Uniaxial-stress-control of competing inter-chain exchange interactions of isosceles-triangular lattice Ising magnet CoNb2O6

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The isosceles triangular lattice Ising antiferromagnet is characterized by the ratio of exchange interactions defined as γ $=J_1$ (along the base direction) $/J_2$ (along the equilateral direction), and its magnetic property dramatically changes, depending on whether γ is larger than 1.0 or not. 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) with $\gamma \simeq 1.33$ in the *a*-*b* plane. If the exchange ratio γ can be controlled in $CoNb_2O_6$ via anisotropic deformation of ITL by uniaxial pressure, variety of interesting magnetic features intrinsic to γ would be observed.

Actually along this context, we succeeded in crossing the Wannier point (γ= 1) and providing access to the region of $\gamma < 1$ by further applying uniaxial pressure p up to 1GPa along the c axis, where AF-II magnetic ordering with q=1/2 is switched to AF-I magnetic ordering with q=0 at the critical pressure $p \simeq 0.8$GPa at which the exchange ratio γ becomes 1.0. This is what exactly suggested by Stephenson's exact calculation for 2D ITL, as is in the experimental reports 22 (N0 1802).

In present experiment, as a continuation of the proposal, we obtained entire $H_{//c} - T$ magnetic phase diagram (with γ~0.91) at p= 1.1GPa, including determination of magnetic structure of magnetic state with q=1/5 newly appearing between AF-I magnetic ground state and field induced ferrimagnetic (FR) phase, as shown in Fig.1. How the IC phase appears in $H_{//c} - T$ magnetic phase diagram at p= 1.1GPa is entirely different from that at p= 0 Pa, corresponding to that one exchange J_1 (along the base direction) wins two exchange J_2 (along the equilateral direction) and there is essentially no competition among spins on isosceles triangular lattice for $\gamma < 1$. Level-crossing considerations using experimentally obtained four magnetic transition fields between AF-I, 5SL,FR,HHFR and IF phases as well as γ~0.91 suggest that ten times smaller negative exchange J_4 and J_3'(compared with J_1 and J_2) is necessary for the appearance of 5SL and HHFR phases, respectively.

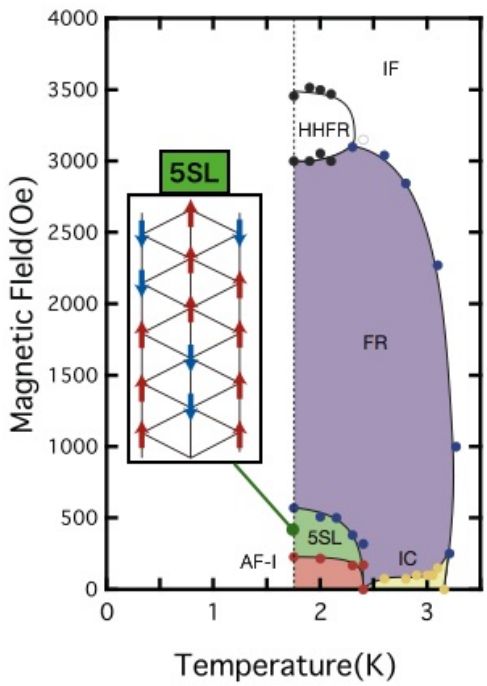

Fig. 1. H//c-T magnetic phase diagram at p= 1.1GPa.