

Disorder in order: localization in a randomless cold atom system

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We present a mapping between the Edwards model of disorder, describing a single particle subjected to the potential of randomly-positioned scatterers, and the Bose polaron problem of a light impurity interacting with a Bose-Einstein condensate (BEC) of heavy atoms. The time evolution of the impurity emulates the disorder-averaged dynamics of the Edwards model. The mapping offers a novel experimental setup to investigate the physics of Anderson localization. It is valid in any space dimensions and can be extended to include interactions between bosons, several particles, and arbitrary scattering and confining potentials. We focus on the case of an impurity interacting with a one-dimensional BEC through a repulsive contact interaction. The polaron model is studied by means of a variational approach, which can be benchmarked against the corresponding, exactly-solvable disorder model. While the simple Chevy *Ansatz* misses the localization physics entirely, a more involved coherent state *Ansatz* combined with the Lee-Low-Pines transform captures the qualitative physics of disorder.

[1] F. Rose and Richard Schmidt, in preparation