

Physics 235 — Nonlinear Plasma Theory
Spring 2019

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

Instructor: Patrick H. Diamond

Class: T, Th: 11:00 am – 12:20 pm
SERF 329

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.



Pre-requisites: Physics 218A or 210B, or Permission of Instructor

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, 1/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 weekly lecture summaries, in turn. These will be read, corrected and ultimately posted.
- ii) Write a paper related to a subject of the class.
 - Topics also relevant to students' research are preferred
 - Instructor will help define topics of mutual interest
 - *Papers can develop into publications*