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Entanglement Inequalities for Majorana Fermions in Semiconductor Nanowires[1] DAVID DRUMMOND, University of California, Riverside, ALEXEY KOVALEV[2], University of Nebraska-Lincoln, CHANG-YU HOU[3], California Institute of Technology, LEONID P. PRYADKO, KIRILL SHTENGEL, University of California, Riverside — Recent work has provided evidence that unpaired Majorana fermions may exist at the ends of a semiconductor nanowire in the presence of s-wave superconductivity, a magnetic field, and strong spin-orbit coupling. While Majorana fermions are interesting in their own right as self-conjugate quasiparticles, they are also sought after because they could serve as the stable building blocks of topological quantum computing. We propose an experiment that would establish the entanglement of these Majorana fermions by testing an analog of the Bell and CHSH inequalities in nanowire systems. Our proposal is viable with realistic system parameters, simple "keyboard" gating, and projective measurement. Simulation results indicate entanglement can be demonstrated with a relatively small amount of accuracy in the gate operations. Our proposal for testing entanglement inequalities can also be adapted to other systems where Majorana fermions may be present, such as topological insulators. In addition to providing further evidence for the existence of the unpaired Majorana fermions, our proposal could be used as an experimental stepping stone to more complicated braiding experiments.

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