Weak anti-localization in a dynamical spin-orbit coupled atomic BEC

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Quantum transport is a central problem in modern physics in a wide variety of systems, ranging from superconductors to insulators. The kicked-rotor model is a well-known platform, that proves to be particularly relevant in the study of Anderson localization. This model consists (in its simpler version) of a cold atomic cloud periodically driven by short pulses of a light induced lattice, realizing a Floquet dynamical system.

Symmetries play an important in the emergence of transport signatures. Tailoring the driving properties of the kicked-rotor, our group has pioneered experimental observations on the role of the system's symmetries on localization properties of spinless particles [1].

Yet, other types of symmetries, such as spin inversion, can also drastically influence the transport and localization properties. For instance, at early times a phenomenon called weak anti-localization is expected [2]. We designed theoretically and implemented experimentally spin-orbit coupling for the kicked-rotor model, an essential tool to control this symmetry.

Using two hyperfine states of a potassium BEC, coupled by Raman transitions and a state-dependent optical lattice, we introduce an original experimental scheme which implements a dynamical spin-orbit coupling in the kicked rotor. The experimental results show clear signatures of anti-localization and allow to probe the role of spin inversion symmetry in disordered quantum systems. The importance of an experimental realization of such a system goes beyond the Anderson localization physics, as it could find echoes in the study of topological classes [3].

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