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Power laws and STM image of standing wave of the topological surface states¹ BANG-FEN ZHU, JING WANG, WEI LI, PENG CHENG, CANLI SONG, TONG ZHANG, XI CHEN, Department of Physics, Tsinghua University, XUCUN MA, KE HE, Institute of Physics, Chinese Academy of Science, JIN-FENG JIA, QI-KUN XUE, Department of Physics, Tsinghua University — We have theoretically and experimentally studied the quasiparticle interference pattern caused by scattering off the step edges of topological surface states in Bi_2Te_3 and Bi_2Se_3 . We propose a general formalism to identify the power law that governs the decaying spatial oscillations of standing wave of the quasiparticle. With strong hexagonal warping of the surface states in Bi_2Te_3 , the standing wave will have different decay index as the Fermi energy varies; while in Bi_2Se_3 , the standing wave has only a single decay index due to weak warping effect. Using a scanning tunneling microscope, we directly observe the standing waves in the local density of states on both surfaces, which together with the analysis of such oscillations at different voltage confirms our theoretical predictions. We further show that, the characteristic scattering wavevectors of the standing wave of surface states caused by scattering off the nonmagnetic impurity in both Bi_2Te_3 and Bi_2Se_3 can also be well explained by this general formalism.

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Jing Wang
Department of Physics, Tsinghua University

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