

## **Microwave Spectroscopy of the Mott-Insulator Transition**

Aaron E. Leanhardt

*Department of Physics, University of Michigan, Ann Arbor, MI 48109-1040, USA*

Ultracold atomic gases confined by an optical lattice provide a defect-free, perfectly crystalline system for studying condensed matter and solid state physics. For interacting bosons hopping across a lattice, there is a competition between tunneling and onsite atom-atom interactions that drives the Mott-Insulator transition between superfluid and insulator states. We have probed this transition in an inhomogeneous system using microwave spectroscopy. Our data quantitatively measures the energy gap in the excitation spectrum of the insulator state and reveals clear evidence for a shell structure with insulating states of different occupancy separated by superfluid regions. Additionally, we have demonstrated a microwave frequency atomic clock free from density-dependent shifts using a Mott-Insulator state with one atom per lattice site.