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Ripple modulated electronic structure of a 3D topological insulator

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Many of the unusual properties of topological insulators can only be realized through a delicate tuning of the Dirac surface state rendering their detection thus far elusive. We have discovered that the surface state dispersion of a prototypical topological insulator can be continuously tuned via a novel topographical route. STM images of Bi_2Te_3 show one-dimensional (striped) ripples with 100nm periodicity. By combining information from Landau level spectra [1] and Fourier transform of interference patterns [2] we show that the ripples induce spatial modulations in the surface state dispersion. We describe how the ripples create topological channels for chiral spin modes at the boundaries such that placing the Fermi energy between the Landau levels of these periodic stripes would result in the first experimental realization of the ideal 1D dissipationless quantum wire. This ability to tune the surface state dispersion locally opens the door to a host of new phenomena in topological insulators.

[1] Yoshinori Okada, Wenwen Zhou, C. Dhital, D. Walkup, Ying Ran, Z. Wang, Stephen D. Wilson & V. Madhavan, Visualizing Landau levels of Dirac electrons in a one dimensional potential, Phys. Rev. Lett. 109, 166407 (2012).
[2] Yoshinori Okada, Wenwen Zhou, C. Dhital, D. Walkup, Stephen D. Wilson & V. Madhavan, Ripple modulated electronic structure of a 3D topological insulator, Nature Communications 3 1158, (2012).