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Studies of Frustrated Heisenberg Triangular Magnet
 CuFeO_2 by Neutron Scattering and Synchrotron X-ray
Diffraction

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ABO_2 type materials, which is one of the “triangular lattice antiferromagnet” (TLA) models with delafossite crystal structure, provide a good example of TLA and present an opportunity to study the geometrical frustration. One of the ABO_2 TLA model materials, CuFeO_2 , is of great interest because of the appearance of “dual character” with both quasi-Ising magnetic ground state and Heisenberg magnetic field-induced states, in spite of the orbital singlet Fe^{3+} ($S = 5/2$, $L = 0$). Although there were previously a great deal of works for CuFeO_2 , the origin of the unusual spin behaviors has not been clarified.

We conceived, as a way to study the unusual spin behaviors, that disturbing the delicate balance of the competing exchange interactions by substituting nonmagnetic Al^{3+} for magnetic Fe^{3+} should retrieve the original Heisenberg spin character of the orbital singlet Fe^{3+} . In this study, therefore, in order to open the way to study the unusual spin behaviors in CuFeO_2 , we have performed the neutron scattering, magnetization, specific heat, and synchrotron radiation x-ray diffraction (SR-XRD) measurements using slightly diluted $\text{CuFe}_{1-x}\text{Al}_x\text{O}_2$ ($0 \leq x \leq 0.05$) single crystals. As the results, we found dramatic changes of quasi-Ising to Heisenberg character in magnetic orderings and excitations by a small amount of nonmagnetic impurity. In addition, we have also revealed a “scalene triangle model” crystal lattice distortion for the 4-sublattice ground state of CuFeO_2 .

In this presentation, I will separately talk about “nonmagnetic impurity effect on magnetic orderings”, “spontaneous crystal distortion” and “magnetic excitation spectrum” in $\text{CuFe}_{1-x}\text{Al}_x\text{O}_2$

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