Title: Modelling of Ultracold Gases in Multidimensional Optical Lattices

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Abstract:

Optical lattices are experimental devices that use laser light to confine ultracold neutral atoms to periodic spatial structures. A system of bosonic atoms in an optical lattice can be described by the Bose–Hubbard model. Although there exist powerful analytic and numerical methods to study this model in one dimension, their extensions to multiple dimensions have not been as successful yet. I present an original numerical method based on tree tensor networks to simulate time evolution in multidimensional lattice systems with a focus on the two-dimensional Bose–Hubbard model. The method is used to investigate phenomena accessible in current experiments. In particular, I have studied phase collapse and revivals, boson expansion, and many-body localization in two-dimensional optical lattices. The outcome of this work is TEBDOL — a program for modelling one-dimensional and two-dimensional lattice systems.

Keywords:

Bose–Hubbard model, multidimensional system, optical lattice, tensor network