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Imaging Dirac-Mass Disorder from Magnetic Dopant-Atoms in the Ferromagnetic Topological Insulator $Cr_x(Bi_{0.1}Sb_{0.9})_{2-x}Te_3$ – Part I CHUNG KOO KIM, INHEE LEE, BNL, JINHO LEE, BNL, SNU, SIMON BILLINGE, BNL, Columbia, RUIDAN ZHONG, JOHN SCHNEELOCH, BNL, Stony Brook, TIANSHENG LIU, BNL, N Univ of China, JOHN TRANQUADA, GENDA GU, BNL, J. C. SEAMUS DAVIS, BNL, Cornell, U of St. Andrews, Kavli Inst. at Cornell — Topological insulators (TI) have a gapless surface state of Dirac fermions protected by the time reversal symmetry (TRS). However, TRS can be broken in the ferromagnetic state induced by magnetic doping. This leads to the opening of "mass gap" at the Dirac point. Such a gap is predicted to involve many exotic phenomena for which understanding the microscopic role of magnetic dopants is critical. But it is unknown how the spatial arrangements of the magnetic dopant atoms influence the Dirac-mass gap at the atomic scale. Here we image the locations of the magnetic (Cr) dopant atoms in the ferromagnetic TI $Cr_{0.08}(Bi_{0.1}Sb_{0.9})_{1.92}Te_3$. Simultaneous visualization of the Dirac-mass gap $\Delta(r)$ reveals its intense disorder, which we demonstrate directly is related to fluctuations in n(r), the areal Cr atom density at the surface. The relationship of the surface-state Fermi wavevectors to both the correlation length and anisotropic structure of $\Delta(r)$ are found consistent with predictions for ferromagnetism mediated by the surface states.

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