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Measurement of Universal Thermodynamic Functions for a Unitary Fermi Gas MUNEKAZU HORIKOSHI, Japan Science and Technology Agency, SHUTA NAKAJIMA, MASAHITO UEDA, University of Tokyo, TAKASHI MUKAIYAMA, University of Electro Communications — We measured universal thermodynamic functions for a Fermi gas at the unitarity limit where the s-wave scattering length diverges, by using ultracold ^{6}Li Fermi atoms confined in an optical dipole trap and its Feshbach resonance. At the unitarity limit, thermodynamics is expressed with a universal form that depends only on the particle density and temperature. We measured the universal function of the internal energy as a function of these parameters by using only the general form of the equation of state and the equation of force balance. The validity of the measured thermodynamic function was confirmed in two ways, i.e., the measurement of energy and speed of sound. Other thermodynamic functions such as the free energy, chemical potential, and entropy were derived from that of the internal energy through general thermodynamic relations. The critical point for the superfluid transition was determined by detecting the emergence of the zero center-of-mass momentum component of the paired fermions by using of a rapid field-sweep technique. The measured critical temperature, internal energy, chemical potential, and entropy at the unitarity limit for a homogeneous case are T/T_F=0.17(1), $E/N\varepsilon_F$=0.34(2), μ/ε_F=0.43(1), and S/Nk_B=0.8(3), respectively.

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