Chez Pierre

Presents ...

Monday, October 30 2023

12:00 pm -1:00 pm

Duboc Room – 4-331

Chez Pierre Seminar

Shlomo Havlin, Bar-Ilan University, Israel

"Interdependent Superconducting Networks".

A theoretical framework for the percolation of interdependent networks will be presented. In interdependent networks, such as infrastructures, when nodes in one network fail, they cause dependent nodes in other networks to also fail. This may happen recursively and can lead to a cascade of failures and to a sudden fragmentation of the system of systems. This is in contrast to a single network where the percolation transition due to failures is continuous. I will present analytical solutions based on the percolation theory, for the functional network and the cascading failures, for a network of n interdependent networks. Our analytical results show that the percolation theory of a single network studied for over 80 years is just a limited case, n=1, of the general and much richer case of n>1. I will also show that interdependent networks embedded in space are significantly more vulnerable and have much richer behavior compared to non-embedded networks. In particular, it will be shown that localized attacks of zero fraction but above a microscopic critical size lead to cascading failures that dynamically propagate like nucleation and yield an abrupt phase transition. I will finally show that the abstract interdependent percolation theory and its novel behavior in networks of networks can be realized and proven in controlled experiments performed by Aviad Frydman on real physical systems. I will present recent experiments that support the interdependent network theory in measurements phase transition in interdependent superconducting networks. Here, a novel abrupt phase transition is observed due to microscopic cascading between the macroscopic systems. This is in contrast to an isolated system that shows a continuous phase transition.

References

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J. Gao et al Nature Physics, 8, 40 (2012)
A. Bashan et al, Nature Physics, 9, 667 (2013)
M. Danziger et al, Nature Physics 15(2), 178 (2019)
B. Gross et al, PRL 129, 268301 (2022)

I. Bonamassa et al, Interdependent superconducting networks, Nature Physics 19, 1163 (2023)