Summary of Lecture 11

Key points include:

1. Terrestrial planets are relatively low mass and close to the Sun, and are mainly rocky plus an atmosphere that contains only a small fraction of the planet's mass. In contrast, Jovian planets are much more massive, farther from the sun, and most of their mass consists of gas. In some sense they are thus mainly atmosphere, although the density of the "atmosphere" becomes greater than that of water far enough below the surface. Indeed, the density is expected to be high enough inside Jupiter (and maybe Saturn) that there isn't room for full atoms; thus the electrons in (for example) hydrogen don't belong to individual atoms and can thus move freely. This means that you can have "metallic" hydrogen!
2. Because Jovian planets are mainly gas, they compress more easily than rock. One surprising consequence is that it is expected that when such a planet is massive enough (a few times the mass of Jupiter), the radius should *decrease* with increasing mass!
3. All the Jovian planets rotate more rapidly than any of the terrestrial planets (the slowest Jovian planet is Uranus, with a rotational period of 17.2 hours, versus the fastest terrestrial planet, Earth, at 24 hours). This plays a role in all Jovian planets having strong winds and storms.
4. All the Jovian planets have a lot of moons (tens each), and rings. No terrestrial has rings, and only two have moons (the Earth has one moon, Mars has two moons). In some sense, Jovian planets are like miniature solar systems.
5. As we recall from our study of gravity, small moons can be very aspherical, but big moons are close to spheres.
6. The inner three of Jupiter's four large moons (in increasing order of distance from Jupiter: Io, Europa, Ganymede, Callisto) have orbital periods in a 1:2:4 ratio. They thus tug on each other in a *resonant* way (think about pushing someone on a swing), which makes their orbits more elliptical than they would be. Then, tides caused by Jupiter "knead" the moons, making them hotter than they would be. This produces volcanoes on Io and allows Europa and Ganymede to have liquid water beneath an ice layer. Given the importance of liquid water to life, could it be that Europa has current life?
7. Saturn's moon Titan (second largest moon in the Solar System, trailing only Ganymede) has an atmosphere with 1.5 times the pressure of Earth's atmosphere; it's mainly nitrogen and is really cold.

8. Saturn's giant rings are a bit mysterious in their origin, but perhaps a moon was torn apart in the last tens of millions of years?