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A multi-site mean-field theory for cold bosonic atoms in optical lattices[1] PAWEL PISARSKI, THOMAS MCINTOSH, ROBERT GOODING, EUGENE ZAREMBA, Queen's University — Mean-field theory is one of the most commonly used approximate methods in condensed matter physics. As applied to the Bose-Hubbard model it provides a simple, qualitative explanation of the Mott insulator – superfluid transition. In its usual form, one invokes a superfluid order parameter to decouple the Bose-Hubbard Hamiltonian into a sum of independent site Hamiltonians. Within this single-site mean-field theory (SSMFT) the equilibrium state is determined by minimizing the grand potential with respect to the order parameter. To improve on this procedure we have developed a multi-site mean-field theory (MSMFT), whereby the lattice is partitioned into small clusters which are decoupled by means of the usual mean-field method. The most general decoupling procedure necessitates the assignment of site-dependent order parameters to the sites bounding the cluster. This leads to a non-trivial topology of the grand potential and one finds, in general, that the equilibrium state is a saddle point. As a result, one cannot use a variational principle to locate the equilibrium states of interest. In this talk, we outline the MSMFT we have developed and give an example of its application.

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