ABSTRACT

The Study of Exact Solution of the Mixed spin-$1/2$ and spin-1 Ising Model on a Decorated Bethe Lattice in an External Magnetic Field

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In this study, the mixed-spin Ising model in the external magnetic field on a decorated Bethe lattice is solved exactly by combining the decoration-iteration transformation with the method of exact recursion relations. The model Hamiltonian includes the nearest-neighbor interaction between the spin-$1/2$ and spin-S atoms, the next-nearest-neighbor interaction between the spin-$1/2$ atoms, the uniaxial single-ion anisotropy and the external magnetic fields. The decoration-iteration transformation makes it possible to establish a rigorous mapping relationship with the equivalent spin-$1/2$ Ising model on a simple Bethe lattice. The model is subsequently exactly treated within the framework of the exact recursion relations. The exact calculations for the partition function, total and both sublattice magnetizations were derived by making use of the rigorous approach. The effect of next-nearest-neighbor interaction, single-ion anisotropy and external magnetic field on magnetic properties of the ferrimagnetic model is studied in particular. The most interesting finding stemming from our present study is an exact evidence of a rather diverse magnetization process. It is shown that the total magnetization may exhibit multicompensation phenomenon and the critical temperature vs. single-ion anisotropy dependence basically changes with the coordination number of the underlying Bethe lattice. It is demonstrated that the investigated spin model with a sufficiently high coordination number of the Bethe lattice may exhibit reentrant phase transitions.

Key Words
Mixed-Spin Ising Model, Bethe Lattice, Decoration-Iteration Transformation, Ferrimagnetism, Magnetic Properties, Reentrant Phase Transitions