Statistical Mechanics of Systems far from Equilibrium

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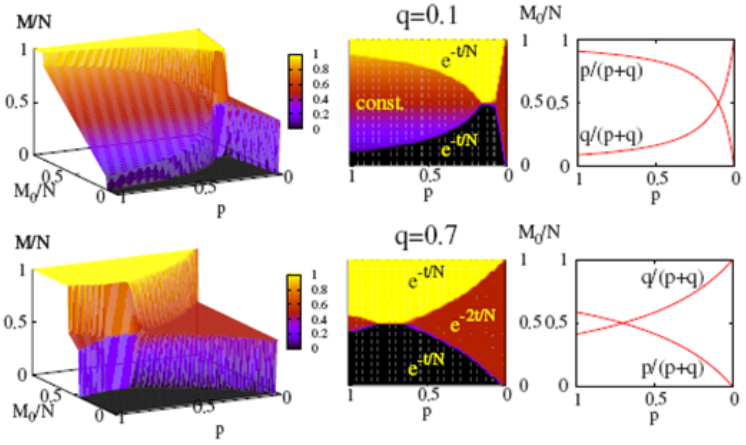
Virginia Tech DMR-0705152

Networks, from power grids and transportation to communication and social ones, became a subject of great interest to statistical physicists recently. Both static properties, such as the distribution of links connected to the various nodes, and dynamic behavior, such as the changes in the states of a node due to its interactions via its links to other nodes, have been studied. In one of the projects supported by this grant, we investigate the dynamics of an *adaptive* network, in which the links themselves are also dynamic, evolving according to the states of the nodes at either end. In our simple model, each node represents an individual with just two opinions (e.g., voting for two political parties, colored as yellow and black in the figure). Starting with M_0 nodes (amongst a total of N) voting yellow and a random distribution of links, a nodes evolves by a simple rule: it assumes the color of the majority of those connected to it. Then the links are updated. A link between nodes of the same [opposite] color is established with probability p [q]. With these simple rules, a variety of final states emerged: full consensus (all of one color), polarization (50-50, red in figure), or frozen at the initial partition (region around M_0/N=p=0.5). The "phase diagrams" for two cases (q=0.1 and 0.7) are shown at left. We formulated a theory which allows all these features to be understood intuitively and predicted quantitatively.



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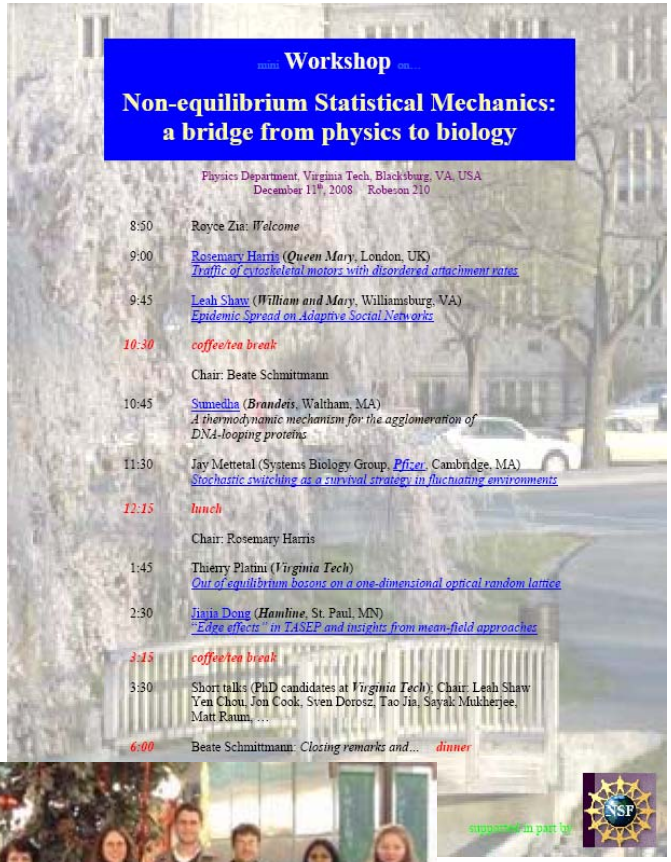
Education and outreach:

Our projects involves a wide spectrum of techniques, so that younger scientists, as well as established researchers, can easily participate. Postdocs, graduate and undergraduate students, as well as summer interns form a integral component of our research. In addition, we bring many national and international visitors to foster their networking. As an example, this grant supported a mini-workshop in December 2008. All the invited speakers are recent PhD's.

In the synergy between junior scientists and senior researchers, we often find that the former excel in discovering new phenomena, through e.g., computer simulations of simple models. Frequently, these discoveries are quite unexpected and, the analytic experiences of the latter play crucial roles in their understanding.



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