

Séminaire AXE 1 - Sciences et Matériaux Quantiques



Friday, 4th September 2026 | 14:00 | Salle 70 de l'IPCMS

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

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–André 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 hyperuniform photonic systems.

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