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Dislocations as ideal metallic quantum wires in topological insulators

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Topological insulators are novel states of matter that have been realized in the recently discovered systems such as $Bi_{0.9}Sb_{0.1}$. What happens if a topological defect is present in such a material? In this talk I will show that strikingly, dislocation lines in a topological insulator can be metallic - i.e. associated with one dimensional fermionic excitations. The condition for the appearance of these modes is derived, and only found to depend on the "weak" topological indices. In contrast to electrons in a regular quantum wire, these modes are topologically protected, and not scattered by disorder. Our results provide a novel route to creating a potentially ideal quantum wire in a bulk solid. Since dislocations are ubiquitous in real materials, they could dominate spin and charge transport in topological insulators. Experimental signatures of such dislocation hosted 1D metals are discussed. The existence of these metallic modes has important consequences for the classification of topological band structures in the presence of lattice order. We also report new results for lattice topological superconductors in three dimensions, where both the two and one dimensional indices appear. (Ref: Ying Ran, Yi Zhang and Ashvin Vishwanath, Nature Physics 5, 298, 2009)