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Title:	Cluster mean field approach to low dimensional quantum magnets
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Abstract:	Collective behaviour of large number of interacting particles results in fascinating phe- nomena ranging from as simple as freezing of water to as complex as appearance of su- perconductivity. Magnetism is a remarkable example of how quantum physics can spring up new surprises even in cases where relevant particles remain immobile. It covers wide scale of complexity, from magnets sticking to our household fridges to the exotic quantum spin liquid phases that define the forefront of current research in quantum magnetism. Low dimensional spin-1/2 magnetic systems are ideal candidates for observing and un- covering mysteries of quantum physics as the combination of low dimensionality and low spin quantum number enhances quantum fluctuations. Motivated by their importance in understanding fundamental aspect of quantum mechanics and potential applications, a plethora of low dimensional magnetic materials have been discovered and studied experi- mentally. However, strictly 1D or 2D magnets are almost never realized in real materials, as contribution from spins in neighboring chains or planes affect the magnetic ordering. This often leads to unexpected ordering and phase transitions. This thesis attempts to understand such low temperature behaviour of real materials, in terms of quasi-1D and 2D model spin Hamiltonians studied using cluster mean field theory (CMFT). The key idea of CMFT is to treat all interaction links located within the cluster exactly, and to make use of the conventional mean field decoupling for interaction links connecting the cluster and the environment. The approach allows for an accurate treatment of short range spatial correlations, as well as thermodynamic behavior, in the mean field spirit. The technique captures the subtle competition between different possibilities of magnetic ordering at the level of finite-size calculations. CMFT successfully explains the origin of low-temperature peak observed in specific heat data reported in the experiments per- formed on CuInVO 5 . For the frustrated ferromagnet β−TeVO 4 , CMFT is able to uncover multiple phase transitions in the absence of applied field. In presence of field, it identifies complex orders such as quadrupolar and vector chiral orders along with specific anomalies like re-entrant transition similar to experimental observations. Furthermore, a problem of disordered antiferromagnetic spin chain with anisotropic impurities is explored. CMFT analysis reveals that a fraction of anisotropic impurities is capable of inducing a Néel type ordering. In addition to providing a satisfactory understanding of observations on CuInVO 5 and β-TeVO 4 , this thesis highlights that CMFT can become a powerful tool in understanding the nature of magnetic order emerging at low temperatures in frustrated as well as disordered magnets.
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