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Experimental studies of spin-imbalanced Fermi gases in 2D geometries[1]

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We study the thermodynamics of a quasi-two-dimensional Fermi gas, which is not quite two-dimensional (2D), but far from three dimensional (3D). This system offers opportunities to test predictions that cross interdisciplinary boundaries, such as enhanced superfluid transition temperatures in spin-imbalanced quasi-2D superconductors, and provides important benchmarks for calculations of the phase diagrams. In the experiments, an ultra-cold Fermi gas is confined in an infrared CO_2 laser standing-wave, which produces periodic pancake-shaped potential wells, separated by 5.3 μm. To study the thermodynamics, we load an ultra-cold mixture of $N_1 = 800$ spin -up and $N_2 < N_1$ spin -down ^{6}Li atoms into each well and image the individual cloud profiles as a function of interaction strength and spin imbalance N_2/N_1. The measured properties are in disagreement with 2D-BCS theory, but can be fit by a 2D-polaron gas model, where each atom is surrounded by a cloud of particle-hole pairs of the opposite spin. However, this model fails to predict a transition to a spin-balanced central region as N_2/N_1 is increased.

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