# THE PHYSICS COLLOQUIUM

Thursday 17 November 2022, 4:00 pm
Nijenborgh 4, 5115.0317 (Schröderzaal)

# Towards higher Curie temperature in intrinsic ferrimagnetic topological insulators


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*Magnetic topological materials are a hotbed for exotic quantum phenomena such as the quantum anomalous Hall effect (QAHE), the topological magneto-electric effect, new topological states like axion insulators and magnetic Weyl semimetals. In reply to the high demand for optimized material systems, magnetic topological insulators made a decade-long journey [1] from extrinsically doped $Bi_2Te_3$ and $(Cr,V)Bi_2(Se,Te)_3$ heterostructures, on which the QAHE was experimentally discovered [2], to the intrinsically magnetic van der Waals material $MnBi_2Te_4$ [3]. The QAHE was observed in $MnBi_2Te_4$ thin films at notably higher temperatures of 1–6 K [4] than in [2], pointing at a perspective pathway of materials optimization towards more robust quantum effects. Since the bulk $MnBi_2Te_4$ is an A-type antiferromagnet with $T_N$ = 25 K, the task of fabricating structurally similar ferri- or ferromagnets with an increasing $T_C$ is very pertinent.*

*$MnBi_2Te_4$ is the progenitor of a family of van der Waals materials $(MnX_2Te_4)(X_2Te_3)_n$, X = Sb or Bi, n = 0–4, which I will introduce in my talk. Their crystal lattices are ordered stacking variants of septuple ($MnX_2Te_4$) layers hosting an ordered magnetic sublattice of Mn(II) atoms and of n quintuple ($X_2Te_3$) spacers. Varying intralayer and interlayer magnetic exchange couplings foster a rich palette of possible magnetic ground states, including ferri- and ferromagnetic. Besides the stacking order, a more subtle factor – Mn/X site intermixing [5] – influences the long-range magnetic order greatly. This phenomenon is particularly prominent in $Mn_{1\pm x}Sb_2Te_4$ where it raises the Curie temperature of a ferrimagnetic-to-paramagnetic transition from 27 to 46 K, while x varies in the range of 0.1–0.2 only [6-9]. We elucidate the Mn/X intermixing by single-crystal X-ray and neutron powder diffraction and link these results to the bulk magnetometry and surface XMCD data. Accumulated insights into an over-arching connection between crystal growth protocols, Mn/Sb patterns and magnetic ground states enable us to push the ordering temperature even further: I will present the recently obtained $Mn_{1.4}Sb_{1.6}Te_2$ with $T_C$ = 55 K and $Mn_{1.9}Sb_{1.3}Te_4$ with $T_C$ = 73 K that bring magnetic topological materials close to the liquid nitrogen limit.*


*REFERENCES*


*[1] Y. Tokura et al. Nature Reviews Physics 1, 126 (2019). [2] C.-Z. Chang et al. Science 340, 167 (2013). [3] M. Otrokov, … A. Isaeva, E.V. Chulkov. Nature 576, 416 (2019) ; [4] Y. Deng et al. Science 367, 895 (2020); [5] A. Zeugner, …, A. Isaeva. Chem. Mater. 31, 2795 (2019) ; [6] Y. Liu et al. Phys. Rev. X 11, 021033 (2021); [7] S. Wimmer et al. Adv. Mater. 33, 2102935 (2021) ; [8] L. Folkers, … A. Isaeva. Z. Krist. 237, 2057 (2021); [9] M. Sahoo, … A. Isaeva. Materials Today Physics, under review.*


*Join us for coffee starting 3:30 p.m. Refreshments will be served after the lecture.*

*For more information contact the host: Antonija Grubisic-Cabo (a.grubisic-cabo@rug.nl)*
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