Facilitation Dynamics and Localization Phenomena in Rydberg Lattice Gases with Position Disorder

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https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.118.063606 [2]

We explore the dynamics of Rydberg excitations in an optical tweezer array under antiblockade (or facilitation) conditions. Because of the finite temperature the atomic positions are randomly spread, an effect that leads to quenched correlated disorder in the interatomic interaction strengths. This drastically affects the facilitation dynamics as we demonstrate experimentally on the elementary example of two atoms. To shed light on the role of disorder in a many-body setting we show that here the dynamics is governed by an Anderson-Fock model, i.e., an Anderson model formulated on a lattice with sites corresponding to many-body Fock states. We first consider a one-dimensional atom chain in a limit that is described by a one-dimensional Anderson-Fock model with disorder on every other site, featuring both localized and delocalized states. We then illustrate the effect of disorder experimentally in a situation in which the system maps on a two-dimensional Anderson-Fock model on a trimmed square lattice. We observe a clear suppression of excitation propagation, which we ascribe to the localization of the many-body wave functions in Hilbert space.

- 12.10.+i Simulations of many-body interactions [3]
- H2020 [4]
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