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Milestones toward Majorana-based quantum computing: Fusion rule detection and topological qubit validation RYAN V. MISHMASH, DAVID AASEN, Caltech, MICHAEL HELL, Lund University and NBI, Copenhagen, ANDREW HIGGINBOTHAM, Harvard and NBI, Copenhagen, JEROEN DANON, NBI, Copenhagen, MARTIN LEIJNSE, Lund University, THOMAS S. JESPERSEN, NBI, Copenhagen, JOSHUA A. FOLK, NBI, Copenhagen and UBC, CHARLES M. MARCUS, KARSTEN FLENSBERG, NBI, Copenhagen, JASON ALICEA, Caltech — We introduce a scheme for preparation, manipulation, and readout of Majorana zero modes in semiconducting wires coated with mesoscopic superconducting islands. Our approach synthesizes recent advances in materials growth with tools commonly used in quantum-dot experiments, including gate-control of tunnel barriers and Coulomb effects, charge sensing, and charge pumping. Recently, we have outlined a sequence of relatively modest milestones which interpolate between zero-mode detection and longer term quantum computing applications. In this talk, I will discuss two of these milestones: (1) detection of fusion rules for non-Abelian anyons using either proximal charge sensing or Majorana-mediated charge pumping and (2) validation of a prototype topological qubit via unconventional scaling relations between the time-averaged qubit splitting and its decoherence times T_1 and T_2. Both of these proposed experiments require only a single wire with two islands—a hardware configuration already available in the laboratory. Furthermore, these pre-braiding experiments can be adapted to other manipulation and readout schemes as well.

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