# Physics Colloquium
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# 428 Pupin Hall


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# "Quantum Computing with Braids"


- A quantum computer is a (so far) hypothetical device which exploits the strange properties of quantum mechanics to perform qualitatively new kinds of computations -- most notably factoring large integers in polynomial time. Given the delicate nature of quantum states (one need only look at them to disturb them!) building a quantum computer will require some method to protect these states from the environment, while at the same time allowing for their coherent manipulation. A particularly elegant proposal for doing this, due to Alexei Kitaev [1] and Michael Freedman and collaborators [2], is called "topological quantum computation" (TQC). In TQC quantum information is stored in exotic states of matter which are intrinsically protected from decoherence, and quantum operations are carried out by dragging particle-like excitations (quasiparticles) around one another in two space dimensions. The resulting quasiparticle trajectories define world-lines in three dimensional space-time, and the corresponding quantum operations depend only on the topology of the braids formed by these world-lines (more precisely, these operations form a nonabelian representation of the braid group). In this talk I will review the basic ideas behind TQC, and then describe recent work [3] showing how to find braids which can be used to perform arbitrary quantum computations using a specific kind of quasiparticle that is particularly promising for experimental realization. [1] A. Yu. Kitaev, Ann. of Phys. 303, 2 (2003). [2] M. Freedman, M. Larsen, and Z. Wang, Comm. Math. Phys. 227, 605 (2002). [3] N.E. Bonesteel, L. Hormozi, G. Zikos, and S.H. Simon, Phys. Rev. Lett, 95, 140503 (2005). (quant-ph/0505065)


*Host: Prof. Pinczuk*