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One-dimensional topological edge states of bismuth bilayers[1]

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A quantum spin Hall (QSH) state of mater, also known as a two-dimensional (2D) topological insulator, is distinguished by one-dimensional (1D) chiral edge modes propagating along the perimeter of the system without backscattering. Among the first systems predicted to be a 2D topological insulator are bilayers of Bismuth (Bi) [1]. Despite being a well-known QSH candidate system which should in principle be accessible to scanning tunneling microscopy (STM) techniques, the experimental attempts carried out so far have suffered from edge imperfections and coupling of the edge states to the substrate. In this talk I will present recent STM experiments on bulk Bi crystals [2] which show that a subset of the predicted Bi-bilayers' topological edge states are in fact decoupled from the states of the substrate which makes it possible to probe the 1D electronic channels experimentally using spectroscopic STM techniques. Spectroscopic features observed in STM are directly compared to model calculations. Furthermore, unique electronic structure of topological edge modes of Bi allows for quantum interference of edge-mode quasi-particles in confined geometries, which is visualized by STM and allows to reveal the absence of backscattering of electrons in the 1d edge channels - the key property of the QSH systems resulting in their remakable coherent propagation. Additionally, I will present comparison to theoretical models of the edge state along with supporting experimental study of Bi(111) surface state's electronic structure.

[1] Murakami, S. Quantum spin Hall effect and enhanced magnetic response by spin–orbit coupling. Phys. Rev. Lett. 97, 236805 (2006).
[2] Ilya K. Drozdov, A. Alexandradinata, Sangjun Jeon, Stevan Nadj-Perge, Huiwen Ji, R. J. Cava, B. Andrei Bernevig, and Ali Yazdani, One-dimensional topological edge states of bismuth bilayers, Nature Physics 10, 664–669 (2014)

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