

Observation of many-body dynamical localization

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The quantum kicked rotor is a paradigmatic model system in quantum physics. As a driven quantum system, it is used to study the transition from the classical to the quantum world and to elucidate the emergence of chaos and diffusion. In contrast to its classical counterpart, it features dynamical localization, specifically Anderson localization in momentum space. The interacting many-body kicked rotor is believed to break localization, as recent experiments suggest [1,2].

In this talk, I will report the experimental observations of 1D strongly interacting gas under periodic and random driving. Starting from 2-nK samples in a compensated flat-bottom optical trap, we observe many-body dynamical localization (MBDL) in a 1D quantum kicked rotor (QKR) setting [3] as the interactions are tuned from zero into the Tonks-Girardeau (TG) regime. After some initial evolution, the momentum distribution freezes and retains its characteristic structure as the sample is kicked periodically hundreds of times. In contrast, for random kicking, the distribution becomes uniform and loses all structure, which indicates thermalization of the system.

[1] Interaction-driven breakdown of dynamical localization in a kicked quantum gas, A. Cao et al., *Nature Physics* 18, 1302 (2022).

[2] Many-body dynamical delocalization in a kicked one-dimensional ultracold gas, J. See Toh et al., *Nature Physics* 18, 1297 (2022).

[3] Observation of many-body dynamical localization, Y. Guo et al., *arXiv:2312.13880* (2023).