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Universal Thermodynamics and Dimensional Crossover of a Strongly Interacting Fermi Gas[1] ARIEL SOMMER, MARK KU, LAWRENCE CHEUK, WASEEM BAKR, TARIK YEFSAH, MARTIN ZWIERLEIN, Department of Physics, MIT-Harvard Center for Ultracold Atoms, and Research Laboratory of Electronics, MIT, Cambridge, Massachusetts 02139, USA — We have measured with high precision the universal thermodynamics of a unitary Fermi gas of ^{6}Li atoms using a novel method that requires no fit or external thermometer. This has allowed us to observe the first direct thermodynamic signature of the superfluid transition, revealed in the compressibility, the chemical potential, the entropy, and the heat capacity. Our precision measurement of the thermodynamics provide a benchmark for many-body theories on strongly interacting fermions, relevant for problems ranging from high-T_c superconductivity to the equation of state of neutron stars. In a separate experiment, we follow the evolution of fermionic pairing from three dimensions to two dimensions. Using a 1D optical lattice, we confine ^{6}Li atoms into stacks of two-dimensional pancakes. The reduced dimensionality leads to a 2-body bound state even on the BCS side of a Feshbach resonance. We have measured the binding energy of such pairs across the dimensional crossover using RF spectroscopy. Surprisingly, the binding energy closely follows the theoretical prediction for two particles in vacuum.

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