UNIVERSITÀ DEGLI STUDI DI PADOVA

SHANGHAI SUMMER SCHOOL
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DATE: 24th August 2016
TIME: 9:00 – 10:15
LOCATION: Osservatorio Astronomico di Asiago, via dell'Osservatorio, 8; Asiago, Vicenza

Statistical Physics of Living Systems: from starlings' flocks to eco-networks

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ABSTRACT

Despite the diversity of shapes and forms (spanning 21 orders of magnitude in mass), living systems are characterized by the recurrent emergence of patterns/regularities independent of their biological details. In ecological communities species interact forming networks with typical topological structures; power-law distributions and long-range correlations are pervasive and can be found both at the level of single organisms, as in gene and protein networks, neuronal activity or individual behaviour, and at the community level, as in bacterial clustering and ecosystems. These features are also typically seen in thermo-dynamical systems in vicinity of a critical phase transition. The great lesson from physics is that criticality can emerge as a collective behaviour in a many-body system with simple (e.g. pairwise) interactions and its characteristics depend only on few details like dimensionality of the system and its symmetries. Data reveal that the key feature of living systems may be related to the architecture of their interaction networks. The topology of the interaction network may actually represent the "parameter" that nature somehow tunes so that the system's responses to stimuli behave like a system near criticality, giving to living systems their unique ability to adapt and respond to perturbations. In this lecture I will give an overview on modelling approaches allowing to explain emergent patterns and critical-like behaviour in living systems.

FURTHER READINGS

1) Suweis S., Simini F., Banavar J.R. and Maritan A. (2013). Emergence of structural and dynamical properties of ecological mutualistic networks. *Nature* 2013 August 22; 500(7463); pp. 449-52. doi: 10.1038/nature12438.

2) Cavagnaa A., Cimarelli A., Irene Giardina I., Giorgio Parisi, Santagati R., Stefanini F. and Viale M. (2010). Scale-free correlations in starling flocks. *Proceedings of the National Academy of Sciences of the United States of America*, vol. 107(26), 11865–11870. doi: 10.1073/pnas.1005766107