ASTR 1030: Homework 1

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Scaling in the Solar System

Scaling is an important skill as it gives the astronomer an intuitive sense of the characteristic physical quantities (e.g., length, mass) involved in any problem. Here, we explore the scales of the Solar System.

1. Research and find out what the masses of the eight (or nine) planets are. Divide them each by the mass of the Earth, $M_E = 6.0 \times 10^{24}$kg, namely

$$m_T = \frac{M}{M_E},$$

where M is the mass of a given planet. Form a table of m_T for all of the planets. Now do the same with the mass of Jupiter ($M_J = 1.9 \times 10^{27}$kg):

$$m_G = \frac{M}{M_J}.$$

Is a dichotomy apparent? What do you think subscripts "T" and "G" stand for?

2. An astronomical unit (AU) is about 1.5×10^{11}m. By definition, the Earth is located 1AU away from the Sun. Research and find out the *mean* distances (denoted by a) from each of the eight (or nine) planets to the Sun in AU. It turns out that these distances can also be estimated using the Titus-Bode law,

$$a = 0.4 + 0.3(2^n),$$

where $n = -\infty, 0, 1, 2, ..., 8$. Using this formula, which planets do not fit within the Titus-Bode scheme?

3. Current models of Solar System formation predict that the Sun and the planets were formed from a giant, primordial disk of debris. In this picture, how do you expect the planets to orbit with respect to the ecliptic? Which planet is the “odd one out”?

4. NASA launched a mission to Pluto on January 19, 2006. It will fly by the (dwarf) planet on July 14, 2015. How fast must it be traveling? Give answer in km/hr.

5. Bonus (Extra Credit): Newton's laws are an approximation, albeit very good ones, when applied to our Solar System. Can you name an example of a physical phenomenon in our Solar System which is not predicted/described by Newton's laws?