

Speaker: Ada Altieri (Université de Paris, France)

Title: Glassy phases in large well-mixed ecosystems with competitive and cooperative interactions

Abstract

Cases in which the number of interacting components is very large are becoming of general interest in disparate fields, such as in ecology and biology, e.g. for bacteria communities, and economy where many agents trade and interact simultaneously both in financial markets and in complex economic systems.

Many of these systems appear often to be poised at the edge of stability, hence displaying enormous responses to external perturbations. This marginal stability condition is usually related to the complex underlying interaction network, which can induce large-scale collective dynamics and therefore critical behaviors.

In this talk, I will present the problem of ecological complexity by focusing on a reference model in theoretical ecology, the disordered Lotka-Volterra model with random symmetric interactions and finite demographic noise. By means of techniques rooted in mean-field spin-glass theory, I will show how to obtain a full characterization of the number of locally stable equilibria and the resulting phase diagram. Notably, I will relate emergent collective behaviors and slow relaxation dynamics to the appearance of disordered phases akin to those occurring in glassy systems, with a special emphasis on a hierarchically organized, amorphous phase (Gardner phase).

Finally, I will discuss the extension of these results to non-logistic growth functions in the dynamics of the species abundances, which turns out to be beneficial to model intra-specific cooperative effects in ecological and biological communities.

References:

A. Altieri, F. Roy, C. Cammarota, G. Biroli, *Phys. Rev. Lett.* 126, 258301 (2021);

A. Altieri, G. Biroli, *arXiv:2105.04519* (2021).