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Bose-Hubbard model with ferromagnetic-like occupation-parity couplings and its realization in imbalanced fermionic superfluids in tubular optical lattices[1] KUEI SUN, CARLOS J. BOLECH, University of Cincinnati — We study a Bose-Hubbard model with a nearest-neighbor occupation-parity coupling that can be considered as energy cost for a domain-wall link between two adjacent sites if their occupation parity is different (one even and the other odd). Our analysis shows that the parity coupling has non-trivial interplay with the tunneling and onsite repulsion, resulting in several exotic quantum phases. For example, a uniform system with zero tunneling can exhibit a pair-liquid phase or phase separation of two Mott insulators, while a trapped system with finite tunneling shows a wedding-cake structure of only even-filling Mott insulators or a structure of central regular superfluid and outer pair superfluid. In addition, we find similar physics in a recent experimental system of imbalanced Fermi gases in optical lattices producing a 2D array of 1D tubes, with the presence of an oscillatory superfluid order parameter (the Fulde-Ferrell-Larkin-Ovchinnikov or FFLO state). We show that the unpaired majority fermions on each tube have a bosonic behavior with cross-tube tunneling, on-tube repulsion, and interplay with the spatial parity of the FFLO order that contributes to the occupation-parity coupling. Therefore, such system provides a realization of our model in two dimensions.

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