Signature of Dirac fermions in type-II Dirac semimetal $NiTe_2$

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Dirac semimetal (DSM) is a type of topological material with fourfold degenerate linear band crossing in the bulk, exhibiting nontrivial spin-momentum locking mediated by spin-orbit coupling (SOC). This is due to the preservation of both inversion symmetry and time-reversal symmetry. $NiTe_2$, a potential candidate of type-II DSM, in addition to the Fermi arcs, has topologically nontrivial surface states below the Fermi level due to nontrivial Z_2 topological gap. The two bulk Dirac points project to the same point in the (001) surface, the surface Fermi arcs occur on the side surfaces (i.e. parallel to the k_z axis). The topological nature of bulk $NiTe_2$ was addressed through Angle-resolved Photoemission spectroscopy (ARPES), revealing the existence of Dirac nodes. Theoretical calculations further speculate that $NiTe_2$ is a promising candidate for exploring topological superconductivity, topological Dirac fermions, and other emergent phenomena for the development of spintronics or topological devices. The chiral magnetic effect is a macroscopic manifestation of the quantum anomaly in the relativistic field theory of chiral fermions which is a phenomenon arising from a collective motion of particles and antiparticles in the Dirac sea. No signature of Dirac fermions has been obtained till now in electrical transport measurements in bulk $NiTe_2$.However, on thinning down to the nanoscale, we observe negative magneto resistance (MR) when the magnetic field is parallel to the current direction at low temperatures up to 10K. The observed phenomenon is a strong evidence of the chiral magnetic effect. It stems from the effective transformation of the Dirac point to Landau levels (LL) with n=0 chiral LL playing a crucial role in the phenomenon. This effect occurs only when a component of the electric field is parallel to the magnetic field and represents a topologically non-trivial gauge field background. Thickness-dependent resistivity with temperature depicts the shifting of chemical potential away from the Dirac point and the presence of topological surface states (TSS). Hall Effect shows the transition from two types of carriers to single type carriers on thinning down the flake and holes being the majority carriers for thinner flakes. We observed weak anti localization from bulk Dirac point which competes with the chiral anomaly.

References

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Figures

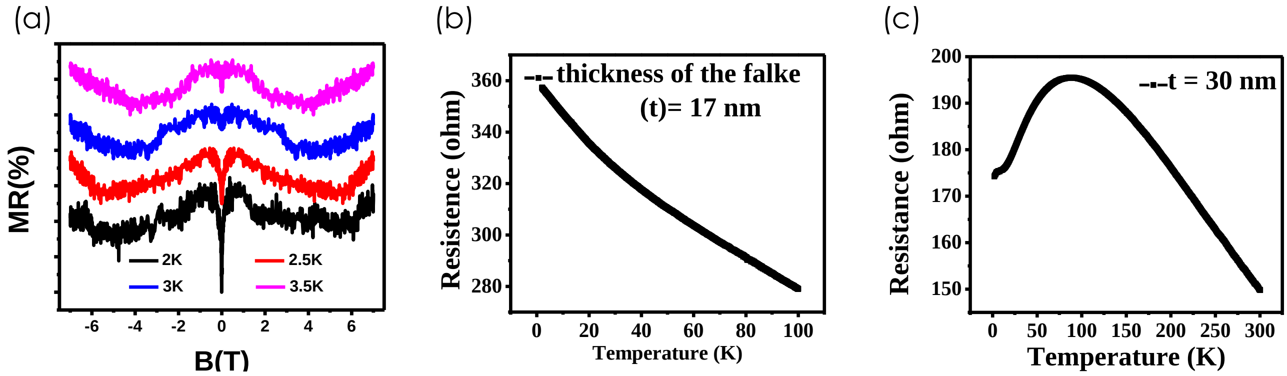

Figure 1: (a)Chiral anomaly in $NiTe_2$ at low temperatures. (b) R vs T for t = 17 nm (c) t = 30 nm.