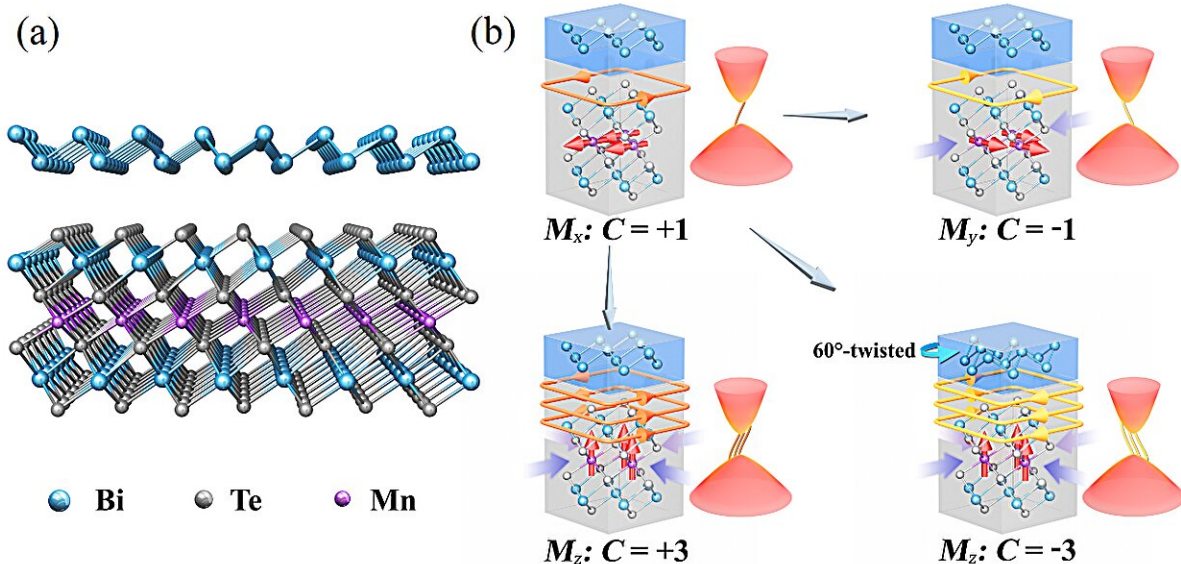


Tunable quantum anomalous Hall effects in van der Waals heterostructures

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(a) Crystal structure of Bi/MnBi₂Te₄ vdW heterostructure. (b) Schematic diagram showing controllable magnetism and topological phase transition in the material. The magnetization orientation (M_i ; $i=x, y, z$; red arrows) is tunable by applying strain (denoted by purple arrows) or magnetic field. QAH states with controllable Chern numbers are realized by changing the magnetization orientation or twisting the vdW heterostructure. Credit: Science China Press

The quantum anomalous Hall effect (QAHE) has unique advantages in topotronic applications, but realizing the QAHE with tunable magnetic and topological properties for building functional devices is still a key

scientific challenge. Through first-principles calculations, researchers have predicted a candidate material that meets these requirements.

The related work was recently [published](#) in the *National Science Review* under the title "Tunable quantum anomalous Hall effects in ferromagnetic van der Waals heterostructures."

Professors Wenhui Duan and Yong Xu from Tsinghua University's Department of Physics are the co-corresponding authors of the paper. Postdoc Feng Xue, affiliated with both the Department of Physics at Tsinghua University and the Beijing Academy of Quantum Information Sciences, is the first author.

Additional co-authors include Professor Ruqian Wu from the University of California, Irvine, Professor Ke He from Tsinghua University, Associate Professor Yusheng Hou from Sun Yat-sen University, doctoral student Zhe Wang from Fudan University, and doctoral student Qiming Xu from Tsinghua University.

The quantum anomalous Hall effect is a topological phenomenon characterized by the appearance of quantized Hall conductance without an [external magnetic field](#), holding significant potential for next-generation electronic devices. Through systematic first-principles calculations, the research team predicts that QAHE induced by both in-plane and out-of-plane magnetization can be achieved within a single material system composed of van der Waals coupled Bi and MnBi_2Te_4 monolayers.

By applying strain, magnetic field, or twisting the materials, significant changes in the magnetic and topological properties of the system can be induced, resulting in highly tunable QAHE states. This study not only provides a practical material platform for topological electronics but also opens new pathways for further experimental and theoretical exploration

of the quantum anomalous Hall effect.

More information: Feng Xue et al, Tunable quantum anomalous Hall effects in ferromagnetic van der Waals heterostructures, *National Science Review* (2023). [DOI: 10.1093/nsr/nwad151](https://doi.org/10.1093/nsr/nwad151)

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