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Progress in the Search for Majorana Fermions in Condensed Matter

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In 1937 Ettore Majorana predicted the existence of a new kind of fermion that, unlike electrons and positrons, constitutes its own antiparticle. Condensed matter physicists are now fervently chasing such "Majorana fermions" in the solid state, motivated by the exotic fundamental physics they harbor as well as quantum computing applications. I will introduce the detailed properties of Majorana fermions using simple toy models for "topological superconductors" that support these novel excitations. I will then discuss feasible ways of engineering topological superconductivity using widely available building blocks and describe how one can unambiguously identify Majoranas in the laboratory. Very recent experiments that have uncovered the first compelling signatures of Majorana modes will also be discussed. These lectures will be based partly on the recent review article in arXiv:1202.1293.