Hybrid Topological Quantum Computation with Majorana Fermions: A Cold Atom Setup

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In this paper we present a hybrid scheme for topological quantum computation in a system of cold atoms trapped in an atomic lattice. A topological qubit subspace is defined using Majorana fermions which emerge in a network of atomic Kitaev one-dimensional wires. We show how braiding can be efficiently implemented in this setup and propose a direct way to demonstrate the non-Abelian nature of Majorana fermions via a single parity measurement. We then introduce a proposal for the efficient, robust and reversible mapping of the topological qubits to a conventional qubit stored in a single atom. There, well-controlled standard techniques can be used to implement the missing gates required for universal computation. Our setup is complemented with an efficient non-destructive protocol to check for errors in the mapping.

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