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FOURIER TRANSFORM SPECTROSCOPY OF THE $a^3\Sigma^+$ AND $X^1\Sigma^+$ STATES IN RbCs

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RbCs is studied in the ultracold regime [1] already since 2005. In order to elaborate optimal schemes for production of ultracold molecules as well as to transfer them into their lowest rovibrational level of the ground state $X^1\Sigma^+$ accurate knowledge of potential energy curves (PEC) of the $a^3\Sigma^+$ / $X^1\Sigma^+$ states close to the asymptotes of Rb (5S) and Cs (6S) atomic pair is crucial.

At present the highest observed vibrational level of $X^1\Sigma^+$ v_X = 119 [2] is rather far (about 30 cm^{-1}) from the dissociation limit, and the $a^3\Sigma^+$ state is not observed at all by conventional spectroscopy. Hence present PECs do not allow calculating scattering lengths and Feshbach resonances with acceptable accuracy.

We report on first high-resolution observations of the RbCs $a^3\Sigma^+$ state as well as ground state vibrational levels higher than v_X= 119 in laser induced fluorescence (LIF) recorded through a Fourier transform spectrometer (FTS).

RbCs molecules were produced in a heat-pipe at a temperature of about 280^0C. Transitions to $a^3\Sigma^+$ were recorded when radiation from a tunable diode laser with central frequency around 705 nm was used for excitation of the $B^1\Pi \leftarrow X^1\Sigma^+$ transitions. The frequency range used in the present experiment was between 14063 cm^{-1} and 14149 cm^1. It is well known that the $B^1\Pi$ state is strongly perturbed by the nearby triplet state $c^3\Sigma^+$ thus opening the window to the triplet manifold. Subsequent LIF transitions ($B^1\Pi \sim c^3\Sigma^+$) $\rightarrow X^1\Sigma^+$ and ($B^1\Pi \sim c^3\Sigma^+$) $\rightarrow a^3\Sigma^+$ were recorded with FTS Bruker IFS 125 HR at a resolution 0.03 cm^{-1}. At present the obtained data field for $a^3\Sigma^+$ state covers v_a from 6 to 31 with rotational levels J_a from 24 to 155.

The very high vibrational levels of the ground $X^1\Sigma^+$ state were observed when the $(4)^1\Sigma^+$ state was excited at frequencies within the range 17542-17609 cm^{-1} applying a single mode dye laser (Coherent 599–21) with Rhodamine 6G dye. At present we have observed (4) $^1\Sigma^+ \rightarrow X^1\Sigma^+$ transitions up to v_X = 127 for rotational levels about 20. For several J_X resonant $X^1\Sigma^+ \sim a^3\Sigma^+$ mixing due to hyperfine interaction is clearly pronounced in the spectra, especially for v_X=122.

First evaluations of the obtained data were already performed for full modeling of singlet ~ triplet coupling through coupled channels calculations yielding potential energy curves for which we believe that they will be accurate enough for a reliable prediction of cold collision parameters for Rb and Cs atomic pairs. Work is in progress.

References

[1] J. M. Sage, S. Sainis, T. Bergeman, D. DeMille, Phys. Rev. Lett. 94, 203001 (2005).
[2] C.E. Fellows, R.F. Gutterres, A. P. C. Campos, J. Verges, and C. Amiot, J. Mol. Spectr. 197, 19 (1999).