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Exploring perfect fluidity in universal atomic gases

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Fermionic systems at unitarity exhibit universal behavior independent of the microscopic interactions. That such systems exist across vastly different fields of physics such as the quark-gluon plasma, neutron matter and ultracold atomic gases allows insights and studies in one to yield consequences to the others. One such common thread relates the hydrodynamics of the universal system to its thermodynamics through the ratio of its shear viscosity to its entropy density. By string theoretic methods, this ratio is currently believed to be bounded from below, in essence defining the perfect fermionic fluid. We study this state of matter in an ultracold atomic gas of ^{6}Li. A mixture of atoms with spins $\pm 1/2$ up/down is tuned with a magnetic field near a broad Feshbach resonance where the scattering cross section between the two spin states diverge. This, along with the ultracold temperatures, ensures a two-body scattering amplitude at the unitary limit. Our previous measurement of the entropy of this strongly-interacting system provides half of the information needed to test the string theory bound. The other half comes from new measurements of viscosity in the normal (non-superfluid) phase of the gas. Viscosity measurements are made by studying the evolution of the density of a rotating and expanding cloud of atoms. Comparison to ideal hydrodynamic motion allows for an estimate of the viscosity. We present the data from these studies and their preliminary analysis, including a comparison to the string theory limit.