Metastability for Interacting Particle Systems

Frank den Hollander, Leiden University, The Netherlands

Main Course at the *2022 PIMS-CRM Summer School in Probability*,
UBC, Vancouver, Canada, May 30 – June 24, 2022.

SCHEDULE COURSE

- Week I:
  Basic principles of metastability.

- Week II:
  Low temperature and fixed volume:
  discrete systems.

- Week III:
  Fixed temperature and large volume:
  continuum systems.

- Week IV:
  Metastability on random graphs.

SCHEDULE WEEK I

- Lecture 1:
  Statistical physics and beyond.
  Motivation, targets and examples.

- Lecture 2:
  Mathematical tools from potential theory:
  capacities, harmonic functions, variational principles.

- Lecture 3:
  Characterisation of metastability.
  Towards Interacting Particle Systems.

- Lecture 4:
  Curie-Weiss model. Phase transition.
  Metastable regime, Eyring-Kramers formula.

SCHEDULE WEEK II

- Lecture 5:
  Hypotheses and universal theorems.
- Lecture 6:
  Proof of the universal theorems.
- Lecture 7:
  Glauber dynamics on a torus.
  Critical droplet and metastable crossover time.
- Lecture 8:
  Kawasaki dynamics on a box with open boundary.
  Critical droplet and metastable crossover time.

SCHEDULE WEEK III

- Lecture 9:
  Widom-Rowlinson model for disks.
  Phase transition. Metastable regime. Critical droplet.
  Metastable crossover time, target theorems.

- Lecture 10:
  Mesoscopic fluctuations of the critical droplet.
  Capillary waves.

- Lecture 11:
  Microscopic fluctuations of the critical droplet.
  Constrained Gibbs measures.

- Lecture 12:
  Widom-Rowlinson model for convex grains.
  Results and speculations.

SCHEDULE WEEK IV

- Lecture 13:
  Erdős-Rényi random graphs
  (dense regime).

- Lecture 14:
  Chung-Lu random graphs
  (dense regime).

- Lecture 15:
  Configuration random graphs
  (sparse regime).

- Lecture 16:
  Challenges for the future.

Metastability for Interacting Particle Systems is a crossroad of ideas, methods and techniques from:

probability theory
functional analysis
combinatorics
statistical physics
network science

As such it is both challenging and captivating.

firework ahead!