Spin excitations in $MgCr_2O_4$

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The geometric spin frustration is widely accepted as a concept to bring out a novel paramagnetic state. However, we measured two magnetic modes with discrete energies in an antiferromagnetic ordered phase in a geometrically frustrated magnet $MgCr_2O_4$ (spinel) by inelastic neutron scattering on a single-crystal specimen, and clarified the spatial spin correlations of the two levels: one is an antiferromagnetic hexamer and another is an antiferromagnetic heptamer.

Figures 1(a) to 1(d) show the present neutron scattering data, the constant-E map at E=4.5 and 9.0 meV in the $hk0$ and hhl zones in the antiferromagnetic phase ($T\sim5$ K). The data of (a) and (b) were measured on HER, and those of (c) and (d) were measured on PONTA and TOPAN, respectively. Figures 1(a) and 1(b) are the same pattern as the quasielastic scattering in the paramagnetic phase, meaning the hexamer. Figure 1(d) looks alike that of the independent seven-spin clusters (heptamers), proposed in the pyrochlore material $Tb_2Ti_2O_7$ with the same magnetic lattice as the B sites in a spinel material. We also confirmed that the intensity pattern in another scattering plane in Fig. 1(c) can be reproduced by the heptamer.

We now discuss the experimental fact that the one material includes the different spatial correlations, which have been emblematic of the geometric spin frustration in the paramagnetic phases of different systems. Also, such experiments will be able to be expanded to the other frustrated magnets in the magnetic *ordered* phases.

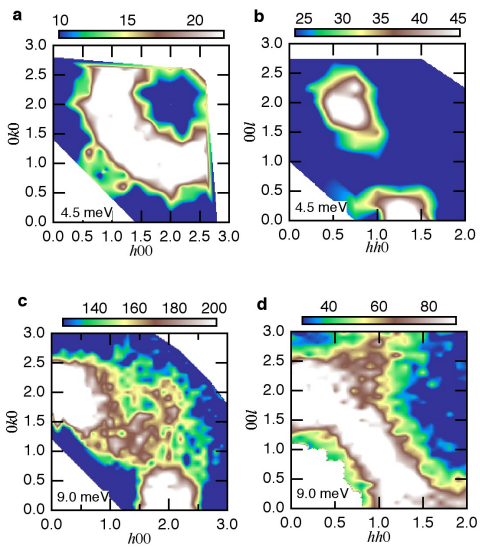

Fig. 1. Color images of single-crystal inelastic scattering of $MgCr_2O_4$, measured in a constant energy mode. The horizontal gauges indicate the scattering intensity in arbitrary units.