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Preparing Fermions in an Optical Lattice at Ultra-Low Temperature[1] J.R. WILLIAMS, R. STITES, J.H. HUCKANS, E.L. HAZLETT, K.M. O'HARA, Penn State University — Fermionic atoms confined in an optical lattice provide an exciting opportunity for the quantum simulation of iconic models of condensed matter physics. The 2D Hubbard model, for example, which purports to describe high-temperature superconductivity in the cuprates, can be experimentally realized. Exploration of the most interesting phases (e.g. anti-ferromagnetism or d-wave superfluidity), however, will require the attainment of extremely low temperatures, or equivalently, near-zero entropy. We present a preparation method in which a cold, spin-polarized gas of fermionic atoms with a peak atomic density greater than that of the lattice site density is initially loaded into a deep 3D cubic optical lattice. The lowest band of the lattice is fully occupied, while the second band is only partially filled. Selective removal of atoms in the second band is accomplished by intensity modulation of the lattice beams which promotes atoms to a higher-lying band, from where they are allowed to escape the trapping region. The atoms that remain completely fill the lowest band and are at an extremely low temperature. We will discuss theoretical limitations on the achievable temperature and our experimental progress.

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