**Scaling and phase transitions in complex networks**

Janusz A. Hołyst

Faculty of Physics, Center of Excellence for Complex Systems Research, Warsaw University of Technology

Universal scaling of distances between vertices of Erdős-Rényi random graphs, scale-free Barabási-Albert models, science collaboration networks, biological networks, Internet Autonomous Systems and public transport networks are observed. A mean distance between two nodes of degrees ki and kj equals to <lij>=A –Blog(kikj). The scaling is valid over several decades. A simple theory for the appearance of this scaling is presented. Parameters A and B depend on the mean value of a node degree <k>nn calculated for the nearest neighbors and on network clustering coefficients.

The second part of the lecture will be devoted to ferromagnetic phase transition in Barabasi–Albert networks. Ising spins put onto a Barabasi–Albert scale-free network show an effective phase transition from ferromagnetism to paramagnetism upon heating, with an effective critical temperature increasing as the logarithm of the system size. Starting with all spins up and upon equilibration pinning the few most-connected spins down nucleates the phase with most of the spins down.