Chiral Electron's Quantum Adventure in Topological Wonderland

Weyl semimetals host massless, chiral electrons, attracting interest for their unique topological properties and exotic quantum phenomena, including the chiral anomaly and Fermi arc surface states. Magnetic Weyl semimetals add an extra layer of complexity through their dependence on magnetism, creating new opportunities for controlling their topological properties. We have studied a mid-infrared chiral photoresponse in the PrAlGe magnetic Weyl semimetal, observing the excitation and probing of chiral electrons from two different linear dispersion energy bands - Weyl bands - near the Fermi level. The signature of the topological Chern number transition from photoexcited chiral electrons is observed alongside the ferromagnetic phase transition below the Curie temperature. The step-like transition of the Chern number offers insight into developing a quantum sensing device that is robust to thermodynamic fluctuations. Due to the proximity of various types of Weyl bands near the Fermi level, low-energy far-infrared polarimetry is necessary to reveal the topological Chern number for each Weyl band. Recently, we invented a new polarimetry apparatus based on surface phonon polaritons that operate within the relatively under-explored low-energy far-infrared spectrum called the THz gap. Far infrared polarimetry based on our invention will offer clear spectral and topological distinctions of Weyl-related phenomena.