Classification of Topological Insulators and Superconductors: the "Ten-Fold Way"

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Topological insulators and superconductors are Fermionic states with a bulk gap, possessing extended modes at their surface which cannot be Anderson localized for topological reasons. An exhaustive classification of these systems is obtained by classifying those problems of Anderson localization, in one dimension less (at the surface), which entirely avoid Anderson localization. We find that in each spatial dimension there exist precisely five distinct classes of topological insulators (superconductors). The different topological sectors within a given such class can be labeled, depending on the case, by an integer winding number, or by a "binary" Z_2 quantity. One of the five classes of topological insulators is the "quantum spin Hall" (or: Z_2-topological) insulator in d=2 and d=3 dimensions, which has been experimentally observed in HgTe/(Hg,Ce)Te semiconductor quantum wells (d=2), and in BiSb alloys and Bi_2 Se_3 (d=3). The other four classes of topological insulators (superconductors) are new. For each spatial dimension d, the five classes of topological insulators are shown to correspond to a certain subset of five of the ten generic symmetry classes of Hamiltonians introduced more than a decade ago by Altland and Zirnbauer in the context of disordered systems (generalizing the three well-known "Wigner-Dyson" symmetry classes). - Besides providing an overview of the classification, we will also discuss the novel (surface) disorder physics of some of these states.

References:

- A.P. Schnyder, S. Ryu, A. Furusaki, A.W.W. Ludwig, Phys. Rev. B 78. 195125 (2008).

- A.P. Schnyder, S. Ryu, A. Furusaki, A.W.W. Ludwig, AIP Conf. Proc. 1134, 10 (2009). (Proceedings of the L.D. Landau Memorial Conference "Advances in Theoretical Physics").

- A.P. Schnyder, S. Ryu, A.W.W. Ludwig, Phys. Rev. Lett. 102, 196804 (2009).

- A.P. Schnyder, S. Ryu, A. Furusaki, A.W.W. Ludwig, "Topological insulators and superconductors: ten-fold way and dimensional hierarchy", arXiv:0912.2157; to appear.