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Ultrafast Optical Excitation of a Persistent Surface-State Population in the Topological Insulator Bi_2Se_3

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Bi_2Se_3 is a material which has gained great attention since it was recognized to be a topological insulator. Due to their topologically-protected spin-textured Dirac surface states, topological insulators have been recognized for their potential in device applications, particularly for spintronics. Thus, much of the experimental focus has been on ways to electronically or optically couple to the surface spin-texture. Using time- and angle- resolved photoemission spectroscopy (TR-ARPES), we optically excite p-type Bi_2Se_3 and study the dynamical response of its electronic structure on a femtosecond timescale. The strength of this technique is that its energy- and angle- resolution allows us to study these dynamics directly within the electronic band structure, so that surface and bulk contributions can be separately resolved. We find that optical excitation produces a metastable population of bulk carriers due to the presence of the bandgap. We discuss the coupling of these carriers to the Dirac surface state, which results in a long-lived nonequilibrium surface carrier distribution. This spin-textured population may present a channel in which to drive transient spin-polarized currents.