Collective modes at the superfluid - Mott glass transition

Thomas Vojta[1], Martin Puschmann[1,2], Jack Crewse[1], Joao C. Getelina[1,3], and Jose A. Hoyos[3]

[1]*Missouri University of Science and Technology, Department of Physics, 1315 North Pine Street, Rolla, MO 65409, USA*
[2]*Institute of Theoretical Physics, University of Regensburg, D-93040, Regensburg, Germany*
[3]*Instituto de Fısica de Sao Carlos, Universidade de Sao Paulo, C.P. 369, Sao Carlos, Sao Paulo, 13560-970, Brazil*

We study the collective excitations, i.e., the Goldstone (phase) mode and the Higgs (amplitude) mode, near the superfluid–Mott glass quantum phase transition in a two-dimensional system of disordered bosons. Using Monte Carlo simulations as well as an inhomogeneous quantum mean-field theory with Gaussian fluctuations, we show that the Higgs mode is strongly localized for all energies. This leads to a noncritical scalar response characterized by a scalar spectral function that features a broad peak whose peak frequency does not soften but remains nonzero across the quantum phase transition.

In contrast, the lowest-energy Goldstone mode undergoes a striking delocalization transition as the system enters the superfluid phase, leading to a zero-frequency spectral peak. We also relate our findings to general results on the localization of bosonic excitations, and we discuss the limits and generality of our approach.

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