Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Ultracold bosons in one-dimensional incommensurate superlattices TOMMASO ROSCILDE, IGNACIO CIRAC, Max-Planck Institute for Quantum Optics — Motivated by recent experiments (L. Fallani et al., cond-mat/0603655), we numerically investigate the ground-state properties of strongly interacting ultracold bosons in a one-dimensional quasi-periodic superlattice, modeled by the Bose-Hubbard Hamiltonian in an incommensurate cosine potential. In the weakly interacting regime, the incommensurate potential (IP) is known to lead to Anderson localization when exceeding a given critical strength. We find that strong repulsion, giving rise to a Mott-insulating state for the system without the IP, introduces an extremely rich physical scenario. For repulsion values away from the Tonks limit an IP added to the Mott phase is effectively screened by a fraction of the particles, and drives the system to a superfluid phase for the remaining fraction. For larger IPs, a cascade of incompressible insulating states appears with incommensurate fractional fillings. The change of filling from a state to the next is usually accompanied by significant particle number fluctuations without superfluidity, namely by Bose-glass behavior in narrow parameter ranges.

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Date submitted: 20 Nov 2006 Electronic form version 1.4