# SEMPARIS – Séminaires en région parisienne

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## Seminaire exceptionnel

**Lundi 17 Avril 2023, 11 :00**
LPENS, E314 (Salle Claude Froidevaux)
Domaines : cond-mat.stat-mech

Titre : *Interdependent Networks : Novel Physical Phase Transitions*

Orateur : **Shlomo Havlin ( Bar-Ilan University )**

Résumé : *A theoretical framework for studying 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. This is in contrast to a single network where the percolation transition due to failures is continuous. I will present analytical solutions based on percolation theory, for the critical thresholds, cascading failures, and the giant functional component of a network of n interdependent networks. Our analytical results show that a single network studied for 80 years is just a limited case, n=1, of the general and a significantly richer case of n¿1. I will also show that interdependent networks embedded in space are significantly more vulnerable and have richer behavior compared to non-embedded networks. In particular, small localized attacks of zero fraction but above a 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 proved in controlled experiments in real physical systems. I will discuss the consequences of the recent theory of interdependent networks on phase transitions in real physical iinterdependent systems and present theory and experiments on interdependent superconducting networks where we recently identified a novel abrupt transition although each isolated system shows a continuous transition.*

*References :*

*[1] S. Buldyrev, G. Paul, H.E. Stanley, S. Havlin, Nature, 464, 08932 (2010).*

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*[3] A. Bashan et al, Nature Physics, 9, 667 (2013)*

*[4] A Majdandzic et al, Nature Physics 10 (1), 34 (2014) ; Nature Comm. 7, 10850 (2016)*

*[5] M. Danziger et al, Nature Physics 15(2), 178 (2019)*

*[6] B. Gross, I Bonamassa and S. Havlin, Fractal fluctuations at mixed-order transitions in interdependent networks, 129 (26), 268301 (2022)*

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