

Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Current aspects of topological superconductivity"

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Abstract: Recent experiments have provided mounting evidence for the existence of Majorana bound states (MBSs) in condensed-matter systems. Until the long-term goal of braiding MBSs is achieved, one is prompted to ask: what is the next step in the study of topological superconductivity and MBSs? In my talk I will discuss two topics relating to this question. In the first part I will examine the possibility of, not only detecting the Majoranas, but also witnessing some of their exotic properties. In particular their non-local nature, or in other words, the fact that the MBS is half a fermion whose occupation is encoded in a nonlocal way. I will show that current cross correlations in a T-junction with a single MBS exhibit universal features, related to the Majorana nonlocality. This will be contrasted with the case of an accidental low-energy Andreev bound state. In the second part I will discuss the possibility of realizing a different topological phase hosting MBSs in currently available experimental platforms. This will be a topological superconducting phase which is protected by time-reversal symmetry, and which is characterized by having a Kramers' pair of MBSs at each end. As I will discuss, repulsive interactions are a necessary ingredient for the realization of this phase. I will present a mechanism, based on the interplay between repulsive interactions and proximity to a conventional superconductor, which drives the system into the topological phase. The effect of interactions is studied analytically using both a mean-field approach and the renormalization group. We corroborate our conclusions numerically using DMRG.

[1] Arbel Haim, Anna Keselman, Erez Berg, Yuval Oreg, Phys. Rev. B, **89**, 220504(R) (2014) [2] Arbel Haim, Erez Berg, Felix von Oppen, Yuval Oreg, Phys. Rev. B, **92**, 245112 (2015)
[3] Arbel Haim, Erez Berg, Felix von Oppen, Yuval Oreg, Phys. Rev. Lett. **114**, 166406 (2015)
[4] Arbel Haim, Konrad Wölms, Erez Berg, Yuval Oreg, Karsten Flensberg, Phys. Rev. B **94**, 115124 (2016) [5] Arbel Haim, Erez Berg, Karsten Flensberg, Yuval Oreg, arXiv:1605.07179

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