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Disorder in spin-1 Bose Hubbard Model

Spinor Bose-Hubbard (BH) models describe strongly correlated lattice systems where bosons have internal angular momentum -spin- whose orientation in space is not externally constrained. In atomic gases, the spin degree of freedom corresponds to the manifold of Zeeman energy states associated to a given hyperfine level. As in the spinless BH case, the competition between the different energy scales present in spinor BH models determines the ordering properties of the ground state. Modifying the energy ratio between the hoping and interactions allows to cross a quantum phase transition between now a spinor superfluid condensate and a Mott insulator (MI) state. Here we illustrate the zero temperature phase diagram of the spin *1* BH model in a 2D square lattice in the presence of disorder using a mean field Gutzwiller ansatz and a stochastic mean field approximation . We focus on the antiferromagnetic case and we study three different types of disorder: in the chemical potential, in the spinor interaction and in the spinless interaction coupling. Our main results can be summarized as follows. In the presence of disorder in the chemical potential, we obtain that MI lobes with odd occupation disappear and the emergence of the Bose glass (BG) phase between MI lobes with even occupancy occurs.For large enough spinor coupling, when the disappearance of the lobes with odd occupancy occurs already in the absence of disorder, a BG of singlets is predicted. Adding disorder in the spinor coupling, we observe that the BG phase appears only between lobes corresponding to *n* and *n+1* occupations with *n*-odd. We explain such a behavior using perturbation theory in the vanishing tunneling limit. Disorder on the spinless interaction coupling reproduces qualitatively the results found for scalar gases, i.e., lobes with occupation larger than a critical value, fixed by the magnitude of the disorder, disappear and BG appears between the remaining ones.