Magnetic excitations and structure of the topological semimetal YbMnSb₂

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Topological semimetals have high carrier mobility in the form of quasiparticles resembling relativistic fermions. Experimental realisations of magnetic topological semimetals are relatively thin on the ground. Here we probe both the magnetic structure and interactions of the topological semimetal candidate YbMnSb₂ using neutron scattering.

YbMnSb₂ belongs to the P4/nmm space group and shows evidence of a magnetic ordering transition involving the Mn moments at ~350 K [1]. This is a relatively high Néel temperature among the family of materials A'MnSb₂ (A = Ca, Sr, Ba, Yb, Eu), which has demonstrated characteristics of the topological semimetals. The quasi-2D plane formed by the Sb ‘square’ may host Weyl or Dirac fermions [1-3]. YbMnSb₂ has previously been studied via quantum oscillations, magnetometry, optical spectroscopy, ab initio band structure calculations, and angle-resolved photon emission spectroscopy [1, 4, 5]. Interestingly, these studies reached different conclusions as to the magnetic structure of YbMnSb₂, and hence its semimetal nature: the jury is out on whether it is a Dirac [4], nodal-line [5], or Weyl semimetal [1].

In this presentation I shall report the magnetic structure of YbMnSb₂ found by neutron diffraction, which is different to any previously proposed structures: C-type antiferromagnetism with the spins pointing along the c axis. This magnetic structure is shared by YbMnBi₂ [6]. Dirac physics is also seen in such A'MnBi₂ materials; however, Bi rather than Sb layers results in stronger spin-orbit coupling. This widens the band gap at any nodes and makes the resulting quasiparticles more massive [1]. We have also measured the spin wave spectrum of YbMnSb₂ and the results of this measurement will be described and compared with the spin dynamics in related materials. The implications for the topology of the electrons will be discussed.

![Figure 1. left, proposed magnetic structure of YbMnSb₂; right, spin wave spectrum of YbMnSb₂ in the h0l plane obtained from inelastic neutron scattering.](image)


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