RESONANCE STUDY OF NONLINEAR EXCITATIONS IN A S = 1 HEISENBERG PLANAR FERROMAGNET $CsNiF_3$

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Introduction

The experimental study of nonlinear spin modes in $CsNiF_3$ was motivated by the theoretical prediction of single–ion bound states [1]. These spin modes might be considered as a quantum mechanical counterpart of intrinsic localized spin modes, which represent nonlinear excitations appearing in a classical spin chain if both nonlinearity and discreteness of the spin distribution are taken into account. Their existence has been theoretically predicted in spin chains with ferromagnetic and antiferromagnetic exchange coupling and for easy plane and easy axis anisotropy [2-3]. The experimental effort for the verification of the existence of single–ion bound states in $CsNiF_3$ was started at the NHMFL in Tallahassee [4]. More specifically, ESR measurements have been conducted in magnetic field up to 14 T, in the frequency range 95 GHz – 420 GHz and for temperatures from 4.2 K up to nominally 200 K. However, due to a variety of reason, resonances arising from the presence of single–ion bound states were not observed, so extension to higher frequencies was required.

Experimental Details

Our experimental efforts were extended to higher frequencies through the use of the High Field Millimeter and Submillimeter Wave Facility, which is capable of operating in the range 150 GHz – 700 GHz and in magnetic field up to 25 T [5]. Spectra were acquired at fixed frequencies and temperatures while ramping the field from zero to 25 T, with most of the data acquired in the temperature range from 5 K to 50 K. The effort was devoted to a range of parameter space involving the predicted transitions both from the ground state to one-magnon state and from the one-magnon state to single-ion bound state.

Results and Discussion

At this time, only preliminary analysis of the spectra has been performed, and the existence of the single–ion bound states has not been confirmed. Instead, for selected frequencies, broad resonance peaks were observed, and the dominant contribution can be associated with the transition from the ground state to one-magnon state. In addition, although different samples and mounting approaches were employed, the spectra are significantly influenced by response associated with the presence of Walker modes [6]. A detailed analysis of the spectra is being performed.

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