Meiji University Global COE Program
29th Mathematical Sciences based on Modeling, Analysis and Simulation seminar

Date： September 27, 2010, 16:30～18:00

Location： Meiji Univ. Ikuta Campus, Build 2 Annex A, Room A207

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Title： Turing patterns in network-organized activator-inhibitor systems

Abstract : Turing instability in activator–inhibitor systems provides a paradigm of non-equilibrium self-organization; it has been extensively investigated for biological and chemical processes. Turing instability should also be possible in networks, and general mathematical methods for its treatment have been formulated previously by Othmer & Scriven in 1971. However, only examples of regular lattices and small networks were explicitly considered. We study Turing patterns in large random networks with strong degree heterogeneity, using the classical Mimura-Murray model on scale-free networks as an example, which reveal striking differences from the classical behavior. The initial linear instability leads to spontaneous differentiation of the network nodes into activator-rich and activator-poor groups but periodic structures are not formed. The emerging Turing patterns become furthermore strongly reshaped at the subsequent nonlinear stage. Multiple coexisting stationary states and hysteresis effects are observed. This peculiar behavior can be understood in the framework of a mean-field theory. Our results offer a new perspective on self-organization phenomena in systems organized as complex networks. Potential applications include ecological metapopulations, cellular networks of early biological morphogenesis, etc. If time permits, I would also like to touch on diffusion-induced chaos in coupled limit-cycle oscillators on scale-free networks, which can be understood almost in parallel with the network Turing patterns.

[1] H. Nakao & A. S. Mikhailov, Turing patterns in network-organized activator-inhibitor systems. Nature Phys. 6, 544-550 (2010).
[2] H. Nakao & A. S. Mikhailov, Diffusion-induced instability and chaos in random oscillator networks. Phys. Rev. E 79, 036214 (2009).

Everyone is welcome to attend the MAS seminar.

Access: 10 minutes on foot from Ikuta St. Odakyu line,
Or 10 minutes by bus No. 13「明治大学正門前」, get off at the last stop.
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