Transport and magnetic properties of the topological (Weyl) semimetal: Hexagonal - $(Mn_{1-\alpha}Fe_{\alpha})_3Ge$ ($\alpha = 0 – 0.3$)

Venus Rai

Jülich Centre for Neutron Science JCNS-2, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

Mn_3Ge displays large anomalous Hall effects (AHE) below the Néel temperature (365 K) that can be switched in a small magnetic field (20 Oe) [1], which makes it a strong candidate for room-temperature spintronic applications. Since the AHE has its origins in the topological Weyl nodes, the AHE can be controlled by tuning the characteristics of Weyl points relative to the Fermi surface, by suitable dopants of the parent phase. Therefore, we have explored the electrical transport and magnetic properties of the $(Mn_{1-\alpha}Fe_{\alpha})_3Ge$ ($\alpha = 0 – 0.3$) samples to study the change in AHE and chiral anomaly of the doped samples. Clear signatures of the AHE and chiral anomaly were observed for samples up to $\alpha = 0.22$, in the temperature regime where magnetization behaves the same as the parent sample. However, the strength of AHE and chiral anomaly decreases with an increase in Fe doping and vanishes beyond $\alpha = 0.22$. To predict the origin of these AHE in doped samples, the ground state magnetic structure of $\alpha = 0.22$ was determined using single-crystal (polarized and unpolarized) neutron diffraction techniques. As expected, we observed that the magnetic structure of the doped sample remains the same as that of the parent compound in the temperature regime where AHE was observed. These observations led us to two main conclusions: (i) the Weyl points are very likely to be present in the doped samples as long as the magnetic structure of the doped sample remains the same as the parent sample and, (ii) the characteristics of the Weyl points can be tuned significantly by suitable doping of the Weyl semimetals.

Reference:

[1] A. K. Nayak, J. E. Fischer, Y. Sun, B. Yan, J. Karel, A. C. Komarek, C. Shekhar, N. Kumar, W. Schnelle, J. Kübler, C. Felser, and S. S. P. Parkin, Sci. Adv. **2**, e1501870 (2016).