北京大学量子材料科学中心

International Center for Quantum Materials, PKU

Seminar

Nonergodic extended phases in wave transport: from disordered to quasiperiodic systems coupled to electromagnetic cavities

Prof. Felipe A. Pinheiro

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Time: 3:00 pm, July 23, 2026 (Thursday)

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Venue: Room w563, Physics building, Peking University

地点：北京大学物理楼，西563会议室

Abstract

Wave transport in complex media is governed by the microscopic nature of quasimodes. In three-dimensional disordered systems, scalar waves can undergo an Anderson transition from diffusion to localization, whereas the vector nature of electromagnetic waves is known to suppress localization. Using the three-dimensional point-dipole model, we show that both scalar and electromagnetic waves exhibit a robust non-ergodic extended phase characterized by fractal quasimodes over a broad range of disorder strengths. While scalar waves eventually localize at strong disorder, electromagnetic waves remain non-ergodic and extended, never reaching a localized regime. We further demonstrate the emergence of non-ergodic extended phases in two additional platforms: the two-dimensional quantum percolation model and the cavity-coupled one-dimensional Aubry–Andr é model. These results highlight the universality and robustness of non-ergodic extended states, opening new opportunities for controlling anomalous wave transport in disordered media. Finally, we show how inverse methods can be used to retrieve the coupling strength between the quantum chain and the cavity, and discuss further applications of these methods in disordered photonic systems.

About the speaker

Prof. Felipe A. Pinheiro received his B.Sc. in Physics from the Federal University of Rio de Janeiro (UFRJ), Brazil, in 1998, his M.Sc. in Physics from the Brazilian Center for Research in Physics (CBPF), Brazil, in 2000, and his Ph.D. in Physics from Joseph Fourier University – Grenoble I, France, in 2003. He subsequently held postdoctoral positions at CBPF (2004) and at the State University of Rio de Janeiro (2005–2006). He has been a visiting researcher at several international institutions, including the Optoelectronics Research Centre at the University of Southampton, United Kingdom (2014–2015), the Institut de Physique de Nice–CNRS, France (2021), Ludwig Maximilian University of Munich, Germany (2023–2024), and Universit é C ôte d'Azur, France (2024).

Prof. Pinheiro was awarded the TWAS-ROLAC Young Scientist Prize in Physics in 2014 and the Royal Society Newton Advanced Fellowship-UK in 2015. He served as Coordinator of the Graduate Program in Physics at UFRJ from 2022 to 2026. He is currently an Associate Professor of Physics at UFRJ, Brazil. His research interests lie in photonics and condensed matter physics, with a particular focus on wave propagation and scattering in complex media and metamaterials, Anderson localization, chiral photonics, and electronic transport in mesoscopic and molecular systems.