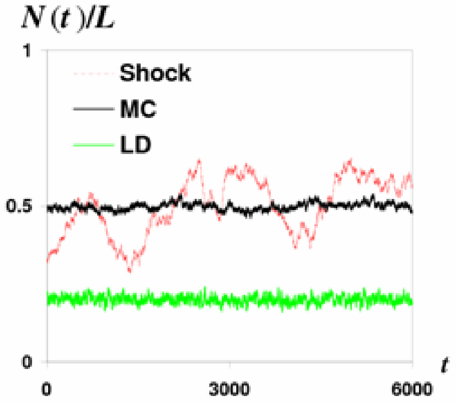
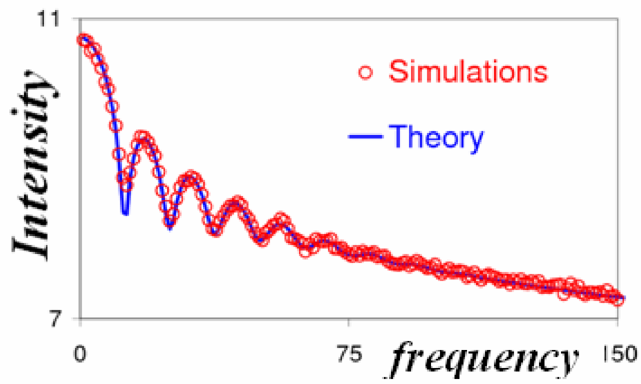
Statistical Mechanics far from Equilibrium

Beate Schmittmann and Royce K.P. Zia
Virginia Tech DMR-0414122

Statistical mechanics is the art (and science) of extracting systematic information from noisy physical processes. Here is an example: an iconic model for vehicular traffic at the macro-scale and protein synthesis at the nano-scale. On a chain of L sites, particles hop *stochastically*, entering from one end, hopping to the next site if it is empty, and leaving at the opposite end. Depending on the entry/exit rates (which model, say, traffic lights at each end of a narrow bridge), the system displays several phases. In the simplest case, the average density is low (e.g., 0.2) but fluctuates in time: $N(t)/L$ (green line in figure on left). Embedded in this seemingly uninteresting trace are remarkable structures. Specifically, the power spectrum of this case (figure on right) is the *most* interesting of the three. A theory for the fluctuations, based on biased diffusion with conserved noise, gives an excellent fit (with just one parameter) to the large damped oscillations. This provides important insight into the intricacies inherent in both this simple model and the related physical systems.





D.A. Adams, R.K.P. Zia and B. Schmittmann, Phys. Rev. Lett. ***99****, 020601 (2007).*

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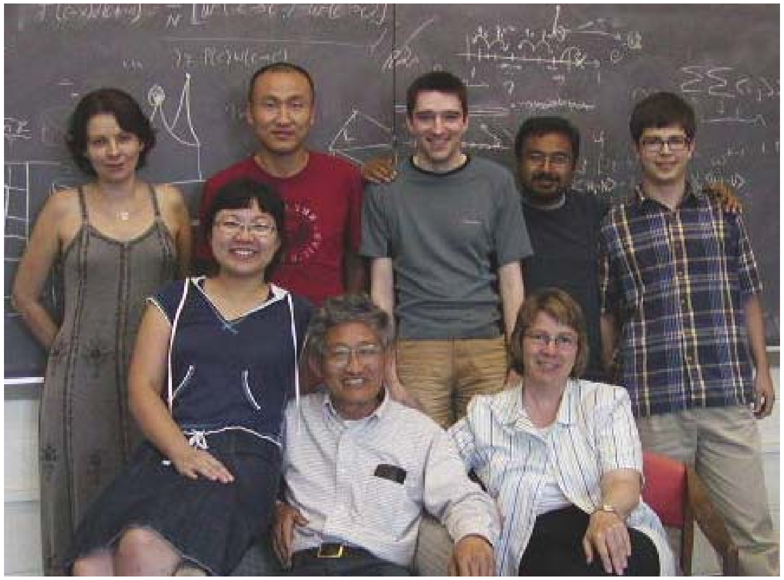
Education and outreach:

As our project involves a wide spectrum of techniques, it is natural that both undergraduates (*David Adams, Brian Skinner*) and graduate (*Jiajia Dong*, *Sayak Mukherjee*) students form a core component of our research. In addition, three postdocs (*Andrew Angel, Izabella Benczik, and Yong Wu*) and a summer intern (*Max Lavrentovich*, undergraduate from Kenyon College) are supported in part by this grant. While junior researchers often discover new phenomena through computer simulations of simple models, full-scale and analytic studies are implemented by the more senior scientists. The work outlined here was carried out by *David Adams*, who just received a BS in Physics and Computer Science.



From left, back row: Izabella Benczik, Yong Wu, Andrew Angel, Sayak Mukherjee, Max Lavrentovich
middle row: Jiajia Dong
front row: Royce Zia, Beate Schmittmann
Not in photo (graduated in May, 2007) *:*
David Adams, Brian Skinner