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**A lattice of double wells for manipulating pairs of cold atoms.**[1] JENNIFER SEBBY-STRABLEY, MARCO ANDERLINI, BEN BROWN, JOHNNY HUCKANS, JENS KRUSE, PATRICIA LEE, IAN SPIELMAN, National Institute of Standards and Technology, STEVE ROLSTON, University of Maryland, JAMES PORTO, WILLIAM PHILLIPS, National Institute of Standards and Technology — We describe the design and implementation of a 2D optical lattice of double wells suitable for isolating and manipulating an array of individual pairs of atoms in an optical lattice. Atoms in the square lattice can be placed in a double well with any of their four nearest neighbors. The properties of the double well (the barrier height and the energy offset of the paired sites) can be dynamically controlled. The topology of the lattice is phase stable against phase noise imparted by vibrational phase noise on mirrors. We demonstrate the dynamic control of the lattice by showing the coherent splitting of atoms from single wells into double wells and observing the resulting double-slit atom diffraction pattern. This lattice can be used to test controlled neutral atom motion among lattice sites and should allow for testing controlled two-qubit gates.

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