ID de Contribution: **1** Type: **Non spécifié**

Anderson Localization of Ultracold Matterwaves in 3D Optical Disorder: Pinpointing the Mobility-Edge

jeudi 13 mars 2025 11:00 (1h 30m)

Anderson localization (AL), an outcome arising from interference of multiple scattering events that result in a complete halt of a wave in disordered media, is a ubiquitous fundamental phenomenon in wave propagation. It's scope includes scalar waves like electrons and ultracold atoms or polarized waves like light or more sophisticated systems like kicked rotors, in 1D, 2D and 3D traps or lattice configurations. A dilute Bose Einstein Condensate (BEC) offers a promising platform to study AL and other quantum transport phenomena in disordered optical potentials, with unrivalled precision and control. AL of atoms in 1D has been observed, quantitatively studied and well understood. In 3D, first evidence of AL is reported, but studies of the AL transition's critical regime remain elusive due to imprecise energy spreads. A new spectroscopic scheme (RF transfer of BEC atoms from a disorder-insensitive state to a to a disorder-sensitive state) is developed and validated in our group, to tackle that bottleneck. We have refined this new method to enable us realize a long lasting goal of measuring the "mobility-edge" of the 3D Anderson transition, relying on the energy-selective population of disorder levels. We present some recent results of this quest and discuss the challenges that persist, and some ideas to address them. The outcomes serve as a test bed for the advanced theories of AL and provide better understanding of wave propagation in quantum regimes.

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