ASTROPHYSICS

Homework Set 2

January 27, 2012

1. Apply Dermott's relation,

$$\log \tau_n = \log \tau_0 + n \log A \ ,$$

to Jupiter and its Galilean moons. Recall that A must be the square root of a small positive integer, and τ_0 must be close to the rotational period of Jupiter. Take 0.41 d for the rotational period of Jupiter, and 1.77 d, 3.55 d, 7.16 d, and 16.69 d for the orbital periods of its moons Io, Europa, Ganymede, and Callisto, respectively. Determine reasonable values for A and $\log \tau_0$. Also determine values of n for each satellite and give the corresponding value of $\log \tau_n$.

2. Consider a satellite in a circular, low-Earth orbit; that is, the satellite's elevation above the Earth's surface is $h \ll R_\oplus$.

   (a) Show that the orbital period τ for such a satellite is approximately

$$\tau = \tau_\oplus \left(1 + \frac{3h}{2R_\oplus}\right) \ .$$

   (b) What is the numerical value of the constant $\tau_\oplus$ in minutes?

   (c) What is the orbital period for a low-*lunar* orbit (as was used by the Apollo command modules)? Assume $h = 100$ km.

3. The brightest star in the night sky is Sirius (surface temperature $T = 10,000$ K, radius $R = 2.4 R_\odot$). How far from Sirius would we have to be (in A.U.) to find a substellar temperature comparable to that of the Earth?

4. In 1958, scientists at the Lincoln Laboratories of MIT reflected a radar beam off of Venus when it was at its greatest angular distance from the Sun. The angle of elongation was 46° and it took 11.5 minutes to receive the return echo from the radar beam.

   (a) Use this information to calculate the Earth-Sun distance assuming circular orbits. That is, determine the number of meters in 1 AU. (*Hint*: Radar beams travel at the speed of light, $c = 3.00 \times 10^8$ m/s.)

(b) Use the information provided to determine the distance of Venus from the Sun in AU.

(c) Given that Mercury is 0.39 AU from the Sun, what is the maximum angle of elongation of Mercury from the Sun as seen from Earth?