Topics in Mathematical Physics

Collective Phenomena in Equilibrium and Nonequilibrium Systems (*Spring 2012*)

Description: The course will start with a broad overview of the physics and mathematics of equilibrium and nonequilibrium statistical mechanics: This will focus on the elucidation and derivation of collective behavior of macroscopic systems made up of very many individual components from the microscopic dynamics of the individual components.

I will then consider application of statistical mechanics to real world problems of current interest. An example of such an application is pattern formation. This occurs in both equilibrium and nonequilibrium systems. The former generally represent low temperature phases in materials and can be studied via equilibrium ensembles. The latter involve dynamical microscopic considerations and are generally described on the macroscopic level by reaction diffusion type equations. The resulting patterns are visible everywhere in biological systems. They range in scale from microns for cells forming an organism to hundreds of meters for flocking birds. Choice of specific topics will be based on student interest.

For background material see the following books:

- Mathematical Biology I and II, J.D. Murray (Springer)
- Large Scale Dynamics of Interacting Particles, H. Spohn (Springer)
- A Kinetic View of Statistical Physics, P. Krapivsky, S. Redner and E. Ben-Naim (Cambridge)
- Dynamics of Self-Organized and Self-Assembled Structures, R. Desai and R. Krapral (Cambridge)
- Evolutionary Games and Population Dynamics, J. Hofbauer and K. Sigmund (Cambridge)

The course will be informal and interactive.

For information about prerequisites please contact me: Joel Lebowitz, lebowitz@math.rutgers.edu.