Here, we present a detailed study on the temperature and angular dependence of the Shubnikov–de Haas (SdH) effect in the semimetal WTe$_2$. This compound was recently shown to display a very large non-saturating magnetoresistance which was attributed to nearly perfectly compensated densities of electrons and holes.[1] We observe four fundamental SdH frequencies and attribute them to spin-orbit split, electron-like, and hole-like Fermi-surface (FS) cross-sectional areas. Their angular dependence seems consistent with ellipsoidal FSs with volumes suggesting a modest excess in the density of electrons with respect to that of the holes, shown in figure 1.

We show that density functional theory (DFT) calculations fail to correctly describe the FSs of WTe$_2$. When their cross-sectional areas are adjusted to reflect the experimental data, the resulting volumes of the electron/hole FSs obtained from the DFT calculations would imply a pronounced imbalance between the densities of electrons and holes. We find evidence for field-dependent Fermi-surface cross-sectional areas by fitting the oscillatory component superimposed onto the magnetoresistivity signal to several Lifshitz-Kosevich components. We also observe a pronounced field-induced renormalization of the effective masses.

Taken together, our observations suggest that the electronic structure of WTe$_2$ is nearly, but not perfectly compensated and evolves with the magnetic field due to the Zeeman splitting. This evolution is likely to contribute to its pronounced magnetoresistivity.


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