



Condensed Matter
Theory Center



center for nanophysics
and advanced materials

Condensed Matter Colloquium

Thursday, October 4, 2012

2 pm, Room 1201

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The search for topologically degenerate states of superconductors and Majorana fermions

Systems with topological degenerate states, which are protected from splitting by local perturbations are one of the most interesting states of quantum matter. Such topological degeneracies are quantum mechanical many-body phenomena where the states involved are associated with the bulk of the system, which in these cases typically support fractionalized excitations. For over a decade the only candidate systems for directly observing consequences of topological degeneracy were the non-Abelian $\nu = 5/2$ fractional quantum Hall state and chiral p-wave superconductors. More recently, it has been realized that topological phases of superconductors, which support Majorana modes and are one of the simplest topologically degenerate systems, may be engineered in a large class of spin-orbit coupled, time-reversal symmetry broken superconducting systems. The genericness of this class of systems has resulted in several experimental attempts, which have successfully observed preliminary evidence for the Majorana modes in the form of zero-bias conductance peaks and doubled Shapiro steps.

After discussing the proposals for observing Majorana fermions in the semiconductors and the experimental evidence we have so far for the existence of these modes we will discuss some of the issues with the present experiment and alternative scenarios for what the experiments could be seeing. I will then discuss future possibilities in terms of modifications to the experiments, which could avoid the issues in the current set-up and also other detection schemes such as ways to directly test the fractionalization properties of the Majorana modes.

Finally, we will briefly discuss how to understand the Majorana modes in a general setting in terms of a non-local order parameter in one dimension by directly connecting it to the Ising model, which was the first condensed matter model where Majorana fermions were understood.

Refreshments at 1:30 pm in Room 1305F

