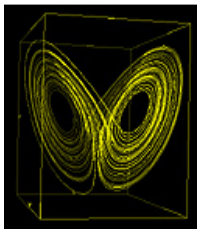
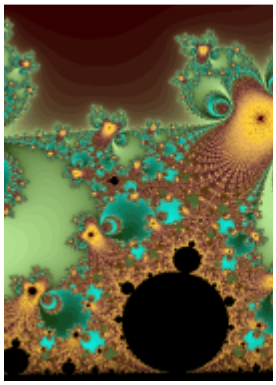
Math 721/722 Nonlinear Dynamics and Chaos

Dynamical systems theory explores modern ideas, techniques, and computer algorithms developed for modeling, analyzing and controlling the time-evolution of natural and man-made systems. This course provides overview of the core mathematical background for nonlinear science, as well as its applications to key problems in ecology and biological systems, chemical reaction-diffusion problems, geophysics, economics, electrical and mechanical oscillations in engineering systems, lasers and nonlinear optics and fluid mechanics.



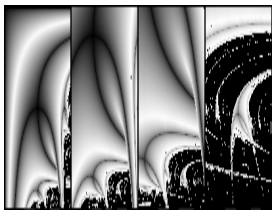
In all cases we would like to make a sound connection of mathematical derivations and physical intuition and comprehend the behavior of various dynamic models arising in engineering and physical sciences.



Mandelbrot set

First part of this course two-semester course (Math.721) starts with analysis of relatively simple nonlinear systems described by second order differential equations. We show that despite their relative simplicity, these models describe complex phenomena that have no analog in linear dynamics. Next we study the synchronization and competition of nonlinear modes, nonlinear resonances, local bifurcations undergoing in continuous and discrete models of natural and engineering systems and enter the area of nonlinear wave.

The second part of this two-semester course (Math.722) is centered on study of bifurcation phenomena leading to development of chaotic behavior. In this connection, we study bifurcation and chaotic behavior in continuous Lorenz equations and discrete dynamical systems as well as introduce fractals and Mandelbrot sets.

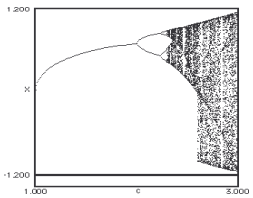


Lyapunov set

Prerequisites. Standard calculus sequence, math. 285, math.330 are desirable but not mandatory.

Main Textbooks. Steven Strogatz, Nonlinear dynamics and Chaos: with Application to Physics, Biology, Chemistry and Engineering. 2000. Perseus Books Publishing.

Additional Textbook. Alwyn Scott, Encyclopedia of Nonlinear Science, 2004, ISBN: 1579583857



Bifurcation diagram of logistic map