

PHYSICS 653: TERM PAPER TOPICS IDEAS 9/04/'03)

To get ideas, you might browse through

(a) back issues of *Physics Today* (see the annual reports e.g. “Physics in 1989”; in recent years, these appeared as a supplement to *APS News*, which is online.

(b) *Reviews of Modern Physics* from the past 20 years.

(c) Look in *Principles of Condensed Matter Physics*, Chaikin and Lubensky.

(d) I have the following proceedings, also published in the journal *Physica: Statistical Physics*, ed. H. E. Stanley (Invited talks from the 1986 Stat Phys conference), *Physica A* 140, Nos. 1 and 2; *Current Problems in Statistical Mechanics*, ed. E. Domany and D. Jasnow, 1991, *Physica A* 177, Nos. 1–3 being papers in honor of Michael Fisher’s 60th birthday; and *Statistical Physics: invited papers from STATPHYS 20* (1998), *Physica A* 263, Nos. 1–4 (1999).

There is also a list of ideas below. Find an entry points to the literature (possibly from me, or from a local expert). Find more recent papers with the Science Citation Index.

LIST OF TOPICS

(*) – Local experts exist

In the list, each category has a number “I”, “V”, etc., corresponding roughly to the part of the lectures that is closest to its topics.

I. Random walks

First-passage problems (?)

Chemotaxis (*)

Origins of fractal dynamics (random walks with anomalous power laws)

There are MANY more relevant topics

II. Misc. Criticality, RG, thermodynamics

Multicritical points

Quantum critical phenomena

[Potts models – experimental realizations]

[Exact solutions of 2D models: Feynman-Vdovichenko, Bethe ansatz]

III. Stochastic dynamics

Nucleation and domain growth kinetics (coarsening)

Dynamic R.G.’s

Stochastic resonance (?)

[Models of $1/f$ noise]

IV+. Liquids and “soft matter”

- Polymers
- Protein folding
- Elasticity of DNA and other biophysics topics
- Correlation functions in liquids (hierarchies of approximate equations)
- Ramakrishnan-Youssef “density functional” theory of freezing (*)
- Liquid crystal phases

V. 2D continuum and interface models

- Wetting transition
- Duality and the Coulomb gas (*)
- Realizations of Kosterlitz-Thouless (magnets, superconducting films, superconducting arrays, superfluid films)
- 2D solids: hexatic phase (orientational order), dislocation-mediated melting
- Conformal field theory (*)
- Topological defects

VI. Non-equilibrium (collective dynamics) models

- Diffusion-limited aggregation model (tree-like fractal growth)
- Growth patterns in bacterial colonies
- Self-organized criticality (evolves towards percolation-like critical state)
- Fully developed turbulence (*)
- Analogies of dynamical systems to phase transitions (*)
- Multifractals
- KPZ eqn. and related models: interface pinning in 2D, surface growth models (*)
- Cellular automata
- Granular media

VII. Disorder (quenched)

- Spin glasses (tricky!)(*)
- Random walks, conduction, and vibrations on percolation clusters (or other fractals)
- Fracture of random networks (*)
- Extreme Type II (High-Tc) superconductors: vortex liquid and vortex glass behavior
- Charge-density wave (de)pinning (*)
- Statistical description of amorphous structure (Zallen, *Physics of Amorphous Solids*)
- Random-field Ising model (*)

VIII. Electronic states/ quantum transport

- Renorm. group for quasiperiodic potentials (*)
- Random matrices (eigenvalues distributed like 1D gas with log interactions)(*)
- Anderson localization