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**Repulsive Fermions in the Optical Lattices: Phase separation or Coexistence of Antiferromagnetism and d-Superfluidity?** S. Y. CHANG, Ohio State University, S. PATHAK, Indian Institute of Science, Bangalore, M. BARANOV, P. ZOLLER, IQOQI-University of Innsbruck, Austria, N. TRIVEDI, Ohio State University — We investigate the system of the strong and repulsively interacting fermions in a two-dimensional square optical lattice by using a variational quantum Monte Carlo method. We show that the phase diagram at small hole dopings away from the half filling results from the competition of the homogeneous phase with both antiferromagnetic(AF) and d-wave superfluid(SF<sub>d</sub>) order parameters and the mixed phase of pure AF and SF<sub>d</sub>. We provide the thermodynamic constraints for the phase separation and the phase coexistence. We also establish a connection to the conventional  $t$ - $J$  model and the resonant fermions in the optical lattice where the multi-band effects can be accounted by an effective model.

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