EFFECTIVE BOSONIC MODELS FOR COLLECTIVE ELECTRONIC FLUCTUATIONS

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Collective electronic fluctuations in correlated materials give rise to various important phenomena, such as charge ordering, superconductivity, Mott insulating and magnetic phases, and plasmon and magnon modes. Description of these correlation effects requires a significant effort, since they almost entirely rely on strong local and nonlocal electron-electron interactions. Some collective phenomena, such as magnetism, can be sufficiently described by simple Heisenberg-like models that are formulated in terms of bosonic variables. This fact suggests that other many-body excitations can also be described by simple bosonic models in the spirit of Heisenberg theory. Here we derive an effective bosonic action for charge and spin degrees of freedom for the extended Hubbard model. Also, we define a physical regime where the obtained model action reduces to a classical Hamiltonian of an effective Ising and Heisenberg models for charge and spin variables, respectively. The derived formalism is reminiscent of Anderson's idea of the effective exchange interaction and takes into account nonlocal correlation effects. The results for the exchange interaction and susceptibility are expressed in terms of single-particle quantities, which can be obtained efficiently in realistic calculations of multiband systems.