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FINE STRUCTURE IN EXCITON-MAGNON BANDS IN Mn^{2+} MAGNETS

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M.Sc. THESIS

Fine Structure in Exciton-Magnon Bands in Mn^{2+} Magnets

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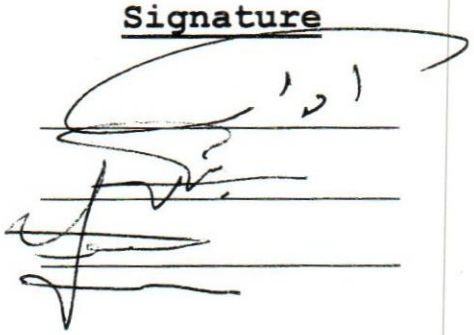

Al-Quds University

2001

بسم الله الرحمن الرحيم

"وما توفيقي إلا بالله"

صدق الله العظيم

DECLARATION

I certify that this thesis submitted for the degree of Master of Physics is the result of may own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed: Hazem Salah.

(Hazem Khaleel Wdaa'h Salah)

Date: 4.9.2001

DEDICATION

To My Parents...

And Wife...

With Love...

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ABSTRACT

FINE STRUCTURE IN EXCITON-MAGNON BANDS IN Mn^{2+} MAGNETS

This thesis deals with the ${}^6A_{1g}({}^6s) \rightarrow {}^4T_{2g}({}^4D)$ Mn^{2+} transitions in antiferromagnetic $RbMnF_3$ ($T_N = 82.6^\circ K$) compound. Fine structure at low temperature was observed in the D-band of $RbMnF_3$ compound. Tentative assignments of this fine structure are discussed by examining the exchange interaction mechanism, spin wave side bands (i.e. exciton-magnon absorption), vibronic mechanism, and spin-orbit interaction (L-S). The analysis shows that The exchange interaction mechanism plays an important role in the appearance of the fine structure in the D-band. The shift in the line position of the D-band can be quantitatively understood by considering the effect of the exchange interaction between the adjacent Mn^{2+} ions. The disappearance of the fine structure peaks in the D-band above T_N was explained in terms of spin disorder and the lack of exchange interaction between neighboring Mn^{2+} ions. The temperature dependence of the D-band in $RbMnF_3$ above T_N proves that this band is an exciton-magnon band in nature.

CHAPTER I

INTRODUCTION

There are several optical absorption bands in the visible and near-ultra violet region due to crystal-field transitions of the Mn^{2+} ions in type II antiferromagnetic manganese compounds such as $RbMnF_3$ ($T_N = 82.6^{o}K$) and $KMnF_3$ ($T_N = 88.3^{o}K$) [1,2]. The assignments of these bands, namely, A, B, C... represents transitions from the sextet ${}^6A_{1g}$ ground state to the quartet ${}^4T_{1g}(I), {}^4T_{2g}(I), {}^4A_{1g} + {}^4E_g \ldots$ excited states [1,3-5]. These absorptions are due to partially allowed electric dipole $d^5 \rightarrow d^5$ transitions, which are otherwise highly forbidden by spin and parity selection rules. In order to explain how these transitions become allowed and to explain the observed intensities, several papers have discussed the role of exchange and vibronic interactions in making these transitions partially allowed [6-12].

Magnon side bands such as magnon-magnon [12-14], exciton-magnon [9,15-16] and exciton-exciton [17-18,71] have been studied extensively in recent years. The studies of these side bands have provided