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Superfluid to Mott Transition in the Bose Hubbard Model: Evidence for New Modes NAOKI KAWASHIMA, YASUYUKI KATO, ISSP, University of Tokyo, Kashiwa, Japan, CHIARA MENOTTI, CRS BEC-INFM and Dipartimento di Fisica, Università di Trento, I-38050 Povo, Italy, NANDINI TRIVEDI, The Ohio State University, Columbus, Ohio — Using a combination of methods (mean-field theory, fluctuations within random phase approximation, and quantum Monte Carlo simulations), we determine the nature of the phases of the Bose Hubbard model. In addition to the sound mode, we find evidence for extra gapped modes in the correlated superfluid phase from the location of the poles of the Green function. We also calculate the effect of thermal and quantum fluctuations on the condensate fraction and compare with recent experiments in optical lattices. In particular, we have obtained the superfluid density and the order parameter independently which agree with each other deep in the condensate phase but disagree in the critical region. We also calculate the Green's function as a function of the distance and the imaginary time separation, from which we estimate the excitation gap of the boson quasi particles.

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