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Improved variational approach to strongly correlated systems: The RVB paradigm at work

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Having in mind simple one-band Hubbard-like models, we present a variational paradigm to understand the physical properties close to a Mott insulator state. The wave function is described by a singular density-density Jastrow factor applied to an uncorrelated mean-field state. Within this framework, the physical quantities can be mapped onto finite-temperature classical averages of a Coulomb gas model, the positive charges corresponding to the sites with doubly occupied sites (doublons) and the negative ones to the empty sites (holons). In the quantum analog described by our variational ansatz the inverse of the classical temperature corresponds to the strength of the Jastrow factor.
In one dimension, this model displays a confined dielectric phase at arbitrary large temperature, whereas, in two dimensions, a Kosterlitz-Thouless transition between a high-temperature plasma phase, with perfect screening, and a low-temperature confined phase is found. Due to the singular interaction, in the two-dimensional metallic phase, the quasiparticle weight vanishes with non-universal power laws and the insulating phase has many anomalous properties. The relevance of this scenario for the phenomenology of underdoped high-temperature superconductors is also discussed.

Keywords : Metal-insulator transition, strong correlation, variational wave functions