DAY 4 (26 June): 14:10 – 14:50

Topological phases of time-reversal invariant superconductors in three dimensions

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It has only been realized in the last few years that there are two distinct classes of time-reversal invariant band insulators: Z_2 topologically trivial and nontirivial insulators. This result was generalized in a recent paper [1], which I will review in my talk.

We systematically study topological phases of time-reversal invariant superconductors (or superfluids) and electronic systems with sublattice symmetry, in three dimensions. We find that there exist three-dimensional topologically nontrivial insulators for five out of ten symmetry classes introduced by Altland and Zirnbauer within the context of random matrix theory. For these systems, the space of insulating ground states satisfying certain discrete symmetry properties is partitioned into topological sectors that are separated by quantum phase transitions. Three of the above five nontrivial phases can be realized as time-reversal invariant superconductors with gapped quasiparticles, in which the different topological sectors are characterized by an integer winding number defined in momentum space. When such three-dimensional topological insulators (gapped superconductors) are terminated by a two-dimensional surface, they can support an arbitrary number (arbitrary even number for singlet pairing) of Dirac fermion (Majorana fermion when spin rotation symmetry is completely broken) surface modes which remain gapless under arbitrary perturbations preserving the characteristic discrete symmetries. In particuar, these surface modes completely evade Anderson localization from random impurities. These topological phases can be thought of as three-dimensional analogues of well-known paird topological phases in two dimensions such as the Moore-Read Pfaffian state.

[1] A.P. Schnyder, S. Ryu, A. Furusaki, and A.W.W. Ludwig, arXiv:0803.2786