High-Field ESR Studies of Azurite

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Introduction

The natural mineral azurite, $Cu_3(CO_3)_2(OH)_2$, is the best known realization of a distorted-diamond chain system, in which the effect of frustrations can be studied. Its ground state orders antiferromagnetically at T_N = 1.9 K. One of the most prominent features of this compound is a magnetization plateau at one third of the saturation magnetization. For magnetic field applied along the *b* axis, the presence of the plateau was revealed between H_{c1} = 16 T and H_{c2} = 26 T, while the magnetization becomes almost fully saturated at H_{c3} = 32.5 T [1]. Such a behavior can be explained by employing an alternating dimer-monomer model. In spite of intensive experimental and theoretical studies of azurite, relatively little is known about its high-field spin dynamics [2]. The goal of this project was using high-field electron spin resonance (ESR) to test the excitation spectrum in azurite across different regions of its phase diagram.

Experimental

Experiments were performed in magnetic field up to 45 T (hybrid magnet, cell 15) using the perturbation-cavity ESR spectrometer (equipped with MVNA network analyzer), at temperatures down to 1.4 K.

Results and Discussion

The ESR excitation spectrum was studied for three orientations of applied magnetic fields, H II a,b,c. The frequency-field diagram of magnetic excitations for H II b (T = 1.4 K) is shown in Fig. 1. The mode A corresponds to excitations of the monomer lattice. Modes B and B' correspond to excitations of the dimer lattice with a gap Δ = 42 K. This value corresponds to the intra-dimer interaction, as calculated recently [3]. The observation of additional high-field modes (mode C and D) can be explained in terms of the effective zone-folding scenario, suggesting an important role of the staggered Dzyaloshinskii-Moriya interaction in this frustrated compound. Our experiments revealed a strong anisotropy of the ESR linewidth for modes B and C, which is planned to be studied in detail in the future.

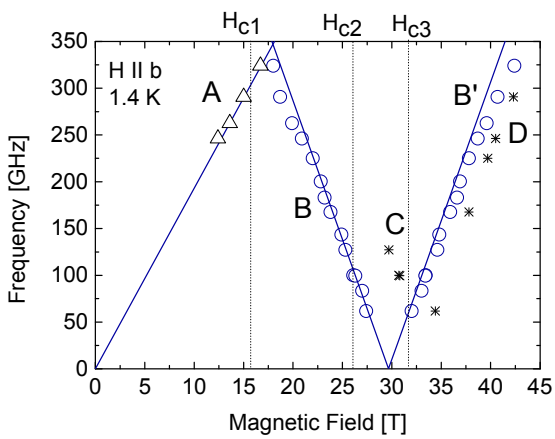

Figure 1. The frequency-field diagram of magnetic excitations in azurite for H II b, T = 1.4 K.

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References

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