上海数学与交叉学科研究院

SIMIS

Shanghai Institute for Mathematics and Interdisciplinary Sciences

SIMIS Seminar series on Quantum computing, Quantum simulation and Strongly-correlated systems

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"The interplay of geometry with non-Hermitian physics and nanoscale Casimir force"

Abstract

Geometry plays a fundamental role in physics, providing essential frameworks for understanding spatial structures, symmetries, and transformations. Algebraic geometry, hyperbolic geometry, and conformal mapping are particularly relevant in non-Hermitian physics, where complex energy landscapes and spectral topology redefine conventional notions of spectra and symmetry, as well as in nanoscale Casimir forces, where surface geometry and material response significantly influence quantum vacuum interactions. This presentation covers two topics: non-Hermitian physics and nanoscale Casimir forces. The first part focuses on spectral topology, which mainly discusses exceptional points and point gaps. I will begin with the order-3 exceptional lines (EL3s) embedded in order-2 exceptional surfaces (ES2s). Since eigenvalue winding numbers become ill-defined, the resultant manifold has been introduced to selectively detect EL3s while disregarding ES2s, enabling the characterization of EL3s and their evolution under perturbations. Next, I will devote myself to establishing a method for determining thermodynamic limit spectra of non-Hermitian hyperbolic lattices (HBLs), generalizing point-gap topology to align with supercell methods developed for Hermitian HBLs. This framework is demonstrated through examples like non-Abelian semimetals and higher-dimensional skin effects. The second part will discuss the nanoscale Casimir force softening from quantum surface responses (QSRs). A three-dimensional conformal mapping method has been established by embedding mesoscopic boundary conditions of electromagnetic fields. It then uncovers that the softening mechanism results from QSRs effectively alter the distance seen by the Casimir interaction. With such an understanding, a recipe to handle the nanoscale Casimir force between nanoscale complex objects has been provided.

Biography of the speaker

Dr. Kun Ding is an Associate Professor at the Department of Physics at Fudan University, starting in Jan. 2021. He got his B.Sc. and Ph.D. in 2008 and 2013 from the Department of Physics, Fudan University. Before joining Fudan University as a faculty, he worked at Imperial College London as a Research Associate from 2019 to 2020 in Prof. Sir John Pendry's group and at Hong Kong University of Science and Technology from 2013 to 2018 as a Post-doctoral Fellow and Research Assistant Professor in Prof. C. T. Chan's group. His research focuses on non-Hermitian physics, Casimir effects, plasmonics, and related topics.

Date and Place: March 12th, Wednesday, 2025, 11:00h-12:00h. Room: 1410. Send comments or questions to: Miguel Tierz (Seminar organizer) to tierz at simis.cn