

Spin-Triplet Excitonic Insulator in the Ultraquantum Limit of HfTe_5

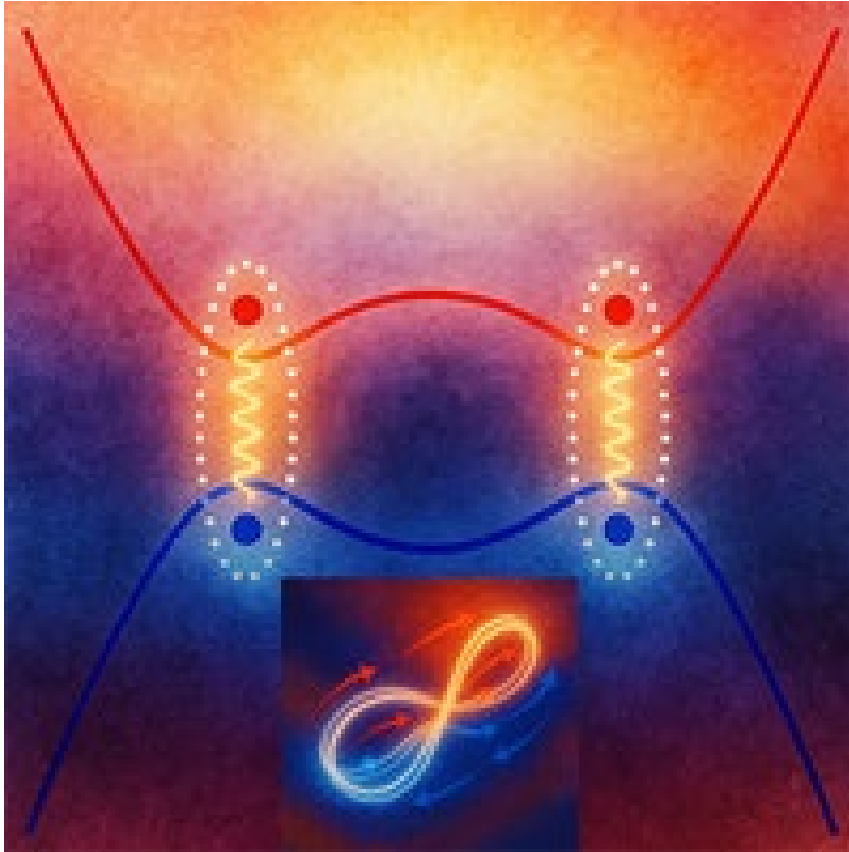


Figure: Discovery of a new quantum state: a spin-triplet excitonic insulator phase realized in the ultra-quantum limit of HfTe_5 , a three-dimensional topological material.

Scientific Achievement

Discovery of a spin-triplet excitonic insulator phase in the ultraquantum limit of HfTe_5 .

Significance and Impact

This work provides the first experimental evidence of a spin-triplet excitonic insulator in a 3D topological material. It introduces a promising platform for exploring spin superfluidity, spin-based Josephson effects, and applications in quantum spintronic devices.

Research Details

- Performed magnetotransport measurements under fields up to 72 T revealing a $\sim 250 \mu\text{eV}$ gap and zero Hall conductivity.
- Observed nonlinear transport and negative longitudinal magnetoresistance indicative of a 1D Weyl phase.
- Theoretical modeling confirms spin-triplet exciton formation between oppositely polarized zeroth Landau levels. The excitonic gap and its BCS-like temperature dependence validate the excitonic insulator scenario.

Liu, J.; Subramanyan, V.; Welser, R.; McSorley, T.; Ho, T.; Graf, D.; Pettes, M. T.; Saxena, A.; Winter, L. E.; Lin, S.-Z.; Jauregui, L. A. Possible Spin-Triplet Excitonic Insulator in the ULTRAQUANTUM Limit of HfTe_5 . *Physical Review Letters*. 2025.

Work was performed, in part, at the Center for Integrated Nanotechnologies.



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