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Ultracold Heteronuclear Fermi-Fermi Molecules

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Spin mixtures of quantum-degenerate fermionic gases exhibit long lifetimes in the strongly-interacting regime near a Feshbach resonance. This has opened the door for numerous key experiments like the creation of Fermi-Fermi molecules, the realization of molecular BEC, the observation of a pairing gap and of superfluidity in a fermionic gas in the BEC-BCS cross-over region near a Feshbach resonance. We present the production of ^{6}Li-^{40}K heteronuclear molecules based on our experimental platform for the production of a two-species mixture of quantum-degenerate Fermi gases. Our production scheme for quantum-degenerate fermionic ^{6}Li and ^{40}K and bosonic ^{87}Rb gases is based on multiple species magneto-optical trapping [1] and sympathetic cooling of the fermions by rubidium. We demonstrated catalytic cooling of lithium by potassium, overcoming the small lithium rubidium cross section. We achieved to simultaneously enter quantum degeneracy for all three species [2] with lowest temperatures of 0.25 and 0.35 times the Fermi temperature for lithium and potassium at about 260 nK. The highest atom numbers achieved are $1.8\text{x}10^5$ for lithium as well as potassium, and about $1\text{x}10^5$ for rubidium. We studied two s-wave Feshbach resonances between lithium and potassium [3] at 155 G and 168 G. By magnetic field sweeps we created about $4{\cdot}10^{46}$Li-^{40}K molecules at conversion efficiencies of up to 50 % [4]. With a Stern-Gerlach purification technique we are able to image molecules and atoms spatially separated from each other. We discuss the lifetime of the molecule-atom mixture close to resonance.

References:

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