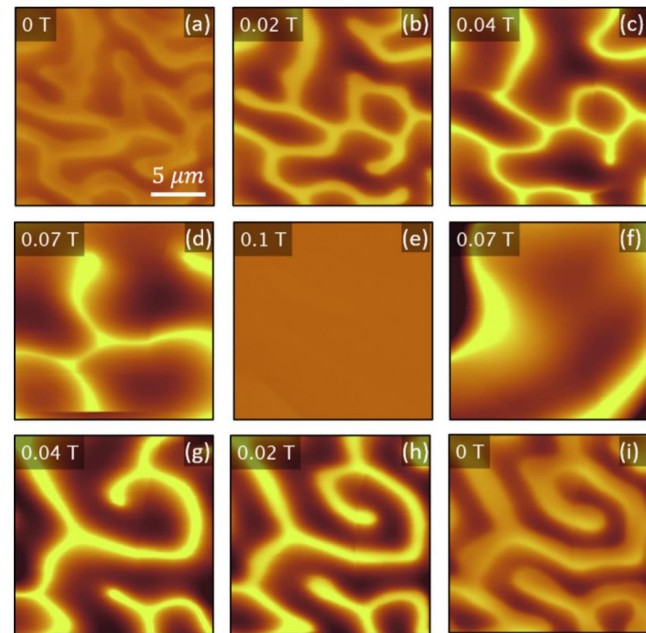


Direct evidence of ferromagnetism in MnSb_2Te_4

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Project Summary: Recent research on intrinsic magnetic topological insulators MnBi_2Te_4 sheds new light on the observation of a high-temperature quantum anomalous Hall effect (QAH) effect. Since the magnetic moments of Mn are antiferromagnetically coupled across adjacent Mn-layers, the realization of true QAHI (at zero fields) is challenging. To achieve QAHI at higher temperatures has thus motivated the search for intrinsic ferromagnetic (FM) topological insulators (TIs). In this study, we succeeded in growing FM MnSb_2Te_4 single crystals with $T_c \sim 33\text{K}$ by tuning growth conditions, in contrast to the antiferromagnetic order previously found. We provide direct evidence of long-range ferromagnetic ordering by directly visualizing the ferromagnetic domains in MnSb_2Te_4 single crystal using cryogenic magnetic force microscopy. The magnetic field dependence of the domains reveals very weak pinning of domain walls, resulting in a negligibly small magnetic hysteresis loop. The temperature dependence of the domain contrast reveals a mean-field-like behavior, in good agreement with that of bulk magnetization measurements. Our results are an important step in synthesizing and understanding ferromagnetic topological insulators, thus opening new possibilities for engineering magnetic and topological structures and devices in this vdW ferromagnet. Published in *Physical Review B* **103**, 134403 (2021) with editor's suggestion

2DCC Role: While MnSb_2Te_4 single crystals reported in literature are antiferromagnetic, the 2DCC developed a unique protocol to synthesize ferromagnetic MnSb_2Te_4 single crystals via controlling disorders.



Sequential magnetic force microscopy images of MnSb_2Te_4 measured at 6 K in various magnetic fields. The field value is shown on the upper left corner of each image.