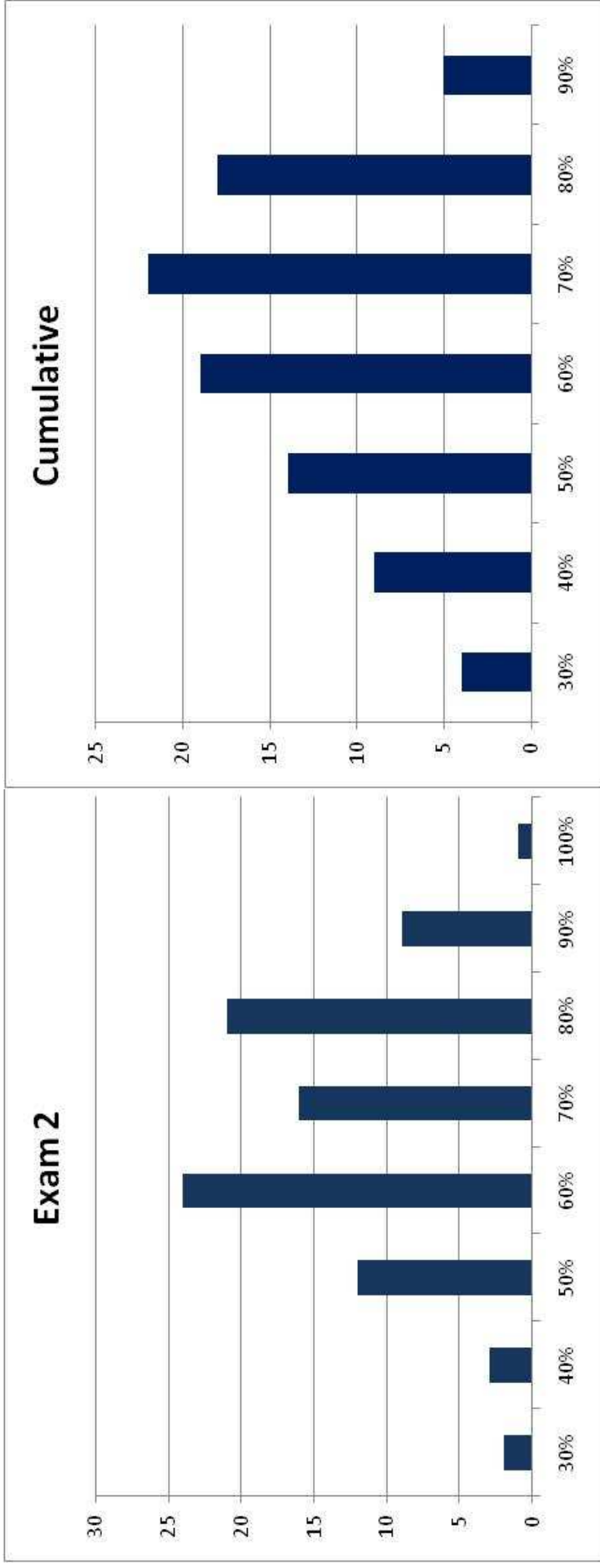




Max = 300

Range = 111 – 305 (37% - 102%)
 Mean = 217 (72%)
 Median = 216 (72%)

Max = 875

Range = 263 – 863 (30% - 99%)
 Mean = 599 (69%)
 Median = 612 (70%)

“All the so called ‘secrets of success’ will not work unless you do!” - Author Unknown

What We Will Learn Today

- What are planet Jupiter's features?
- How did Jupiter form and what is it made of?
- What is the weather on Jupiter like?
- How does Jupiter's magnetosphere compare with Earth's?
- Does Jupiter have a ring?
- How have we explored Jupiter?
- How is Jupiter unique in the Solar System?

Planet Jupiter's Details

Property	Value
Semi-major axis	5.2 AU
Size (radius)	11.2 R _{Earth} Largest planet in SS
Mass	318 M _{Earth} Most massive planet in SS
Average density	1.33 g/cc
Composition	Mostly Hydrogen & Helium
Average cloud-top temperature	125 K
Moons	> 63 Most known moons in SS
Orbital period	11.9 years
Rotation period (sidereal)*	9.8 hours Fastest rotator in SS
Axis tilt	3.1°
Orbital inclination	1.3°
Orbital eccentricity	0.048

* Measured based on rotation of magnetic field lines

The Jovian Planets



Fig 11.1

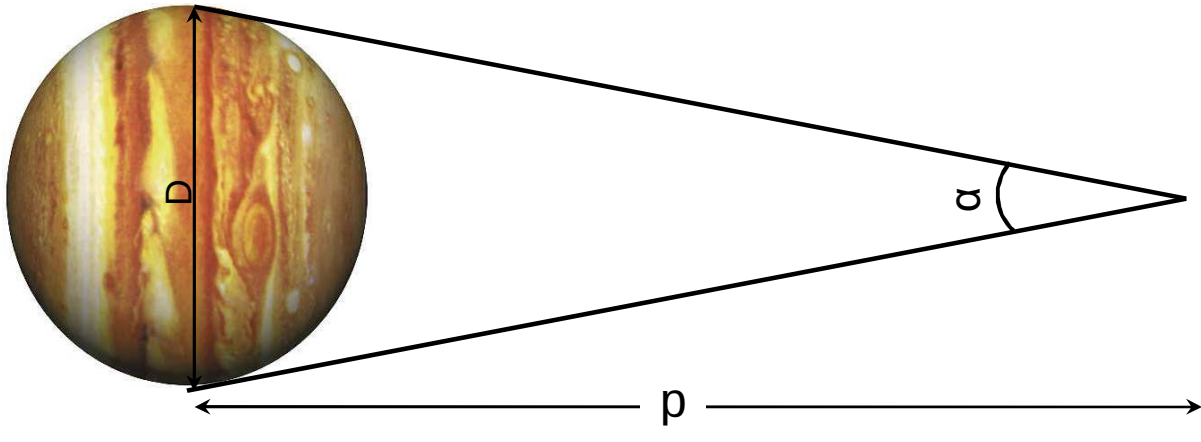
- Much larger than their terrestrial counterparts
- Gaseous composition
- Active weather
- Colorful clouds
- Rings

How Did Jupiter Form?

- Beyond the frost line
- Hydrogen compounds condense
 - H_2O , CH_4 , NH_3
- ~ 10 Earth-mass planetary core forms
- Gravity allows it to capture H_2 & He atmosphere
- Grows into a gas giant
 - Now 99% H_2 & He
 - Traces of H_2O , CH_4 , NH_3 , PH_3 , S compounds

Determining Jupiter's Size & Scale

- Copernicus determined relative distances in SS
- Needed to calibrate the scale
- Venus transit used in 1760s to measure 1 AU
- Angular size + distance gives us linear size
- P and a of Jovian moons gives us mass



$$D = d \cdot \alpha$$

Jupiter's Relatively High Density

- Jupiter is over 3 times as massive as Saturn
 - But only slightly larger
- In fact, Jupiter is as large as the smallest stars
- If Jupiter were 13 times more massive, it would be a Brown Dwarf (Deuterium fusion in the core)
- If it were 80 times more massive, it would be a star (Hydrogen fusion in the core)



Sun, M, L, T dwarfs, Jupiter

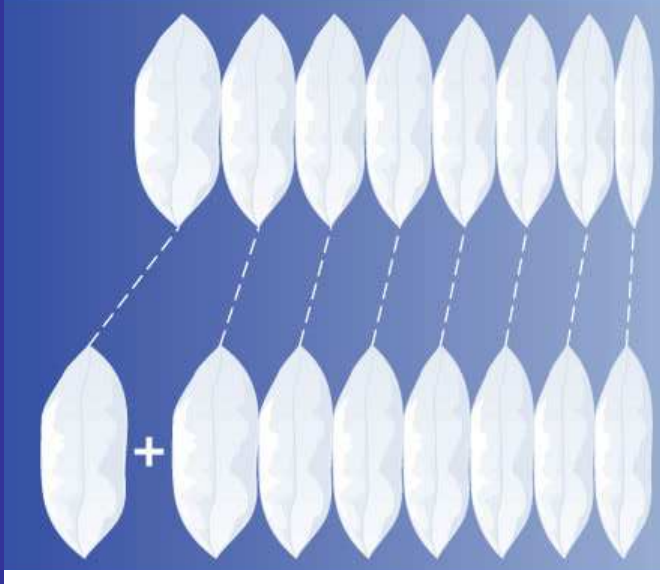
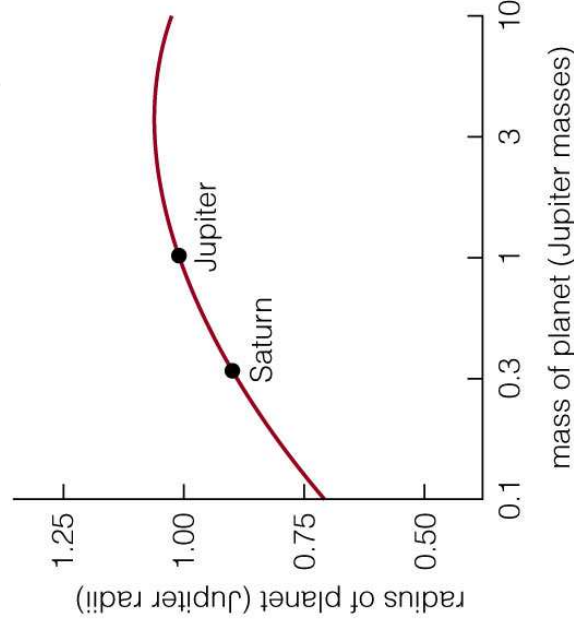


Fig 11.2



Inside Jupiter

- Cloud tops are at 125 K
- Temperature and pressure increase as you go down
 - At about 14,000 km down (20%)
 - Pressure ~ 2 million bars
 - Temperature ~ 5,000 K (like Sun's surface)

- Primarily known by fitting interior models to observed features

- Like we discussed for the Sun
- Probe dropped from Galileo was destroyed after descending 200 km
- Why is Hydrogen liquid despite such high temperatures?
- What is the minimum core temperature to fuse Hydrogen?

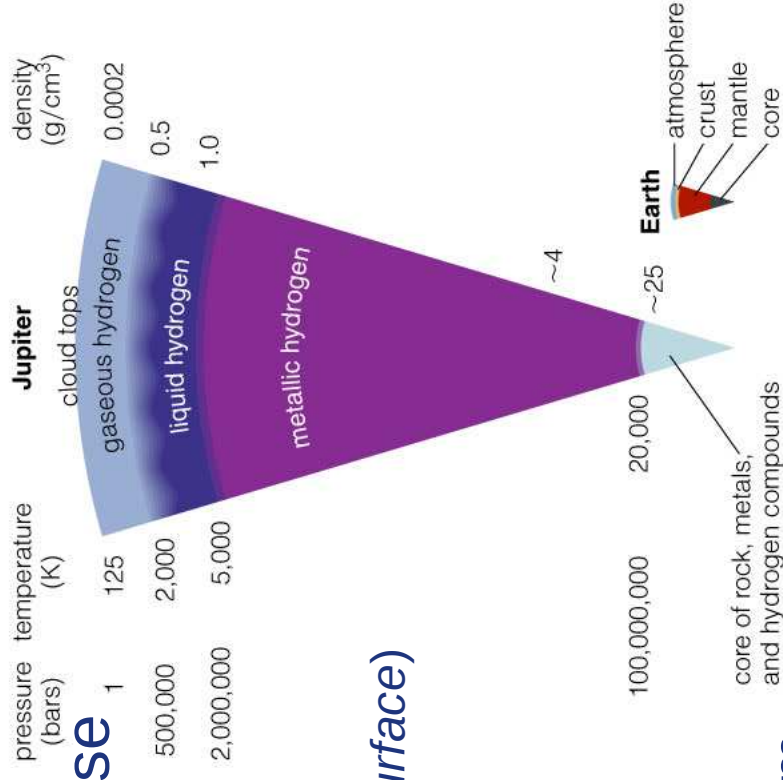


Fig 11.4

The Weather on Jupiter

- Temperature and pressure ranges allow for very interesting environments
 - Ammonia, hydrosulfide, water clouds
 - “Snowfalls” do occur in layers!
 - Colorful layers: Zones, Belts
- Internal heat source
 - Trapped heat from accretion
 - Radioactivity
 - Ongoing contraction
 - Light output = 2 x Sunlight received

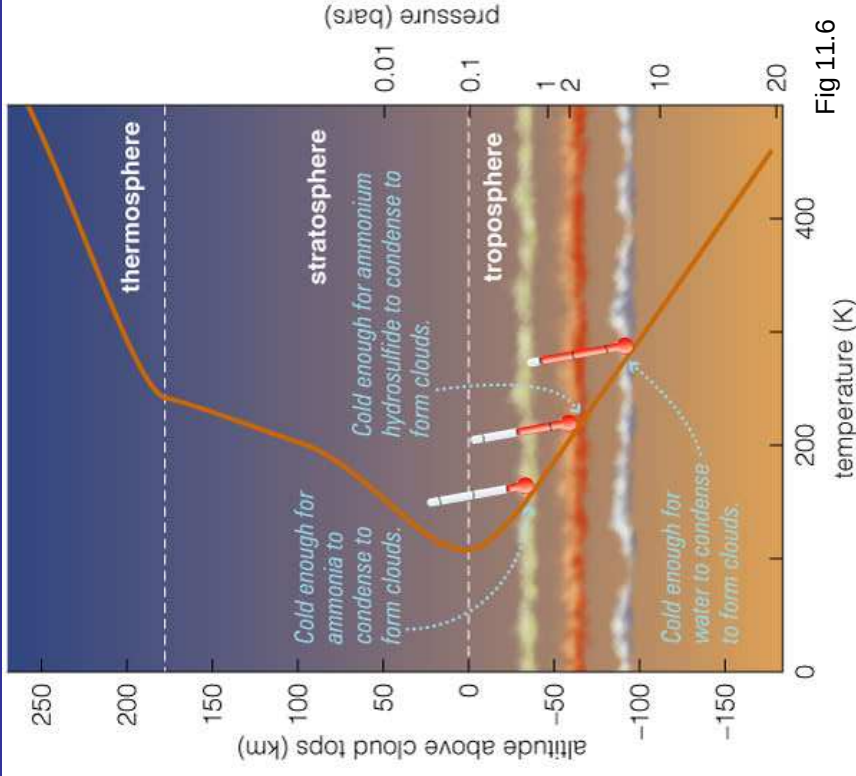


Fig 11.6

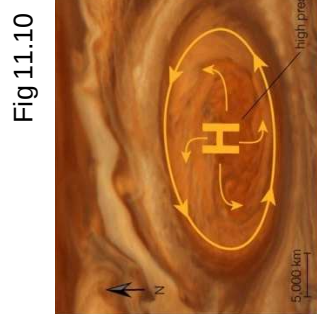


Fig 11.10

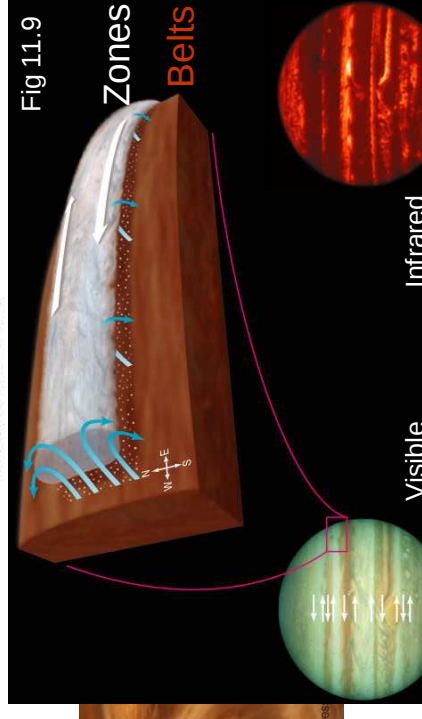


Fig 11.9

- Very active winds, weather
 - Strong Coriolis effect
 - Large size, fast rotation
 - Great Red Spot
 - > 2 x Earth size, lasts 100s of years!

Jupiter's Strong Magnetosphere

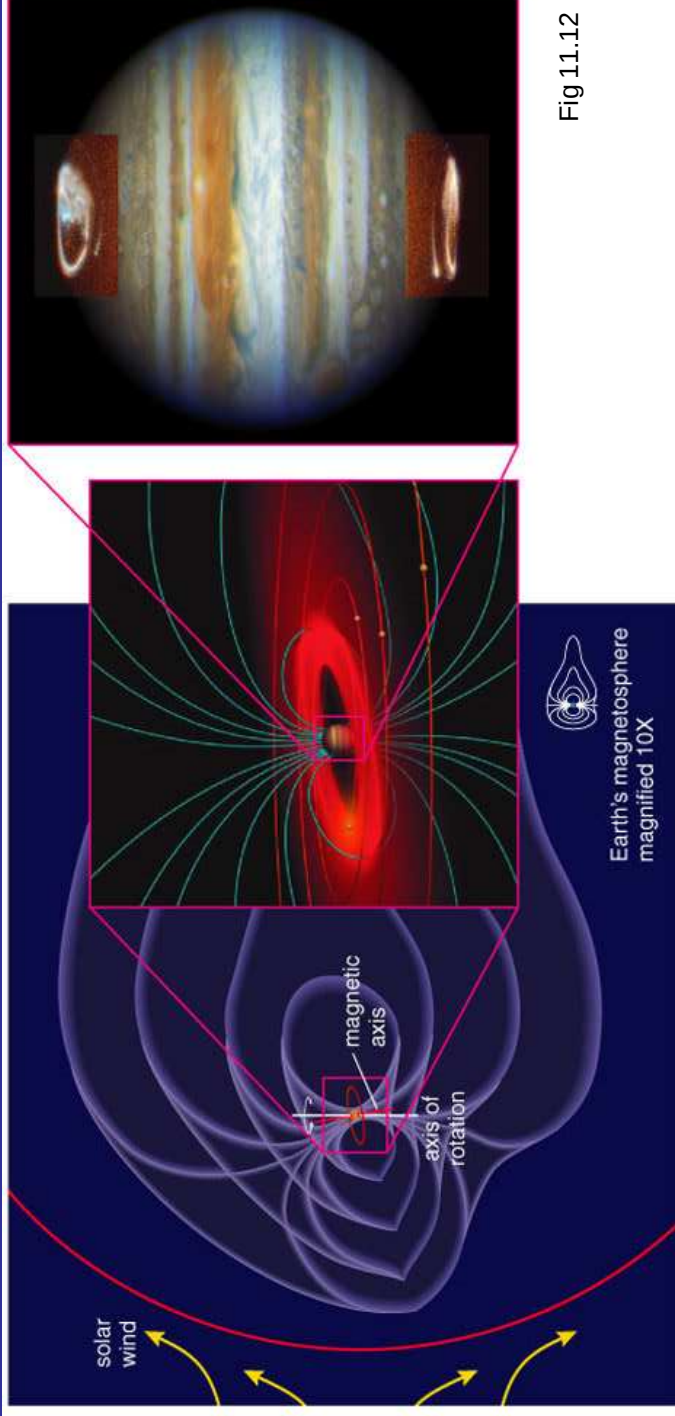


Fig 11.12

- Jupiter's strong magnetic field results from
 - Conducting interior (metallic Hydrogen)
 - Internal heat (Convection)
 - Fast rotation
- Torus of charged particles
 - Charged particles from the Sun & Io's volcanoes
- Jovian aurorae observed by HST

Jupiter's Wimpy Ring

- Discovered by Voyager after passing Jupiter and seeing its night side
 - We never see phases of Jupiter or see its night side from the Earth. Why?

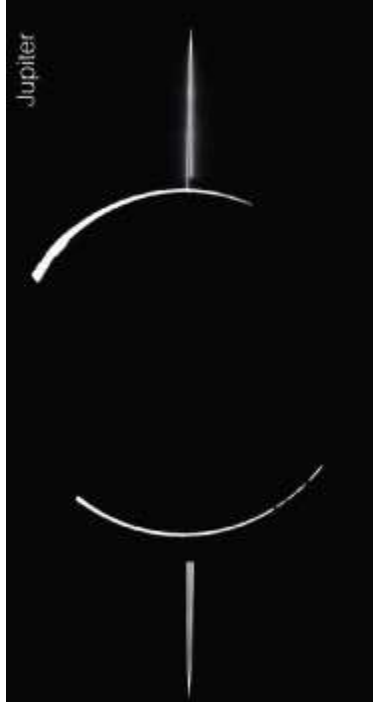
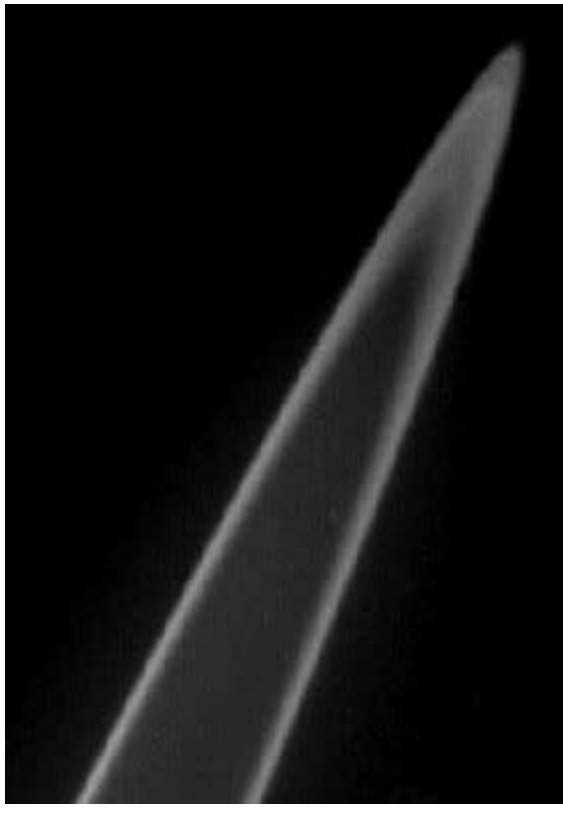


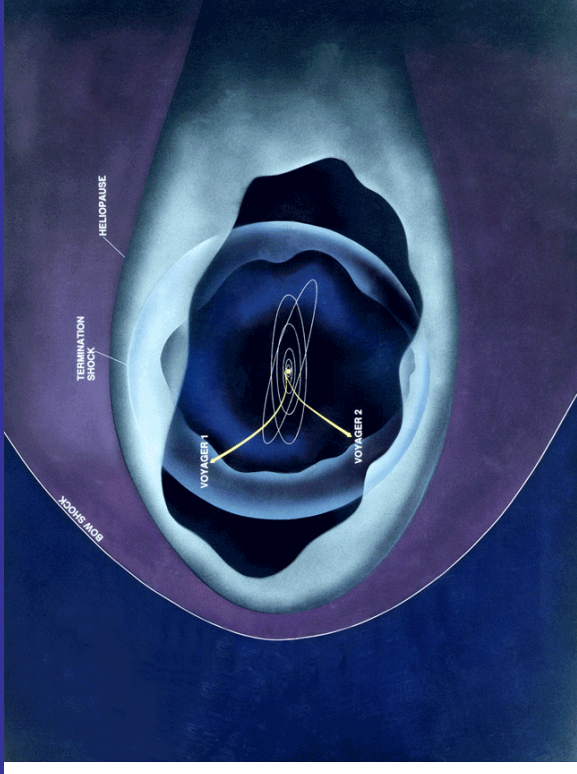
Fig 11.34: Voyager 1 discovery image



Voyager 2 detailed image

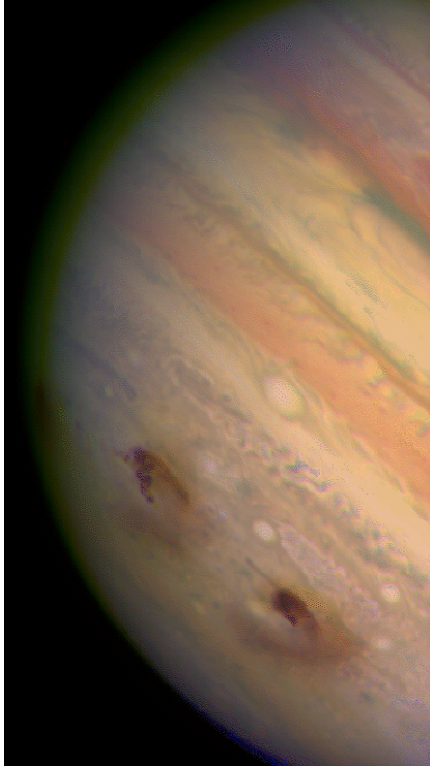
Exploring Jupiter

- Pioneer 10 & 11
 - Flew by Jupiter & Saturn in 1970s
- Voyager 1, launched 1977
 - Flew by Jupiter & Saturn
 - Farthest human-made object
 - Speeding away at 38000 mph! What fuel does it use?
- Voyager 2, launched 1977
 - Flew by all four Jovian planets
- Galileo
 - Orbited Jupiter 1995 – 2003
 - Dropped probes into Jupiter
 - Sent crashing into Jupiter at end of a productive life
 - To prevent contamination of possible life at Europa



Unique Features of Jupiter

- Largest & most massive planet in SS
- Largest magnetosphere
 - Extends beyond Saturn's orbit
- Wimpiest ring system
- Has the most known moons
 - Has its own “solar system”!
- Fastest rotator in the SS
- Most extreme temperature range in atmosphere among planets
- Biggest, longest known storm (Big Red Spot)
- Only planet to have been observed being impacted by a comet (Shoemaker-Levy 9, July 1994)



HST image of SL9 impact on Jupiter