Polarized neutron diffraction of Hexagonal-$(Mn_{0.78}Fe_{0.22})_3Ge$

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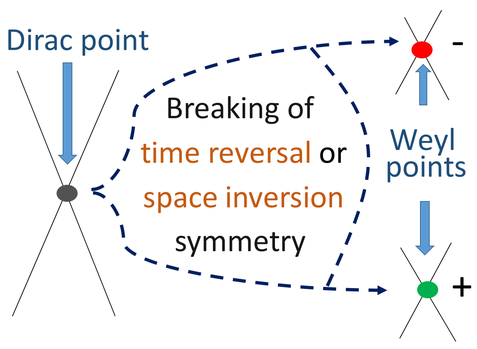
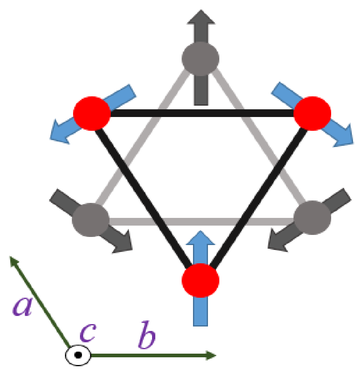
Introduction:

- Interests in the Weyl semimentals developed due to the observed anomalous transport effects.
- Mn_3Ge is the magnetic Weyl semimetal.
- Fe doping in Mn_3Ge changes magnetic structure and moment.
- *Study of transport behavior and magnetic structure of the Fe doped sample can help us understand the role of magnetism in anomalous transport properties.*

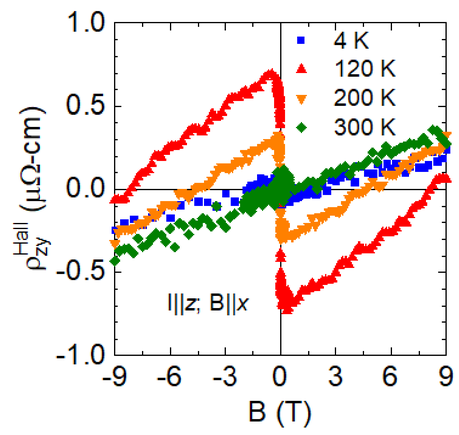


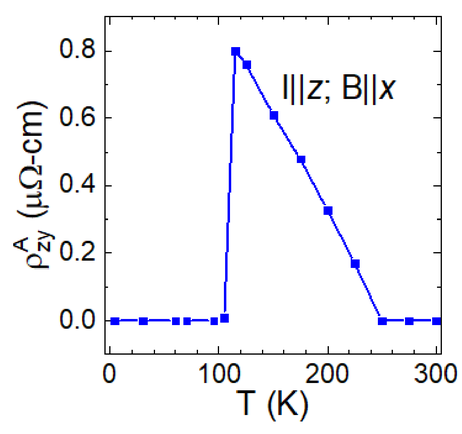


Magnetic structure of Mn_3Ge

Anomalous Hall effect:

- Non zero anomalous Hall resistivity is observed between T_{N1} and T_{N2}.



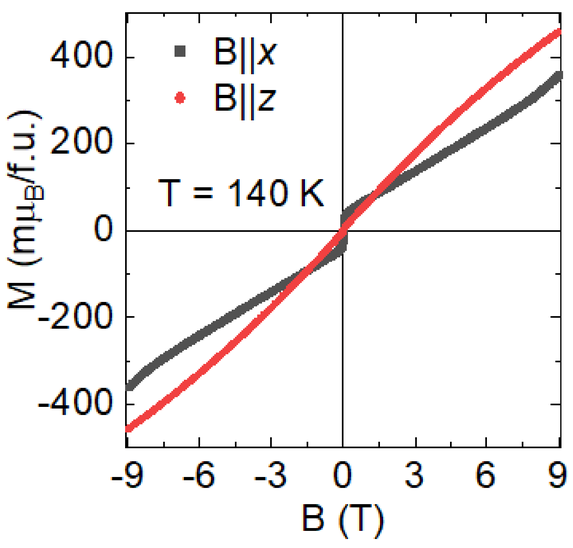


- *Weyl points are likely to be present in the sample.*

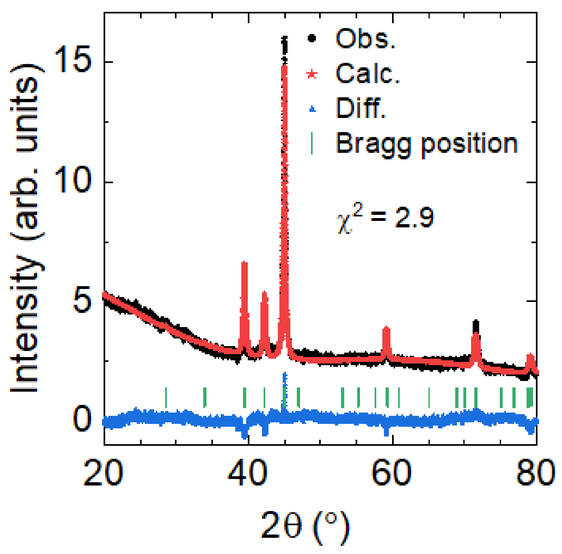
Sample characterization:

- Single crystal $(Mn_{0.78}Fe_{0.22})_{3.2}Ge$ was synthesized.
- X-Ray powder diffraction (XRD) analysis shows pure hexagonal phase.
- Space group: $P6_3/mmc$; a = 5.2978(4) Å , c = 4.2976(9) Å.
- Magnetization and resistivity measurements show magnetic phase tansitions at 240 K (T_{N1}) and 105 K (T_{N2}).
- T_{N1} decreases from 365 K to 240 K compared to Mn_3Ge.

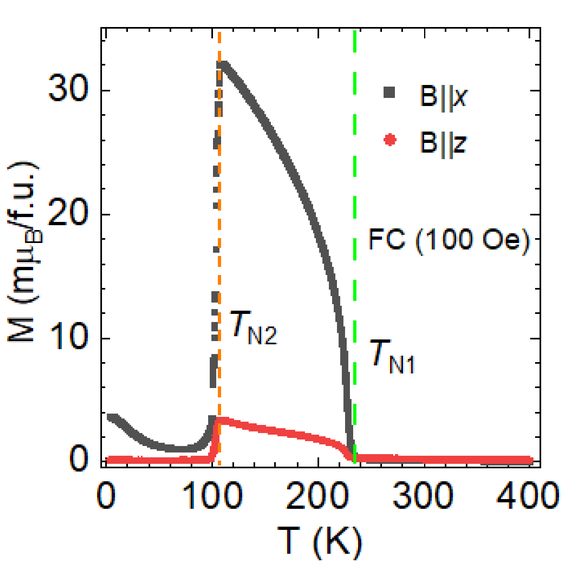
Magnetization-field



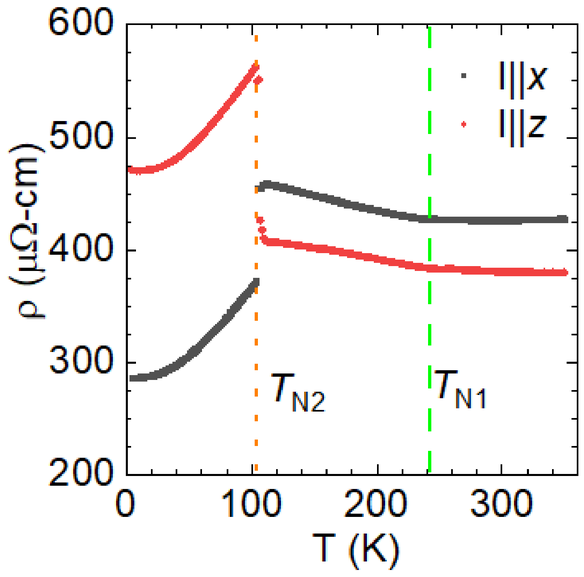
Powder XRD



Magnetization-temperature

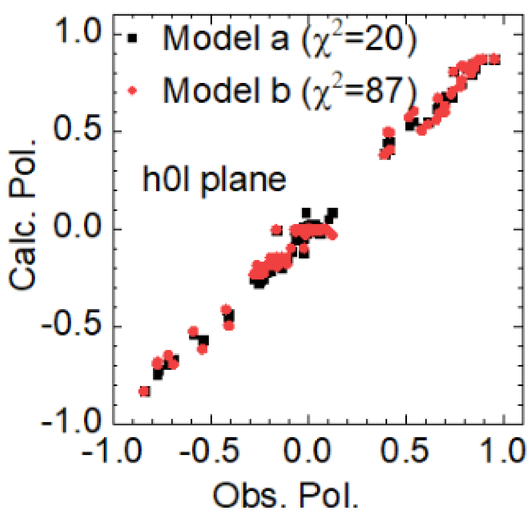


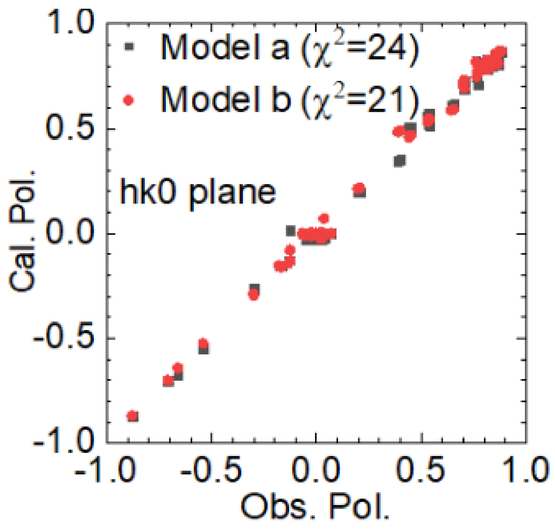
Resistivity

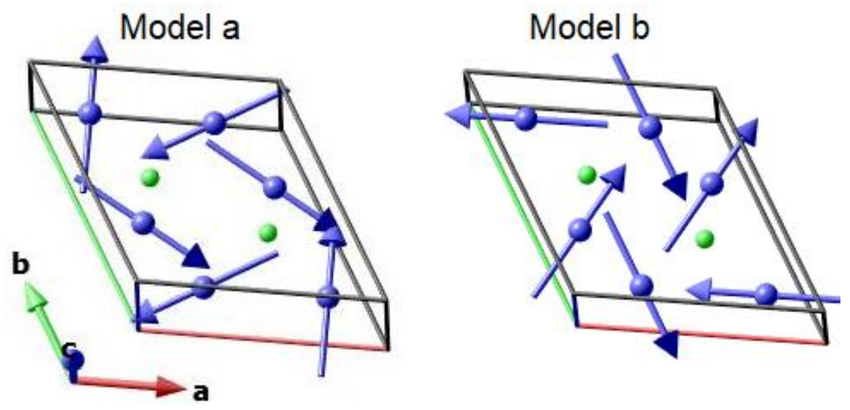


Polarized neutron diffraction (PND):

- PND was performed at 130 K and 4 K using CRYOPAD setup at D3, ILL, France.
- The data analysis at 4 K is under progress. The magnetic structure at 4 K is different from the 130 K.
- At 130 K, two magnetic structures (Model a, b) are possible as both the models fit almost equally well.
- Magnetic moment (T = 130 K) : 2.5(1) μ_B







Summary:

- Magnetization and Hall resistivity measurements of the sample show similar behavior as the parent sample, in the intermediate temperature range.
- PND analysis at 130 K shows that the doped sample possesses in plane antiferromagnetic structure in the temperature range of T_{N1} and T_{N2}.
- *Weyl points are likely to be present in 22% Fe doped sample in the temperature range of 105 K – 240 K.*
- *Magnetic structure and Weyl points are intimately connected as AHE vanishes below T_{N2}.*