EART290Q 2020

WEEK #5 – ORBITS AND TIDES

Topics/Concepts

Tidal torque & dissipation

Synchronous vs. non-synchronous bodies

Kepler's laws, orbital angular momentum and energy, semi-major axis, mean motion

Momentum is conserved but energy isn't

Eccentricity damping, tidal heating

Equations

$n^2 = \frac{GM}{a^3}$ $\quad E = \frac{-GMm}{2a}$ $\quad L = mna^2\sqrt{1-e^2}$

Tidal torque (non-synchronous) $T = \frac{3}{2} k_2 m^2 G \frac{R_p^5}{a^6} \frac{1}{Q}$

Tidal dissipation (non-synchronous) $\dot{E} = nT$

Tidal dissipation (synchronous) $\dot{E} = \frac{21}{2} \frac{R^5 n^5}{G} e^2 \frac{k_2}{Q} = 7e^2 nT$

Numbers

G=6.67x10^{-11} m^{3}s^{-2}kg^{-1} $\quad Q_{solid}$~10^2 $\quad Q_{gas}$~10^5

Homogeneous, fluid body: h_2=5/2, k_2=3/2

References

Murray, C.D., S.F. Dermott, *Solar System Dynamics*, CUP 1999, Chapter 4.

Goldreich, P., S. Soter, Q in the solar system, *Icarus* 5, 375-389, 1966.