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Experiments with Interacting Fermi Gases[1]

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An optically-trapped mixture of spin 1/2-up and spin 1/2-down ^{6}Li atoms provides a paradigm for exploring interacting Fermi systems in nature. This ultracold atomic gas offers unprecedented opportunities to test theoretical techniques that cross interdisciplinary boundaries. A bias magnetic field is used to tune the gas near a Feshbach resonance, enabling studies from the weakly interacting regime to the most strongly interacting nonrelativistic system known. In the weakly interacting regime, the gas exhibits nearly undamped spin waves. In the strongly interacting regime, it exhibits a high temperature superfluid transition and extremely low viscosity hydrodynamics in the normal fluid. The strongly interacting regime is of great interest in the quark-gluon plasma and string theory communities, where it has been conjectured that the ratio of the shear viscosity to the entropy density has a universal lower bound, which defines a perfect fluid. I will describe our all-optical cooling methods and our studies of the thermodynamic and hydrodynamic properties of the ^{6}Li cloud, as well as our discovery of a new mechanism for creating spin waves in this system.

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