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Imaging the Impact of Impurities on Topological Surface States

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Harnessing the technological potential of the spin-polarized surface states on topological insulators requires a detailed understanding of the impact of nanoscale disorder on those surface states. We employ spectroscopic scanning tunneling microscopy (STM) in the presence of a magnetic field to visualize the impact of intrinsic impurities on topological surface states in Sb and Bi_2Se_3. We find a variety of impurities with different energy profiles that elastically scatter surface states through dispersive quasiparticle interference (QPI), that inelastically scatter surface states into the bulk, that locally destroy the extended surface state Landau level wavefunctions, or that form local resonant states interacting with the Dirac quasiparticles. By identifying impurities that strongly interact with and limit the mobility of the topological surface states, our impurity studies can directly advise the growth and development of future topological materials.

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