and ν is given in units of E_F/h. This prediction requires that atoms transferred to the third spin-state have only weak interactions with the other atoms, so that "final state effects" are negligible [15–22], as is the case for ${}^{40}K$ atoms. In Fig. 1b, we plot a measured rf spectrum multiplied by $2^{3/2}\pi^2\nu^{3/2}$. The rf spectrum, $\Gamma(\nu)$, is normalized so that the integral over the rf lineshape equals 0.5. Empirically, we observe the predicted $1/\nu^{3/2}$ behavior for $\nu > \nu_C$. To obtain the contact we average $2^{3/2}\pi^2\nu^{3/2}\Gamma(\nu)$ for $\nu > \nu_C$ where $\nu_C = 5$ for $(k_F a)^{-1} > -0.5$, and $\nu_C = 3$ for $(k_F a)^{-1} < -0.5$.

The connection between the tail of the rf spectrum and the high-k tail of the momentum distribution can be seen in the Fermi spectral function, which can be probed using photoemission spectroscopy for ultra cold atoms [10]. Recent photoemission spectroscopy results on a strongly interacting Fermi gas [23] revealed a weak, negatively dispersing feature at high k that persists to temperatures well above T_F. This feature was attributed to the effect of interactions, or the contact, consistent with a recent prediction that the $1/k^4$ tail in $n(k)$ should correspond to a high-k part of the spectral function that disperses as $-k^2$ [24]. Atom photoemission spectroscopy, which is based upon momentum-resolved rf spectroscopy, also provides a method for measuring $n(k)$. By integrating over the energy axis, or equivalently, summing data taken for different rf frequencies, we obtain $n(k)$. This alternative method for measuring $n(k)$ yields results similar to the ballistic expansion technique, but avoids the issue of magnetic-field ramp rates.

In Fig. 2 we show the measured contact for different values of the dimensionless interaction strength, $1/k_F a$. Here, the contact is extracted using the three different techniques described above to probe two distinct microscopic quantities, namely the momentum distribution and the rf lineshape. We find that the amplitude of the $1/k^4$ tail of $n(k)$ and the coefficient of the $1/\nu^{3/2}$ tail of the rf spectra yield consistent values for C. The solid line is a prediction for the contact that was reported in Fig. 1 of Ref. [5]. This prediction consists of the BCS limit, interpolation of Monte Carlo data near unitarity, and the BEC limit for a trapped gas at zero temperature and uses a local density approximation.

Remarkably, the Tan relations predict that the contact, as revealed in probes of the microscopic behavior of the gas, is directly connected to the thermodynamics of the gas. To test the Tan relations, we measure the potential energy and release energy of the cloud. The total energy of the trapped gas divided by the number of particles, E, is the sum of three contributions, the kinetic energy T, the external potential energy V, and the interaction