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Localization effects in the disordered two-dimensional Bose-Hubbard-model

Some experiments already have shown signatures of many-body localization (MBL) in the disordered Bose-Hubbard model in one and two dimensional ultra cold atomic lattice gases [1] as well as the related superfluid to Bose-glass transition in three dimensions for moderate disorder [2]. A proper theoretical understanding of the MBL phenomenon depends on knowledge about the full eigenstate spectrum. Therefore, commonly used exact numerical studies have been limited to small system sizes. In contrast, the related Bose-glass phase can already be understood via the ground state. To obtain beyond mean-field insight into the full fluctuation spectrum we use the fluctuation operator expansion method [3], which also incorporates effects of entanglement. This way, we can perform a scaling analysis of both localization phenomena within a single framework. With the collection of obtained critical points, we are able to map out a phase diagram showing the superfluid to Bose-glass transition in the ground state as well as the presence of a mobility-edge in the corresponding many-body excitations.

[1] C. D'Errico et al., PRL 113, 095301 (2014); J.-y. Choi et al., Science 352, 1547 (2016)
[2] C. Meldgin et al., Nature Physics 12, 646 (2016)
[3] A. Geißler et al., PRA 98, 063635 (2018)

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