Physics 235 — Nonlinear Plasma Theory
Spring 2022

Transport in Random Media, Fat Tails and Intermittency, Avalanching and Entrainment

Instructor: Patrick H. Diamond

Class: MWF: 2:00 p.m. – 2:50 p.m.
MW: Center Hall, F: Remote

This course looks in depth at the physics of transport and beyond the usual mean field/quasilinear approaches. Examples are drawn from plasmas, fluids, and statistical mechanics. The course may be of interest to students in plasma, fluid, bio, astro or statistical physics.

Topics

A) Transport in Random Media

i) Review of Hamiltonian chaos and quasilinear theory of transport

ii) Transport in stochastic magnetic fields — $Ku < 1$ ($Ku \equiv$ Kubo #)

iii) Particle transport and self-consistency

iv) Toward high Ku, with strong scattering

v) Systems: random media, shear dispersion, cellular arrays

vi) Percolation and statistical topography

B) Intermittency and Transport

i) Intermittency and fractals, multi-scaling

ii) Hurst exponent, R/S analysis, relation to fractal dimension

iii) Lévy stability and Lévy flights

iv) Fat tails, "mild vs. wild" behavior

v) CTRW models of anomalous diffusion

vi) Theory and applications of fractional kinetics

C) Avalanching, Entrainment and Self-Organized Criticality (SOC)

i) Basic concepts of avalanching and turbulence entrainment/turbulence spreading

ii) SOC: origins and basic concepts, l/f noise

iii) Traffic flow and jams

iv) Hydrodynamic models of SOC; Burgers turbulence; subcriticality

v) Models of entrainment

vi) Spreading, zonal patterns, staircases — implications for magnetic confinement

D) Selected Topics — TBD

Course Requirements

Each student is required to:

i) Prepare lecture summaries, in turn. These will be read, corrected and ultimately posted.

ii) Participate actively.