Electron Spin Resonance Study of the Geometrically Frustrated $Ba_3CuSb_2O_9$

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Introduction

Recently, there has been much interest in the novel frustrated antiferromagnet $Ba_3CuSb_2O_9$ [1-3]. Its structural Cu-Sb "dumbbells" possess electric dipoles that order into a $\sqrt{3} \times \sqrt{3}$ nanoscale pattern, leading to a decorated honeycomb spin lattice of magnetic Cu^{2+} (S = 1/2) ions [1]. The nearest-neighbor Heisenberg antiferromagnet on the honeycomb lattice is expected to undergo a bulk magnetic transition, yet the Cu^{2+} spins remain fluctuating at the lowest accessible temperatures [2], suggesting a spin-liquid ground state (GS) [1, 2]. Fluctuations are present even in the orbital channel, as a unique spin-orbital short-range ordered GS was recently suggested [3]. Such a GS could potentially be verified by electron spin resonance (ESR), providing a complementary local-scale insight.

Experimental

Experiments were performed at the EMR NHMFL facility on the homodyne detection system (17 T magnet).

Results and Discussion

In contrast to the previous ESR study performed at 27.5 GHz [1], we have found out that in samples with hexagonal symmetry the local environment at the Cu^{2+} sites is anisotropic already at high temperatures. At lower temperatures additional narrower features appear, which originate from g-factor shifts (in the range Δg = 0.084 – 0.328) that are temperature-dependent and therefore not due to an impurity phase.

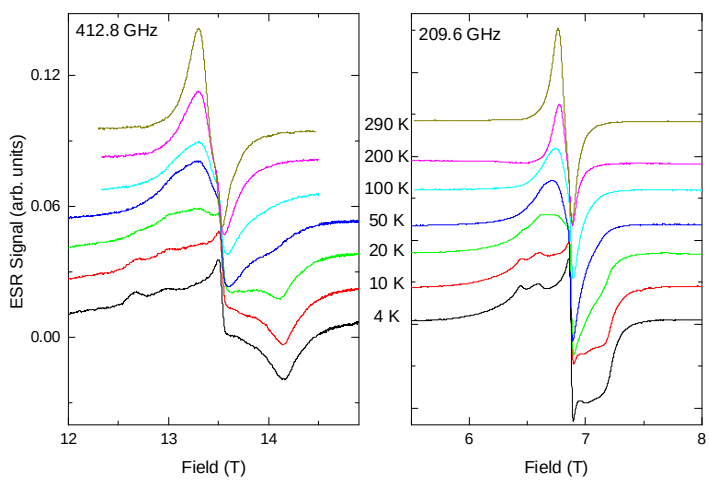

Figure 1: T-dependent ESR spectra of $Ba_3CuSb_2O_9$ at two selected frequencies.

Conclusions

The complexity of the low-temperature ESR spectra, encompassing both narrower features and a broad featureless ESR component, is likely due to orbital fluctuations that slow down at low temperatures (thus disabling dynamical averaging) and/or is due to an inhomogeneous GS. As the typical orbital fluctuation frequency is around 500 GHz [2], ESR measurement at higher frequencies and fields would be essential to reveal at what frequency the associated Jahn-Teller distortions become static and whether the magnetic GS is homogeneous.

Acknowledgements

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References

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[2] Quilliam, J., *et al.*, Phys. Rev. Lett., **109**, 117203 (2012).
[3] Ishiguro, Y., *et al.*, Nat. Commun., **4**, 2022 (2013).