Neutron diffraction study in triangular spin tube CsCrF4

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Theoretical study in 1D chain of antiferromagnetic triangular spins,“ spin tube ”, predicts RVB-like spin liquid state with resonating spin dimers [1]. Spin correlation decays exponentially and finite spin gap opens at q=pi in the magnetic excitation [2]. Further theoretical study suggests an exotic phase such as Tomonaga Lattinger Liquid with chiral order by applying magnetic field or by introducing lattice distortion [3]. Very recently an ideal candidate of the triangle spin tube CsCrF4 [4] was discovered. Cr3+ ions with localized S=3/2 spins forms equilateral triangles in the a-b plane and they form 1D chain in the c direction. The measured bulk properties including magnetic susceptibility and heat capacity were consistent with typical behaviors of the spin tube [4]. Hence we study the neutron diffraction study in CsCrF4 to reveal the ground state of triangular spin tube.

In April 2009 we performed the initial neutron diffraction experiment on powder crystalline sample with reasonable quality. We used 5G beamline with collimation setup open-80 ’-sample-PG-80 ’-open. Neutron energy is fixed at 14.7meV and saphire filter is installed to eliminate high energy neutrons. ORANGE type cryostat was used to achieve low temperature.

We measured diffraction pattern at T = 1.5 K and 10 K. To our surprise unidentified peaks were observed at 1.5K at 2theta ~ 19 °, 22 °, and 25 ° as indicated by red solid curves in the Figure. Then we measured the temperature dependence and we found that the peaks seemed to behave as order parameter with the critical temperature of 4K. The results indicated the magnetic order, which is totally contradicts previous scenario discussed in Ref.[4]. Hence we prepared new powder sample with special care and performed the second neutron experiment in March 2010. The black curve is the new data. Obviously all the peaks were safely indexed and no magnetic peaks were found. This means no magnetic order down to 1.5K and we conclude that spin liquid is realized in triangular spin tube CsCrF4.

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[2] S. Nishimoto, et al., Phys. Rev. B 78, 054421 (2008).
[3] M. Sato, et al., Phys. Rev. B 75, 014411 (2007).
[4] H. Manaka, et al., J. Phys. Soc. Jpn. 78, 093701 (2009).

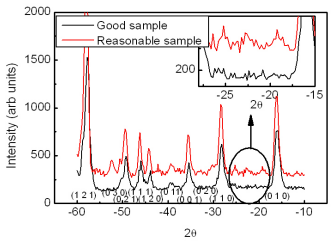

Fig. 1. Neutron diffraction in CsCrF4.