Stability of charge-stripe phases in a system of spinless fermions or hardcore bosons

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We consider two strongly correlated two-component quantum systems, consisting of quantum mobile particles and classical immobile particles. The both systems are described by Falicov–Kimball-like Hamiltonians on a square lattice, extended by direct short-range interactions between the immobile particles. In the first system the mobile particles are spinless fermions while in the second one they are hardcore bosons. We construct rigorously ground-state phase diagrams of the both systems in the strong-coupling regime and at half-filling. Two main conclusions are drawn. Firstly, short-range interactions in quantum gases are sufficient for the appearance of charge stripe-ordered phases. By varying the intensity of a direct nearest-neighbor interaction between the immobile particles, the both systems can be driven from a phase-separated state (the segregated phase) to a crystalline state (the chessboard phase) and these transitions occur necessarily via charge-stripe phases: via a diagonal striped phase in the case of fermions and via vertical (horizontal) striped phases in the case of hardcore bosons. Secondly, the phase diagrams of the two systems are definitely different. However, if the strongest effective interaction in the fermionic case gets frustrated gently, then the phase diagram becomes similar to that of the bosonic case. Influence of the hopping anisotropy on striped phases has been considered.

9.7 cm

13.4 cm

Subject category :

1. Correlated Electrons and High Temperature Superconductors

Presentation mode :
poster

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