INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Renormalization-Group Calculations for the Critical Properties of Perovskite Manganites, Uranium Superconductors, and Hexagonal Manganites

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SHORT ABSTRACT

In this dissertation, we use renormalization-group (RG) analyses to explore the critical behavior of various strongly correlated spin-lattice coupled systems, namely, perovskite manganites, uranium superconductors, and hexagonal manganites. These systems found increasing interest in recent years due to their various important technological applications. They exhibit widely varying critical behavior near their magnetic transition points. Perovskite manganites undergo paramagnetic-ferromagnetic phase transition and we consider a Ginzburg-Landau type Hamiltonian with a nonlocal interaction to model their critical behavior. When the interaction is long-ranged in nature, the model is capable of capturing the critical exponents near tricriticality. However, the agreement is not so good for experimental samples exhibiting critical exponents away from tricriticality. When a screened nonlocal interaction is considered, the obtained exponents are in good agreement with the experimental samples that exhibit departure from tricriticality. In spite of the widely varying static critical behavior, perovskite manganites show unusual dynamic critical behavior resulting in a constant value of the linewidth exponent. Consequently we take a time dependent Ginzburg Landau model with the screened nonlocal Hamiltonian. A dynamic RG calculation yields a constant linewidth exponent over the relevant range of nonlocality in agreement with experimental observations. These findings signify that the model contains the static and dynamic universality classes of perovskite manganites.

We further model the dynamics of the conserved order parameter in uranium superconductors with our long-range model Hamiltonian. Performing a dynamic RG analysis, we find the predicted critical exponents to be in good agreement with the experimental observations. We also consider the conserved dynamics with the screened interaction and calculate the critical exponents for doped uniaxial ferromagnets and isomorphous salts to find reasonable values of critical exponents. Finally, we address the critical properties of hexagonal antiferromagnetic manganites with a model involving energy-spin coupling. The resulting values of the critical exponents turn out to be comparable with available experimental estimates.