

# Homework Assignment 6

**Due: Sunday November 1, 11:59 pm, UBLearn's Digital Dropbox**

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

1. Use the Lyapunov program to make a plot of the exponent as a function of the parameter  $r$  in the period doubling and chaotic regions. Modify the program to calculate the entropy  $S$  and plot it in this range of  $r$ . Compare and comment on the significance of the two plots.

<http://www.physics.buffalo.edu/phy410-505/topic4/lec-4-1.pdf>

2. Explore the phase space of the standard map for different values of the kicking parameter  $k$  (for example 0, 0.1, 0.5, 0.7, 0.9, 1.3, 4.0, 4.5) and describe the nature of the trajectories in terms of motion of the rotor. Simulate a small rectangle of initial points. How does the shape of this rectangle evolve for different values of  $k$ ?

<http://www.physics.buffalo.edu/phy410-505/topic4/lec-4-2.pdf>

3. Generate trajectories and Poincaré sections for different values of the parameter  $r$  in the Lorenz equations. For example, it is known that the transition from steady state convection to chaotic behavior occurs at  $r = 470/19 \approx 24.74$ . Choose values just below and above this transition point and comment on the nature of the trajectories. Another interesting region occurs around  $r = 160$ . Below this value, the trajectories are periodic and exhibit period doubling behavior similar to the logistic map. Above  $r = 160$  some trajectories exhibit intermittency, which is characterized by periodic behavior over many periods that is suddenly interrupted by bursts of activity.

<http://www.physics.buffalo.edu/phy410-505/topic4/lec-4-3.pdf>