Ground state optical transfer of ultracold KRb molecules

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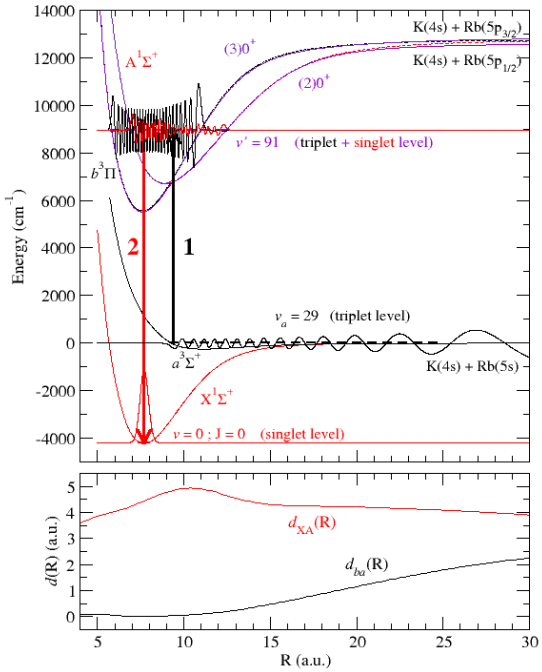
Polar molecules have a richer internal structure than atoms and possess a strong electric dipole moment in the molecular frame. Due to this specific feature, cold an ultracold polar molecules opened the way towards fascinating researches and new possibilities for controlling quantum systems.

In this work we will focus on the ground state ultracold KRb molecules production [1]. Initially, the molecules are formed by magneto-association of ultracold atoms through a Feshbach resonance : the molecules are then in a weakly bound vibrational level with triplet character. Finally, we want the molecules to be optically transferred to the lowest electronic, vibrational and rotational level, with singlet character. To do this, a two-step STIRAP transfer scheme is used. To achieve highly efficient transfer, we need to determine a suitable intermediate level with a mixed triplet and singlet character. This requirement can be fulfilled by vibrational level of the $(b^3\Pi$ / $A^1\Sigma^+)$ states mixed by the spin-orbit coupling. We have investigated such a transfer scheme by using state of the art Potential Energy Curves (PECs), R-dependent spin-orbit coupling and transition dipole moment *d(R)* to perform our calculations.



The proposed transfer scheme is summarized on the joint figure. The initial weakly bound, the intermediate and the final absolute ground levels wavefunctions are shown together with the involved PECs (upper panel) and the relevant transition dipole moments *d(R)* (lower panel).

To avoid collisional losses during manipulation, the molecules are loaded in an optical lattice with one molecule per lattice site. We have investigated the interaction of KRb molecules with an oscillating electric field in order to conveniently choose the wavelength of the trapping laser so that the initial and final molecular levels involved in the STIRAP scheme are equally well trapped. We have then determined the magic wavelength for which the dynamic polarizability acquired by the molecules (interacting with the trapping light) is equal in both the initial and the final states [2].

References:

[1] K.-K Ni et al., Science **322**, 231 (2008).

[2] R. Vexiau et al., Eur. Phys. J. D **65**, 243 (2011).