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Bose Einstein Condensation as a Quantum Phase Transition in an Optical Lattice Model

One of the most remarkable recent developments in the study of ultracold Bose gases is the observation of a reversible transition from a Bose Einstein condensate to a state composed of localized atoms as the strength of a periodic, optical trapping potential is varied. We present a model of this phenomenon which we are able to analyze rigorously. The gas is a hard core lattice gas and the optical lattice is modelled by a periodic potential of strength λ. For small and temperature λ BEC is proved to occur, while at large λ BEC disappears, even in the ground state, which is a Mott-insulator state with a characteristic gap. The inter-particle interaction is essential for this effect. Surprisingly, the condensation is always into the $p = 0$ mode, while the density itself has the periodicity of the imposed potential. This is joint work with M. Aizenman, E.H. Lieb, R. Seiringer and J.P. Solovej.