The spin up and spin down electrons in Dirac materials, such as graphene, share a Dirac-cone in momentum space. Weyl semimetals split this degeneracy into two Weyl-nodes with opposite handedness of spin-chirality, this provides the possibility of observing new phenomena. Weyl electrons, for example, are predicted to give rise to a chiral anomaly, whereby parallel electric and magnetic fields can pump an imbalance between the Weyl nodes leading to a topologically protected current.

To date all Weyl metals not only possess Weyl electrons but also trivial electrons, complicating the search for the associated phenomena. Our solution was to use extreme magnetic fields (95 tesla) to drive the Weyl metal TaAs deep into its quantum limit where only the purely chiral zeroth Landau levels are populated, and there we observed the chiral anomaly.

This illustrates how high magnetic fields can be used to overcome material constraints and access a state composed purely of Weyl fermions, and points the way to inducing new correlated states of matter composed of these exotic quasiparticles.

Facilities: 100 tesla and 65 tesla short pulsed magnet systems.