Queen Mary
University of London

LDSG Workshop on
Stochastic Dynamics and Nonequilibrium Statistical Mechanics

Organisers:
Rosemary J. Harris and Hugo Touchette
School of Mathematical Sciences, Queen Mary, University of London

Friday, 11th July 2008

Description

Will there ever be a complete theory of nonequilibrium systems having the same predictive power as that of equilibrium statistical mechanics? Though most researchers in statistical mechanics would hope and conjecture that the answer is yes, we do not have at present such a theory.

We know, of course, a lot about nonequilibrium systems. Results such as Onsager's reciprocity relations, Onsager and Machlup's principle of minimum dissipation, and the more recent results that are Jarzynski's equality and the Gallavotti-Cohen fluctuation theorem, among others, all point to many general and interesting properties of nonequilibrium systems and their fluctuations. However, no one has come up so far with a common thread – a common theory – accounting for or integrating all of these results. Does such a theory exist? Can these results be viewed as consequences of a small number of general principles? Taking equilibrium statistical mechanics as a model, is there a way to devise a theory based on something generalizing the concept of a statistical-mechanical ensemble that would be applicable to nonequilibrium systems at large?

This mini-workshop will aim at summarizing part of our current understanding of these questions and at advancing some possible answers. The speakers will provide a background for the discussion by presenting some recent results related to the foundations of nonequilibrium statistical mechanics. An open discussion will follow, at which participants are expected to ask questions and advance ideas as to where we stand in terms of research on nonequilibrium systems, and how we might pursue that research. Everyone is welcome.

Schedule

11:00-11:30	Tea/coffee/welcome
11:30-12:30	Rosemary J. Harris, *School of Mathematical Sciences, Queen Mary, University of London* *Current fluctuations in stochastic non-equilibrium systems: Phase transitions and symmetries*
12:30-1:30	Lunch break
1:45-2:45	R. Mike L. Evans, *School of Physics and Astronomy, University of Leeds* *Complex fluids under shear: Theories and experiments*
3:00-4:00	Richard Blythe, *SUPA, School of Physics, University of Edinburgh* *The appearance of a partition function, fugacities and Boltzmann weights in nonequilibrium steady states*
4:00-4:15	Tea/coffee
4:15-5:15	Round table: Open problems in nonequilibrium statistical mechanics
Evening	Discussion in the Pub

About the LDSG series

This workshop is part of a series of collaborative meetings held by the London Dynamical Systems Group (LDSG), which consists of the Dynamical Systems groups at Imperial, Queen Mary, Surrey and UCL. The meetings are supported by a Scheme 3 grant from the London Mathematical Society.

Attendance at this workshop is free.

For more information, please contact

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Location

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Directions: `http://www.maths.qmul.ac.uk/about/location.shtml`

Nearest tube stations: Stepney Green (District line) and Mile End (Central line)

Current fluctuations in stochastic non-equilibrium systems: Phase transitions and symmetries

Rosemary S. Harris

School of Mathematical Sciences, Queen Mary, University of London

I will illustrate the significance of current fluctuations in stochastic many-particle systems with reference to exact calculations for the paradigmatic Zero-Range Process. This simple model offers some insight into the structure of non-equilibrium statistical mechanics and contributes to an understanding of the application and validity of so-called fluctuation theorems. Time-permitting, I will also discuss some more general questions and recent progress.

Complex fluids under shear: Theories and experiments

R. Mike. L. Evans

School of Physics and Astronomy, University of Leeds

I shall give a brief introduction to some of the phenomena observed in steady-state flow of complex fluids, that have intriguing similarities to equilibrium phase behaviour, suggesting that some of the ideas of statistical mechanics could be applied in this non-equilibrium context. I shall discuss the statistical properties of real fluids in driven steady states, and describe a theoretical framework that allows us to make progress in this field. That theory has been tested on a realistic system of particles in motion: a set of rotors interacting via nearest-neighbour forces, and subjected to shear flow. I shall report the results of simulations in which the rotors force-balance equations were numerically solved and time-stepped, in order to test the predictions, thereby validating a statistical treatment of a non-equilibrium system of particles interacting via Newtonian forces.

The appearance of a partition function, fugacities and Boltzmann weights in nonequilibrium steady states

Richard Blythe

SUPA, School of Physics, University of Edinburgh

Systems that are driven by their environment may exhibit nonequilibrium steady states characterised by a constant flux of energy, mass or some other physical quantity. Since the principle of equal a priori probabilities does not apply, one does not necessarily expect the framework of equilibrium statistical mechanics to have much to say about these states.

In this talk, I will show some examples of where equilibrium statistical mechanical concepts have proven useful in understanding nonequilibrium steady states. First, I will demonstrate the utility of a partition function and its Lee-Yang zeros in encoding nonequilibrium phase behaviour. Then I will provide a partial explanation for this phenomenon through a mapping of a nonequilibrium ensemble (defined by transition rates) to an equilibrium ensemble (constrained by fugacities). Finally, I will show how light shed by recently-established fluctuation theorems reveals the relevance of Boltzmann weights to nonequilibrium stochastic dynamics.