

Subcycle time-resolved THz-ARPES of topological surface currents in two-dimensional momentum space

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Abstract

Angle-resolved photoelectron spectroscopy (ARPES) experiments with THz-excitation and subcycle temporal resolution are a unique tool to measure field-driven currents at surfaces and were so far only possible by resolving one specific cut momentum vs. energy within the center of the Brillouin-zone, most prominently demonstrated for the topological insulators Bi₂Te₃. We present the first subcycle-resolved THz-ARPES measurements on Bi₂Te₃ resolving the full Dirac cone in two-dimensional momentum space. Our newly established setup uses a 200 kHz repetition-rate laser system and allows for generation of two-cycle 20-40 THz pulses reaching MV/cm peak field strength at the sample surface, combined with an ultrashort 400-nm two-photon probe with 10 fs temporal resolution. The high repetition rate together with the Scienta DA30 photoelectron analyzer enables the measurement of full 3D (momentum in x- and y-direction vs. energy) time-resolved data sets, giving unique insights into the electron scattering processes within the Dirac cone.