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Exploring an ultracold Fermi-Fermi mixture of ^{6}Li and ^{40}K atoms[1]

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All experiments in the prospering field of strongly interacting Fermi gases have so far been restricted to spin mixtures of either ^{6}Li or ^{40}K atoms. Many new opportunities are offered by mixtures of different species, with the combination of ^{6}Li and ^{40}K being the obvious prime candidate for a Fermi-Fermi mixture. Such systems promise new experimental model systems, e.g., for superfluid regimes with pairing of particles with different masses or novel quantum phases in optical lattices. Essential for further progress in this field is to understand the elementary interaction properties of such a mixture. We have realized an optically trapped mixture of ^{6}Li and ^{40}K and identified a number of Feshbach resonances in various combinations of spin states. We have interpreted our data using a simple asymptotic bound state model and full coupled channels calculations. This unambiguously assigns the observed resonances in terms of various s- and p-wave molecular states and fully characterizes the ground-state scattering properties in any combination of spin states. We find a triplet scattering length of $+63.5(1)a_0$ and a singlet scattering length of $+52.1(3)a_0$, where a_0 is Bohr's radius. All identified s-wave Feshbach resonances are rather narrow and closed-channel dominated. This finding is important for further experiments, e.g. for generalized BEC-BCS crossover studies in an ultracold Fermi-Fermi system involving different masses. Work performed in collaboration with E. Wille, F. Spiegelhalder, G. Kerner, D. Naik, A. Trenkwalder, G. Hendl, F. Schreck (IQOQI and Univ. Innsbruck); T. Tiecke, J. Walraven (Univ. Amsterdam); S. Kokkelmans (Univ. Eindhoven); E. Tiesinga, P. Julienne (JQI, NIST and Univ. Maryland).

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