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•Editorial•
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Editor's Focus

Spin waves in magnetic Weyl semimetals

Intrinsic magnetic topological materials, namely the stoichiometric magnetic compounds possessing both inherent magnetic order and topological electronic states, have attracted tremendous interest in the research of condensed matter physics and materials science [1]. Such materials not only bring new opportunities to realize many exotic topological phenomena under time-reversal symmetry breaking, but also show great potential in applications of quantum technology [2]. For example, the intrinsic magnetic topological insulators are expected to provide a very clean platform for the quantum anomalous Hall effect, quantized topological magneto-electric effect and chiral Majorana fermions at relatively high temperatures [1,3]. In magnetic Weyl semimetals (MWSMs), the Weyl nodes, as defined by the linearly crossing points between the conduction and valence bands near the Fermi energy, behave as monopoles of Berry curvature with opposite chiralities and thus lift the spin degeneracy [1-4]. The exotic transport properties of bulk MWSMs have been predicted, including the chiral anomaly, gravitational anomaly, intrinsic anomalous Hall effect, anomalous Nernst effect, large magnetoresistance and spin Hall effect [1-5]. Despite these phenomena proved to be strongly related to their static magnetic orders, the role of dynamic spin interactions along with their interplay with topological electron states is not clear yet.

So far, several MWSMs have been theoretically proposed, such as $SrRuO_3$, $Y_2Ir_2O_7$, $HgCr_2Se_4$, and Co_2TiGe [6], but most of them need to be further verified by surface spectroscopic probes. In 2018, a ferromagnetic Shandite compound $Co_3Sn_2S_2$ was identified as an ideal MWSM with a very promising anomalous Hall conductivity and anomalous Hall angle in comparison with other typical magnetic systems [7]. In a recent study, Liu et al. [8] from the Institute of Physics, Chinese Academy of Sciences, explored the low-energy spin waves in $Co_3Sn_2S_2$ single crystals via inelastic neutron scattering experiments at the Australian Centre for Neutron Scattering, ANSTO. They discovered three-dimensional spin excitations with clear in-plane and *c*-axis dispersions in both the ferromagnetic state (T=8 K << T_C=175 K) and paramagnetic state (T=200 K), suggesting three-dimensional and moderate spin correlations between the two-dimensional kagome layers of Co. The itinerant ferromagnetism in the $Co_3Sn_2S_2$ compound was revealed to have a full spin wave gap below 2.3 meV at $T = 4$ K, with its temperature dependence significantly deviating from the conventional magnetic order parameter. After analyses by a phenomenological model firstly proposed in the $SrRuO_3$ compound [9], they concluded that such deviation offers clear evidence for the intimate interplay between the Weyl nodes (magnetic monopoles in momentum space) and the spin waves (in real space).

To search the trace of Weyl fermions in the spin waves of MWSMs would help us better understand the magnetic interactions in these fascinating topological materials, which enables establishment of an adequate microscopic model of magnetic topological materials as well as tuning of their topological electron states. After all, not all magnetic topological materials can have such spin-fermion coupling (e.g., $CaMnBi_2$, $YbMnBi_2$, and $Sr_{1-x}Mn_{1-y}Sb_2$) [10]. In this sense, $Co_3Sn_2S_2$ together with its doped compounds opens a new avenue to explore exotic topological phenomena and future technological applications related to spin interactions.

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