Effects of restricted geometry on Bose-Einstein condensation in optical lattices

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We study the influence of the restricted geometry of a cubic lattice confined within finite slab of L layers (i.e. of the form $\infty \times \infty \times L$) on the ground state properties of interacting bosons in the optical lattice. Using the quantum rotor approach for the Bose-Hubbard model, we quantify how the restricted slab geometry affects the superfluid to Mott-insulator transition. For increasing values of L both analytical approach for large L as well as direct calculation using lattice density of states for any arbitrary L shows that the behavior of the system becomesindistinguishable from the cubic bulk case ($L = \infty$) even for relatively small values of L ($L \approx 10$). This may appear as an important justification of treating bosons inoptical lattices using methods of statistical physics pertinent for infinite systems.