Solar System Dynamics
PtyS 553

Spring 2012, MW 9:00 – 10:15 am (or as decided among class)
Space Sci. 301 (or occasionally in 312)

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Materials:

Planetary Dynamics notes, by Burns and Greenberg
Solar System Dynamics, by Dermott and Murray (recommended)
Fundamentals of Celestial Mechanics, by Danby (supplementary)
Orbital Motion, by A. Roy (supplementary)

Format:

Class will be built around problem-solving by students, often investigating issues in the real solar system. Often classes will start with discussions of solutions led by students (selected at the time each assignment is made), including discussion of the implications of the results and the techniques. That will be followed by a lecture, and set-up for the next assignment, including tips for solutions. Don't get scared; the frequency of assignments is intended to keep students engaged with the material, not to be overly arduous. It will be fine if students collaborate on solutions and/or seek guidance from the instructor, but the presenter (in addition to showing the preferred solution) should highlight issues, uncertainties, disagreements, paradoxes, etc., and all students should be prepared to raise such issues for vigorous discussion and resolution in class.

Students will required to do a term project. By the middle of the semester, each student will identify an interesting issue (you select, I approve) in planetary dynamics to review (or optionally do original research) in terms of the material covered in class during the semester. A paper and class presentation will be required at the end of the semester. This semeste
r I am downplaying the term project somewhat, so as not to conflict with research projects required in other classes.

Student Performance Evaluation:

Regular assignments (submitted hardcopy)	(20%)
Participation in class discussions	(20%)
Midterm exam	(20%)
Exam #2	(25%)
Term Project	(15%)

Calendar (subject to change):

<u>Introduction</u>	
Week 1	Some history; Newton's derivation
	Gauss's thm.; reduce 2-body to motion in $1/r^2$ field
<u>Two-body Problem</u>	
Week 2	Sol'n in space: ang mom, energy, conic sections
	Rotating ref. frame, epicycles
Week 3	orb. elements, Sol'n in time: Kepler's eqn, hodograph, etc.
	Escape vel., Grav. cross-section, planetary accretion
Week 4	Encounter velocity stats.
	More planetary accretion, hyperbolic kepler's eqn.
Week 5	Expansions of elliptic motion
	Viscosity in planetary rings
Week 6	Review
	EXAM
<u>Impulses on two-body orbits</u>	
Week 7	Review Exam; orbit elements as coords
	Effects of impulses, derive Δelements, coord. rotation
Week 8	Continue Δelement eqns.; Epicycles with oblateness
	Interpret Δelement eqns. and compare with epicycles
Week 9	More physical interpretation of Δelement eqns.
<u>Restricted Three-Body Problem</u>	
Week 10	Eqns. of motion in rotating frame
	Jacobi integral and interpretation
Week 11	Equilibrium points and stability
	Tisserand criterion; asteroids, meteorites, comets
Week 12	Hill sphere; Tisserand sphere of influence
<u>Perturbation Equations</u>	
Week 13	Disturbing potential; Derive Lagrange planetary eqns.
	Expansion of disturbing function, significance for resonance
Week 14	Mean-motion resonances: Titan-Hyperion example
	Secular resonances: Titan-Rhea example, extra-solar planets
Week 15	Other resonant effects; Review
	EXAM #2
Week 16	Exam review
	Term Project presentations