Conversion of an Atomic Fermi Gas to a Molecular Bose Gas

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An ultracold Fermi gas of ^{6}Li atoms was converted into an ultracold gas of $^6Li_2$ molecules. This was accomplished by adiabatic passage through a magnetically tuned scattering resonance between pairs of free atoms and a bound molecular state ("Feshbach resonance"). More than 10^5 molecules were produced with 50% efficiency and confined to an optical trap. The molecules are formed with a high degree of vibrational excitation, so they would normally be expected to collisionally decay into molecules with lower vibrational energy, causing rapid heating and destruction of the ultracold gas. However, we have observed lifetimes of ~1 s, which is sufficient for thermalization and the formation of a Bose-Einstein condensate (BEC) of molecules. The extended lifetime is apparently a quantum statistical effect related to the suppression of *s*-wave interactions between identical fermions. The phase space density of the bosons is estimated to be greater than 0.5. I will discuss our attempts to directly image a molecular condensate using an optical transition in the molecule. This would not only provide direct detection of the condensate, but also the means to observe its formation. The ultimate objective of this work is to form a Fermi superfluid by inducing Cooper pairing in the Fermi gas. According to theory, the necessary temperature and density conditions have been achieved. I will discuss our attempts to detect superfluid properties.