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Pairing and superfluidity in a gas of strongly interacting fermions

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Ultracold quantum degenerate Fermi gases provide a remarkable opportunity to study superfluidity with the control and precision of atomic physics. We have studied a two-component gas of lithium-6 atoms for various strengths of the interactions and population imbalances and obtained the phase diagram for the superfluid and normal phases. Below a tricritical temperature, the first order phase transition is observed through a discontinuity of the density at the superfluid-to-normal phase boundary. Insight into the nature of fermionic pairing is obtained through RF spectroscopy. In the superfluid system studied previously which consists of atoms in the two lowest hyperfine states (the 1-2 mixture), RF spectra could not be consistently interpreted due to strong final state interactions. We find that a 1-3 mixture is stable and yields clean pair dissociation spectra from which we obtain the size of the superfluid pairs. The value of $1.4/\mathrm{k}_F$ is smaller than the interparticle spacing and constitutes the smallest pair size observed in any fermionic superfluids. This work was done in collaboration with Yong-Il Shin, Christian Schunck, and Andre Schirotzek.