ULTRACOLD ALKALI METAL ATOMS AND DIMERS: A QUANTUM PARADISE

PAUL S. JULIENNE, *Atomic Physics Division and Joint Quantum Institute, NIST, Gaithersburg, MD 20899-8234*.

Experimental studies with ultracold alkali metal atoms have proved to be enormously successful over the last several years, giving rise to multidisciplinary research with bosonic or fermionic quantum degenerate systems in atomic gases or reduced dimensional optical lattice structures. Several groups have recently produced single molecules made by combining two individual atoms confined in single cells of an optical lattice array. Much of this work is made possible because of the precise control available by tuning bound states through the molecular dissociation threshold with a magnetic field. Constructing predictive theoretical models of such systems requires an accurate knowledge of the bound and scattering states near the dissociation threshold of the two atoms. This in turn requires a knowledge of the potential energy curves and spin-interactions of the molecular dimer. The key to characterizing interactions of ground state atoms is knowing the s-wave scattering lengths for the $^1\Sigma$ and $^3\Sigma$ molecular potentials and the van der Waals dispersion coefficient. Semiempirical models, calibrated against experimental data, give an excellent description of the near-threshold molecular physics when the necessary data are available. This talk will give examples using the Li_2, Cs_2, and KRb systems, all of which are being used in current experimental research. Also, ultracold quasi-two electron atoms such as Sr and Yb have been successfully cooled to the microkelvin domain. Experimental groups are starting to work with mixed alkali-Sr or alkali-Yb systems, about which little is known.