ABSTRACT

PHASE DIAGRAMS OF THE MIXED SPIN-1/2 AND SPIN-1 ISING HEISENBERG MODEL ON THE DECORATED BETHE LATTICE

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In this work, we have studied the mixed spin-1 and spin-1/2 Ising–Heisenberg model on the diamond-like decorated Bethe lattice. The model under consideration describes a hybrid classical-quantum system consisting of the Ising and Heisenberg spins, which interact among themselves either through the Ising or XXZ Heisenberg nearest-neighbor interaction. The model was studied by combining the decoration-iteration transformation with the exact recursion relations. Within the framework of this rigorous method, we have obtained a precise mapping relationship between the partition function of the mixed-spin Ising–Heisenberg model on the diamond-like decorated Bethe lattice and the partition function of the equivalent spin-1 BEG model on a simple Bethe lattice. In addition, the rigorous mapping theorems and exact spin identities have been employed in order to derive analytically precise results. Both sublattice magnetizations of the Ising and Heisenberg spins are exactly calculated with the aim to examine phase diagrams, thermal variations of the total and sublattice magnetizations.

It has been demonstrated that the ground-state phase diagram constitutes two different phases. Apart from the usual CFP, the peculiar DP may form the ground state. A competition between Ising and Heisenberg interactions leads to a peculiar spin-liquid ground state. A possibility of observing reentrant regions in the finite-temperature phase diagrams have been also investigated in detail. It has been evidenced that the second-order phase transition line displays reentrance just in a restricted region of the parameter space, which is close enough to the ground-state boundary between the CFP and DP, if and only if, the sufficiently high coordination number q>4 is assumed. On the other hand, no reentrance can be found in the relevant phase boundaries for the system with the coordination number $q=3$ and 4. The thermal dependences of both sublattice magnetizations, quadrupolar moment and higher order correlation function were also investigated and discussed in detail.

Key words: Ising–Heisenberg model; Bethe lattice; Reentrant phase transition; Exact result