FILD-INDUCED SUCCESSIVE PHASE TRANSITIONS IN QUASI-TWO-DIMENSIONAL FRUSTRATED ANTIFERROMAGNET Ba_2CoTeO_6 AND HIGHLY DEGENERATED CLASSICAL GROUND STATES

H. Tanaka[1], P. Chanlert[1], N. Kurita[1], D. Goto[2], A. Matsuo[2], and K. Kindo[2]

[1]*Department of Physics, Tokyo Institute of Technology, Meguro-ku, Tokyo 152-8551, Japan*
[2]*Institute for Solid State Physics, The University of Tokyo, Kashiwa, Chiba 277-8581, Japan*

Frustrated quantum magnets often provide a stage to embody the remarkable macroscopic quantum many-body effect in a magnetic field. In general, the frustrated magnets have highly degenerate classical ground state in a magnetic field. For Heisenberg triangular-lattice antiferromagnet (TLAF), the classical ground state in the magnetic field is infinitely degenerate. This classical degeneracy can be lifted by the quantum fluctuation, which is most remarkable for spin-1/2 case, and a specific spin state is selected as the ground state. A symbolic quantum effect is that the *up-up-down* state is stabilized in a finite field range, which emerges as a magnetization plateau at one-third of the saturation magnetization. This 1/3-magnetization plateau was observed in the quasi-2D Heisenberg-like TLAF $Ba_3CoSb_2O_9$ [1,2]. The entire quantum phases observed in magnetic fields for $Ba_3CoSb_2O_9$ [1-3] were almost completely understood from the microscopic model [4,5].

In this talk, we present the results of magnetization measurements on trigonal compound Ba_2CoTeO_6 [4], in which Co^{2+} ion has an effective spin-1/2. This compound is a unique antiferromagnet that exhibits strong frustration originated from both geometry and competing interactions. In Ba_2CoTeO_6, magnetic Co^{2+} ions form two subsystems A and B; single and bilayer triangular lattices, as shown in Fig. 1. The subsystems A and B are magnetically described as an S=1/2 triangular-lattice Heisenberg-like antiferromagnet and a J_1-J_2 honeycomb-lattice Ising-like antiferromagnet, respectively. Ba_2CoTeO_6 undergoes magnetic phase transitions at T_{N1}=12.0 and T_{N2}=3.0 K, which can be interpreted as the orderings of the subsystems B and A, respectively. It was found that the magnetization curve is approximately given by the superposition of those for isolated subsystems A and B. This indicates that the coupling between subsystems A and B is weak. The subsystem A exhibits a magnetization plateau at one-third of the saturation magnetization M_s for magnetic field H perpendicular to the c axis caused by the quantum order-by-disorder, as observed in $Ba_3CoSb_2O_9$ [1,2], whereas for $H \parallel c$, the subsystem B shows three-step metamagnetic transitions with plateaus at M=0, $M_s/3$ and $M_s/2$ before saturation. We analyzed the magnetization process for $H \parallel c$ in the subsystem B on the basis of the Ising model and found that the classical ground state at $M=M_s/3$ for $J_2/J_1>1/2$ and that at $M_s/2$ are infinitely degenerate. This classical degeneracy can be lifted by the quantum fluctuation that arises from the finite transverse component of the exchange interaction.

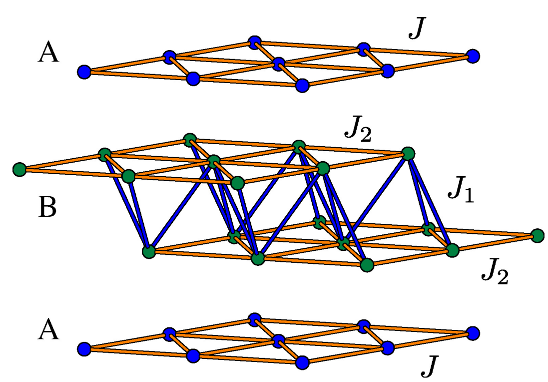

Fig. 1: Magnetic subsystems A and B.

[1] Y. Shirata *et al*., Phys. Rev. Lett. **108**, 057205 (2012).
[2] T. Susuki *et al*., Phys. Rev. Lett. **110**, 267201 (2013).
[3] H. D. Zhou *et al*., Phys. Rev. Lett. **109**, 267206 (2012).
[4] G. Koutroulakis *et al*., Phys. Rev. B **91**, 024410 (2015).
[5] D. Yamamoto *et al*., Phys. Rev. Lett. **114**, 027201 (2015).
[6] S. A. Ivanov *et al*., Dalton Trans. **39**, 5490 (2010).

Category: LD
Email: tanaka@lee.phys.titech.ac.jp