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Replica Symmetry Breaking in the Bose Glass

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Abstract:

We investigate the nature of the compressible Bose glass phase of the disordered Bose-Hubbard model and demonstrate the existence of a glass-like replica symmetry breaking (RSB) order param- eter in terms of particle number fluctuations. Starting from a strong-coupling expansion around the atomic limit, we study the instability of the Mott insulator towards the formation of a Bose glass. We add some infinitesimal RSB, following the Parisi hierarchical approach in the most gen- eral form, and observe its flow under the momentum-shell renormalization group scheme. We find a new fixed point with one-step RSB, corresponding to the transition between the Mott insulator and a Bose glass phase with hitherto unseen RSB. This finding is consistent with the expectation of glassy behavior and the established breakdown of self-averaging, as well as with previous results showing RSB in the fermionic analog, the compressible Anderson glass. We discuss the possibility of measuring the glass-like order parameter in optical lattice experiments as well as in certain spin systems which are in the same universality class as the Bose-Hubbard model.