Finding pathways for creation of cold molecules by laser spectroscopy

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The diatomic alkali molecules are of serious interest for the cold matter physics. This research is focused on developing a model for efficient transfer of ^{23}Na^{39}K molecules from the Na(3s)+K(4s) asymptote to the lowest levels of the singlet ground state. The experiment is done in an ultrasonic beam apparatus, using a Λ -scheme with fixed pump and scanning dump laser. The signals are observed as dark lines on a constant fluorescence. The intermediate level is chosen to be strongly perturbed by the $B^1\Pi$ - $c^3\Sigma^+$ states mixing [1], helping to overcome the singlet-triplet transfer prohibition. In the beam NaK is created in its singlet ground state and the transfer is driven to the triplet state, but this scheme can work also in the reversed direction. Precise potential energy curves for singlet and triplet ground state already exist from previous work of our group [2]. We observe highly resolved hyperfine spectra of various rovibrational levels (from v=2 up to the asymptote, for N=4,6,8) of the $a^3\Sigma^+$ state with resolution better than 10MHz. Two different theoretical models are used in parallel to describe the observations. The first one is based on molecular parameters. The other uses potential curves, taking into account all couplings as functions of the internuclear distance and calculating the energy levels for all the quantum numbers in a coupled state model. With these results an efficient pathway for the creation of cold NaK molecules is demonstrated.

References

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