Multifractal properties of the ground state of the Bose-Hubbard model

Jakob Lindinger

12th December 2017

We study the multifractal properties of the ground state of the one-dimensional Bose-Hubbard model in Fock space. We confirm that the limit of vanishing interaction exhibits non-trivial multifractality in the Fock basis [1]. In order to get access to the multifractal properties at arbitrary values of the interaction strength, we use exact diagonalisation and quantum Monte Carlo simulations (which enable us to reach $L = 30$ in certain cases, corresponding to a Hilbert space of size $\mathcal{N} \approx 6 \times 10^{16}$). Our results suggest the existence of non-trivial multifractality in the ground state for a large range of interaction values. We find that an analysis of the generalised fractal dimensions for different densities exposes qualitatively the superfluid to Mott insulator transition. We furthermore explore different methods to quantitatively characterise the transition.

[1] E. Bogomolny. Multifractality in simple systems. Presentation at the conference "Complex patterns in wave functions: drums, graphs, and disorder" at the Kavli Royal Society Centre, UK. 2012