Quantum Materials(RMn_6Sn_6; R= Ho, Nd) Under Extreme Condition (QuantumExtreme)

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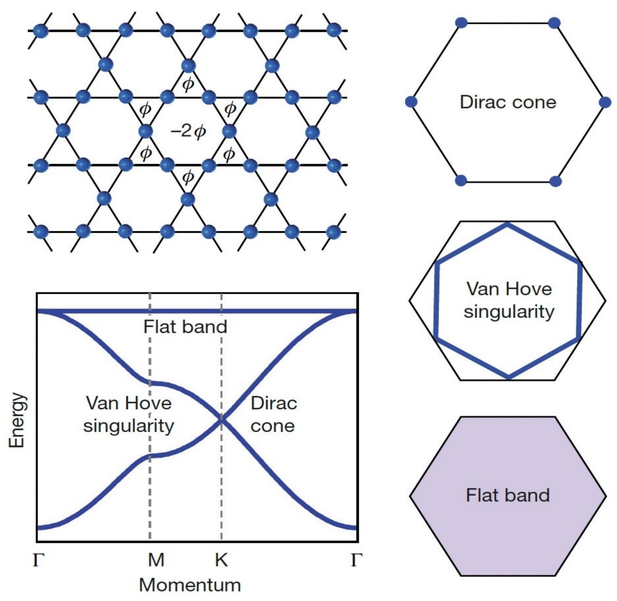
Motivation and Objectives



Kagome lattice:

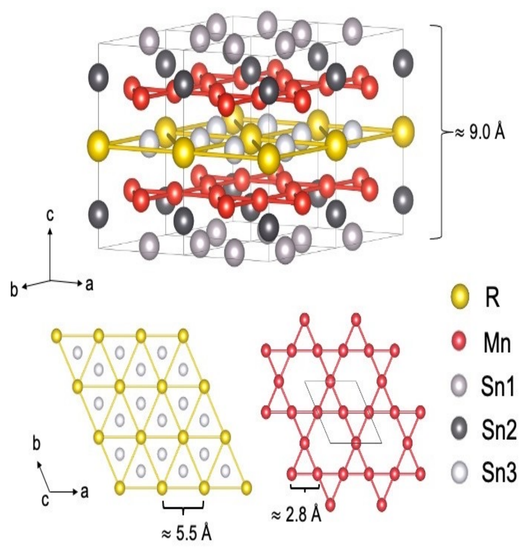
- Hosts **Dirac Fermions**, **flat bands**, and **van Hove singularities**
- Topological quantum electronic properties

RMn_6Sn_6 : Topological Kagome magnet

- **Spin quantization of Mn at Kagome layer and band gap at Dirac points are correlated (Rare earth)**

Yin, JX., *et al*. *Nature* **612**, 647–657 (2022).

$HoMn_6Sn_6$: P_6/mmm

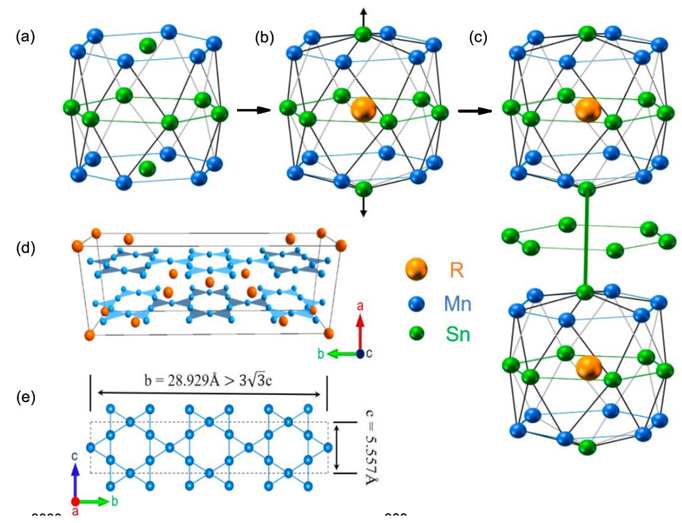


Spin quantization axis of Mn in Kagome layer depends upon magneto crystalline anisotropy of Ho**: Easy cone anisotropy**

Objective: Pressure tunability of spin anisotropy: Single crystal Neutron scattering under pressure

F. Kabir *et al*., Phys. Rev. Mater. 6, 064404 (2022)

$NdMn_6Sn_6$: *Distorted Kagome system*



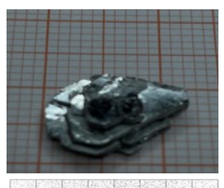
- Distorted orthorhombic structure (***Immm***)
- Multiple spin reorientation transition
- Correlated structural disorder
- Resolved structure only by powder diffraction

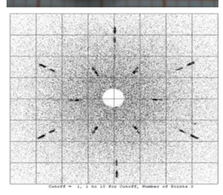
Objective: Correaltion between structural disorder and magnetism: Single crystal Neutron scattering to review the crystal and magnetic structure

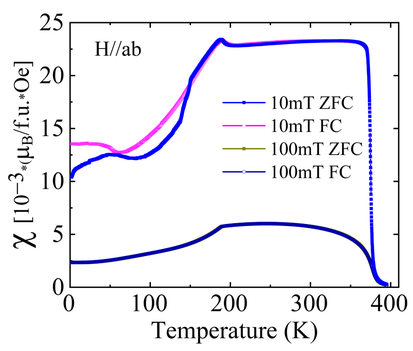
W. Ma *et al.*, Phys. Rev. B **103**, 235109(2021)

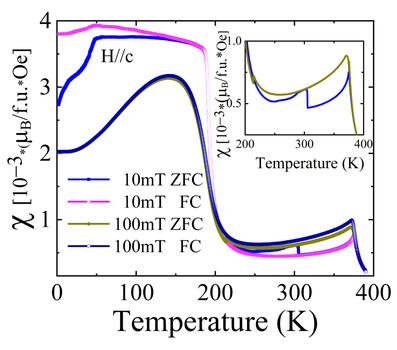
Preliminary characterizations

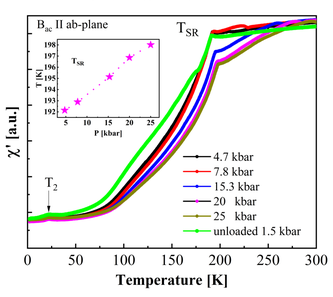
$HoMn_6Sn_6$:Pressure tuning of magnetism

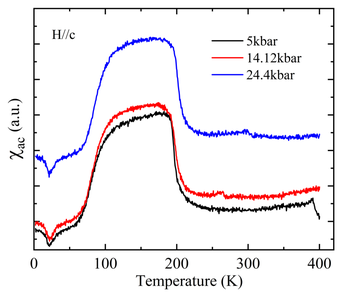


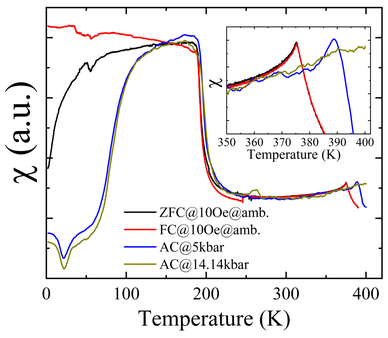


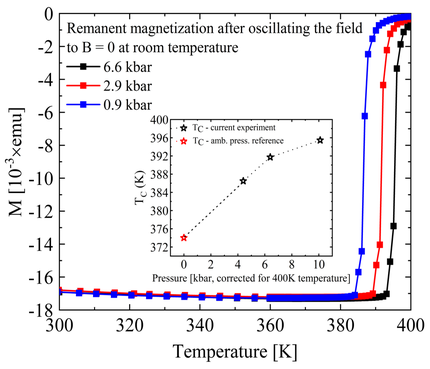






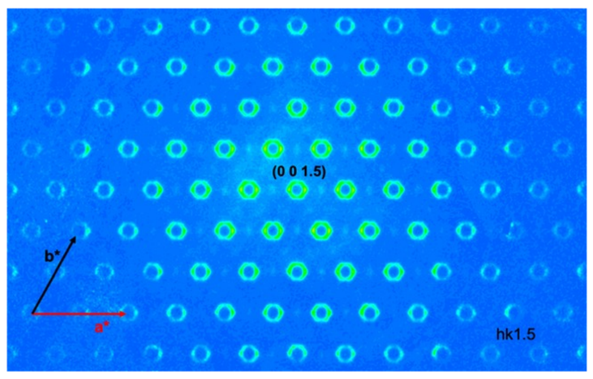


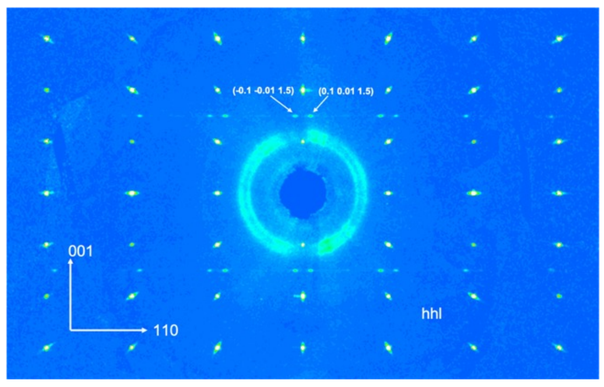


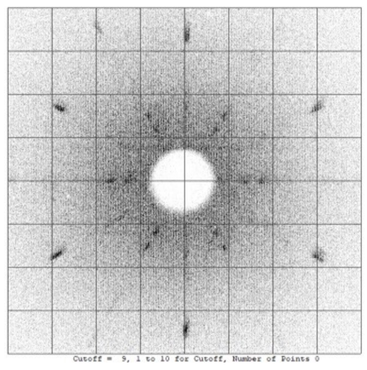


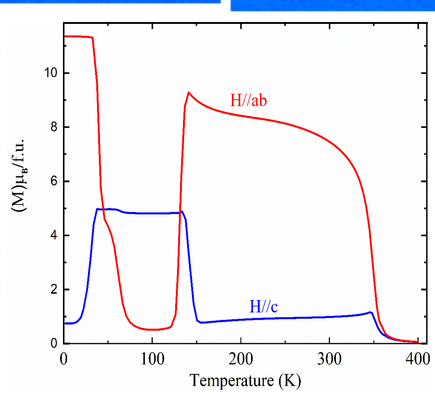
- Single crystal is grown by Sn flux
- DC and AC magnetic charactezation: Both ambient and under pressure (upto 3GPa)
- Ferrimagnetic (in ab plane) order below Tc (373 K) and undergoes spin reorientation from easy plane to easy cone (49° to c direction) states below T_{SR} (192 K)
- The T_{SR} almost varies linearly within ambient pressure (190 K) to 25 kbar (198 K) range.
- Tc varies nonlinearly with in ambient pressure (374 K) to 5 Kbar (395 K) range and shifts beyond the highest measured temperature at 400 K above 5 Kbar

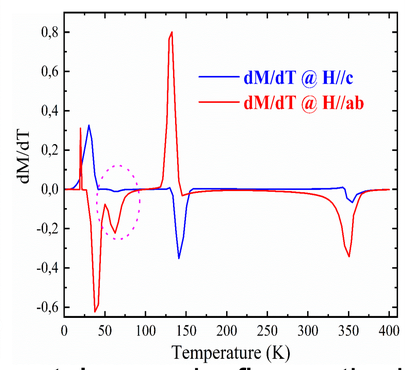
$NdMn_6Sn_6$:Single crystal X-ray diffraction and Magnetism











- X-ray diffraction and magnetization study on single crystal grown by flux method
- Pseudohexagonal Laue pattern is observed
- Reflections can be indexed (93%) with reduced hexagonal cell (a=5.5662(5), b=5.5680(6), c=4.5836(3), α= 90.032(7), β=89.982, γ=119.998(11))
- Hexagon like diffuse scattering features in the (h,k,±1.5) reciprocal planes
- Transitions at Tc~375 and other two main spin reorientations at ~150K and 40K
- Additional peculiar transitional anomaly is observed at ~ 60K

Conclusion and future plans

- The crtical transition is much higher than 400K
- T_{SR} changes monotonocally but change in Tc is nonmonotonic
- Additional transitional anomaly ~ 300K at low field is intriguing
- Direct investigation with neutron scattering can elucidate the role of lattice and interplaner coupling to address the features.
- The average crystal structure must be reviewed with single crystal neutron diffraction for the crystal and magnetic structure.
- The role of correlated srtructural disorder with with magnetism.
- Investigation of pressure tunability of crystal and magnetic structure in order to unravel the correlation among the lattice and spin degrees of freedom.

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