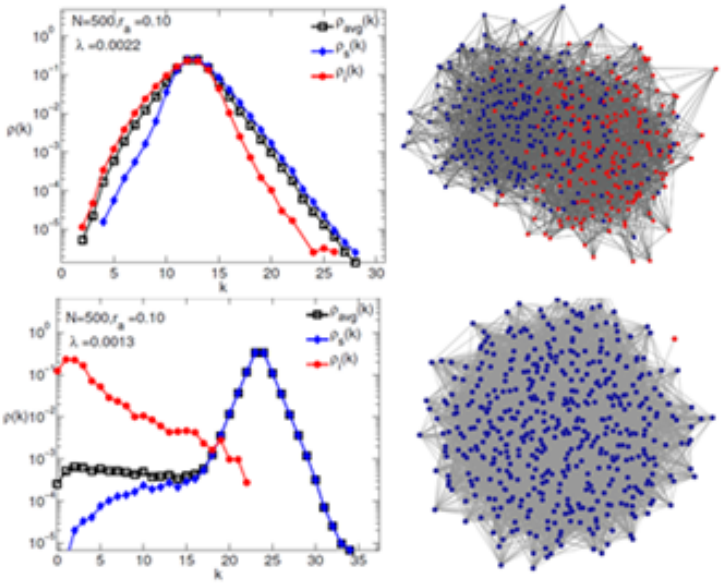
Statistical Mechanics of Systems far from Equilibrium

Beate Schmittmann and Royce K.P. Zia
Virginia Tech DMR-1005417

Much of our research this year, carried out mainly by Wenjia Liu (PhD student, now at Iowa State) and Shivakumar Jolad (postdoc, now Assistant Professor at IIT-Gandhinagar, INDIA), focused on the effects of a *dynamic* network on the statistics of its connectivity as well as the spreading of an epidemics on such a network. The setting we are modeling is a society of individuals (nodes) with a changing set of contacts (links). A typical person has a *preferred* number of contacts, e.g., introverts *vs.* extroverts. Further, this preferred number (denoted by κ) generally changes with time, often in response to some external crisis, e.g., a spreading epidemic. Thus, we are motivated to construct a network in which a node tends to cut/add links when its contacts are more/less than κ. In particular, it can respond to an epidemic by lowering κ. Clearly, such action would raise the threshold for the onset of an epidemic. If we further allow healthy individuals to "discriminate" against infected ones, the social network would display a richer behavior. The figure illustrates this with a network of 5000 nodes (healthy/infected = blue/red), below and above the threshold (lower and upper panels). Note that, in an epidemic, this society shows clustering of the two populations. The plots display histograms of the number of contacts (k) of a healthy/infected node, and also for an "average node" (black curve). Here, κ is chosen to be 25 if the fraction of infected is 40% or less, and lowered to10 otherwise.



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Broader impact:

Taking seriously the NSF mission to educate students and mentor junior scientists, we work closely with undergraduates to PhD candidates, as well as postdocs and alumni in academic and industrial settings. Our group members not only present work at conferences and workshops, but also enjoy social outings together. Serving our scientific community, we published pedagogical reviews on nonequilibrium statistical mechanics and its role in biological transport phenomena. Further afield, both of us regularly reach out to the general public, giving lectures on, e.g., "*What is Physics? – a personal perspective*" and "*Traffic, Genes, and Stocks: New Questions in Non-Equilibrium Statistical Physics.*" Well attended, these events typically enjoyed positive feedback.

Clockwise from top left: *Shivakumar Jolad (postdoc), Wenjia Liu (PhD), Royce Zia, Beate Schmittmann, WJL, SJ, BS, Sara Case (Junior, now at Vanderbilt), RZ, WJL, Jiajia Dong (PhD, now at Bucknell), Jenny Zia, and Clinton Durney (Senior, now at Ohio State)..*
Not in photos: *Hyunju Kim (postdoc).*