Calorimetric Study of Organic Triangular Antiferromagnets of the TNN Family in High Magnetic Fields

Yuko Hosokoshi, Ayaka Higashiguchi, Kohsuke Takada (Osaka Prefecture University, Physical Science); Yasu Takano (University of Florida, Physics)

Introduction

Geometrically frustrated spin systems have attracted much interest because of a possible emergence of exotic ground states, such as spin liquids, spin ice, and unconventional ordered states. Of particular interest is the so-called antiferromagnetic spin triangle, a spin trimer in which each spin interacts antiferromagnetically with two other spins. We have developed spin triangles made of organic radicals whose spins are highly isotropic. The rational designing of intramolecular magnetic interactions gives the equilateral triangle of S=1/2 coupled antiferromagnetically. Employment of two kinds radical moieties of nitronyl nitroxide (NN) and iminonitroxide (IM) gives two equilateral spin triangle compounds TNN and TIM with $2J/k_B$=-6 and -2 K, respectively. The crystals of TIM form a two-dimensional Kagome network in the *ab* plane by the intermolecular magnetic interactions, whereas TNN forms a triangular network in the *ab* plane, coupled via inter-sheet contacts along the *c* axis. The combination of the radical moieties of NN and IM, two kinds of isosceles spin triangle compounds BNN and BIM have been developed. The excited and ground state properties in high magnetic fields at low temperature were examined for BNN and BIM and the results were compared with that of TNN and TIM.

Experimental

The samples were synthesized and crystallized from CH_3CN solutions and were characterized by means of X-ray diffraction and PPMS calorimetry in the PI's laboratory at Osaka Prefecture University. The specific-heat, magnetocaloric-effect, and magnetic-torque measurements were performed in SCM1 at the NHMFL DC-Field Facility by Ayaka Higashiguchi, a graduate student of the PI's group, in collaboration with Prof. Y. Takano's group at the University of Florida and with T. Murphy and Dr. J.-H. Park at the NHMFL.

Results and Discussion

Figure 1 shows the magnetic-torque data, taken in SCM1, for BNN. The results strongly suggest that BNN has two magnetically ordered phases: the low-field phase occurs at fields below about 0.5 T, and a high-field phase occurs at fields between about 7 T and 9 T. We obtained similar results for BIM where the two ordered regions are below about 0.7 T and between about 4.5 T and 5.7 T. However, even at zero field, where the ordering temperature is expected to be the highest, the specific heats of both compounds exhibit only a precursory rise at 0.1 K, not a peak, indicating that the ordering temperatures are lower than 0.1 K.

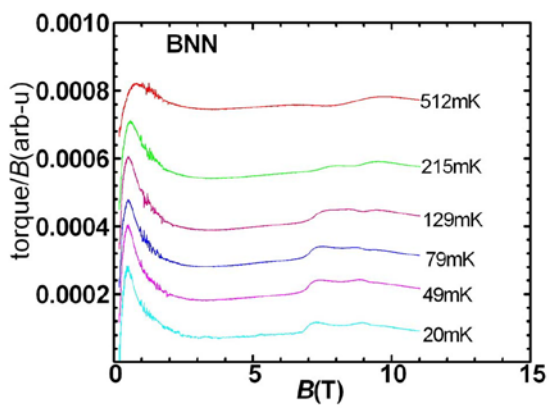

Figure 1. Magnetic torque on BNN as a function of magnetic field. For clarity, the curves have been shifted.

Conclusions

We have studied the low-temperature magnetic properties of isosceles spin triangles BNN and BIM and observed the two magnetically ordered phases similarly to TNN. In TNN which has the highest transition temperature, the phase boundary of the high-field phase was highly asymmetric, indicating an absence of particle-hole symmetry. We will proceed to study the unique properties of the ordered phase of TNN in magnetic fields.

Acknowledgements

This study was partially supported by Kakenhi from the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. Support from the international office in OPU is also acknowledged

References

[1] Takada, K. *et al.*, The 13th Int. Conf. on Molecule-based Magnets, Orlando, USA, #TuC2 (2012).