Lecture 20 - 2

Saturn ☃️

27 February, 2012  
(Continue reading Chapter 7 as background for lecture notes)

Basic Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from Sun</td>
<td>9.5 AU</td>
</tr>
<tr>
<td>Diameter</td>
<td>9.4 D.</td>
</tr>
<tr>
<td>Revolution Period</td>
<td>29.4 y.</td>
</tr>
<tr>
<td>Mass</td>
<td>95 M.</td>
</tr>
<tr>
<td>Rotation Period</td>
<td>0.44 d.</td>
</tr>
<tr>
<td>Density</td>
<td>0.7 g/cm³</td>
</tr>
<tr>
<td>Density</td>
<td>atm. pressure</td>
</tr>
<tr>
<td>mag field</td>
<td>very strong</td>
</tr>
</tbody>
</table>


For more info, see [http://sse.jpl.nasa.gov/planets/indes.cfm](http://sse.jpl.nasa.gov/planets/indes.cfm) and click on Saturn.

I. Interior  (Similar to that of Jupiter. Like Jupiter, Saturn radiates more energy than it receives from the Sun.)

Core – thought to be a central region of metal surrounded by rock (primarily Iron and silicates)

Liquid metallic hydrogen – large part of the interior is in the form of molecular hydrogen stripped of an electron ($H_2^+$). This region is responsible for creating the strong Saturnian magnetic field.

Liquid molecular hydrogen – large outer layer made of neutral molecular hydrogen ($H_2$). The top part of this layer can be considered to be the visible “surface” of the planet. Saturn has no solid crust.

II. Atmosphere  [Like Jupiter, we can define Saturn’s atmosphere as the layer of liquid $H_2$ down to a depth of approximately 1% of Saturn’s radius.]

Composition -- Similar to that of Jupiter and the Sun except for a loss of some Helium: 92.4% H, 7.4% He, 0.2% everything else, e.g mostly methane (CH₄) and ammonia (NH₃)

Zones -- bright bands of rising warmer gas in the upper atmosphere.

Belts -- dark bands of cooler falling gas.

Clouds -- concentrations of ammonia (NH₃), methane (CH₄), but with less contrast than on Jupiter.

Cyclonic Storms – rapid circular motions, the driver for which is the rapid rotation of the entire planet.

Winds – stronger winds than observed on Jupiter (by a factor of about 4).

III. Magnetic Field

Like Jupiter, Saturn has a powerful magnetic field. Although its surface field is 10-20 times weaker than on Jupiter (and about the same as the field strength at the Earth’s surface), the total magnetic field strength for Saturn is 100 times stronger than that of the Earth.

IV. moons – (~50) In keeping with our previous discussion of Jupiter, we will discuss in detail only moons with radii larger than 1000 km; Saturn has only one such moon – Titan (in contrast to Jupiter’s 4).

Titan -- discovered by Huygens in 1665, it is the second largest moon in the solar system. Titan’s radius of 2575 km is ~3.5x larger than Saturn’s next largest moon. Titan is the only moon thought to have a substantial atmosphere. Titan’s surface temperature is near the “triple-point” for methane (CH₄); methane gas dominates the atmosphere, with methane liquid+solid in vast surface oceans and/or ices.

Other moons -- most likely rocky bodies coated with ices. 9 moons have radii between 100 to 800 km.

V. Rings

Saturn’s most distinguishing visual feature is its spectacular ring system. The rings are thought to be either the remnants of a destroyed moon or material which never formed a moon due to strong tidal forces.

Composition – small ice and rock particles (micron to meter sized)

Location – at radii inside the Roche Limit, the radius at which tidal forces from Saturn will pull a lightly bound object apart. The Roche Limit is typically at 2.5 times the radius of the planet.

Cassini’s Division – observable gap between the brightest (B) ring and a fainter outermost (A) ring