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The exchange statistics of Majorana fermions in quasi-one-dimensional networks DAVID J. CLARKE, University of California, Riverside, JAY D. SAU, University of Maryland, College Park, SUMANTA TEWARI, Clemson University — Under appropriate external conditions a semiconductor with strong spin-orbit coupling in proximity to an s-wave superconductor can be in a topological superconducting (TS) phase. In the topological phase, various defects of the order parameter trap zero energy excitations called Majorana bound states. In a wire geometry the relevant defects are the two ends of the topological region, and each traps a localized zero energy excitation. A network of such wires allows the pairwise exchange of the Majorana bound states. Alicea et al. have shown that these bound states obey non- Abelian exchange statistics, and have proposed [1] such a system as a platform for topological quantum computation (TQC). Here we show that the particular realization of non- Abelian statistics produced in a Majorana wire network is highly dependent on the local properties of individual wire junctions. For a simply connected network, the possible realizations can be characterized by the chirality of individual junctions. We demonstrate how this chirality may be calculated for a particular junction. There is in general no requirement for junction chiralities to remain consistent across a wire network. Careful control of the junction chirality is required for TQC applications of Majorana wire networks. [1] J. Alicea et al., arXiv:1006.4395.

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