Abstract Submitted
for the DAMOP06 Meeting of
The American Physical Society

Atomtronics: An Ultracold Analog of Semiconductor Devices
BRIAN SEAMAN, MERET KRAEMER, DANA ANDERSON, MURRAY HOLLAND, JILA, University of Colorado — An atom transistor, atom diode and the atomic analogs of solid state electronic components such as the p-type and n-type materials are devised in ultracold boson lattices. An atomic p-type material is based on a lattice with slightly less than integer filling, a small number of holes, which is a superfluid system. The n-type material is created from a bosonic lattice that has just above integer filling, which is also superfluid. An atomic diode is created by attaching a p-type and an n-type material and imposing an external step potential which places each side of the diode at the edge of the Mott insulator and superfluid boundary. Biasing of the diode will either move the system into a completely insulating state or a superfluid state depending on the direction of the bias. When two atom diodes are connected in reverse direction, an atomic transistor is created. These materials provide the building blocks for more advanced atomtronic devices as well as extremely sensitive sensors and controllers.

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Date submitted: 24 Jan 2006 Electronic form version 1.4