Ecological Dynamics on Large Metapopulation Graphs

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Abstract

In this presentation, we discuss reaction-diffusion models for predator-prey dynamics in patch-structured populations with between-patch dispersal on large graphs. We aim to unify two classical approaches for studying spatial dynamics in ecological systems: spatially-continuous models where dispersal typically follows a local diffusion operator and spatially-discrete patch models with more general network connectivity between the patches. Making use of the recently-developed formalism of graph limits, or graphons, we derive a continuum analogue of patch reaction-diffusion models which can describe the role of dispersal in the presence of non-local connectivity schemes like small-world or power law networks. A useful feature of these continuum limits is that one can find threshold quantities for the onset of pattern formation in predator-prey models and for persistence of a disease outbreak in terms of the non-local dispersal kernel, and therefore the qualitative behavior of these metapopulation dynamics is intricately linked to the topology of the dispersal network. We will place particular emphasis on the nonlinear stability of patterned states and regimes in which patterned steady states can coexist bistably with spatially uniform states.