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Incommensurate superfluidity of bosons in the optical lattice of double-well potentials VLADIMIR M. STOJANOVIC, Carnegie Mellon University, CONGJUN WU, University of California, San Diego, W. VINCENT LIU, University of Pittsburgh, SANKAR DAS SARMA, University of Maryland, College Park — We study the first excited band of the Bose-Hubbard model in a double-well optical lattice, a setup recently experimentally realized by a group at NIST. A unique feature of this system is the two lowest bands being far separated from the higher bands, which leads to a greatly reduced phase space for the decay of bosons initially occupying the first excited band. By calculating the parameters of the Bose-Hubbard model based on the nonseparable optical lattice potential used in the NIST experiments, we estimate that in the most favorable situations the lifetime of bosons in the first excited band can be several orders of magnitude longer than the characteristic time scales associated with nearest-neighbor tunneling. An additional novel feature of this system is that the band-minima of the excited band occur at an incommensurate finite crystal momentum, suggesting a new superfluid state of circulating currents that spontaneously breaks the time-reversal, rotational, and translational symmetries. We discuss possible physical consequences of this unconventional state.

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