Experimentelle Physik 2

Seminar Festkörperphysik (CMP Seminar)

Aktuelle Probleme der Festkörperphysik für Studenten und Mitarbeiter
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Manipulation of quantum metric in a topological chiral antiferromagnet at room temperature

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The quantum metric and Berry curvature are two fundamental and distinct factors that describe the geometry of quantum eigenstates. While the role of the Berry curvature in governing various condensed-matter states has been investigated extensively [1,2], the quantum metric, which was also predicted to induce topological phenomena of equal importance [3], has rarely been studied. Recently, breakthrough has been made in observing the quantum-metric nonlinear Hall effect in a van der Waals magnet [4,5], but the effect is limited at cryogenic temperature and is tuned by strong magnetic fields of several teslas. In our study [6], we demonstrate room-temperature manipulation of the quantum-metric structure of electronic states through its interplay with the interfacial spin texture in a topological chiral antiferromagnet/heavy metal Mn_3Sn/Pt heterostructure, which is manifested in a time-reversal-odd second-order Hall effect (ScHE). We also show the flexibility in controlling the quantum-metric structure with moderate magnetic field and verify the quantum-metric origin of the observed ScHE by theoretical modeling. Our results open the possibility of building applicable nonlinear devices by harnessing the quantum-metric structure.

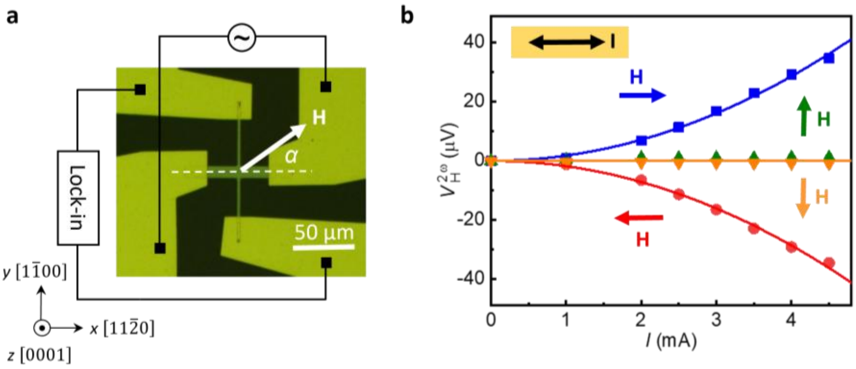

Figure. 1 **a**, Optical image of a Hall bar device and measurement setup for proving ScHE. **b**, ScHE as a funcation of applied current when the magnetic field of 0.4 T was applied alongα = 0° (blue), 90° (green), 180° (red) and 270° (orange).

References

[1] D. Xiao *et al.*, Rev. Mod. Phys. **82**, 1959 (2010).
[2] L. Šmejkal *et al.*, Nat. Phys. **14**, 242 (2018).
[3] Y. Gao *et al.*, Phys. Rev. Lett. **112**, 166601 (2014).
[4] A. Gao *et al.*, Science **381**,181 (2023).
[5] N. Wang *et al.*, Nature **621**, 487 (2023).
[6] J. Han, T. Uchimura *et al.*, Nat. Phys. **20**, 1110 (2024).