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Controlling exotic Dirac cones with moire superlattices[1]

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We discuss the effects of a moire superlattice on two-dimensional Dirac cones on the surface of a topological insulator and in nodal superconductors. First, we will present our recent theory to describe twisting a single, anomalous Dirac cone on the surface of a three-dimensional topological insulator (3D TI). Distinct from twisted bilayer graphene, twisting the surface of a 3D TI cannot open miniband gaps, and instead satellite Dirac cones emerge that can greatly renormalize the low energy excitations. This renormalization of the surface Dirac cone produces a greatly enhanced surface density of states that can lead to correlated Hartree-Fock like instabilities on the surface of a 3D TI. We demonstrate the success of this theory by comparing to exact lattice model simulations and ab-initio calculations of a superlattice potential on the surface of Bi_2Se_3. Second, the theory of twisting 2D nodal superconductors will be presented. It is demonstrated that the Bogoliubov-De Gennes quasiparticle velocity can vanish at a magic-angle where correlated symmetry broken states (within the superconducting phase) emerge. By applying an interlayer current we demonstrate that the magic-angle gives rise to a topological superconductor with a quantized thermal Hall effect and gapless thermal currents on the boundary. The value of the magic-angle in a variety of putative nodal superconductors will be presented.

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