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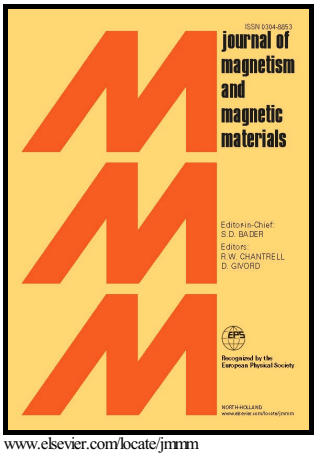


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PII: S0304-8853(16)32175-8
DOI: http://dx.doi.org/10.1016/j.jmmm.2016.09.064
Reference: MAGMA61845

To appear in: *Journal of Magnetism and Magnetic Materials*

Received date: 12 June 2015
Revised date: 7 August 2016
Accepted date: 11 September 2016

Cite this article as: H. Rezania, Spin structure factors of Heisenberg spin chain i the presence of anisotropy and magnetic field, *Journal of Magnetism an Magnetic Materials,* http://dx.doi.org/10.1016/j.jmmm.2016.09.064

# Spin structure factors of Heisenberg spin chain in the presence of anisotropy and magnetic field

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(Dated: September 13, 2016)

We have theoretically studied the spin structure factors of spin chain in the presence of longitudinal field and transverse anisotropy. The possible effects of easy axis magnetization are investigated in terms of anisotropy in the Heisenberg interactions. This anisotropy is considered for exchange coupling constants perpendicular to magnetic field direction. The original spin model hamiltonian is mapped to a bosonic model via a hard core bosonic transformation where an infinite hard core repulsion is imposed to constrain one boson occupation per site. Using Green's function approach, the energy spectrum of quasiparticle excitation has been obtained. The spectrum of the bosonic gas has been implemented in order to obtain two particle propagator which corresponds to spin structure factor of original Heisenberg chain model Hamiltonian. The results show the position of peak in the longitudinal structure factor at fixed value for anisotropy moves to higher frequency with magnetic field. Also the intensity of dynamical structure factor decreases with magnetic field. A small dependence of longitudinal dynamical spin structure factor on the anisotropy is observed for fixed value of magnetic field. Our results show longitudinal static structure factor is found to be monotonically increasing with magnetic field due to increase of spins aligning along magnetic field. Furthermore the dispersion behaviors of static longitudinal and transverse structure factors for different magnetic fields and anisotropy parameters are addressed.

PACS numbers: 75.10.Pq,75.40.Gb, 66.70.-f, 44. 10.+i

Keywords: Spin structure, longitudinal, transverse
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## I. INTRODUCTION

The antiferromagnetic (AF) heisenberg chain is an important model to describe real materials and at the same time the most important paradigm of low-dimensional quantum magnetism. It allows to introduce many of the scenarios such as, gapless Luttinger liquid[2], the Kosterlitz-Thouless phase transition[1], gapped and gapless excitation continua. From prominent examples of both low and high antiferromagnetic exchange couplings, one can point to $SrCuO_2$, $Sr_2CuO_3$ and $Cu(C_4H_4N_2)(NO_3)$. In the presence of external magnetic fields, finite temperature high resolution spectroscopies such as inelastic neutron scattering[3] and magnetic transport[4] have theoretically been calculated by dynamical correlation functions of the Heisenberg chain. Speciallly, field induced effects on the dynamical spin correlation function in low dimensional quantum spin models have been attracting much interest from theoretical and experimental point of view in recent years[5–7]. AF Heisenberg chain in the presence of axial anisotropy at finite non zero values for magnetic field is a solvable model. Its ground state properties have been investigated within Bethe-Ansatz[8,9]. Static thermodynamic quantities, eg. the specific heat, the magnetic susceptibility and magnetization have been investigated by several methods including thermodynamic Bethe Ansatz, Quantum monte Carlo and Density matrix renormalization group[10–12]. In this work we have studied the crossover between the field induced ferromagnet and the Luttinger liquid below $B_c$ based on vanishing energy gap in one particle excitation spectrum of bosonic gas model. The AF Heisenberg model on the chain with longitudinal anisotropy and applied magnetic field has been studied by numerical and theoretical methods. Quantum Monte Carlo based on stochastic series expansion and maximum-Entropy methods have been implemented to evaluate the longitudinal and transverse dynamic structure factor from vanishing magnetic fields up to and above the threshold critical field for ferromagnetic saturation, as well as for high and for intermediate temperatures[13]. Also heat capacity and magnetization measurements are experimentally repeorted in an S=1 one dimensional Heisenberg antiferromagnet[14]. Furthermore the effects of transverse staggered field and exchange anisotropy $\delta$ on Electron Spin Resonance in the S=1/2 quantum antiferromagnetic chain at low temperature $T$ has been discussed using exact results on the Sine-Gordon field theory[15]. The spin-1/2 antiferromagnetic Heisenberg chain in both perpendicular uniform and staggered magnetic fields has been studied using the density-matrix renormalization group method[16]. In this study, low energy properties, magnetization and spin correlation functions are found at very high magnetic fields. In the other theoretical work, the dynamical structure factor of anisotropic heisenberg spin-1/2 chain in a transverse magnetic field at zero temperature has been determined by combining exact results with a mean field approximation[17]. The momentum and frequency-dependence