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Understanding ultracold polar molecules

PAUL JULIENNE, NIST

The successful production of a dense sample of ultracold ground state KRb polar molecules [1] opens the door to a new era of research with dipolar gases and lattices of such species. This feat was achieved by first associating a K and a Rb atom to make a weakly bound Feshbach molecule and then coherently transferring the population to the ground vibrational level of the molecule. This talk focuses on theoretical issues associated with making and using ultracold polar molecules, using KRb as an example [2]. Full understanding of this species and the processes by which it is made requires taking advantage of accurate molecular potentials [3], *ab initio* calculations [4], and the properties of the long-range potential. A highly accurate model is available for KRb for all bound states below the ground state separated atom limit and could be constructed for other species. The next step is to develop an understanding of the interactions between polar molecules, and their control in the ultracold domain. Understanding long-range interactions and threshold resonances will be crucial for future work. [1] K.-K. Ni, *et al*, Science 322, 231(2008). [2] P. S. Julienne, arXiv:0812:1233. [3] Pashov *et al.*, Phys. Rev. A76, 022511 (2007). [4] S. Kotochigova, *et al.*, arXiv:0901.1486.