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Many body localization of bosons in optical lattices.

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This contribution is based mainly on [1]. Many-body localization for a system of bosons trapped in a one dimensional lattice is discussed.

Two models that may be realized for cold atoms in optical lattices are considered. The first one is Bose–Hubbard model with a random on–site potential

$$H = -J \sum_{\langle i,j \rangle} \hat{a}_i^+ \hat{a}_j + \frac{U}{2} \sum_i \hat{n}_i (\hat{n}_i - 1) + \sum_i \mu_i \hat{n}_i$$

where \hat{a}_i^+ and \hat{a}_i are operators creating and annihilating boson at site i of the lattice, J and U are respectively tunneling amplitude and interaction strength and μ_i is a random on–site potential distributed uniformly in interval $[-W, W]$. The random on–site potential model is compared with random interactions model [2-3]

$$H = -J \sum_{\langle i,j \rangle} \hat{a}_i^+ \hat{a}_j + \frac{1}{2} \sum_i U_i \hat{n}_i (\hat{n}_i - 1)$$

where $U_i \in [0, U]$ is random interaction strength.

While the origin and character of the disorder in both systems is different they show interesting similar properties. In particular, many-body localization appears for a sufficiently large disorder strengths W and U as verified by a time evolution of initial density wave states as well as using statistical

properties of energy levels for small system sizes. Starting with different initial states, we observe that the localization properties are energy-dependent which reveals an inverted many-body localization edge in both systems – that finding is also verified by statistical analysis of energy spectrum – see Fig.~1.

Moreover, we consider computationally challenging regime of transition between many body localized and extended phases where we observe a characteristic algebraic decay of density correlations which may be attributed to subdiffusion (and Griffiths-like regions) in the studied systems. Ergodicity breaking in the disordered Bose-Hubbard models is compared with the slowing-down of the time evolution of the clean system at large interactions.

[1] P. Sierant and J. Zakrzewski,
Many-body localization of bosons in optical lattices,
New J. Phys. **20** 043032 (2018)

[2] Piotr Sierant, Dominique Delande, and Jakub Zakrzewski,
Many-body localization due to random interactions,
Phys. Rev. A **95**, 021601 (2017)

[3] Piotr Sierant, Dominique Delande, Jakub Zakrzewski,
Many-body localization for randomly interacting bosons,
Acta Physica Polonica A **132**, 1707 (2017)

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