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Direct optical detection of Weyl fermion chirality in a topological semimetal

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A Weyl semimetal (WSM) is a novel topological phase of matter, in which Weyl fermions (WFs) arise as pseudo-magnetic monopoles in its momentum space. The chirality of the WFs, given by the sign of the monopole charge, is central to the Weyl physics, since it directly serves as the sign of the topological number and gives rise to exotic properties such as Fermi arcs and the chiral anomaly. Despite being the defining property of a WSM, the chirality of the WFs has never been experimentally measured. Here, we directly detect the chirality of the WFs by measuring the photocurrent in response to circularly polarized mid-infrared light. The resulting photocurrent is determined by both the chirality of WFs and that of the photons. Our results pave the way for realizing a wide range of theoretical proposals for studying and controlling the WFs and their associated quantum anomalies by optical and electrical means. More broadly, the two chiralities, analogous to the two valleys in 2D materials, lead to a new degree of freedom in a 3D crystal with potential novel pathways to store and carry information.