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New Topological States of Matter: Material Platforms for Novel Fermions

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Electrons in solids organize in ways to give rise to distinct phases of matter such as insulators, metals, magnets or superconductors. In the last ten years or so, it has become increasingly clear that in addition to the symmetry-based classification of matter, topological consideration of electronic wavefunctions plays a key role in determining distinct phases of matter [for an introductory review, Hasan & Kane, Reviews of Modern Physics 82, 3045 (2010)]. In this talk, I present how tuning a 3D topological insulator whose surface hosts an unpaired Dirac fermion can give rise to topological superconductors with helical Cooper pairing leading to novel Majorana platforms, Weyl fermion semimetals with “fractional” surface Fermi surfaces, and other topological nodal states of matter from a combined conceptual,computational and experimental point of view.