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Deterministic Control of two Fermions in a Double Well THOMAS LOMPE[1], SIMON MURMANN, ANDREA BERGSCHNEIDER, VINCENT KLINKHAMER, GERHARD ZUERN, SELIM JOCHIM, University of Heidelberg — The behavior of an ensemble of fermionic particles confined in a periodic potential is one of the richest topics of condensed matter physics. The simplest and most widely used theoretical description of such systems is provided by the Fermi-Hubbard Hamiltonian. We realize this Hamiltonian by deterministically preparing systems of two fermionic atoms trapped in a double well potential in a quantum state of our choice. We have studied the tunneling dynamics of this system as a function of the interparticle interactions and found good agreement with theoretical expectations. We have thus obtained a single-site addressable realization of the Fermi-Hubbard model where all parameters can be fully controlled and freely tuned. As a first experiment we prepared systems of one $|\uparrow\rangle$ and one $|\downarrow\rangle$ atom in the ground state of the double well, introduced repulsive (attractive) interparticle interactions and observed the crossover into a Mott-insulating (charge-density-wave) regime by measuring the occupation statistics of the individual sites. By adding a third well to the system this approach could be be used to directly observe ordered charge-density-waves and antiferromagnetic ordering.

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