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New cooling schemes for creating ultra-low entropy states of fermions in optical lattices[1] CHRISTIE CHIU, GEOFFREY JI, ANTON MAZURENKO, MUQING XU, DANIEL GREIF, MARKUS GREINER, Harvard University — Ultracold fermions in optical lattices are a powerful platform for addressing open questions on strongly correlated quantum phases. The readout and control afforded by quantum gas microscopy offers a unique insight into such systems and a deep understanding of the microscopic mechanisms at play. In our experiment, we use a digital mirror device to control the potential landscape of individual atoms. We shape the underlying confinement potential and create near-perfect band insulators of doublons containing more than 250 particles. We then use this band insulator as a starting point for a scheme based on adiabatic state preparation: we continuously change the Hamiltonian by controlling site offsets on individual sites to transform the many-body state into an antiferromagnet at half-filling. In the final state we detect strong antiferromagnetic correlations and find the temperature to be below the magnetic exchange energy. We study the applicability of this scheme to various system sizes and initial configurations, including double-wells, spin ladders as well as regular 1D and 2D lattices. This new cooling method potentially allows realizing temperatures in the future where a superconducting state is expected in the Hubbard model.

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