Title: Quantum mixtures of atoms and molecules

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Abstract: We trap atomic ensembles of fermionic lithium and bosonic rubidium, and cool both species into the quantum degenerate regime. We realize a Bose-Fermi mixture with tunable interactions, create a molecular Bose Einstein condensate, observe pre-formed pairs in a strongly interacting Fermi gas, and demonstrate phase coherent transformation of atoms into deeply bound molecules. Our aim is to study Bose-Fermi atomic mixtures and Li2 and RbLi molecules in the ground ro-vibrational state. Of particular interest, paramagnetic molecules are essential to many quantum materials proposals. Thus a central goal is to answer the fundamental question facing the field “Are alkali-dimers (and in particular Li2 and RbLi molecules) in the lowest triplet (paramagnetic) state metastable or not ?"