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The two-dimensional disordered Bose-Hubbard model: phase diagrams and new applications

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The Bose glass (BG) phase is the Griffiths region of the disordered Bose Hubbard model (BHM), characterized by finite, quasi-superfluid (SF) clusters within a Mott insulating (MI) background. In the first part of the talk it is proposed to utilize this characterization to identify the complete $T = 0$ phase diagram of the disordered BHM in $d \geq 2$ dimensions. Defining SF clusters through sites with non-integer mean boson number they occur first at the MI-BG boundary and they percolate at the BG-SF transition. An application to local mean field ground states of the $2d$ disordered BHM predicts phase diagrams that are in an excellent agreement with quantum Monte Carlo results. In the second part of the talk we consider ultracold bosonic atoms in an optical lattice, which interact with the mode of a high finesse resonator or cavity, whose wave length is incommensurate with the lattice period. The system is described by a BHM, whose coefficients, due to the cavity field, depend on the atomic densities at all sites. It is khown that due to this cavity backaction the atoms self-organize into a phase reminiscent of a BG in large regions of the parameter space.