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Thermodynamic Measurements in a Strongly Interacting Fermi Gas[1]

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The thermodynamics of strongly interacting Fermi gases is of broad interest, as these systems exhibit universal behavior, where the properties are independent of the details of the microscopic interactions. These gases provide models for testing nonperturbative many-body theories in a variety of fields from neutron stars and nuclear matter to quark-gluon plasmas and high-temperature superconductors. We have observed sound wave propagation throughout the crossover region, by magnetically tuning from a weakly-interacting Fermi gas through the resonant Fermi superfluid regime to a Bose condensate of dimer molecules. The measured sound velocities test the zero-temperature equation of state and confirm the universal hypothesis. We also explore finite-temperature thermodynamics in the universal regime, by measuring the dependence of the entropy on the total energy. These measurements determine the critical temperature for the superfluid transition without invoking any specific theoretical model.

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