

Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Majorana Tunnel Junctions"

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Abstract: Majorana bound states have attracted wide attention in recent years as they can form the building blocks of a robust, topologically-protected qubit. In my talk I present results on how to generate, detect and manipulate Majorana bound states within tunnel junctions. In the first part I discuss φ_0 Josephson junctions which are characterized by a finite supercurrent at zero superconducting phase difference and which interestingly require identical ingredients as those needed to generate Majorana bound states in nanowire systems. I demonstrate that the anomalous phase shift of a φ_0 Josephson junction can serve as a new qualitative indicator for Majorana bound states [1] which is readily accessible through recent experiments. In the second part of my talk I propose a hybrid qubit formed by a quantum dot spin qubit and Majorana bound state qubit. I propose both a set of quantum gates acting on the hybrid qubit which is universal for quantum computation without projective measurements and a scalable surface code architecture [2]. In the last part of my talk, I focus on proximity-induced π Josephson junctions in topological insulator edges. I present two models for realizing such a π junction in the absence of external magnetic field and show how they can be utilized to generate a time-reversal symmetric topological superconductor hosting Kramers pairs of Majorana bound states at its interfaces [3].

[1] C. Schrade, S. Hoffman, and D. Loss, arXiv:1607.07794

[2] S. Hoffman, C. Schrade, J. Klinovaja, and D. Loss, PRB 94, 045316 (2016)

[3] C. Schrade, A. Zyuzin, J. Klinovaja, and D. Loss, PRL 115, 237001 (2015)

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