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Realizing Parafermions in Optical Lattices FANGLI LIU, Joint Quantum Institute, Department of Physics, University of Maryland-College Park, ALEXEY GORSHKOV, Joint Quantum Institute, Joint Center for Quantum Information and Computer Science, University of Maryland-College Park — Parafermions, which are the fractional versions of Majorana fermions, possess more exotic braiding statistics than Majorana fermions and are therefore more powerful from the point of view of topological quantum computing. We propose a scheme to realize parafermionic zero modes in optical lattices, without the use of superconductive paring. With the help of laser assisted tunneling and on-site interactions, two layers of ultracold atoms in distinct hyperfine states can be engineered to host $\pm 1/m$ fractional quantum Hall states. We then introduce a finite-extent potential barrier that pierces both layers – this gives rise to two counter-propagating edge states that sit on top of each other. Finally, laser induced coupling is used to introduce backscattering between the two edge states and to gap them out. We show that the resulting defects give rise to the topological degeneracy associated with parafermions. We also discuss methods for preparation and detection.

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