

Physics 525
ADVANCED STATISTICAL PHYSICS

OUTLINE:

This is the second quarter of the graduate statistical mechanics course, with as focus equilibrium and non-equilibrium phase transitions and scale invariant phenomena in general.

The course will start with a general introduction to equilibrium critical phenomena, including how scale invariance and universality arise, and why Landau theory fails at criticality.

This is followed by an introduction of scale invariance and renormalization theory from a geometric perspective, i.e., starting from fractal structures, accumulating into the real space renormalization method.

Next the class will discuss examples of two dimensional equilibrium critical phenomena, like: vortices in He films, crystalline surface roughening, Kosterlitz-Thouless phase transitions, the duality of many 2D equilibrium systems to Coulomb gases with logarithmic interactions, and the renormalization theory of the latter.

In the last part of the course the class can choose to cover the exact solution of the 2D Ising model, using the transfer matrix (path integral) and leading to the equivalence to one dimensional free fermion dynamics; and in general to Luttinger liquid theory and conformal invariance.

Or the class can choose to cover non-equilibrium statistical physics, in particular master equations describing interface phenomena like KPZ growth and population dynamics like directed percolation; followed maybe by a brief overview of self-organized critical phenomena.

TEXTBOOK:

The core text book for this class is “Equilibrium Statistical Physics” by Plischke and Bergerson. (World Scientific, 1994)

A secondary optional text is Quantum and Statistical field Theory by Le Ballac. (World Scientific, 1994)