

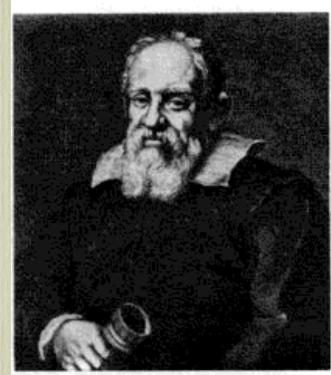
Farewell to Earth: Planets and other things

Galileo leaves Earth:
NASA



Farewell to Earth

- *Galileo to Galileo*
- *Person to Space probe*



Quick look at the moon

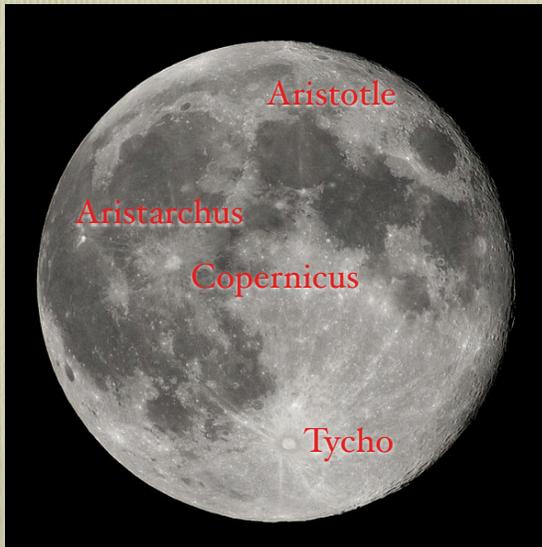
- [Dennis Di Cicco \(TWAN\)](#)
- Moonrise over Boston



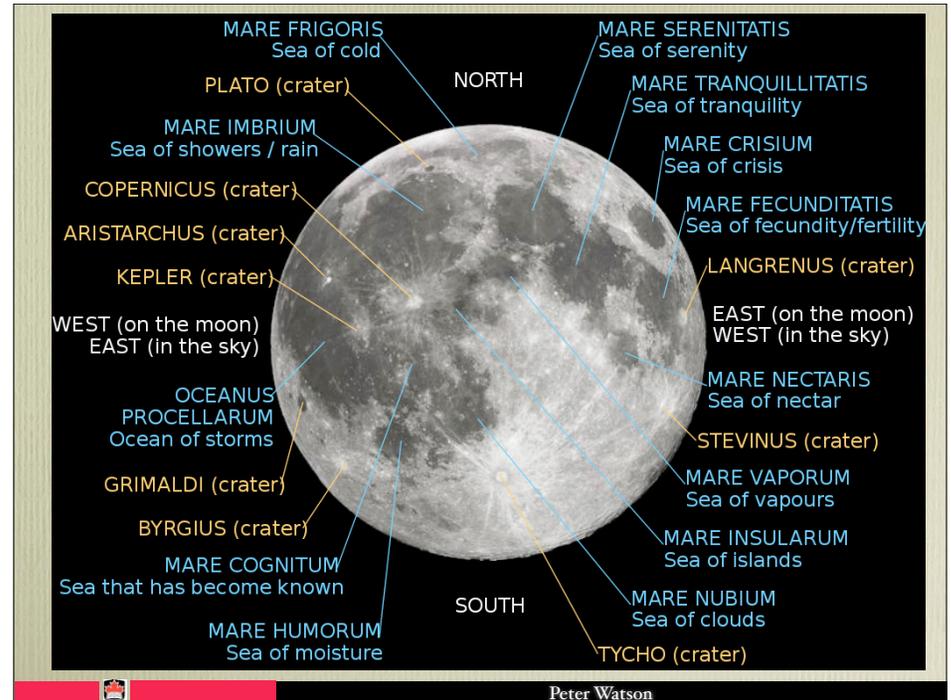
Earthrise from Apollo 8



Nearside



Peter Watson



Peter Watson

- Craters: formed by impact, mostly old
- rays are “splash marks” indicative of more recent impacts
- This is Tycho & Copernicus



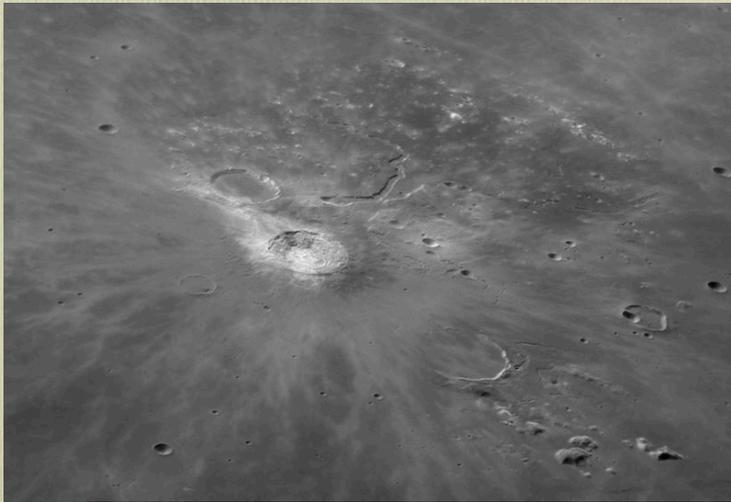
Steve Mandel,
Hidden Valley Observatory

Copernicus as seen by Lunar orbite



Peter Watson

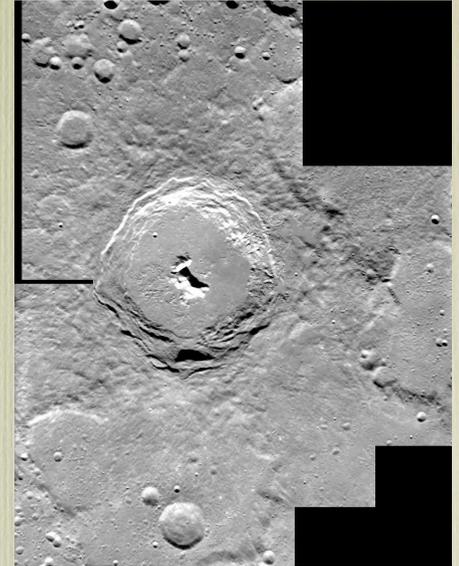
- Can estimate ages by erosion/burial of craters
- This is Aristarchus (new) and Herodotus (old)



Credit &
Copyright:
Alan
Friedman

Peter Watson

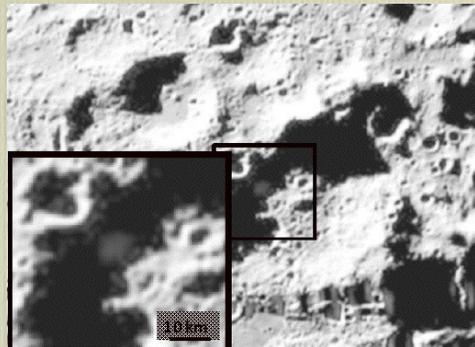
- This is Pythagoras (new)



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Is there water on the moon?

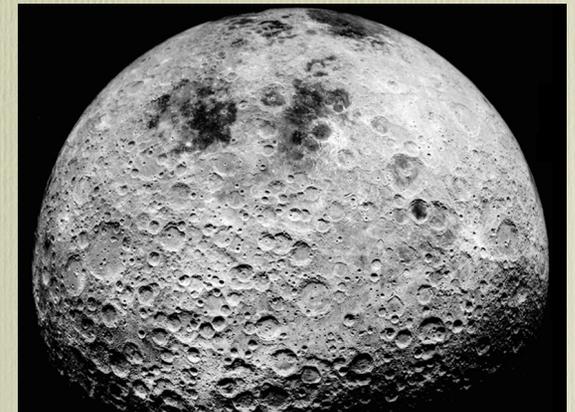
- Tiny amounts, as demoed by probe, may exist in shadows



Peter Watson

Farside

- Apollo 16
- Note much more cratered, no maria



Peter Watson

History (best bet)

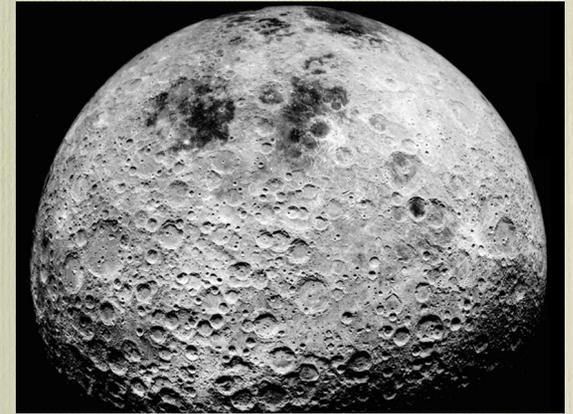
- Earth formed as single planet 4.5 billion years ago
- Collision formed ring of debris
 - Less dense moon coalesced out of debris
 - Second collision melted surface, created maria
 - later bombardment formed craters: those on earth mostly eroded away (see later)



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Farside

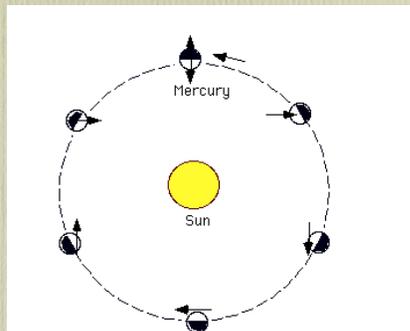
- Apollo 16
- Note much more cratered, no maria



Peter Watson

Mercury

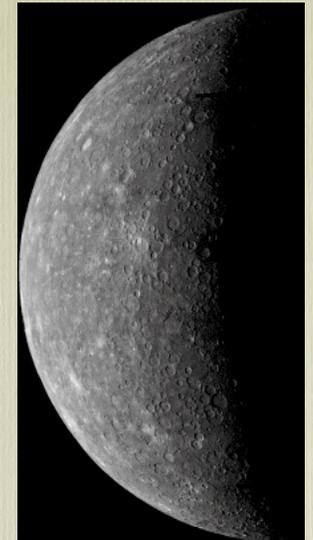
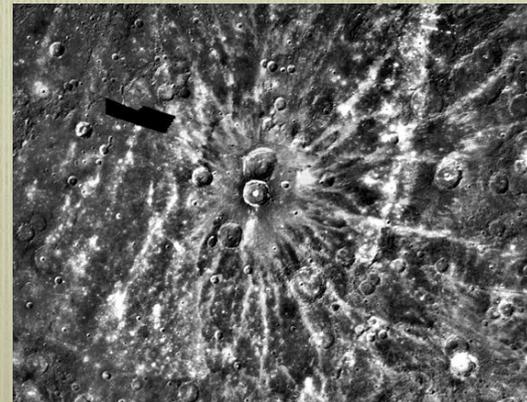
- Hard to see from Canada, since close to sun
- Orbital period of 88 days.
- Rotational period ~ 56 days
- Long thought to be ~ 88 days: In fact, it is 2/3 of the orbital period).



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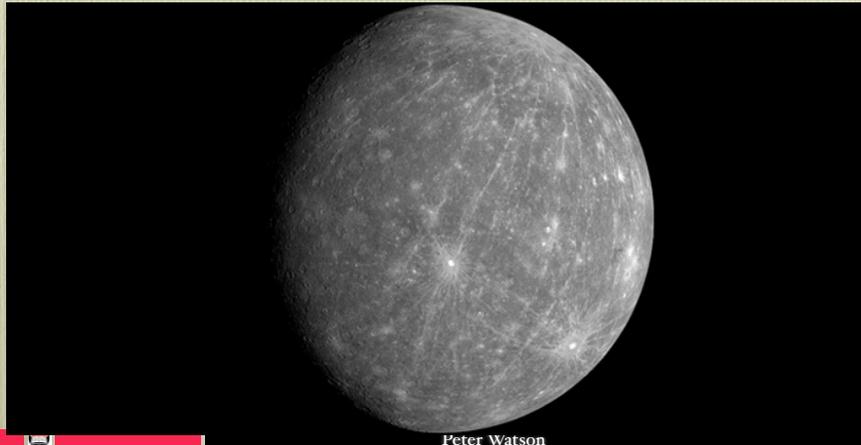
Mercury

- Always seemed to be really boring
- This is Degas crater



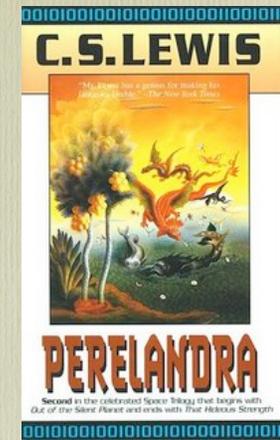
Peter Watson

- Fortunately NASA has sent Messenger to Mercury
- Started orbit in March 2011
- And it **IS** really boring

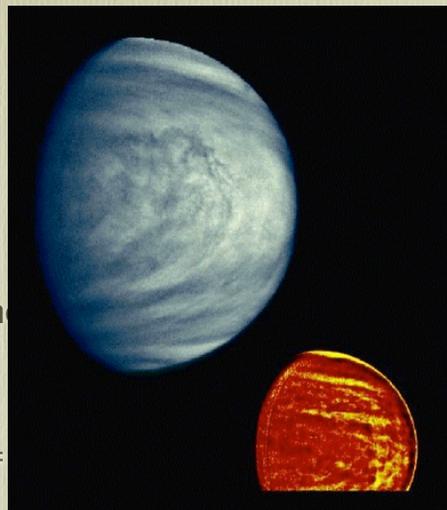


Venus

- Popular with writers: e.g C. S Lewis
- So does it look like this?



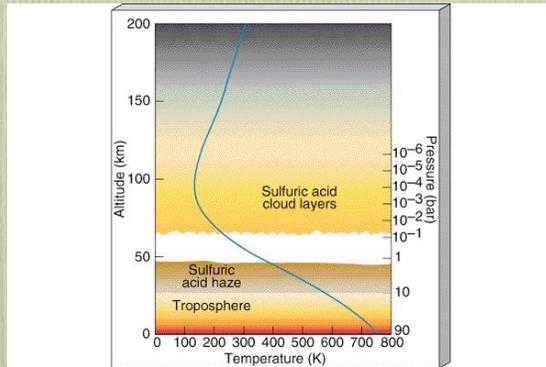
- Almost featureless in optical.
- Usual picture is UV (upper) or infrared (lower) and only shows cloud-tops.
- Venera, Pioneer and radar showed surface for first time
- Year = 225 days.
- Rotation (i.e. 1 venus day = 243 days backwards (so sun "rises" in the west: unknown till 1961)



Venera 14

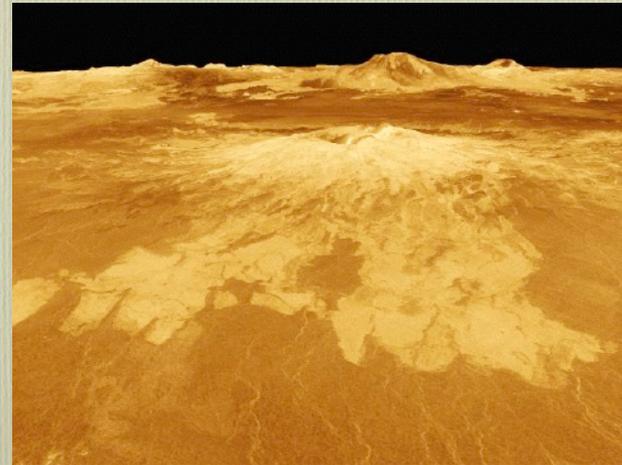


- Atmosphere very dense Mainly CO₂
- Upper clouds rotate in 4 days (~360 km hr⁻¹)
- At surface, gentle winds, but temperature ~ 900 °C



Peter Watson

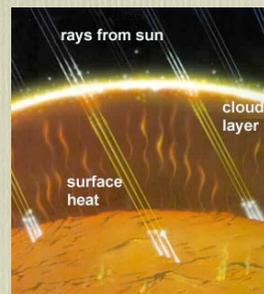
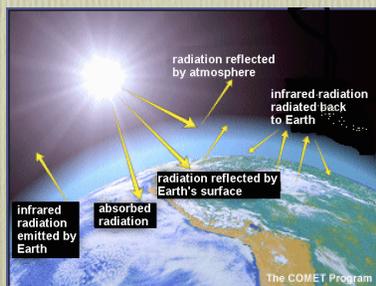
- Sapas Mons, a volcano 400 km across and 1.5 km high.
- lava flows extend for hundreds of km.



Peter Watson

Why is "Earth's Twin" so utterly different?

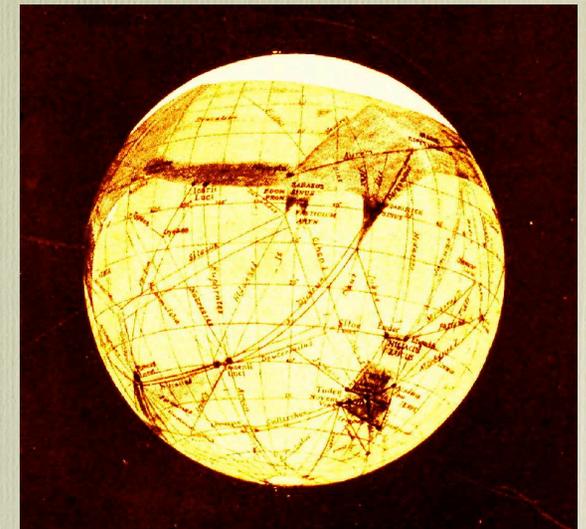
- Runaway greenhouse effect



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Mars

- Very popular with writers:
- Bradbury did it best ("Sands of Mars")
- Lowell observed canals



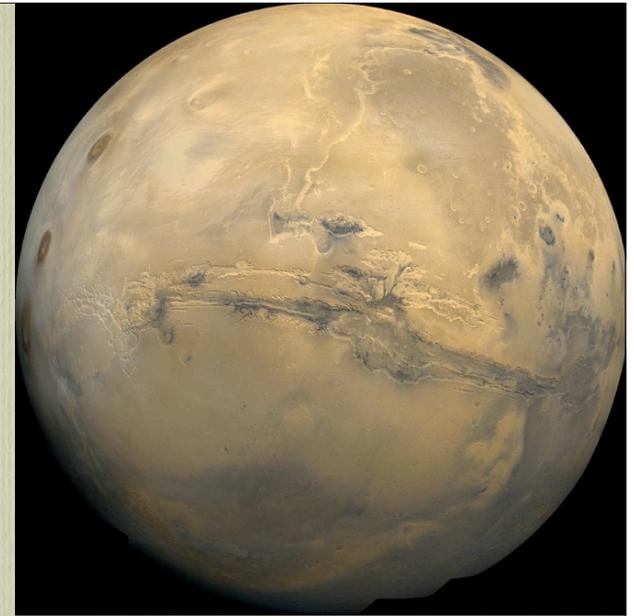
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- Atmosphere: pressure ~0.005 bar
- 95% CO₂, rest O₂ (oxygen), N₂ (nitrogen), Argon + very little water
- Temperature range -80°C -> 30°C
- polar caps are frozen CO₂



Mars - February 1995
 PR95-17 - ST ScI OPO - March 21, 1995
 P. James (U.Toledo), S. Lee (U.CO), NASA
 HST · WFPC2

- Valles Marineris
- The Grand Canyon of Mars
- 3000 km long
- Up to 600 km wide
- Up to 8 km deep



Peter Watson

- Olympus Mons
- 25 km high, 500 km round
- evidence of lava flows.
- Much larger than equivalent ones on earth (why?)



Peter Watson

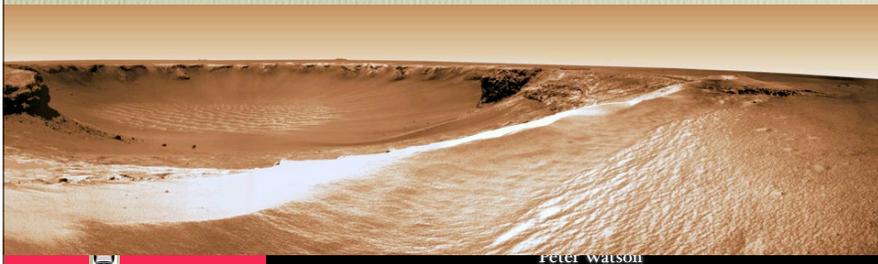
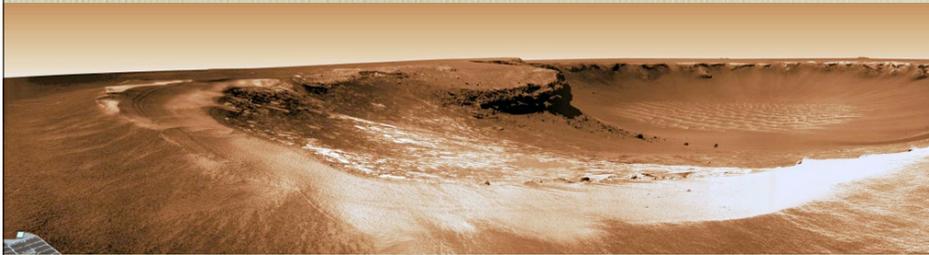
Impact craters

- Lots, at various stages of newness



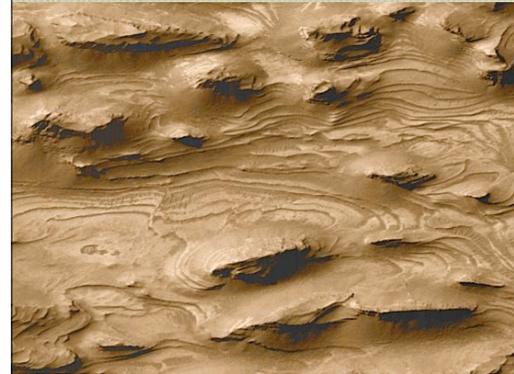
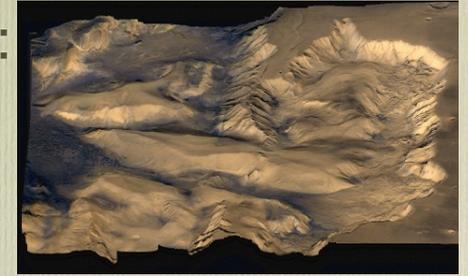
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- Note the quality of pictures now: Victoria crater.
- Frost is frozen CO₂



Peter Watson

Candor Chasma: Massive rift valley.

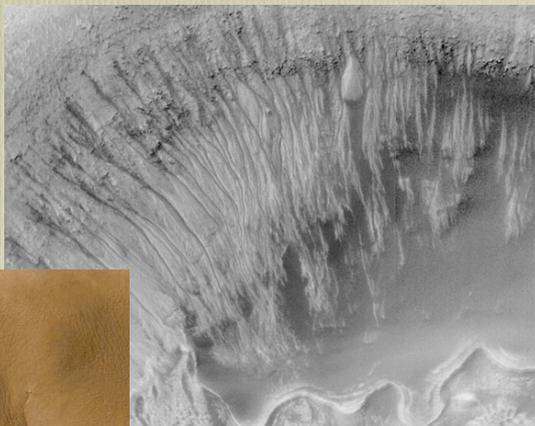


- The interesting problem:
- Does Mars have water?
- Some places look just as though it once did



Peter Watson

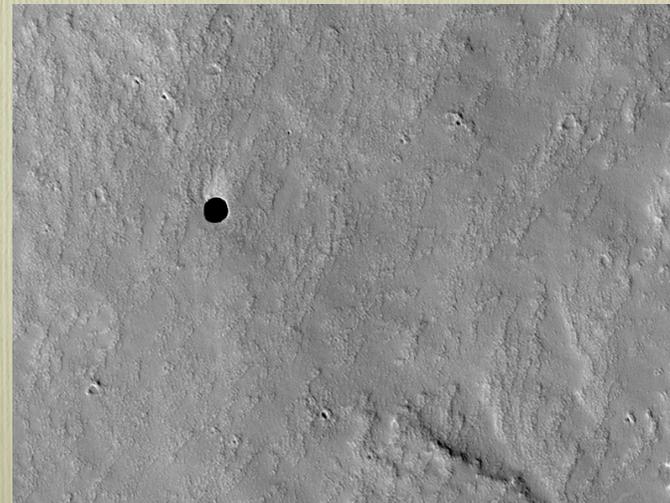
This is the Newton crater



and what really look like
arroyos in New Mexico

Peter Watson

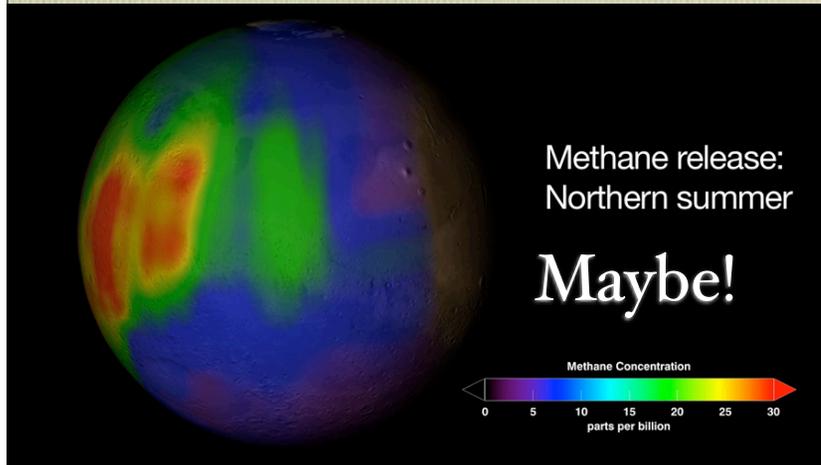
"holes": caves where water could still exist
underground.
Maybe there was a lot of water: could still be some



Peter Watson

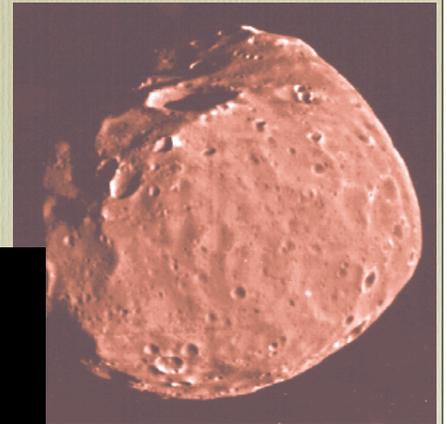
So does this mean there is life on Mars?

- Methane is a hint



Peter Watson

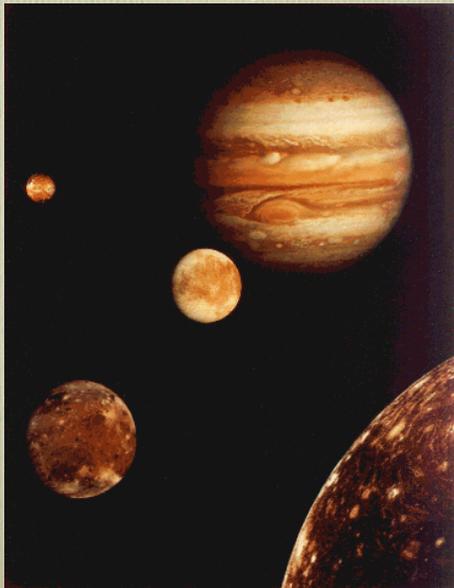
- Two small lumpy moons.
- Phobos



Deimos

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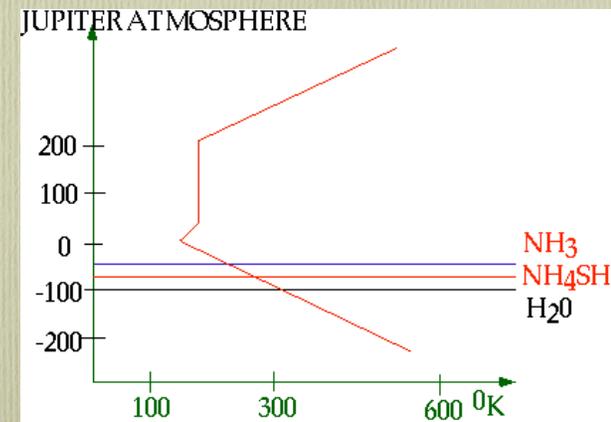
Jupiter and Moons



- Largest planet by far.
- Strongly banded appearance,
- bands lie lower in atmosphere than light areas

Peter Watson

- Colours due to complex organic molecules:
- No surface in usual sense.



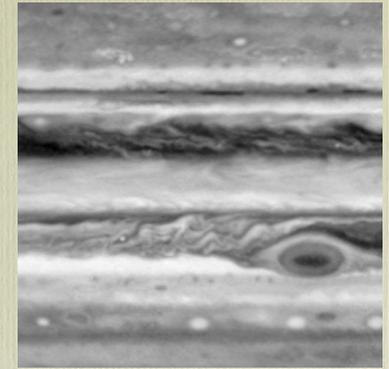
Peter Watson

- Great Red Spot, noted since 1600's: 20,000 km x 50,000 km.
- Top of spot extends well above surrounding cloud tops.



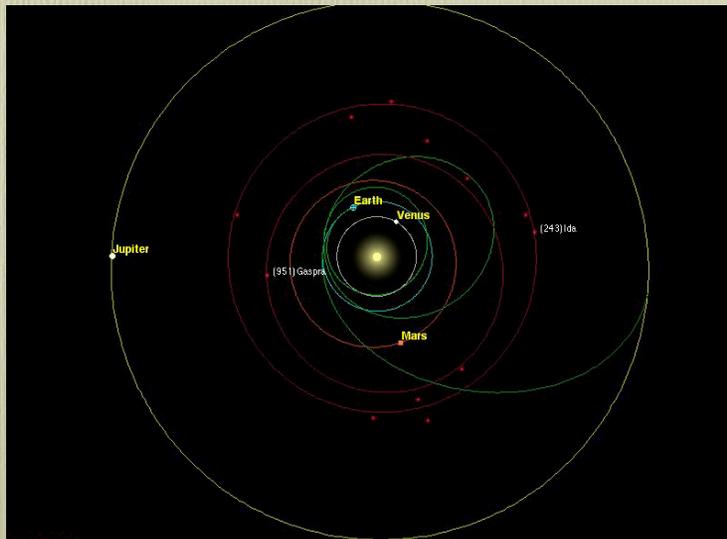
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- Obviously a "hurricane"
- Speeds of rotation ~ 500 km/hr
- Lifetime not too surprising:
- 1000 x bigger than terrestrial hurricanes, so lifetime could well be 1000 x longer!



Peter Watson

Galileo, the space probe



05:00:00 PM



Peter Watson

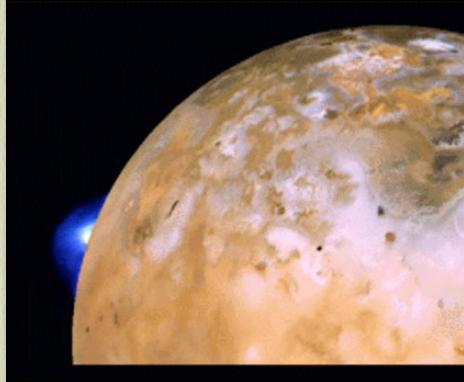
Moons of Jupiter: Io

- Four large moons, easily visible with binoculars
- Can watch Io rotating



Peter Watson

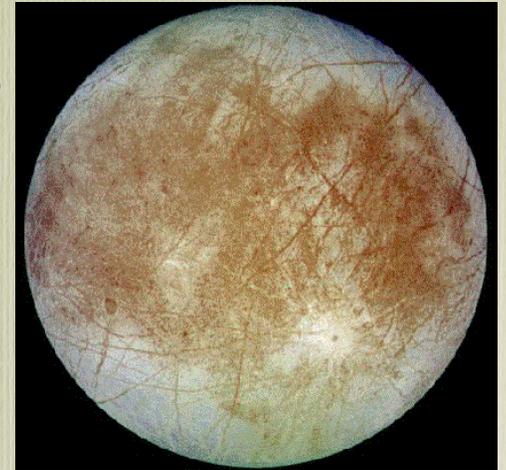
- Io is in a state of continuous volcanic eruption.
- Volcanic plumes to 250 km
- Vulcanism caused by "tidal pumping" by other moons.



Peter Watson

Moons of Jupiter: Europa

- Rock covered with ice, probably slushy since no impact craters.



Peter Watson

- Close-ups show odd crustal structures, almost like pack-ice



Peter Watson

Moons of Jupiter: Ganymede

- Largest moon in the solar system
- Ice on rock.



- Many craters,
- Huge transverse faults

Peter Watson

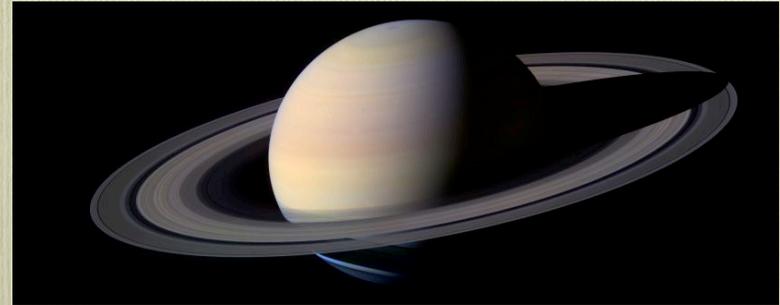
- Chain of craters:
- maybe made by a comet hitting



Peter Watson

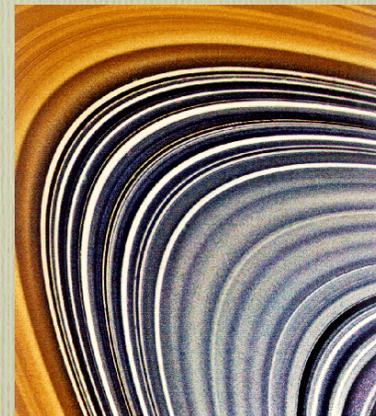
Saturn

- Atmosphere similar to Jupiter, but less heating (internal & sun) so weather better!



Peter Watson

Cassini fly-through of Saturn:
still pictures assembled by Stephen van Vuuren



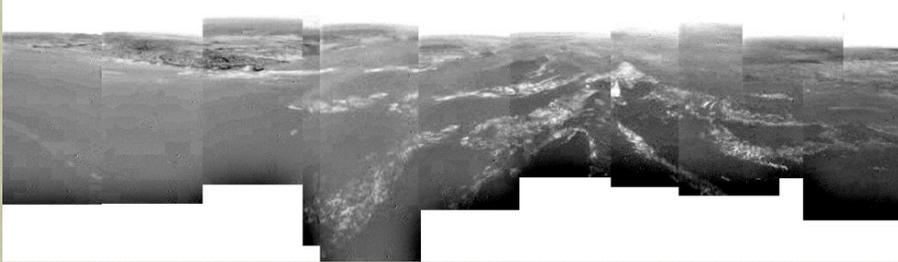
- Galileo described them as "Handles"
- Made of small ice pellets and dust (moonlets)
- many thousands of ringlets, some braided
- rings very thin (< 2 km) held in place by "shepherd" moons



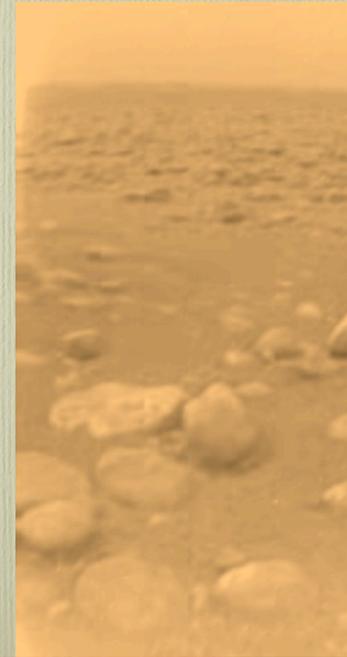
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Titan

- larger than our moon, yellow atmosphere so surface invisible
- Touchdown of probe: 14 January 2005,
- The white streaks are 'fog' of methane or ethane vapour. Wind speed at 6-7 m/s.



Peter Watson



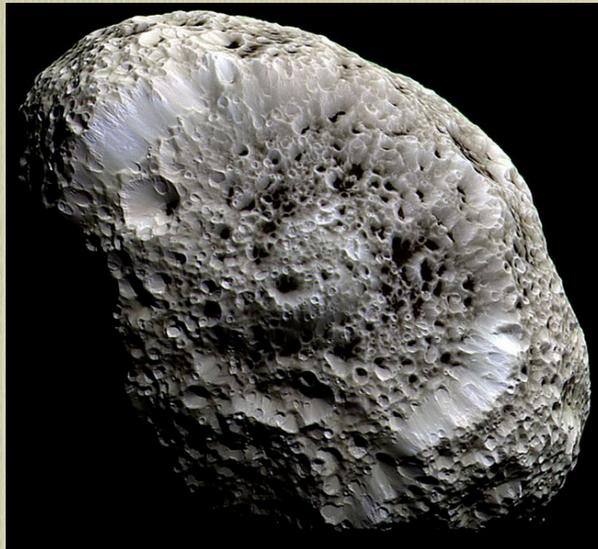
- Touch down at 4.5 m/s
- probe penetrated 15 cm.
- Surface consistency of wet sand or clay.



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Hyperion

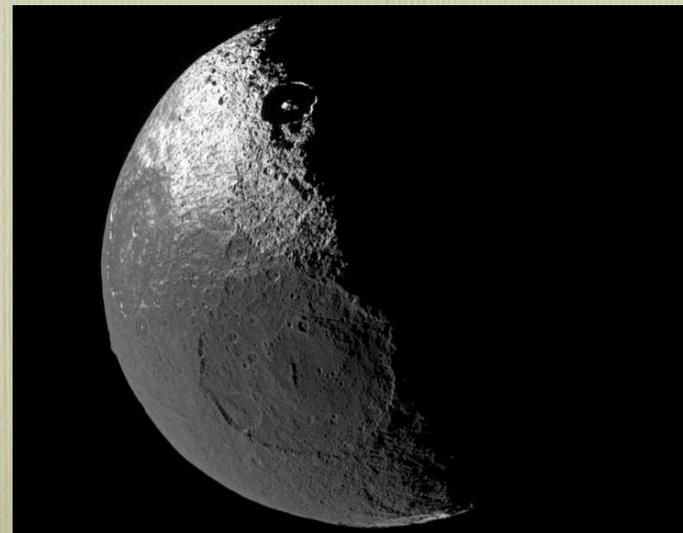
- Density about 1/2 water (!)
- suggests spongy texture!



Peter Watson

Iapetus

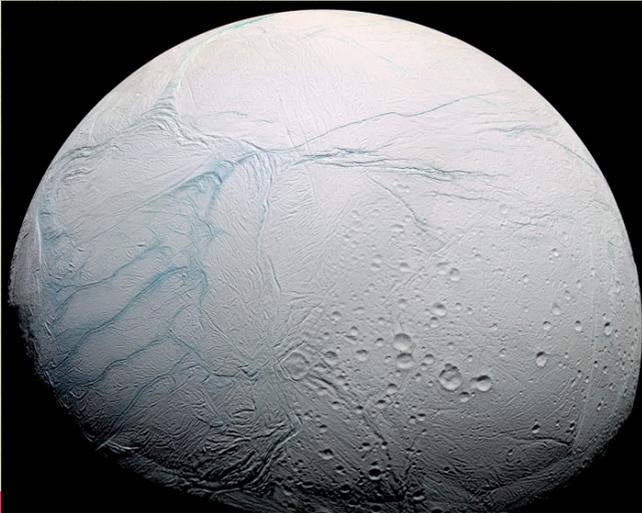
- Half of moon is covered in material as black as coal!



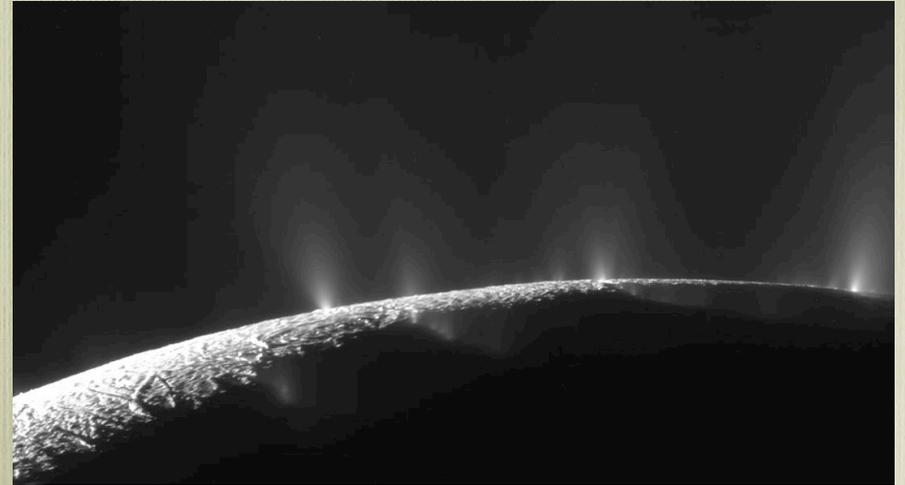
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Enceladus

Giant stripey snowball?



- With ice volcanoes!



Peter Watson

- and finally (for the time being)
- Spitzer space telescope found a new, very diffuse dark ring round Saturn
- Could be source of the dark face of Iapetus



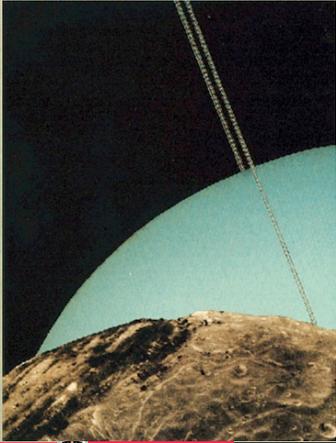
Uranus

- Pale blue in colour, almost featureless



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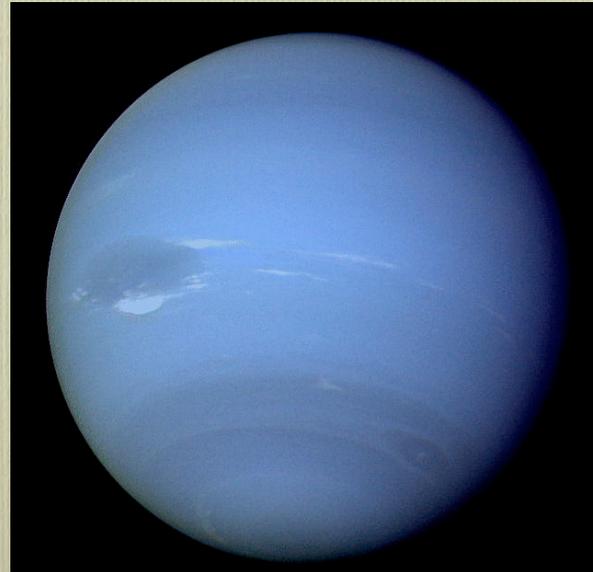
Has rings, but
very unlike
Saturn



- This is maybe what it would look like from Ariel

Peter Watson

Neptune



- One major moon, Triton has an atmosphere,
- retrograde orbit (captured asteroid?).
- Other smaller moons. Appearance similar to outer moons of Jupiter:



Peter Watson

Pluto-Charon



2.75 billion miles out (OK, it was poetic license)

But is it a planet?

Peter Watson

Acknowledgements

- Astronomy Picture of the Day (APOD)
- NASA
- ESA
- Next talk: so what else is out there?

