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Unconventional Bose-Einstein Condensations of Two-species Bosons in the p -orbital Bands in Optical Lattice JHSH-SHIH YOU, Department of Physics, Harvard University, I-KANG LIU, Department of Physics and Graduate Institute of Photonics, National Changhua University of Education, DAW-WEI WANG, Physics Department and Physics division, National Center for Theoretical Sciences, National Tsing-Hua University, SHIH-CHUAN GOU, Department of Physics and Graduate Institute of Photonics, National Changhua University of Education, CONGJUN WU, Department of Physics, University of California, San Diego — We investigate the unconventional Bose-Einstein condensations of two-species mixture with p -wave symmetry in the second band of a bipartite optical lattice. Different from the single-species case, the two-species boson mixture exhibits two non-equivalent complex BECs in the intraspecies-interaction-dominating regime, with one breaking time-reversal symmetry while the other not. When the interspecies interaction is tuned across the $SU(2)$ invariant point, the system undergoes a quantum phase transition toward a real-valued checkerboard state characterized by a staggered spin density structure. An experimental scheme for phase measurement is presented. Finally, we will show strong coupling analysis on anti-Hund's rule, Mott-insulating states and the superfluid.

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