EART290Q 2020

WEEK #7 – SHAPE, GRAVITY, INTERNAL STRUCTURE

Topics/Concepts

Rotational flattening, oblate/prolate spheroid, triaxial ellipsoid

Moments of inertia, J_2, C_{22}, orbital precession

Hydrostatic equilibrium, Darwin-Radau relationship

"Tidal" vs. "fluid" Love numbers

Equations

Sat. rotational potential $V_{rot} = \frac{1}{3}\omega^2 R^2$ $q = \frac{R\omega^2}{g} = \frac{R^3\omega^2}{Gm_s}$

Sat. tidal potential $V_{tid} = \frac{Gm_p R^2}{a^3}$ [$=\omega^2 R^2$ for synchronous sat.]

Hydrostatic Quantity	Planet	Synch. Satellite
$J_2 = \frac{C-A}{MR^2}$	$\frac{1}{3}qk_2$	$\frac{5}{6}qk_2$
$\frac{a-c}{R}$	$\frac{1}{2}qh_2$	$2qh_2$
C_{22}/J_2	0	3/10
$\frac{b-c}{a-c}$	1	¼

Hydrostatic relationships: $k_2=h_2-1$ $\frac{C}{MR^2} = \frac{2}{3}\left[1-\frac{2}{5}\left(\frac{5}{h_2}-1\right)^{1/2}\right]$ (Darwin-Radau)

References

Murray, C.D., S.F. Dermott, *Solar System Dynamics*, CUP 1999, Chapters 4 and 5.

Dermott, S.F., Shapes and gravitational moments of satellites and asteroids, Icarus 37, 575-586, 1979.

Anderson, J.D. et al., Io's gravity field and interior structure, *JGR* 106, 32963-32969, 2001.