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Quantum Phases with Bose-Condensed Cesium Atoms in an Optical Lattice XIBO ZHANG, CHEN-LUNG HUNG, NATHAN GEMELKE, CHENG CHIN, James Fanck Institute, University of Chicago — The realization of the Mott-insulator to superfluid phase transition with neutral atoms in an optical lattice provides a tantalizing opportunity to test many-body physics with a high degree of accuracy. We report progress on an experimental and quantitative comparison of the superfluid to Mott-insulator quantum phase boundary with results from the Bose-Hubbard model, using Bose-condensed cesium atoms confined to a thin layer of an optical lattice potential. Feshbach resonances with cesium atoms enable us to scan the on-site interaction over a wide range without modifying the tunneling rate and the overall trapping potential; chemical potential can be adjusted by loading a varied mean atomic density into the lattice. We describe the physical apparatus constructed for this investigation, including novel construction designed to achieve precise and agile control of the magnetic field used in tuning interactions, adiabatic loading and manipulation of the lattice potential, and tight two-dimensional confinement applied to negate the effect of gravity without sacrifice in system homogeneity.

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