Interferometric Single-Shot Parity Measurement in InAs-Al Hybrid Devices

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The fusion of non-Abelian anyons or topological defects is a fundamental operation in measurement-only topological quantum computation. In topological superconductors, this operation amounts to a determination of the shared fermion parity of Majorana zero modes. As a step towards this, we implement a single-shot interferometric measurement of fermion parity in indium arsenide-aluminum heterostructures with a gate-defined nanowire. The interferometer is formed by tunnel-coupling the proximitized nanowire to quantum dots. The nanowire causes a state-dependent shift of these quantum dots' quantum capacitance of up to 1 fF. Our quantum capacitance measurements show flux h/2e-periodic bimodality with a signal-to-noise ratio of 1 in 3.7 μs at optimal flux values. From the time traces of the quantum capacitance measurements, we extract a dwell time in the two associated states that is longer than 1 ms at in-plane magnetic fields of approximately 2 T. These results are consistent with a measurement of the fermion parity encoded in a pair of Majorana zero modes that are separated by approximately 3 μm and subjected to a low rate of poisoning by non-equilibrium quasiparticles. The large capacitance shift and long poisoning time enable a parity measurement error probability of 1%.