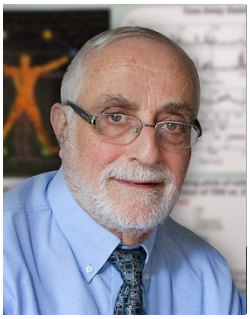
Dresden University of Technology

Faculty of Physics

PHYSICS COLLOQUIUM

Speaker:

Prof. Shlomo Havlin
Bar-Ilan University,
Israel



Topic:

General Theory and Microscopic Origin of Abrupt Phase Transitions based on Network Theory

Time and place:

Tuesday, January 20, 2026, **2:50 pm** – hybrid event
The colloquium will be held in REC/C213.
Online participation possible:
Zoom-Meeting: Meeting-ID: 631 3817 8900 / passcode: PC-WiSe25
https://tu-dresden.zoom-x.de/j/63138178900?pwd=TlmGawPz1dtDA6VzO2N1XdqqI7bE6b.1

Host:

Prof. Marc Timme

Abstract:

Phase transitions (PTs) are fundamental phenomena in statistical physics and condensed matter, manifesting as abrupt or continuous changes in system properties. I will show that the theory of *interdependent networks* can identify the *microscopic mechanisms* behind abrupt first-order nucleation and mixed-order phase transitions. Interdependent networks appear in all aspects of nature and technology. Examples include the physiological systems in our body and infrastructures. A theoretical framework for percolation theory 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 contrasts with 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 cascading failures, for a network of n interdependent networks. Our analytical results show that the percolation theory of a single network studied for over 90 years is just a limited case, n=1, of the general and significantly richer case of n>1. I will also show that interdependent networks embedded in space are extremely vulnerable and have significantly richer behavior compared to non-embedded networks. 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 interdependent superconducting networks as well in coupled laser systems in the lab of Patrick Sebbah.

Bio: Prof. Shlomo Havlin has made fundamental contributions to the physics of complex systems and statistical physics. These discoveries have impacted many other fields such as medicine, biology, geophysics, and more. Havlin received the Bakhuis Roosenboom Medal of the Royal Society of Netherlands (2023), the Israel prize in Physics (2018), Order of the Star of Italy, President of Italy (2017), the Lilienfeld, APS, USA (2010), and many others. Havlin has been a pioneer in the development of network science. His main interest in the last 15 years focus on interdependent networks, cascading failures, abrupt transitions, networks of networks and their implications to real world problems including the experimentally discovery of interdependent superconducting networks and laser systems.