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Quantum phase transition of a Bose gas in a lattice with a controlled number of atoms per site XU DU, C. RYU, EMEK YESILADA, SHOUPU WAN, DANIEL HEINZEN, The University of Texas at Austin — We have studied the superfluid-Mott insulator quantum phase transition [1] of a gas of ^{87}Rb atoms in an optical lattice. We are able to prepare the gas with a controllable number of one, two, or three atoms per lattice site, as verified with photoassociation spectroscopy. We measure momentum distributions using standard time-of-flight imaging techniques. These are similar to those of ref. [1], and exhibit narrow peaks at moderate lattice strengths. We find that the width of these peaks increases for lattice heights greater than about 13 times the recoil energy [2], and we observe interesting differences in this behavior, depending on the number of atoms per site. The data suggest that the quantum phase transition occurs at higher lattice strength with larger site occupation. We acknowledge the support of this work by the R. A. Welch Foundation, The N. S. F., and the D.O.E. Quantum Optics Initiative. [1] Markus Greiner *et al.,* Nature **415**, 39 (2002). [2] Thilo Stöferle *et al.*, Phys. Rev. Lett. **92**, 130403 (2004).

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