

One-dimensional Bose gas in optical lattices of arbitrary strength

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One-dimensional Bose gas with contact interaction in optical lattices at zero temperature is investigated by means of the exact diffusion Monte Carlo algorithm. The results obtained from the fundamental continuous model are compared with those obtained from the lattice (discrete) Bose-Hubbard model, using exact diagonalization, and from the quantum sine-Gordon model. We map out the complete phase diagram of the continuous model and determine the regions of applicability of the Bose-Hubbard model. Various physical quantities characterizing the systems are calculated, and it is demonstrated that the sine-Gordon model used for shallow lattices is inaccurate.

- [04.10.+s Entanglement in spin models/oscillator chains](#) [3]
- [12. SIMULATIONS](#) [4]
- [12.30.+u Universal quantum simulators with specific systems \(e.g. trapped ions, optical lattices, etc.\)](#) [5]
- [04. ENTANGLEMENT IN MANY-BODY SYSTEMS](#) [6]
- [SIQS](#) [7]

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