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Majorana fermions in quasi-1D and higher dimensional ultracold optical lattices CHUNLEI QU, The University of Texas at Dallas, MING GONG, The Chinese University of Hong Kong, YONG XU, The University of Texas at Dallas, SUMANTA TEWARI, Clemson University, CHUANWEI ZHANG, The University of Texas at Dallas — We show that Majorana fermions (MFs) exist in quasi-one dimensional (quasi-1D) and higher dimensional fermionic optical lattices with strictly 1D spin-orbit coupling which has already been realized in experiments. For a quasi-1D topological BCS superfluid, there are multiple MFs at each end which are topologically protected by a chiral symmetry. In the generalization to higher dimensions, the multiple MFs form a zero energy flat band. An additional experimentally tunable in-plane Zeeman field drives the system to a topological Fulde-Ferrell (FF) superfluid phase. We find that even though the multiple MFs are robust against the in-plane Zeeman field if the order parameters at the different chains are enforced to be identical, they are destroyed in the self-consistently obtained FF phase where the order parameters are inhomogeneous on the boundaries. Our results are useful to guide the experimentalists on searching for MFs in the context of ultracold fermionic atoms.

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