Astronomy 2110 Homework #9

Spring 2024 Due Thursday, April 11 in class.

For full credit you must write your solutions neatly and include all work. Do not forget the units.

1) Astronomers can detect the presence of hydrogen in stars by looking for the characteristic absorption lines of hydrogen in the star's visible spectrum (Fig. 5-21). They can also detect hydrogen in emission (Fig. 5-18). Explain why neither of those techniques helped to locate Hydrogen in Jupiter's atmosphere.

2) Jupiter's equatorial diameter and the rotation period at Jupiter's equator are given in Table 12-1. Use these data to calculate the speed (in km/s) at which an object at the cloudtops along Jupiter's equator moves around the center of the planet.

3) It has been claimed that Saturn would float if one had a large enough bathtub to put it in. Using the mass and size of Saturn given in Table 12-2 (or Wikipedia), confirm that the average density of Saturn is about 690 kg/m^3, and comment on this fanciful claim.

4) (a) Calculate the equilibrium temperature at the cloudtops of Jupiter assuming an albedo of zero (no reflected light). Assume the energy received by the Sun is equal to the energy emitted by Jupiter in the infrared. (b) Given that Jupiter actually emits twice as much energy per second as it receives, calculate what the average temperature must be at the cloudtops.

5) The Galileo Probe had a mass of 339 kg. On Earth, its weight was 3320 newtons, or 747 lbs. What was the gravitational force that Jupiter exerted on the Galileo Probe when it entered Jupiter's clouds?

6) What is the evidence for an ocean of liquid water beneath Europa's icy surface? What evidence is there that other substances are dissolved in this ocean?

7) The larger the orbit of a Galilean satellite, the less geological activity that satellite has. Explain why this is.

8) Why does the presence of methane in Titan's atmosphere imply that Titan has had recent volcanic activity?

9) Assuming material is ejected from Io into Jupiter's magnetosphere at the rate of 1 ton/second (1000 kg/s), how long will it be before Io loses 10% of its mass? How does your answer compare with the age of the solar system?

10) To an observer on Enceladus, what is the time interval between successive oppositions of Dione? Explain your answer. (b) To an observer on Enceladus, what is the angular diameter of Dione at opposition? How does this compare to the angular diameter of the Moon as seen from Earth (about 0.5 degrees)?