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Fachbereich Physik, Universität Stuttgart
Max-Planck-Institut für Festkörperforschung
Max-Planck-Institut für Intelligente Systeme

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Chiral magnetic effect in a topological Weyl semimetal

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Abstract

The conduction electrons in a Weyl semimetal have an unusual velocity distribution in the Brillouin zone. The conical band structure (Weyl cone) has a chirality that generates a net current at the Fermi level in the presence of a magnetic field. The Weyl cones come in pairs of opposite chirality, so that the total current vanishes in equilibrium, but a nonzero current parallel to the field remains if the cones are offset in energy. This is the chiral magnetic effect from particle physics. Here we show that in condensed matter this effect is strongly modified by the topologically protected surface states in a Weyl semimetal, the so-called "surface Fermi arcs". These offer the possibility to observe the chiral magnetic effect without Landau levels.

In a Weyl superconductor the chiral magnetic effect can even be observed in equilibrium, by means of a flux bias that gaps out one of the two chiralities.