Observation of Coherent Forward Scattering in a disordered quantum system

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Abstract

Anderson localization is the absence of diffusion in certain disordered media. The transport and localization properties of disordered quantum systems are greatly affected by symmetries. Here, we present a novel technique which allows the realization an artificial gauge field in a synthetic (temporal) dimension of a disordered, periodically driven (Floquet) quantum system. Our technique is used experimentally to control the Time-Reversal Symmetry properties of the Kicked Rotor – a paradigmatic model of classical and quantum chaos. Using this system, we were recently able to provide the first observation and characterization of a direct 'microscopic' interference smoking gun of the Anderson Localization, the so-called "Coherent Forward Scattering" (CFS) phenomenon – thus confirming its very recent theoretical prediction. This result is complemented by an accurate measurement of the universal scaling function b(g) [4] in two different universality classes. The Coherent Forward Scattering, in conjunction with its weak-localization counterpart, the "Coherent Backscattering" (CBS), can be extremely valuable tools for future probing novel phenomena, emerging from the interplay of many-body effects or symmetry properties with the Anderson physics.

Keywords: Quantum chaos, Kicked Rotor, Anderson localization, Artifical gauge fields, Coherent Forward Scattering

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