Topological Surface States in Topological Insulators and Superconductors: Discovery and the New Frontiers

M. Z. Hasan, Professor of Physics

Princeton University

Three dimensional topological insulators (originally called "Topological Insulators") are a new phase of matter which realizes a non-quantum-Hall-like topological state in bulk matter and unlike the quantum Hall liquids can be turned into superconductors [1-3]. In this talk, I will briefly review the basic theory, predictions and experimental discovery of topological insulators at ALS-LBNL. I will then discuss experimental results that demonstrate the properties of topological insulators such as spin-momentum helical locking, non-trivial Berry's phases, mirror Chern number, absence of backscattering or no U-turn, protection by time-reversal symmetry and the existence of room temperature topological order. I will also report the possible exotic roles of superconductivity and magnetism in doped topological insulators and their potential applications.

[1] M.Z. H. and C.L. Kane; Rev. of Mod. Phys. 82, 3045 (2010).
[2] M.Z. H. and J.E.Moore; Ann. Rev. of Cond.Mat.Phys. (2011).
[3] M.Z. H., D. Hsieh, Y. Xia, L.A. Wray, S.-Y. Xu and C.L. Kane; A new experimental approach for the exploration of topological quantum phenomena : Topological Insulators and Superconductors arXiv:1105.0396 (Review Article) (2011)