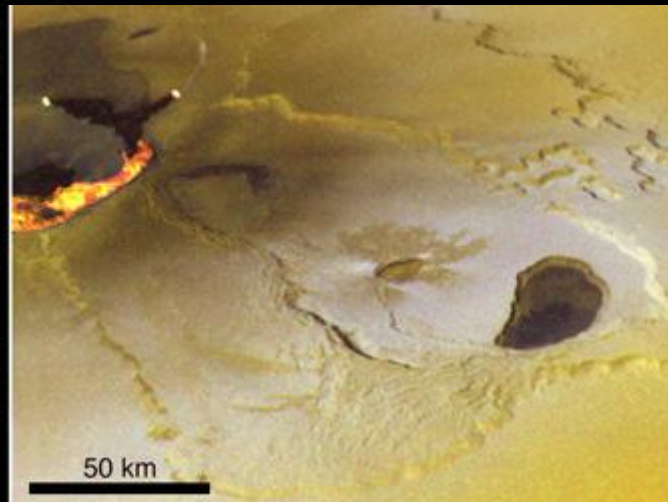
Io

- Molten interior due to tidal forces from Jupiter
- Currently active volcanoes!

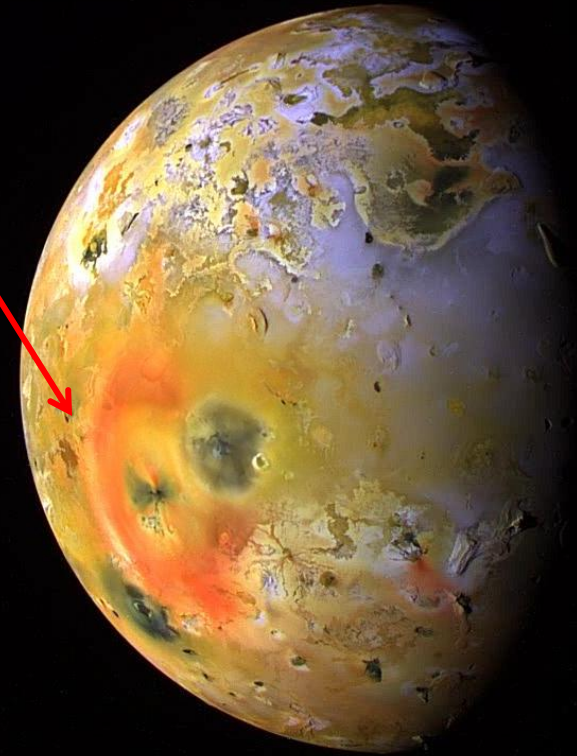
New Horizons



Tvashtar

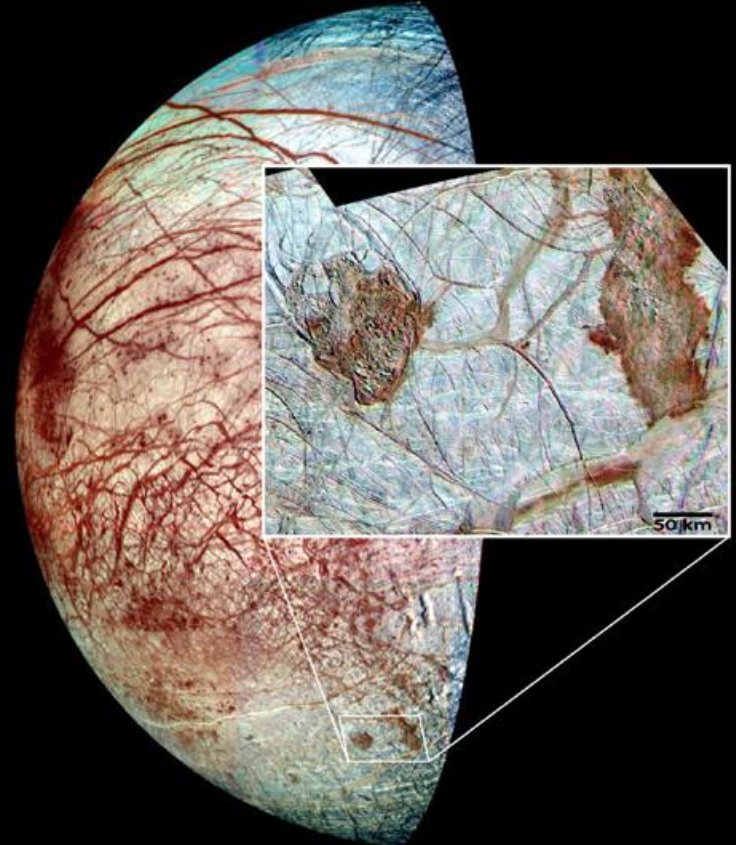
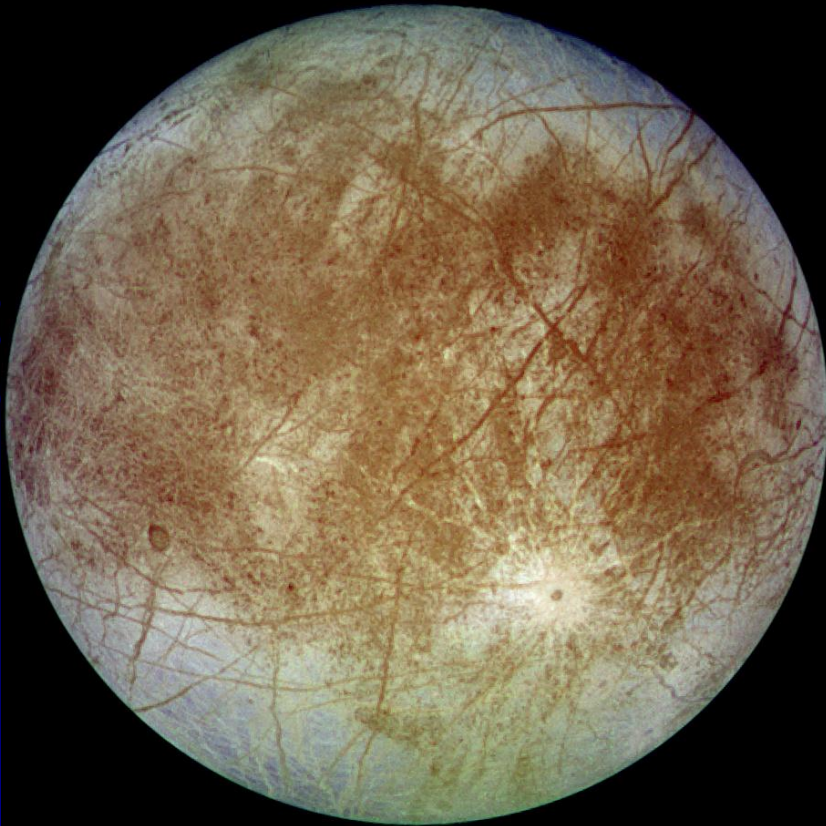


Pele



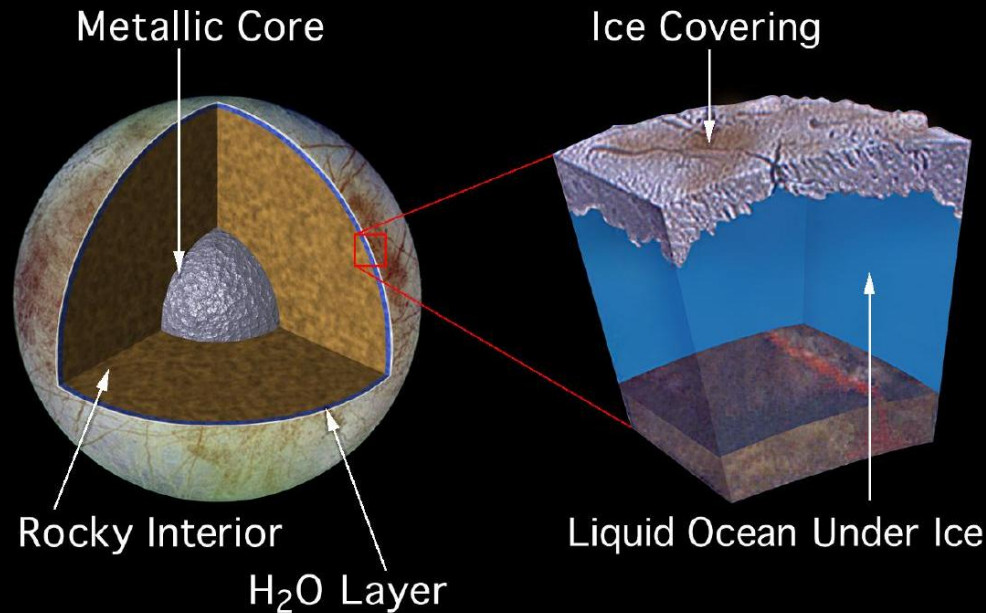
Europa

- Europa is covered in ice with possible sub-surface ocean!



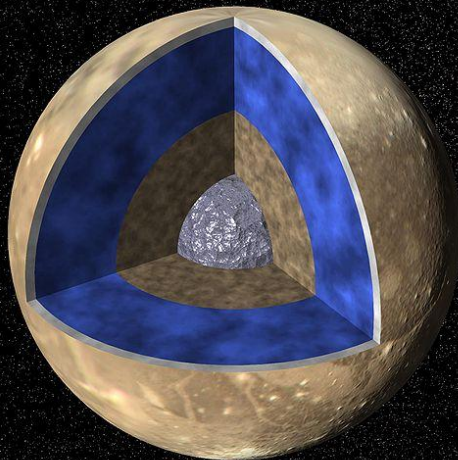
Europa

- Exterior temperature: -170°C
- Possibly 2x as much water as Earth with high oxygen content
- Life???



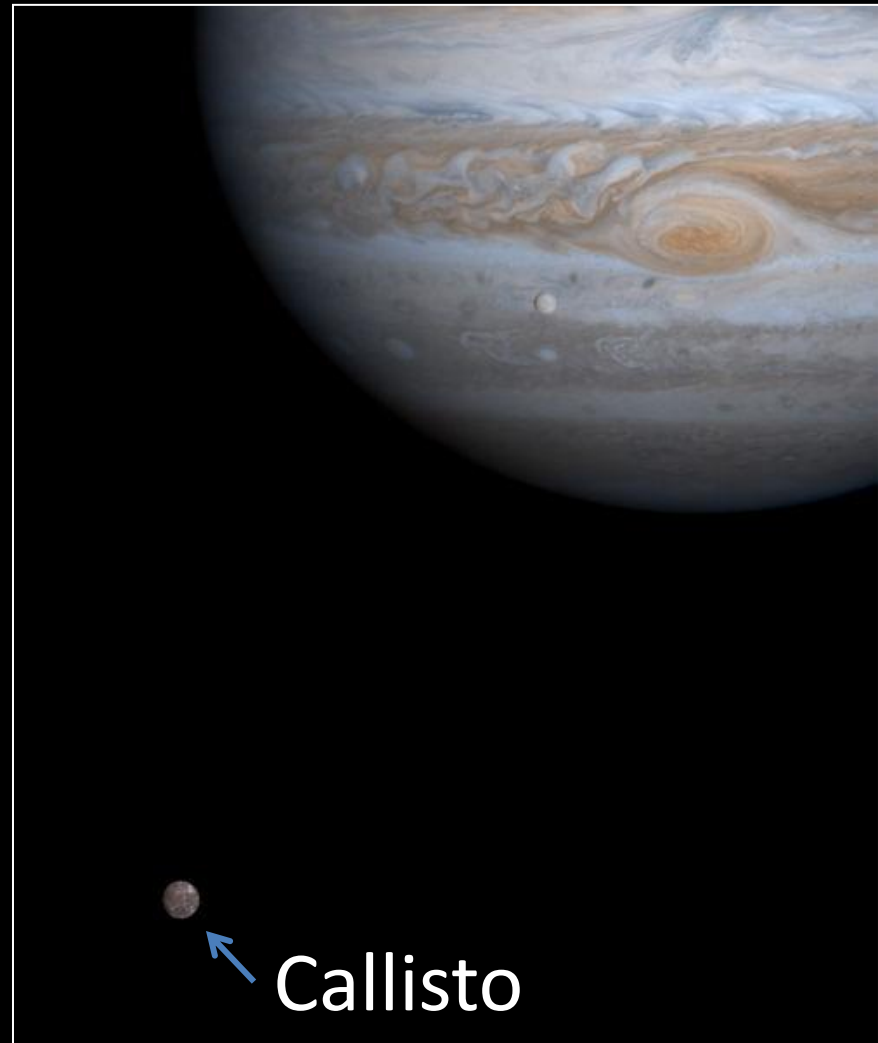
Ganymede

- Rock covered in silicate and water ice
- Own magnetic field
- Thin oxygen atmosphere
- Deep sub-surface ocean?



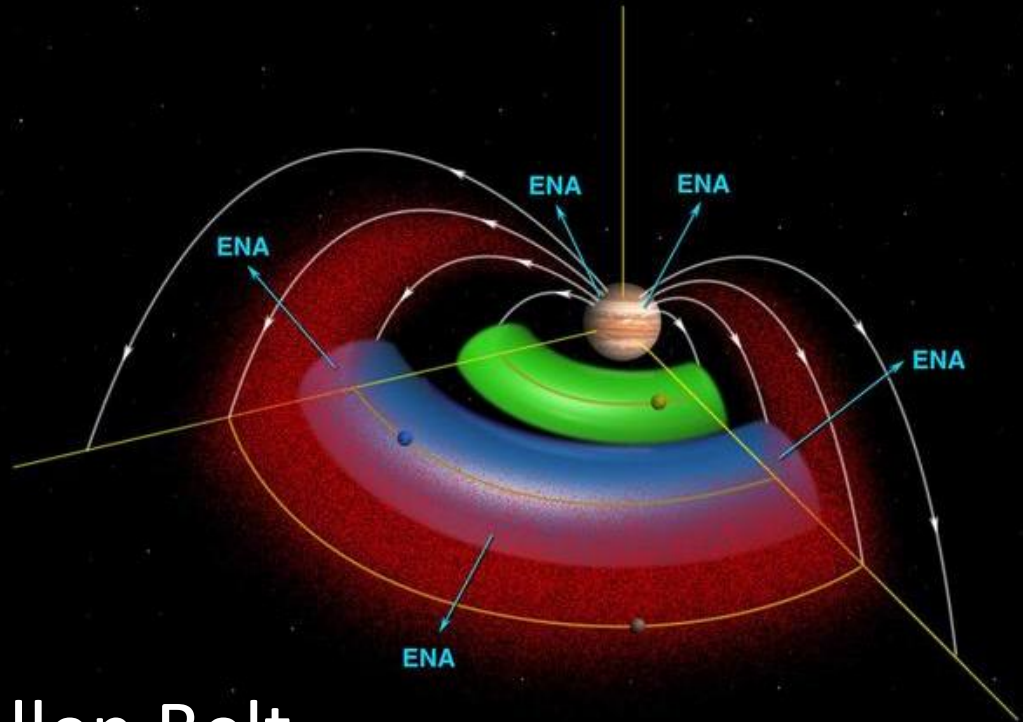
Callisto

- ~Size of Mercury
- Rock with some ice
- Heavily cratered



Hostile Moons?

- Cassini detected regions of “Energetic Neutral Atoms (ENA)” trapped in Jupiters strong magnetic field



- Similar to Van Allen Belt

Neutral Mercury



MESSENGER Image

Distance: 0.4 AU to sun

1 day=174 Earth days
(two Mercury years=1 day)

Day temp: 300 Celsius
Night temp: -160 Celsius

No atmosphere
Mostly made of Iron

Earth's moon

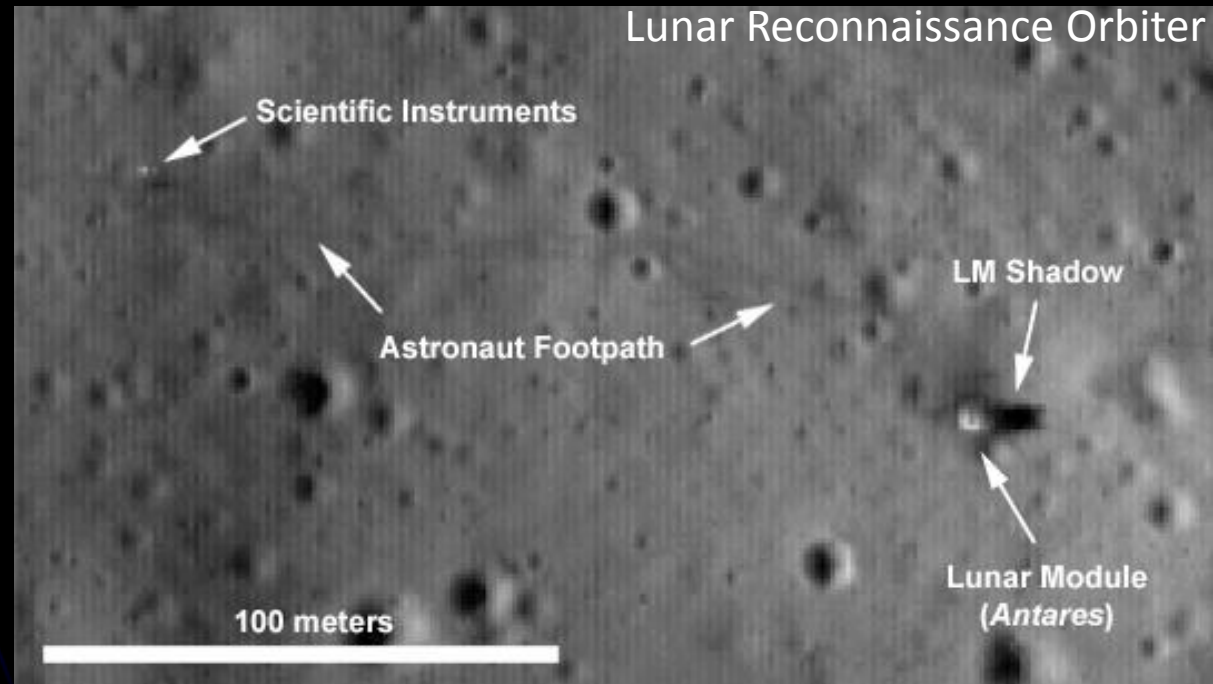
Rocky, heavily cratered

Only astronomical body man has set foot on

Tidally locked to Earth



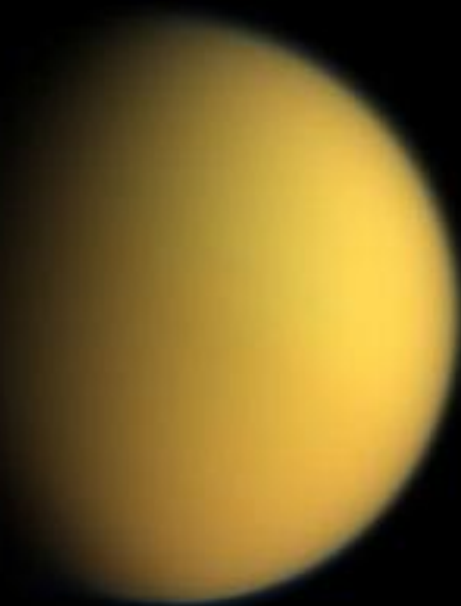
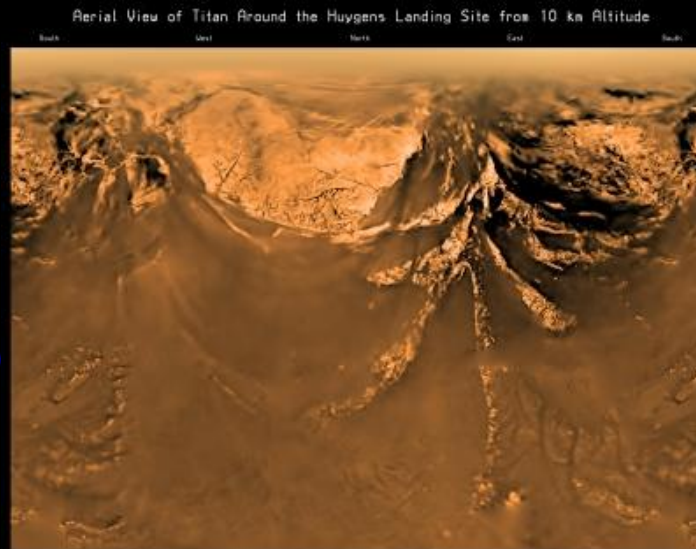
WIYN 0.9m



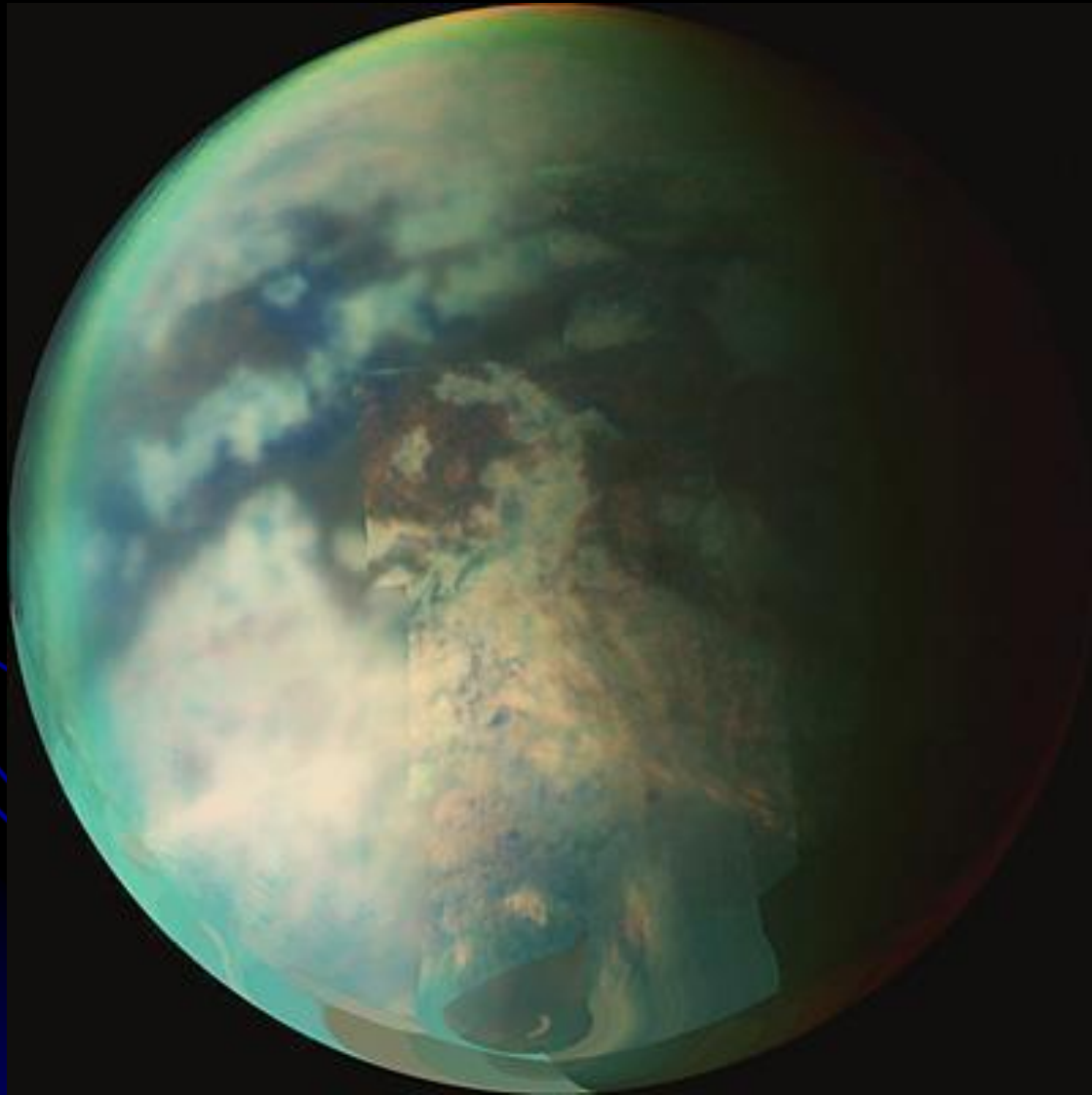
100 meters

Saturn's Moon Titan

- Surface temp -180 Celsius
- Cold atmosphere made of Nitrogen
- Liquid methane lakes on surface!
- Similar to Early Earth?

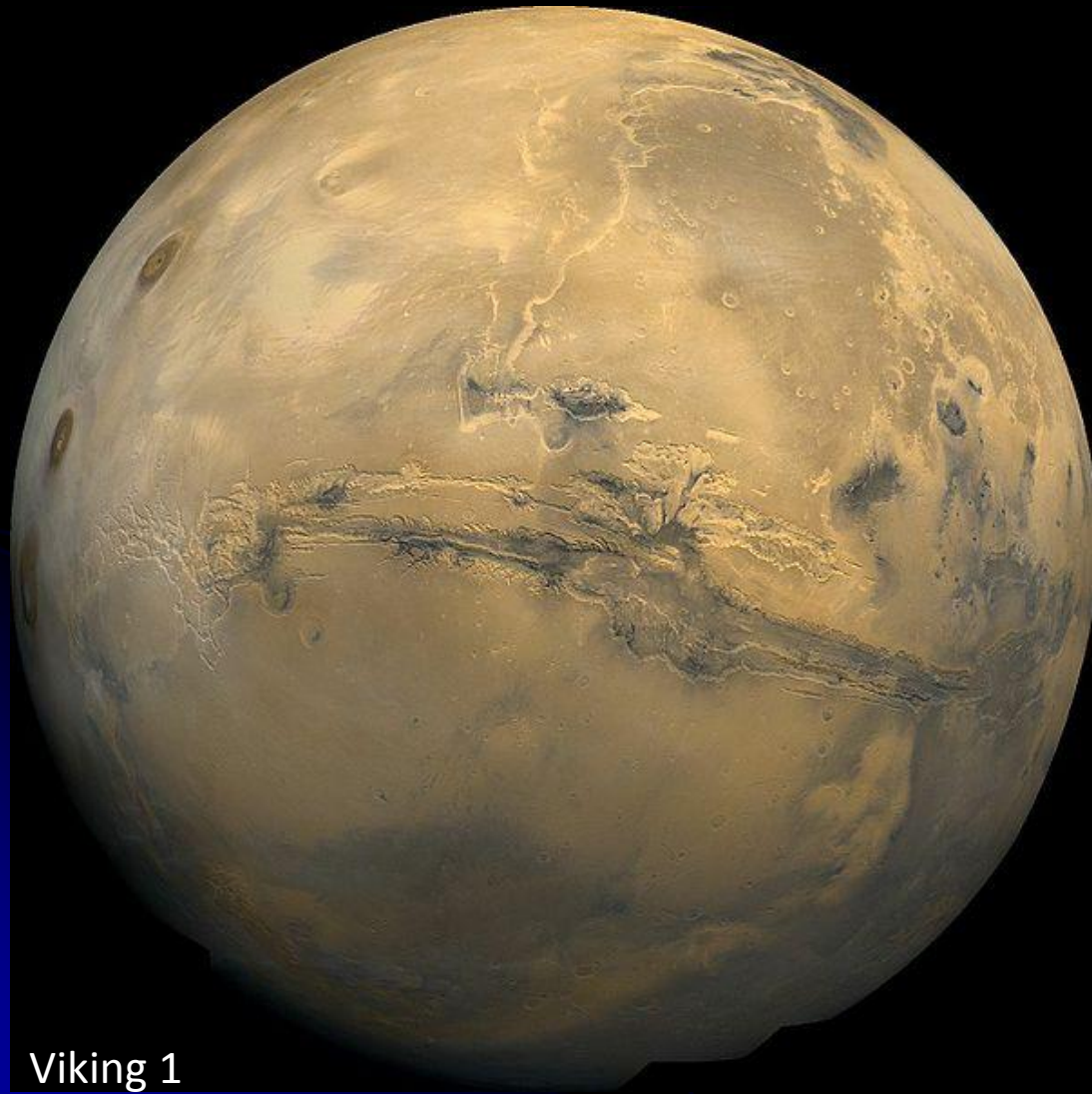


Titan False Color Image... Earth?!?!



Cassini

Friendly Mars



Distance: 1.6 Au

Size: $\frac{1}{2}$ size of Earth

Temp: -60 Celcius (avg)

The Red Planet

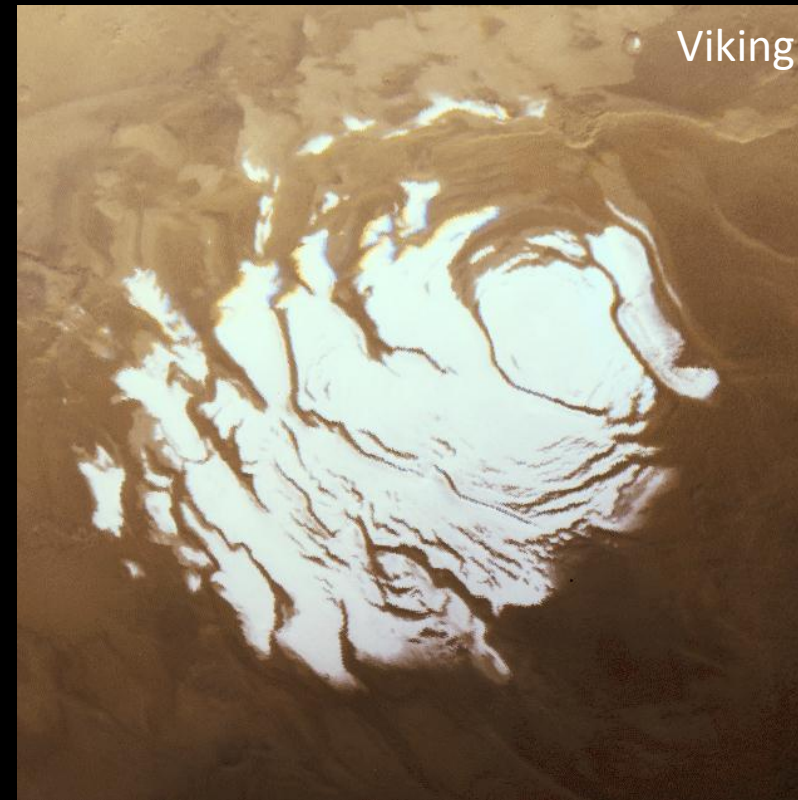
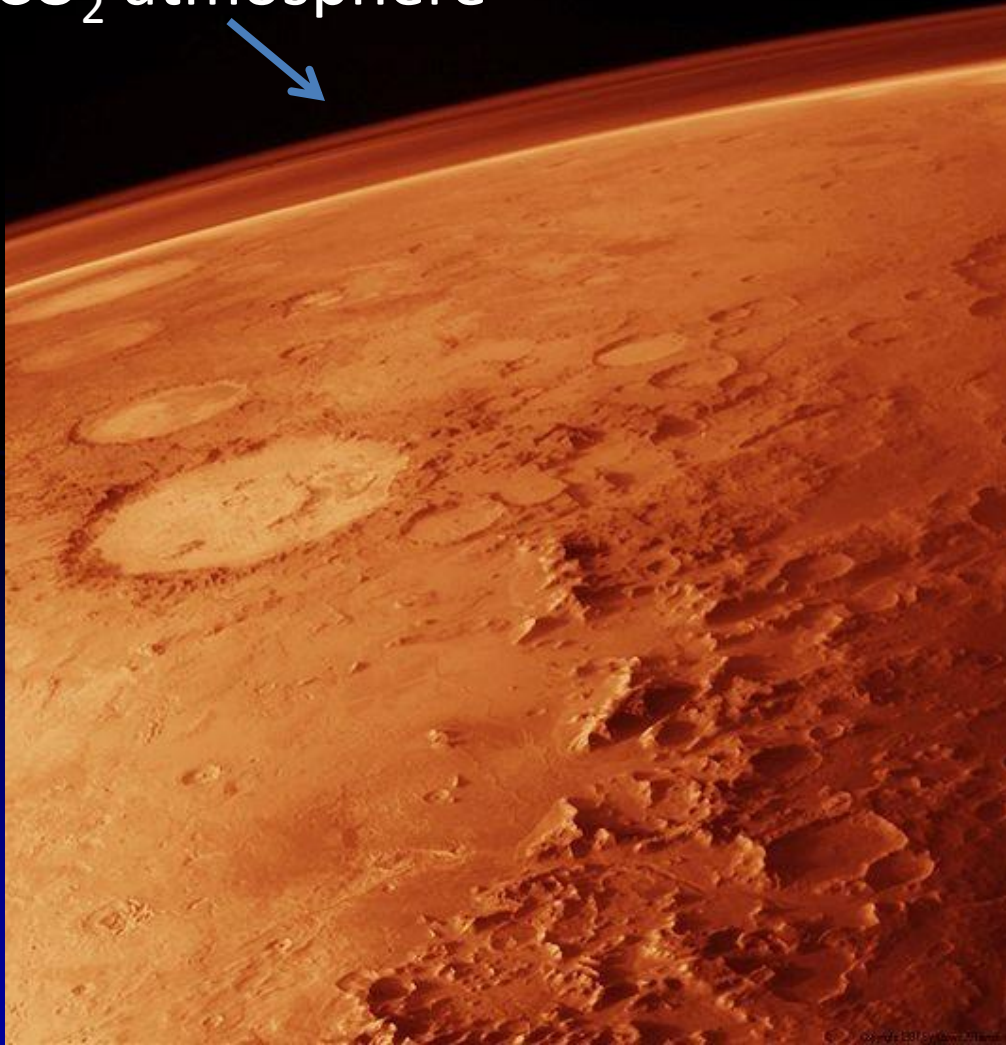
-Why?

Polar CO₂ ice caps

Thin carbon dioxide
atmosphere

Atmosphere and Ice Caps

CO₂ atmosphere

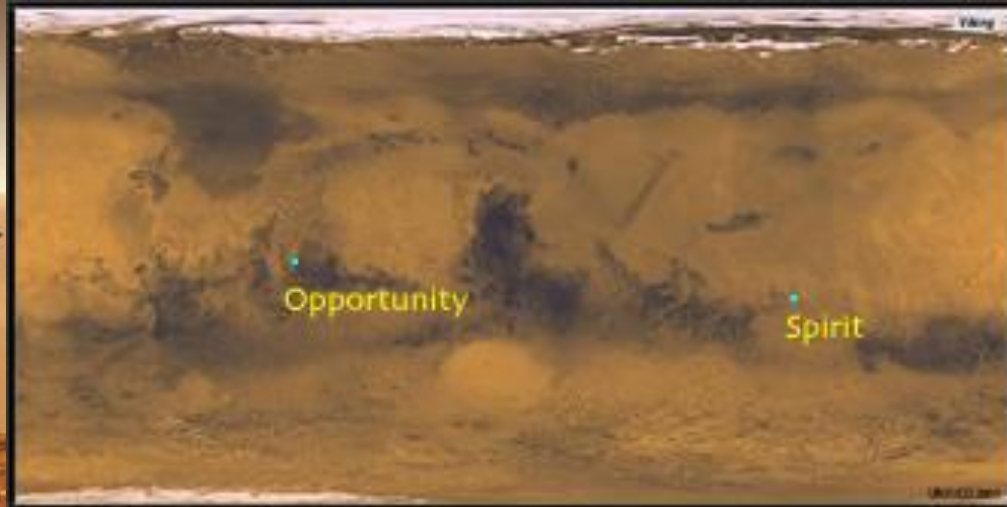


Polar ice caps grow and shrink over the seasons

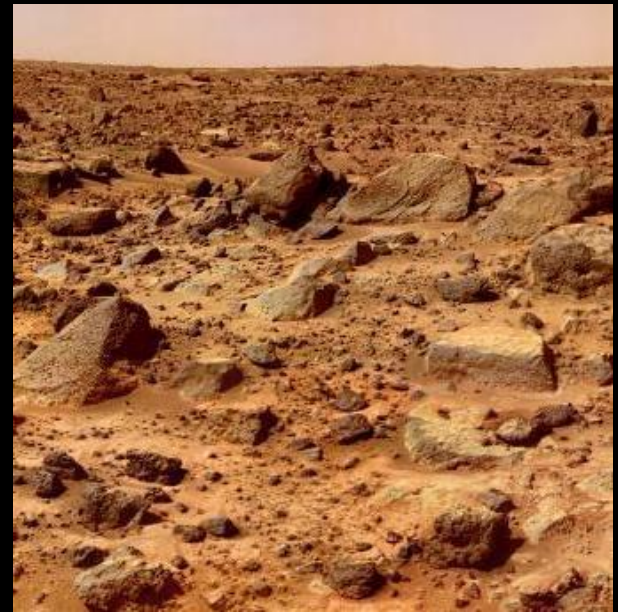
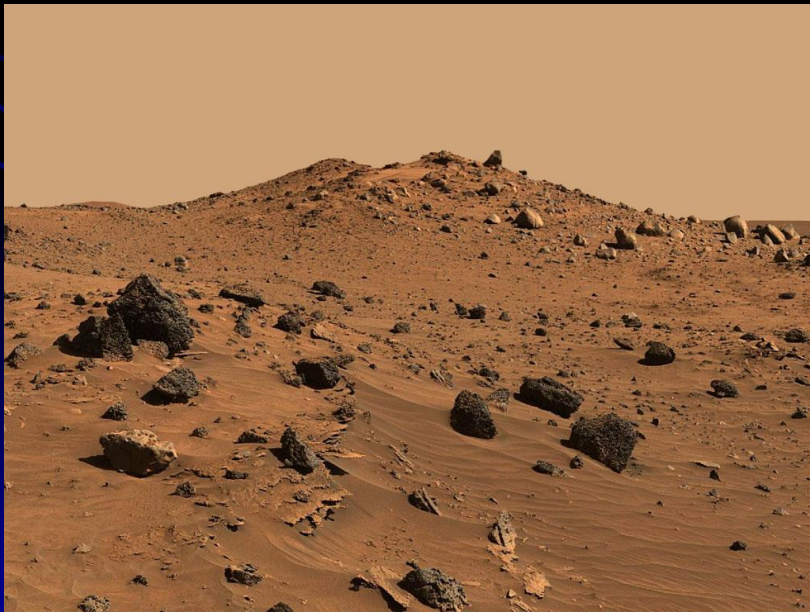
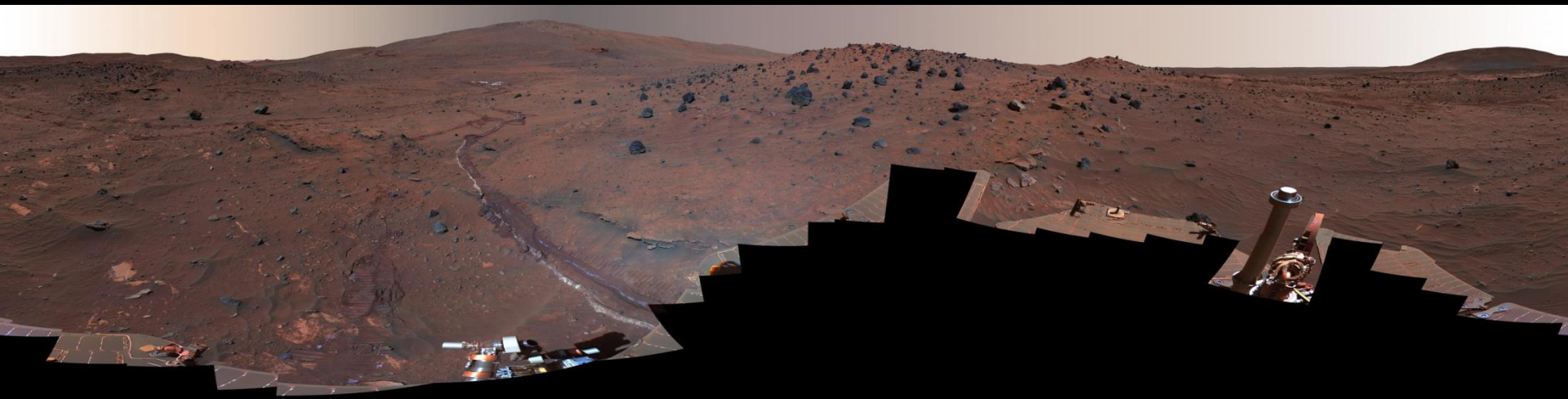
Spirit & Opportunity



- Almost identical rovers designed to explore the Martian surface (5ft x 5ft)
- Both rovers landed on Mars in 2004
- Landed and roved different areas

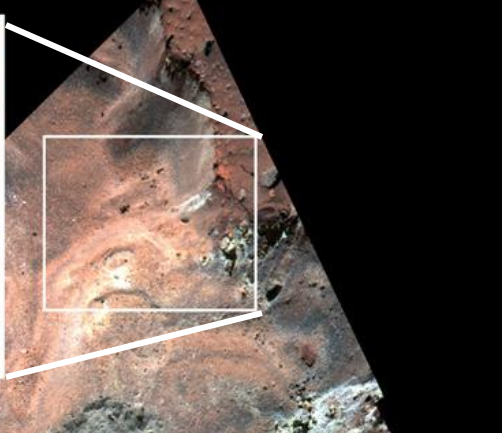


Martian Surface

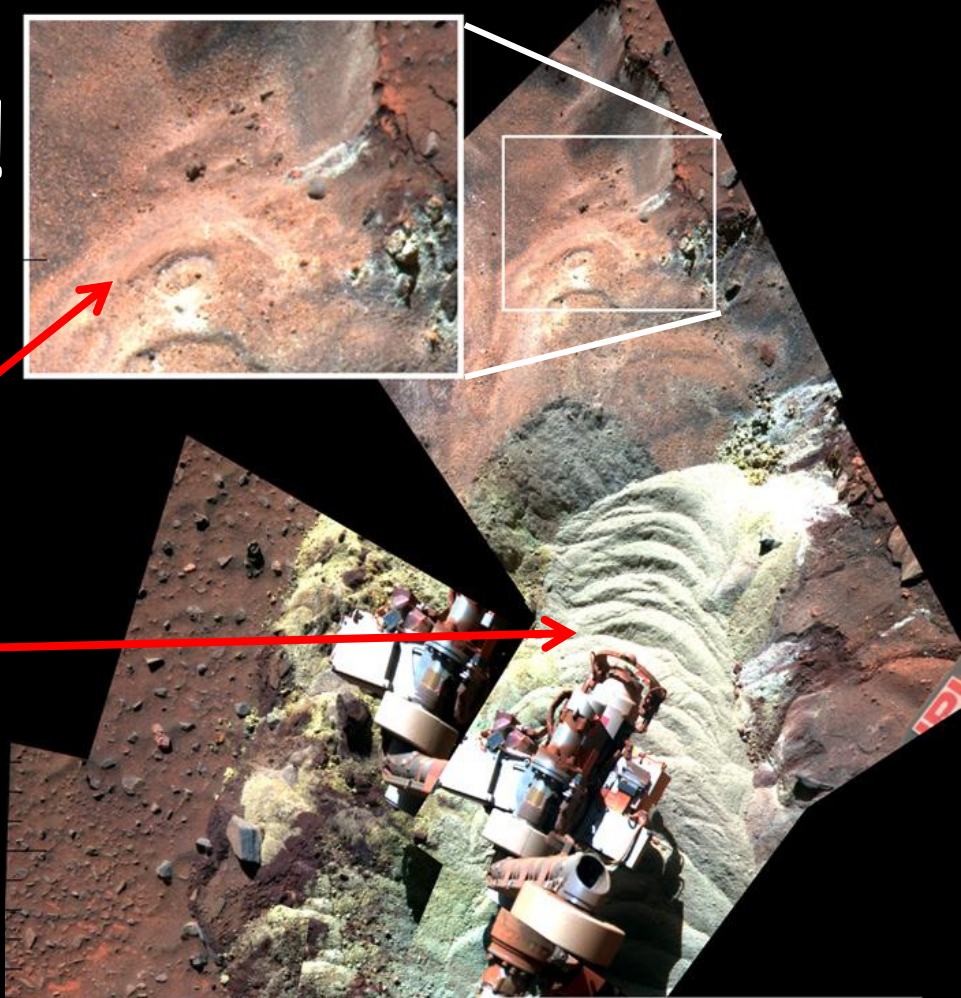


Spirit Finds Water!

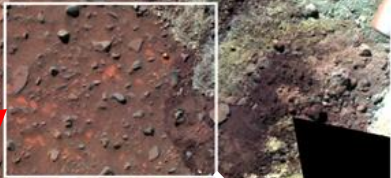
Dry sand and dust



Silica rich layer from hot springs



Normal Martian surface



More Evidence for Water/Habitability

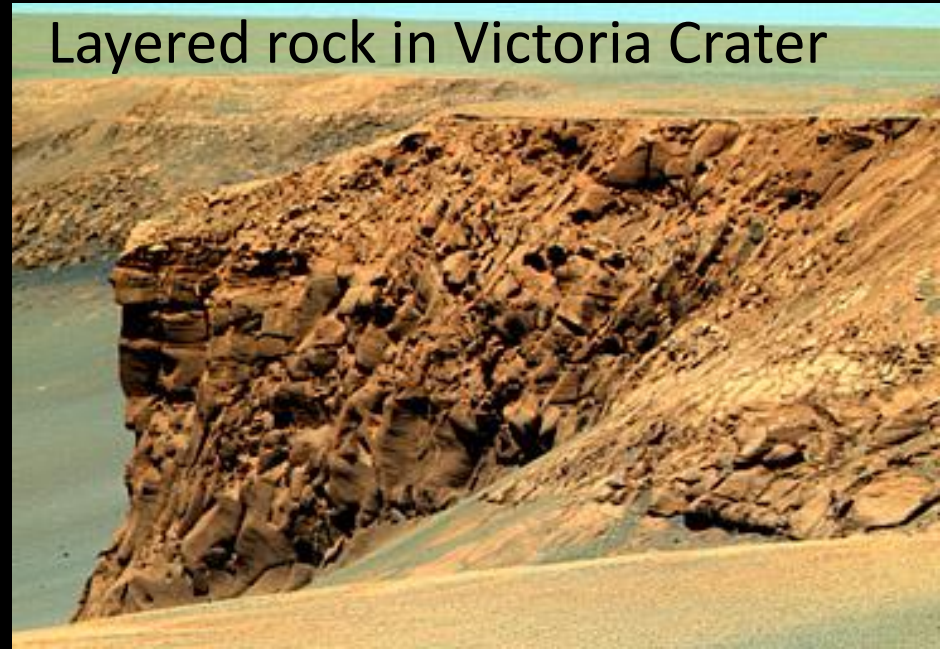
Iron rich “blueberries”



Starbucks?!?!?!?



Layered rock in Victoria Crater



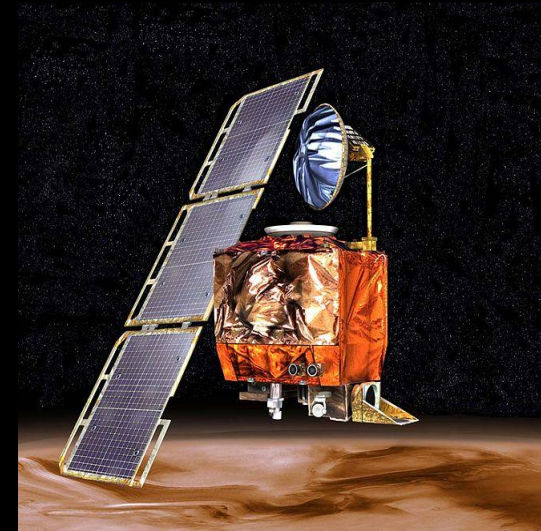
Calcium Carbonate



Units are important!!!!



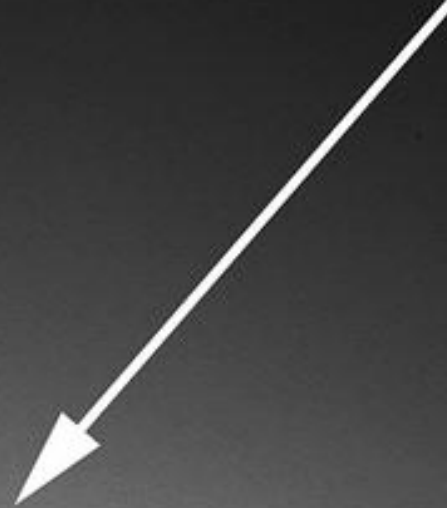
- Mars climate orbiter crashed landed on Mars instead of entering into orbit



Why?

- The Americans used miles & feet in their calculations while the Europeans used km & meter.
- Nobody wrote down their units!
- Astronomers lost a \$327 MILLION dollar instrument!

You are here



Earth: The Truly Friendly Planet