Magnetic structure of a new Dresselhaus magnet

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Antiferromagnetic spintronics has attracted much attention recently, since antiferromagnets have several advantages over ferromagnets for future applications like memory storage devices [1]. Antiferromagnets produce no stray fields, leading to robustness against external perturbations. Access speed in memory for writing and erasing—if achieved—is generally limited by the resonance frequency, which for antiferromagnets can be much higher than ferromagnets. While a practical implementation of antiferromagnetic spintronics is missing, several potential avenues toward this goal remain unexplored.

Quite recently, a new theory has been proposed for insulating antiferromagnetic spintronics [2]. The Rashba and Dresselhaus spin-orbit coupling in a metal combines the spin and motional degrees of freedom of electrons, resulting in a spin texture. In insulators, where the motional degree of freedom is quenched, the spin degree of freedom remains, and spin current can be carried by the collective motion of spin waves on momentum space. The ordered moments in antiferromagnets are associated with a two-fold degeneracy in the magnon polarizations [3] (precession motion direction of the spin) that serve as internal degrees of freedom analogous to electron spins. The Dzyaloshinskii–Moriya interaction in the spatial inversion symmetry (SIS) broken system couples these two magnon degrees of freedom as a function of the magnon momentum, leading to a rich texture even in insulators.

The effects on the magnon dispersion due to broken SIS are observed in noncentrosymmetric magnets such as MnSi and α-$Cu_2V_2O_7$ [4]. The Dzyaloshinskii–Moriya interaction (D) shifts two-fold degenerate magnon branches in opposite momentum directions, and the dispersion relation is actually confirmed by neutron scattering studies. In addition, a specific combination of magnetic anisotropy, D, and the magnetic field is predicted to stabilize momentum-dependent magnetic moments [2].

The noncentrosymmetric 2D Dresselhaus antiferromagnet $Sr_2MnSi_2O_7$ is known to be one of the model compounds. However, a transition at T_N = 3.4 K [5] implies that the energy scale in the compound is rather small, hence the split of the magnon branch could be insufficient to be observed. We therefore search for another candidate, and have found $Sr_2MnGe_2S_6O$ showing T_N = 15.5 K [6], with roughly five times larger energy scale. We hereby commenced the magnetic structure study of this particular material.

Powder neutron diffraction measurement was performed on T1-3 HERMES. We successfully observed magnetic reflections at the base temperature, and applied irreducible representation analysis to refine the magnetic structure. Apart from other Dresselhaus magnets, our compound turns out to show a C-type magnetic structure. The magnetic moment size as a function of temperature was also investigated.

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