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Implementing Majorana fermions in a cold-atom honeycomb lattice with the textured pairing order parameter RUIZHI PAN, DONG-LING DENG, Joint Quantum Institute, University of Maryland, College Park, Maryland, CHARLES CLARK, Joint Quantum Institute, University of Maryland, College Park, Maryland; National Institute of Standards and Technology, Gaithersburg, Maryland — Recent studies in the realization of Majorana Fermion (MF) quasiparticles have focused on engineering the topological superconductivity by combining conventional superconductors and the spin-textured electronic materials. We propose an effective model to create unpaired MFs at the honeycomb lattice edge by generalizing a 2-dimensional topologically nontrivial Haldane model and introducing textured pairing order parameters. The core idea is to add both the spin-singlet and textured spin-triplet superconducting pairings to the pseudospin-state dependent honeycomb lattice with broken Time-Reversal Symmetry (TRS) and satisfy generalized "sweet spot" conditions like in the Kitaev chain model. In our model, the system has the gapped superconducting phase and gapless phase, each of which further bifurcates associated with zero or nonzero topological winding numbers. We claim that the gapped superconducting and gapless phases further divide the TRS broken class and effective Majorana zero modes will arise at edge in some phases. Our theoretical model and several concepts such as the textured pairing order parameter and the "strength" of TRS breaking may an play important role in the future research on implementing MFs with cold atoms in optical lattices.

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