High Field EPR Studies of Magnetically Dilute $Fe_{17}Ga$ Molecular Wheels

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Introduction

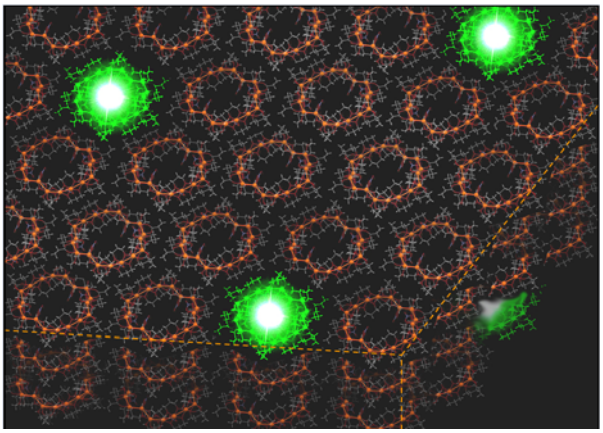

Fig. 1: Artistic representation of a magnetically dilute single crystal of $Fe_{17}Ga$ molecular wheels.

The study of decoherence in molecular magnets has become relevant to their potential as hardware for quantum information technologies. In solid state form, molecular magnets show short decoherence times, mainly due to interactions between molecules within the crystal and interactions of the electronic spin with the nuclear spin of neighboring ions within the molecule. These specifics have made the standard techniques inappropriate for the study of quantum dynamics in molecular magnets. Recent works have reported the first direct measurements of the decoherence time of molecular magnets. For this, dilution of the molecules in liquid to increase intermolecular separation, thus reducing dipolar dephasing, or polarization of the spin bath by large magnetic fields at low temperatures had to be employed. Unfortunately, the dilution of molecular magnets in a liquid solution conveys a dispersion of the molecular spin orientation and anisotropy axes which causes the molecules within the sample to respond differently to an applied external field. In addition, the large magnetic fields necessary to polarize (freeze) the spin bath limits the experimental conditions of the study. In the experiments on-going in collaboration with the NHMFL groups we used single crystals of Ga doped molecular Fe_{18} wheels (see figure), in which a control of the doping allows to tune the intermolecular separation while retaining the order associated with the single crystal.

Experimental

Experiments were performed using two setups, the commercial Bruker X-band spectrometer (9.7 GHz) and the high frequency quasi-optical EPR resonance spectrometer (with 12 T magnet) [1]. Several different resonators were used, including a Fabry-Perot.

Results and Discussion

Single crystals of low Ga concentration (0.005%) Fe_{18} wheels where characterized with CW EPR spectroscopy at different frequencies. Due to the low signal of small crystals of such diluted samples, pulse EPR experiments did not produce results.

Conclusions

We have yet to obtain definitive results, but the collaboration is on-going and we are preparing future experiments with different molecular magnets.

Acknowledgements

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References

[1] Morley, G., *et al*., Rev. Sci. Instrum. **79**, 064703 (2008).