



Monte Carlo study of alternate mixed spin-5/2 and spin-2 Ising ferrimagnetic system on the Bethe lattice

A. Jabar^a, R. Masrour^{a,b,*}, A. Benyoussef^{a,c,d}, M. Hamedoun^c

^a Laboratoire de Magnétisme et Physique des Hautes Energies L.M.P.H.E.URAC 12, Université Mohammed V, Faculté des Sciences, B.P. 1014 Rabat, Morocco

^b Laboratory of Materials, Processes, Environment and Quality, Cady Ayyed University, National School of Applied Sciences, PB 63 46000 Safi, Morocco

^c Institute of Nanomaterials and Nanotechnologies, MAScIR, Rabat, Morocco

^d Hassan II Academy of Science and Technology, Rabat, Morocco

ARTICLE INFO

Article history:

Received 21 May 2015

Received in revised form

27 July 2015

Accepted 23 August 2015

Available online 28 August 2015

Keywords:

Mixed alternate spins

Magnetic properties

Transition temperature

Magnetic coercive field

ABSTRACT

The magnetic properties of alternate mixed spin-5/2 and spin-2 Ising model on the Bethe lattice have been studied by using the Monte Carlo simulations. The ground state phase diagrams of alternate mixed spin-5/2 and spin-2 Ising model on the Bethe lattice has been obtained. The thermal total magnetization and magnetization of spins-5/2 and spin-2 with the different exchange interactions, external magnetic field and temperatures have been studied. The critical temperature have been deduced. The magnetic hysteresis cycle on the Bethe lattice has been deduced for different values of exchange interactions, for different values of crystal field and for different sizes. The magnetic coercive field has been deduced.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

The mixed-spin Ising ferrimagnetic models with interactions between the spins of the two sublattice system and external agencies have been studied with exact or many approximate methods. It is clear that there may be many possibilities of mixing the spin- σ_A and spin- σ_B with $\sigma_A \neq \sigma_B$ in obtaining the Ising ferrimagnetic systems to propose some models for physical materials. Maybe the highest mixed-spin system is the one with spin-2 and spin-5/2 and which has been studied with many techniques for different physical reasons such as: the magnetic properties of the ferrimagnetic system with dilution was investigated on the basis of the effective-field theory with correlations [1], including the effect of the transverse field [2] and on a two-dimensional honeycomb lattice by the use of a Monte Carlo simulation (MC) [3]. The compensation temperatures induced by longitudinal fields in a mixed spin Ising ferrimagnet are obtained by Ref. [4]. The first order phase transition of mixed spin-2 and spin-5/2 Ising system in honeycomb lattice with two single ion anisotropies is studied by

Monte Carlo (MC) simulation [5]. The dynamic magnetic properties in the kinetic mixed spin-2 and spin-5/2 Ising model under a time-dependent magnetic field has been studied by Ref. [6]. The stationary states of the kinetic mixed spin-2 and spin-5/2 Ising ferrimagnetic system with repulsive biquadratic coupling are examined within a mean-field approach under the presence of a time varying (sinusoidal) magnetic field [7]. The Nonequilibrium magnetic properties in a two-dimensional kinetic mixed spin-2 and spin-5/2 Ising system in the presence of a time-varying (sinusoidal) magnetic field are studied within the effective-field theory with correlations [8]. The magnetic properties of a nonequilibrium mixed spin-2 and spin-5/2 Ising ferrimagnetic system with a crystal-field interaction (D) in the presence of a time-varying magnetic field on a hexagonal lattice are studied by using the Glauber-type stochastic dynamics [9]. The influence of the layer thickness and the surface intralayer exchange coupling on the magnetic and thermodynamic properties of the mixed spin-2 and spin-5/2 ferrimagnetic systems are studied in detail by the Monte Carlo simulation [10]. The mixed spin-1/2 and spin-S ($S > 1/2$) Ising ferrimagnetic systems with a crystal field are studied within the framework of the exact recursion relations on the Bethe lattice by Ref. [11]. A number of characteristic behaviors for field variations are obtained especially for antiferromagnetic interaction in the Ising model with crystal-field under uniform

* Corresponding author at: Laboratory of Materials, Processes, Environment and Quality, Cady Ayyed University, National School of Applied Sciences, PB 63 46000 Safi, Morocco.

E-mail address: rachidmasrour@hotmail.com (R. Masrour).

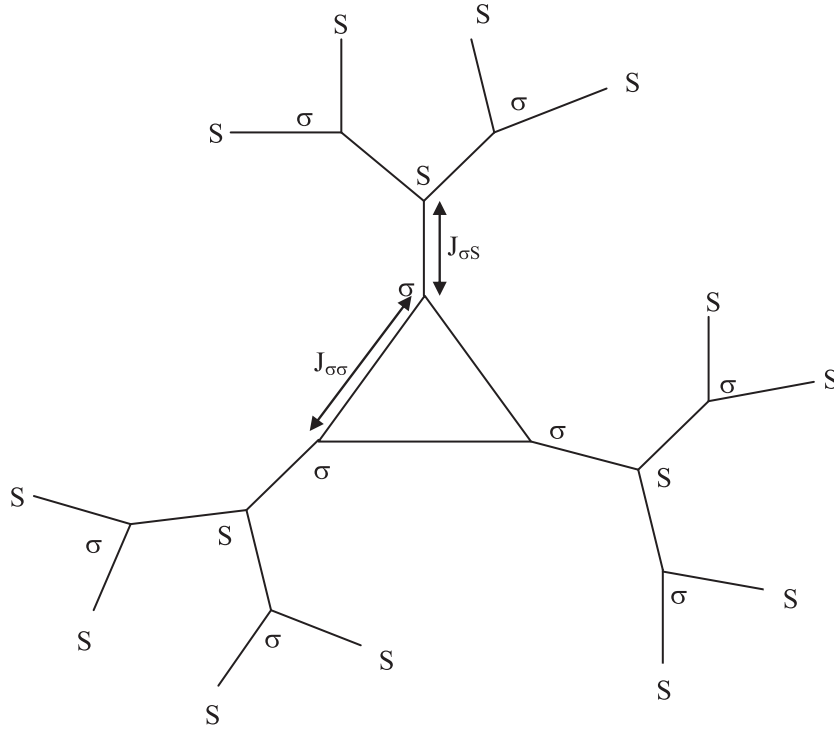


Fig. 1. Bethe lattice for mixed spin-5/2 and spin-2 Ising model on the Bethe with $N_\sigma=9$ and $N_S=15$ spins numbers.

longitudinal magnetic field by Ref. [12]. The antiferromagnetic and ferrimagnetic Ising model on the two-fold Cayley tree graph with fully q -coordinated sites is investigated in an external magnetic field by Refs. [13,14]. The phase diagrams for the Ising model on a Cayley tree-like lattice, called Triangular Chandelier, with competing nearest-neighbor interactions, prolonged next-nearest-neighbor interactions and one-level next-nearest-neighbor quadruple interactions have been investigated by Refs. [15,16]. The critical behaviors of the half-integer mixed spin-3/2 and spin-5/2 Blume-Capel Ising ferrimagnetic system, have been studied by the exact recursion relations on the Bethe lattice [17]. The kinetic spin-5/2 Blume-Capel model with bilinear exchange interaction and single-ion crystal field on a square lattice is studied by Ref. [18]. The Phase diagrams of a nonequilibrium mixed spin-3/2 and spin-2 Ising system in an oscillating magnetic field has been investigated by Ref. [19]. The phase diagrams for a nonequilibrium mixed spin-1/2 and spin-2 Ising ferrimagnetic system on a square lattice in the presence of a time dependent oscillating external magnetic field is given by Ref. [20]. The outline of the rest of the present Letter is as follows. In Section 2, the model and its formulation, namely, Ising model. In Section 3, the Monte Carlo simulations are presented. In Section 4, the results and discussion are given. Finally, we give a conclusion in Section 5.

2. Model and formulations

The Hamiltonian of the mixed spins-5/2 and 2 Ising model on the Bethe lattice with different spins such as in see Fig. 1 includes nearest neighbors interactions, the crystal field and external

magnetic field is given as:

$$H = -J_{\sigma\sigma} \sum_{\langle i,j \rangle} \sigma_i \sigma_j - J_{\sigma S} \sum_{\langle i,k \rangle} \sigma_i S_k - \Delta \left(\sum_i \sigma_i^2 + \sum_k S_k^2 \right) - h \left(\sum_i \sigma_i + \sum_k S_k \right) \quad (1)$$

where $\langle i, j \rangle$ stand for the first nearest neighbor spins i and j , Δ represent the crystal field and h is the external magnetic field. The $J_{\sigma\sigma}$ and $J_{\sigma S}$ are the exchange interactions between the first nearest-neighbor magnetic atoms with spins σ - σ and S - σ , respectively. The spins moment S and σ are: $\pm 5/2$, $\pm 3/2$, and $\pm 1/2$ and ± 2 , ± 1 , and 0, respectively. In full text the $J_{\sigma\sigma}$ has been taken 1.

3. Monte Carlo simulations

The mixed spins- S and σ Ising model on the Bethe lattice is assumed to reside in the unit cells and the system consists of the total number of spins $N=N_\sigma+N_S$, with $N_\sigma=9$ and $N_S=15$ spins. We apply a standard sampling method to simulate the Hamiltonian given by Eq. (1). Cyclic boundary conditions on the lattice were imposed and the configurations were generated by sequentially traversing the lattice and making single-spin flip attempts. The flips are accepted or rejected according to a heat-bath algorithm under the Metropolis approximation. Our data were generated with 10^5 Monte Carlo steps per spin, discarding the first 10^4 Monte Carlo simulations. Starting from different initial conditions, we performed the average of each parameter and estimate the Monte Carlo simulations, averaging over many initial conditions.

Download English Version:

<https://daneshyari.com/en/article/1798780>

Download Persian Version:

<https://daneshyari.com/article/1798780>

[Daneshyari.com](https://daneshyari.com)