Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Fermionic Quantum Error Correction and Robust Schemes for Information Processing with Majorana Zero Modes"

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Abstract: Recently, there has been a growing effort towards storing quantum information in fermionic states, so that the fermion occupation number is used to define a physical qubit. Quantum information processing and error correction in fermion systems requires a new computational model, however, since Fermi statistics prevents a mapping of local quantum gates acting on fermions to local gates acting on bosons.

We introduce practical steps towards fermionic quantum information processing in a platform with Majorana zero modes, before discussing a general framework for error-correction in any fermionic system. We first introduce a measurement-based scheme for performing unitary "braiding" operations on Majorana zero modes and for detecting their non-Abelian statistics without moving or hybridizing them. In our scheme, the topological qubit encoded in any pair of well-separated Majorana zero modes in a mesoscopic superconductor island is read out from the transmission phase shift in electron "teleportation" through the island in the Coulomb blockade regime. We propose experimental setups to measure this phase shift.

For quantum information processing to be feasible in any fermionic system requires actively correcting for quasiparticle poisoning errors. To address this issue, we introduce a framework for quantum error-correction in fermionic systems. We demonstrate that fermionic quantum error-correcting codes may be constructed from certain *classical* error-correcting codes, and use this mapping to introduce a wide range of fermion codes, including the simplest code to correct for quasiparticle poisoning errors, as well as more complex codes that can detect higher weight errors. We conclude by discussing possible physical implementations.

12:00pm
Tuesday, February 7, 2017
Duboc Room (4-331)

Host: Michael Pretko