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Transport discovery of emerged robust helical surface states in $Z_2 = 0$ systems HUA JIANG, Department of Physics and Jiangsu Key Laboratory of Thin Films, Soochow University, Suzhou 215006,China, HAIWEN LIU, JI FENG, QINGFENG SUN, X.C. XIE, International Center for Quantum Materials, Peking University, Beijing 100871, China — We study the possibility of realizing robust helical surface states in $Z_2 = 0$ systems. We find the emergence of robust helical edge (surface) states in both 2D and 3D $Z_2 = 0$ systems, arising from anisotropic confinement in a finite-size sample. Based on transport simulations of anisotropic Bernevig-Hughes-Zhang (BHZ) model, we demonstrate quantized conductance of helical edge states under strong nonmagnetic disorders. The robustness of helical surface states due to anisotropic confinement is generalizable to 3D weak topological insulators. Moreover, the proposed $Z_2 = 0$ systems possess additional exotic properties than in $Z_2 = 1$ TIs. In particular, by controlling the sample size and strain engineered anisotropy, this mechanism allows for efficient tuning of the effective energy gap, and fabrication of valley filter and valley valve without breaking time reversal symmetry.

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