Anisotropic control of exchange interactions in a frustrated isosceles triangular lattice Ising antiferromagnet CoNb2O6

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The triangular antiferromagnet with a partially released geometrical frustration has been attracting particular attention because of a possibility of the appearance of an unusual magnetic order absent in both frustrated and unfrustrated magnets. As one of the model materials, we have studied an Ising magnet $CoNb_2O_6$, where the quasi-1D ferromagnetic zigzag chains along the *c* axis form a frustrated antiferromagnetic isosceles-triangular lattice (ITL) in the *a*-*b* plane. Neutron scattering works have revealed interesting magnetic features, such as rich *H*-*T* magnetic phase diagram under magnetic fields in the *a*-*c* plane, propagation-vector-dependent magnetic correlations and anisotropic domain-growth kinetics. These features are primarily due to the isosceles triangular geometry of Ising-like Co spins and the exchange ratio of nearest neighbor interaction J_1 to next-nearest neighbor one J_2, i.e. $\gamma = J_1/J_2 \simeq 1.33$, which is not far from 1.0(Wannier point) of the triangular lattice in Stephenson's magnetic phase diagram. If the exchange ratio γ can be controlled in $CoNb_2O_6$ by distorting ITL by uniaxial stress, variety of interesting magnetic features intrinsic to γ would be observed. Along this context, we have succeed in controlling the exchange ratio γ from 1.33 to 1.80 by applying uniaxial stress p up to 400 MPa along the *a* axis (J_2 direction), as is clearly seen in variation of the propagation wave number *q* of sinusoidally-amplitude-modulated incommensurate (IC) state at the phase transition temperature T_1 (from IC to paramagnetic state)[S. Kobayashi et al., Phys. Rev. B. 90, 060412(R) (2014)].

To investigate how the exchange ratio γ changes under applying uniaxial stress along the *b* axis (J_1 direction), we performed the neutron-diffraction measurements at the two-axis diffractometer E4 installed at the Berlin Neutron Scattering Center in the Helmholtz Centre Berlin for Materials and Energy. The wavelength of incident neutron was 2.44 Å. This time, we newly introduced transverse-uniaxial stress device so that we can provide access to the (*HK*0) scattering zone under applied vertical magnetic field to the *c* axis. As shown in the figure, in contrast to applying uniaxial stress along the *a* axis (J_2 direction), the exchange interaction ratio γ oppositely moves from 1.33 to 1.13. Adding *p* dependence of magnetic phase transition fields obtained by dc-SQUID and ac-susceptibility measurements, we obtained the results that J_1 increases by ∼10 % and J_2 decreases by ∼5 % under p = 400 MPa along the *a* axis, while J_1 decreases by ∼7 % and J_2 increases by ∼8 % under p = 400 MPa along the *b* axis.

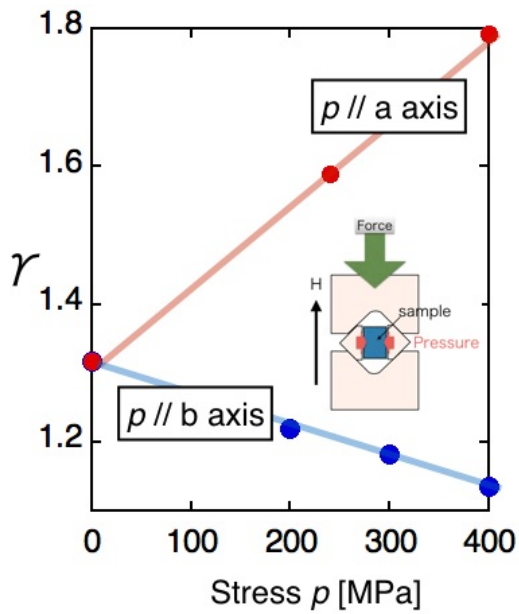

Fig. 1. Uniaxial stress p dependence of the ratio gamma of exchange constants.