Journal of Physics: Conference Series **635** (2015) 032042 doi:10.1088/1742-6596/635/3/032042

Observation of Electronic States of Rb_2 in the Energy Range 20300-21900 cm^{-1}

J. Yang[1], Z. Zhou, W. Zhao, X. Han, X. Dai[2]

State Key Laboratory for Low-Dimensional Quantum Physics, Department of Physics, Tsinghua University, Beijing 100084, China

Synopsis Thousands of energy levels of Rb_2 along with dozens of collisional lines are observed in the energy range 20300 – 21900 cm^{-1} using double resonance technique. They are assigned as the $2^3\Pi_{0g}$, $4^1\Sigma_g^+$, and $3^1\Sigma_g^+$ states. Strong perturbations among the three states are observed.

Diatomic alkali molecules play an important role in the research of cold atoms and molecules, coherent control, etc [1-4]. So there is an obvious need for accurate knowledge of their electronic structures, especial for diatomic rubidium molecules.

Using Infrared-Infrared Double Resonance (IIDR) high resolution spectroscopy, we have observed the $2^3\Pi_{0g}$, $4^1\Sigma_g^+$, and $3^1\Sigma_g^+$ electronic states of Rb_2 in the 20300-21900 cm^{-1} energy range (see **Figure 1**) [5-6].

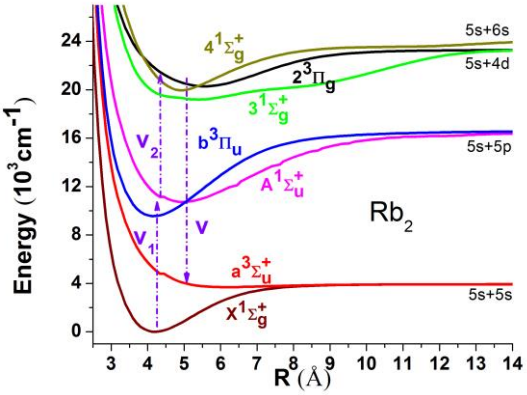

Figure 1. Ab *initio* potential energy functions for several states of Rb_2. The dotted line arrows v_1, v_2 and v represent the process of Infrared-Infrared Double Resonance (IIDR).

In our experimental setup, the temperature of the rubidium vapor was about 550 K and 100 Pa Argon was filled as a buffer gas. Two Toptica DL 100 single-mode cw diode lasers were employed as the pump laser and the probe laser, respectively. The lasers overlap at the center of the heat pipe oven. We collect the fluorescence by a photomultiplier with an optical filter.

The energy levels of the middle states $A^1\Sigma_u^+$ and $b^3\Pi_{0u}$, which are strongly mixed and have both singlet and triplet characteristics, were used as the intermediate levels. So both the upper singlet and triplet states can be accessed.

For each state, we obtained abundant energy levels. The absolute vibrational quantum number assignment is based on the isotope effect since the states of both the $^{85}Rb^{85}Rb$ and $^{85}Rb^{87}Rb$ isotopomers are observed.

In addition, we have detected dozens of lines due to collisional transfer and their assignments are all confirmed. Based on the observed term values of each state, we obtain their molecular constants and RKR potential curves.

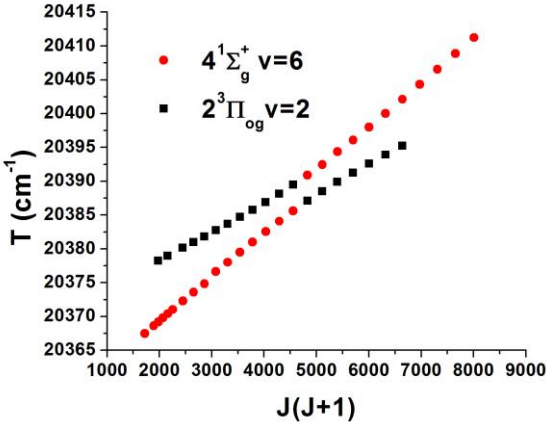

Figure 2. Observed avoided crossing between $2^3\Pi_g$ state v=2 and $4^1\Sigma_g^+$ state v=6 energy bands.

By comparing the observed term values and the calculated term values from the molecular constants, strong perturbations between the $2^3\Pi_{0g}$ and $4^1\Sigma_g^+$ states are clearly demonstrated (see **Figure 2**), as well as between the $4^1\Sigma_g^+$ and $3^1\Sigma_g^+$ states.

References

[1] T. Takekoshi *et al* 2011 *Phys. Rev. A* **83** 062504
[2] P. S. Zuchowski *et al* 2010 *Phys. Rev. A.* **81** 060703
[3] G. Auboeck *et al* 2010 *J. Chem. Phys.* **132** 054304
[4] H. E. L. Martay *et al* 2009 *J. Chem. Phys.* **80** 033403
[5] Y. Guan *et al* 2013 *J. Chem. Phys.* **139** 144303
[6] X. Han *et al* 2014 *Chem. Phys. Lett.* **601** 124058

[1]E-mail: yangjx12@mails.tsinghua.edu.cn
[2]E-mail: xingcandai@mail.tsinghua.edu.cn