Physics 109: Homework #10 Solutions

10.1 Jupiter, Saturn, and Neptune all emit more energy than they absorb from the Sun by factors of 60%, 50%, and 60%, which indicates that they are self-luminous. We know this through infrared observations of the planets. The source of the heat is believed to be internal energy from gravitational contraction. Saturn may be generating energy now from the condensation of helium out of its metallic hydrogen core. In this case the energy is being generated by the helium falling toward the center of the planet. Uranus appears not to be self-luminous, but the reason why it is so different from Neptune is not fully understood.

10.2 The magnetic fields of the gas giant planets are all stronger than that of the Earth's. Jupiter and Saturn have fields that are centered on the planet and are aligned well with their rotational axes, properties that are similar to Earth's field. Uranus and Neptune have magnetic fields that are mis-aligned with their rotation axes and not centered on the planet.

10.3 From the orbital size and period of Charon it was possible to determine the mass of the Pluto-Charon system. Eclipses of Pluto by Charon allowed astronomers to determine the diameters of both bodies, as well as to make crude maps of surface features on Pluto. This system is unique in the solar system because it is the only system where both the planet and moon are in synchronous rotation with the satellite's orbit.

10.4 All of the rings of the giant planets lie within the Roche limit. The rings, which consist of individual particles orbiting the planet, are all very thin or flat and show sharp edges. They differ obviously in how extensive they are, with Saturn's well-known rings being the most spectacular. Jupiter's ring is rather faint and is believed to consist of very small particles with short lifetimes (few thousand years) that are continually being resupplied. Both Saturn and Uranus are known to have narrow rings that are gravitationally confined by pairs of so-called shepherding satellites.

10.5 Collisions between ring particles ensure that rings are flat. Orbital resonances with planetary satellites keep rings sharp-edged.