Saturn

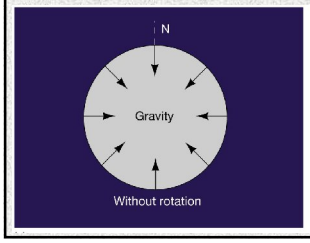
- In many ways, Saturn resembles a smaller version of Jupiter
- Saturn is still many times larger and more massive than the Earth
- Saturn's ring system makes it one of the most photogenic bodies in the Solar System
- Saturn's moons, mainly Titan, may prove even more interesting than the moons of Jupiter

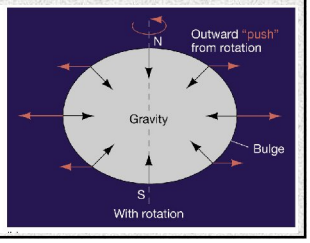
Properties of Saturn

Semimajor Axis	9.54 A.U.	
Orbital Eccentricity	0.054	
Orbital Period	29.4 years	
Rotational Period	0.44 days	
Mass	5.68 x 10^{26} kg	95 x Earth
Radius	60,268 km	9.45 x Earth
Average Density	0.687 g/cm^3	0.125 x Earth
Surface Gravity	10.4 m/s^2	1.07 x Earth
Surface Temperature	97K (cloud tops)	~300K
Atmosphere	Hydrogen, Helium	

Saturn's Rotation

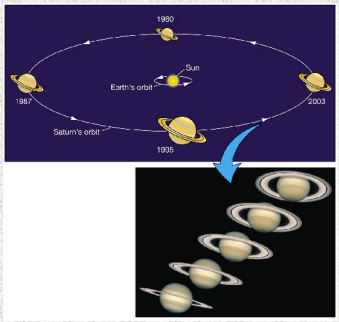
- Like Jupiter, Saturn's fast rotation and low density cause it to stretch at the equator
- The radius along the equator is over 6,000 km longer than the radius at the poles, making it the 'flattest' planet





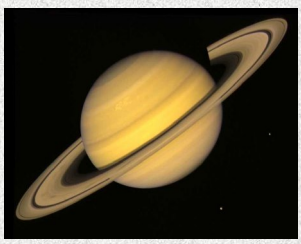
Saturn's Tilt

- Saturn's rotational axis is tilted relative to its orbit around the Sun by 27°
- As Saturn revolves around the Sun every ~30 years, we see different viewpoints of the planet and rings
- During some times in the orbit, the rings are seen edge-on and nearly disappear



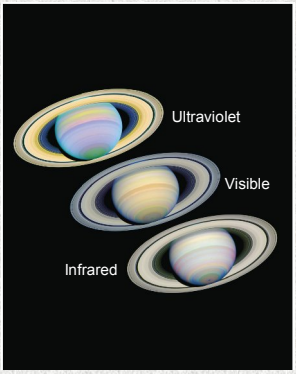
Saturn's Atmosphere

- Also like Jupiter, Saturn's atmosphere is comprised mainly of hydrogen and helium
  - 92.4% hydrogen
  - 7.4% helium
  - 0.2% methane
  - 0.02% ammonia
- Saturn has an abnormally low amount of helium compared to Jupiter and the Sun
- The explanation to this mystery may solve others



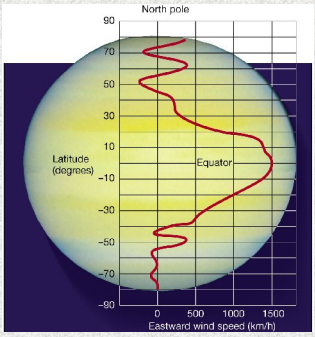
Cloud Bands on Saturn

- Colors and contrast in Saturn's clouds are much more bland than on Jupiter
- The cloud bands show up clearly at different wavelengths, however
- These are the same type of planet wide weather systems stretched by Saturn's fast rotation



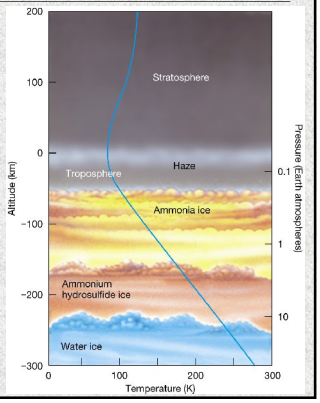
Zonal Flow on Saturn

- As on Jupiter, the colored bands usually correspond to wind zones of different speeds and directions
- Winds speed around the equator are more than 3 times faster than on Jupiter
- Saturn's central winds also dominate a much larger fraction of the planet



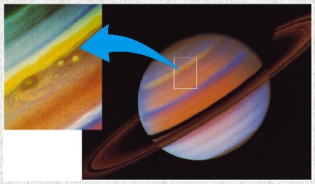
Atmospheric Layers

- Cloud layers in Saturn's atmosphere are virtually identical to Jupiter's
- The main difference is the size of the layers
  - Saturn - 200 km thick
  - Jupiter - 80 km thick
- Saturn's lower mass means less gravity to compress the cloud layers



Weather on Saturn

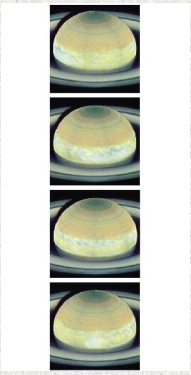
- To the human eye, Saturn's cloud tops look calm
- Computer enhanced images reveal more detail, including the familiar oval storms
- The level of activity in the atmosphere is generally less than that of Jupiter



Color enhanced image of Saturn

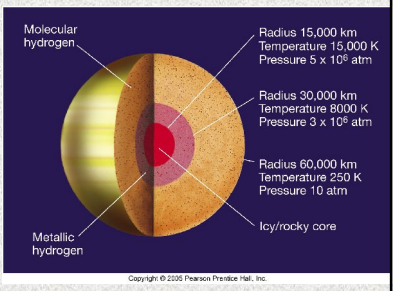
Weather on Saturn

- Only a few large storms have appeared on Saturn, and usually appear as white spots or bands
- These Hubble images were taken at approximately two hour intervals
- The storm has been stretched across the surface by Saturn's fast rotation



Saturn's Interior

- Saturn's interior structure matches Jupiter's as well
- The layer of liquid metallic hydrogen is smaller, while the central rocky core is larger
- Temperatures are the core are still hot enough for the rock to be molten



Internal Heat Source

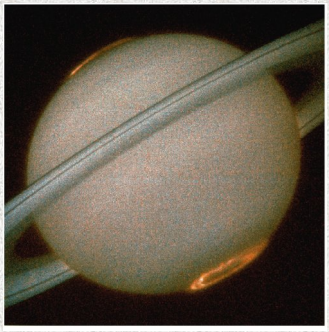
- Like Jupiter, Saturn emits more energy than it receives from the Sun (3 times more!)
- Unlike Jupiter, Saturn should not have retained enough heat from formation to explain this excess energy
- Saturn's smaller size would have allowed it to lose that heat a long time ago

Helium Rain

- Remember that Saturn's atmosphere is lacking helium
- Temperatures and pressures in Saturn's interior are just right for helium to dissolve into liquid
- This liquid condenses, then falls deeper into the interior like rain
- Energy is released as the droplets fall, providing the extra energy we see

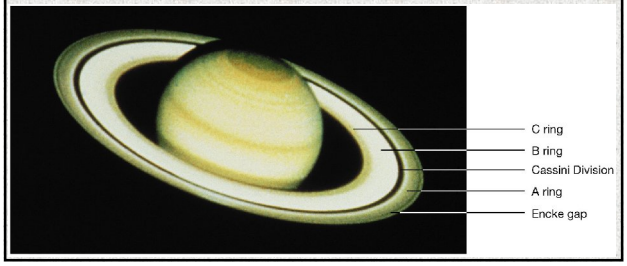
Saturn's Magnetosphere

- A spinning, metallic core on Saturn creates a magnetic field
- This field is quite large, but still many times smaller than Jupiter's
- Like Earth and Jupiter, aurorae have been recorded around Saturn's poles



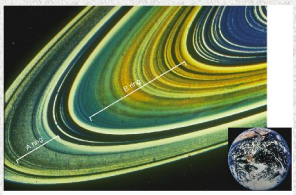
Saturn's Rings from Earth

- Even from Earth, Saturn's rings appear as more than just a solid band
- In this view, the rings are broken into 3 parts, with two 'gaps' or divisions easily visible



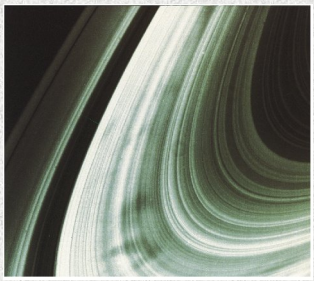
Saturn's Rings from Voyager

- Close up images taken by the Voyager space probes revealed that the larger rings were actually made up of smaller ringlets
- The light and dark variations are mainly due to variations in density of the material in the rings
- Dark areas have much less material, usually caused by interactions with Saturn's moons



Patterns in the Rings

- Over time, some noticeable patterns have emerged in the rings
- Black 'spokes', like those to the right, appear briefly during the rings rotation
- They are believed to be small dust particles disturbed by electric charge built up in the rings (like static electricity)



Ring Composition

- Analysis of the behavior, reflectivity, and composition of the rings reveal them to be small icy particles
- Sizes range from microscopic to tens of meters
- The majority of the bodies are about the size of a snowball
- We will talk more about ring formation and the link to Saturn's moons on Monday