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Magnetic Ordering on the Surface of a Topological Crystalline Insulator

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Topological crystalline insulators (TCI's) are a class of materials which can support non-trivial band topology protected by crystalline symmetry. Using analytic and numerical methods, we study the effect of bulk magnetic impurities on a model of (Sn,Pb)Te alloys which are believed to be TCI's in their topological state. When the Fermi energy is in a bulk gap, gapless surface states are occupied. Their energies are affected by the magnetic ordering on the surface, particularly when it breaks the mirror symmetry. Focusing on the (111) surface, which supports four independent surface Dirac cones, we derive the surface states and their coupling to the magnetic moments. Ordering of the moments on the surface opens gaps in the surface spectra, with gap sizes depending on the orientations of the magnetic moments relative to the different Γ-L directions in the bulk. This leads to ferromagnetic ordering with magnetization direction sensitive to the doping of the system. The surface magnetization supports a transition from a state with a two-fold easy axis to one with six degenerate minima driven by the filling of the surface states. Computations of the spin stiffness confirm the linear stability of these states. Possible experimental signatures of these magnetic orderings and transitions among them will be discussed.