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Experimental progress on Majoranas in semiconductors

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Majoranas in semiconductor nanowires can be probed via various electrical measurements. Tunnel spectroscopy reveals zero-bias peaks in the differential conductance. These zero-bias peaks have a particular dependence on magnetic field (amplitude and direction) and electron density. This dependence allows to falsify many alternative theories for the observations. New challenges include a direct demonstration of topological protection, which is provided by a parity protection: How stable is the system's occupation in terms of an even or an odd number of quasi-particles? We demonstrate that the quasi-particle parity in a superconducting Cooperpair box can be stable over timescales of minutes. To demonstrate this protection for Majoranas it is crucial that the induced superconducting gap has negligible sub-gap states. To obtain such "hard gaps" under Majorana conditions currently forms the most important challenge. We report on progress in optimizing materials and measurement techniques.