Transport and macroscopic quantum tunneling of one-dimensional Bose gases in an optical lattice

Ippei Danshita[1], Charles W. Clark[2], and Anatoli Polkovnikov[3]

[1] Computational Condensed Matter Physics Laboratory, RIKEN, Wako, Saitama 351-0198, JAPAN

[2] Joint Quantum Institute, National Institute of Standards and Technology and University of Maryland, Gaithersburg, Maryland 20899, USA

[3] Department of Physics, Boston University, Boston, Massachusetts 02215, USA

In recent experiments of cold atomic gases confined in optical lattices, transport of one-dimensional (1D) Bose gases has been investigated by suddenly displacing the confining potential [1] and using a moving optical lattice [2]. In this work, we discuss the superfluidity of 1D Bose gases in optical lattice and especially focus on explaining the experiment of Fertig *et al.* [1], where unexpectedly strong inhibition of transport was observed [4]. Since mean-field theories fail even qualitatively to describe the transport properties of such 1D Bose gases due to strong quantum fluctuations, we use the time-evolving block decimation method [3] to simulate the experiment. We show that the strong inhibition of transport observed in the experiment is attributed to the breakdown of superfluid flow accelerated by quantum fluctuations. Moreover, we relate the damping of the dipole oscillation to the decay of supercurrents via macroscopic quantum tunneling in a ring optical lattice.

References

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