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Helical Metal Inside a Topological Band Insulator YI ZHANG, YING RAN, ASHVIN VISHWANATH, UC Berkeley — Topological defects, such as domain walls and vortices, have long fascinated physicists. A novel twist is added in quantum systems like the B-phase of superfluid helium He_3, where vortices are associated with low energy excitations in the cores. Similarly, cosmic strings may be tied to propagating fermion modes. Can analogous phenomena occur in crystalline solids that host a plethora of topological defects? Here we show that indeed dislocation lines are associated with one dimensional fermionic excitations in a 'topological insulator', a novel band insulator believed to be realized in the bulk material $Bi_{0.9}Sb_{0.1}$. In contrast to fermionic excitations in a regular quantum wire, these modes are topologically protected like the helical edge states of the quantum spin-Hall insulator, and not scattered by disorder. Since dislocations are ubiquitous in real materials, these excitations could dominate spin and charge transport in topological insulators. Our results provide a novel route to creating a potentially ideal quantum wire in a bulk solid.

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