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Probing spin chirality of photoexcited topological insulators Bi_2Te_2Se and Bi_2Se_3 with circular dichroism angle-resolved photoemission spectroscopy

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Dirac surface states of three-dimensional topological insulators has been intense studied. Here we use time-of-flight angle-resolved photoemission spectroscopy (ARPES) combined with pump-probe technique and circular dichroism to investigate the angular momentum transfer of low energy polarized photons to two prototype topological insulators, Bi_2Te_2Se and Bi_2Se_3. Based on the analysis of circular dichroism of pump-probe multi-dimensional ARPES, our comparative study reveals that the spin texture of photoexcited Dirac states in Bi_2Te_2Se presents a stronger out-of-plane spin precession compared to that of Bi_2Se_3. We show that the multi-dimensional ARPES approach provides an effective way to probe the spin texture of photoexcited topological insulators, with the advantage of disentangling experimental geometry and matrix element effects.