Direct observation of Coherent Backward Scattering and Coherent Forward Scattering peaks in a shaken Bose gas

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The quantum kicked rotor is a paradigmatic model of chaotic dynamics, where the classical unbounded diffusion in momentum is suppressed. This effect is called the dynamical localization, and is the equivalent in momentum space of Anderson localization, a very well-known phenomenon arising from quantum interference effects in the presence of spatial disorder. Both localization effects exhibit distinct peak signatures in reciprocal space. The Coherent Back-Scattering (CBS) peak is a marker of weak localization, and has been observed in numerous systems. The recently predicted Coherent Forward Scattering (CFS) peak[1] however, is a hallmark of strong (Anderson) localization, and has only been observed indirectly so far [2]. In this talk, I will present the recent experimental observation of the coherent forward scattering peak with ultra-cold atoms[3]. This peak is not only a key hallmark of non-ergodic behavior but also crucially encodes the system's underlying symmetries.

References: [1] T. Karpiuk, N. Cherroret, K. L. Lee, B. Grémaud, C. A. Müller, and C. Miniatura Phys. Rev. Lett. 109, 190601 (2012). [2] Hainaut, C., Manai, I., Clément, JF. et al. Nat Commun 9, 1382 (2018). [3] F. Arrouas, J. Hébraud, N. Ombredane, E. Flament, D. Ronco, N. Dupont, J. Billy, G. Lemarié, C. Miniatura, B. Georgeot, B. Peaudecerf and D. Guéry-Odelin, in preparation (2025).