Non-local orders and exotic phases in Hubbard-like low dimensional systems

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Abstract

The experimental realization of time-dependent ultracold lattice systems has paved the way towards the implementation of new Hubbard-like Hamiltonians. We show that in a one-dimensional two-component lattice dipolar Fermi gas the competition between long range repulsion and correlated hopping induced by periodically modulated on-site interaction allows for the formation of hidden magnetic phases, with degenerate protected edge modes. The magnetism, characterized solely by string-like nonlocal order parameters, manifests in the charge and/or in the spin degrees of freedom [1]. In the spin sector, the underlying order is associated with the presence of a delocalized alternation of up and down spins in a background of doublons and holons (where a doublon consists of two fermions with opposite spin on the same lattice site and an holon is an empty site). In the charge sector the role of the up and down spins and that of doublons and holons is reversed; thus the magnetism consists in the presence of alternated and diluted doublons and holons in a string of singly occupied sites. Phases associated with the parity order, where holons and doublons or up and down spins appear to be localized in pairs, are also present in the phase diagram of our model.

We also discuss to which extent non-local orders can characterize the physics of higher dimensional interacting quantum systems, and whether string order parameters are still suitable, upon appropriate generalization, for capturing it. We present the generalization of the definition of the parity operators to the two dimensional case [2] and apply it to study the superfluid-Mott insulator transition in the Bose Hubbard model

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C. Degli Esposti Boschi, A. Montorsi and M. Roncaglia, Phys. Rev. B. 94, 085119 (2016)

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