Quantum critical states in quasiperiodic lattices: Theory and Experiment

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The disordered quantum systems host three types of fundamental quantum states, the extended, localized, and critical states, of which the multifractal critical states are much less understood compared with the former two. Conventionally the characterization of the quantum critical states relies on arduous numerical verification. In this talk, I will present an analytic study of the critical states in quasiperiodic systems, and further present our recent experimental realization. Through the Avila global theory, a Fields Medal work which we introduced to ultracold atoms, we propose a class of exactly solvable models, dubbed mosaic lattice models, hosting novel types of exact mobility edges separating localized from quantum critical or extended states, With these exactly solvable models, we discover a universal mechanism for the critical states that the such states are due to the vanishing Lyapunov exponent and the incommensurately distributed hopping zeros in the thermodynamic limit, which also serve as a rigorous characterization of the critical states. Further, based on the considerable progresses in spin-orbit coupled optical Raman lattices, which have been widely applied to simulate topological phases, we discuss our latest experimental realization of the present predictions. In particular, a unified model with seven fundamental localization phases is realized in experiment. Future important issues will be commented.

References

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