

Homework Assignment 7

Due: Tuesday November 10, 11:59 pm, UBlerns Digital Dropbox

PHY 410: choose any two problems. PHY 505: work all three problems

1. Explore the dynamics of the pendulum and describe 5 types of motion that you find most interesting, providing examples of real space and/or phase space plots. Possibilities include under, critical, and overdamping; oscillations and rotations; period doubling (try the range $1.35 < F_D < 1.5$); chaotic motion; strange attractors; and intermittency. The model has several parameters $g, \ell, q, F_D, \Omega_D$. The critical parameter to vary is the driving force amplitude F_D . Try fixing $\ell = 9.8$ so the natural frequency $\Omega = 1$. Many references use a driving frequency $\Omega_D = 2/3$. The damping constant q is not critical except for very small driving frequency: choose $q = 0.5$. Then try varying $F_D = 0.1, 0.5, 0.9, 1.2, 1.35-1.5, \dots$

<http://www.physics.buffalo.edu/phy410-505/topic4/lec-4-4.pdf>

2. First consider small oscillations. Simulate the two normal modes of the double pendulum: measure the normal mode frequencies and verify the mode behavior by plotting the trajectories $\theta_{1,2}(t)$.
Next, explore the full nonlinear behavior by generating Poincaré sections for energy $E = 1, 5, 10, 15, 40$. Try different initial conditions for each value of the energy E . For example, with $E = 15$, try the two different initial values sets (1) $\theta_1 = 1.1$, and $\theta_2 = 0$, and (2) $\theta_1 = 0$, and $\theta_2 = 0$. Describe qualitatively the types of motion you observe.

<http://www.physics.buffalo.edu/phy410-505/topic4/lec-4-5.pdf>

3. Explore the trajectories of the restricted planar circular three-body problem for various values of μ and C . See the references in the notes for ideas on what to look for. Dr. Sethna's "Jupiter" website has some interesting orbit pictures and software you can download and play with. Choose three different trajectories that you find most interesting and describe what you learned by generating and examining them.

<http://www.physics.buffalo.edu/phy410-505/topic4/lec-4-6.pdf>