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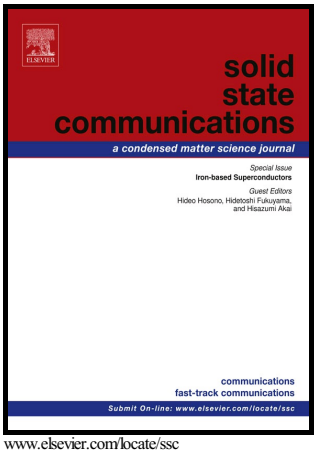

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Competition between spin and charge order in a one-dimensional lattice

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Abstract

In this paper, we study the presence of competing instabilities in one-dimensional (1D) extended Hubbard model (EHM). Using the extended two-particle self-consistent approximation (ETPSC), we derive the density and interaction dependent crossover diagram for spin and charge density wave fluctuations at arbitrary wave number. We determine the phase transitions of the system by means of spin and charge susceptibilities. We draw the phase diagram which separates different phases of the model for several effective particle densities.

Keywords: A. One-dimensional lattice; B. TPSC approach; D. Spin and charge susceptibilities; D. Phase diagram

1. INTRODUCTION

In the context of strongly correlated electron systems, single-band Hubbard model with on-site interaction U and hopping amplitude t is the simplest model of correlated electrons [1]. Inter-band hopping terms are ignored and referred to multi-band Hamiltonians[2]. Competing orders, due to the different particle interactions, in these type of systems are also quite common. For example, in high-temperature (hT_c) superconductors and some organic materials, the screening is not perfect so the site-site interactions play a considerable role, in such cases the Extended Hubbard model is also more useful. This Hamiltonian takes into account a nearest-neighbor interaction of strength V [3, 4]. This model has also been used to understand the behavior of quasi-one-dimensional materials including conductive polymers such as polyacetylene [5], organic-charge transfer materials such as $TTF-TCNQ$ or $(TMTSF)_2PF_6$ [6], carbon nanotubes [7] and Quantum wires[8]. In the present paper, we have used the extended version of the two-particle self-consistent (TPSC) approach that allows one to treat the extended Hubbard model. The ETPSC approach is a semi-analytical, non-perturbative and non-diagrammatic approach, at non-zero temperatures, which works best from weak to intermediate values of coupling (U and V less than the bandwidth $W = 2zt = 4dt$ with $z = 2$, the number of nearest neighbors, in $d = 1$)[9, 10]. The large-U limit of the model is referred to as the t-J model which is derivable by means of a canonical transformation as an expansion in t/U. People have calculated the boson and electron Green's functions of this model based on a diagrammatic, variational-derivative discription at [11]. Representation of Hamiltonian by X operators and then using the functional derivative approach is another powerful method to investigate the ground state propersites