Homogeneous Perturbation Between the c'$_4{}^1\Sigma_u^+$(v'=0) and b' $^1\Sigma_u^+$(v'=1) Rotational States of N_2

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Introduction

Many measurements and accurate theoretical calculations have been reported about the c'$_4{}^1\Sigma_u^+$and b' $^1\Sigma_u^+$states. Yoshino et al[1] reported homogeneous perturbation between the c'$_4{}^1\Sigma_u^+$ (v'=0) and b' $^1\Sigma_u^+$ (v'=1) states with absorption spectrum. Their perturbation theoretical calculations agree with experimental data.

In this study rotational resolved emission spectra of the c'$_4{}^1\Sigma_u^+$ (v'=0) and b'$^1\Sigma_u^+$ (v'=1) states were observed. Lifetime measurements about the rotational levels were performed using single bunch mode.

Experiment

The experiments were performed on beam line 20A. The synchrotron radiation was monochromized by 3-m normal incidence Eagle mounted scanning monochromator with a 2,400 line/mm grating which has resolution (E/ΔE) of about 60,000 with 10μm exit/entrance slit widths.

We used two detectors on this experiment. One is MCP (Microchannel plate) and the other is PMT (Photomultiplier tube) with MgF_2 window. Since each detector has different wavelength sensitivity, upper level $\rightarrow$ ground state $X^1\Sigma_g^+$ transition is observed by MCP, and upper level : $a^1\Pi_g$ transition is observed by PMT.

Results and Discussion

Observed spectra using MCP and PMT show in Fig.1(a) and Fig.1(b), respectively. Since the c'$_4$(0) and b'(1) states have the same symmetricity, rotational levels which have the same rotational quantum number J', occur homogeneous perturbation[2]. The influence of the perturbation irregularity is confirmed from interval of rotational lines. In Fig.1(a), the b'(1) band overlapped the c_4'(0) band. Since the c_4'(0) states internuclear distance is near that of the ground state. Therefore, it seems that the c_4'(0) states has large emission intensity by the Frank-Condon principle. As seen in Fig.1(b) rotational levels which are largely perturbed, have intensities much larger than those of other rotational levels. It is noted that upper level $\rightarrow$ $a^1\Pi_g$ transitions are increased by homogeneous perturbation.

Fig.2 represent the lifetimes of rotational lines of the c'$_4$(0) and b'(1) states. Rotational levels of c'$_4$(0) have lifetimes 0.59~1.16 nsec and those of b'(1) have lifetimes 0.71~1.59 nsec.

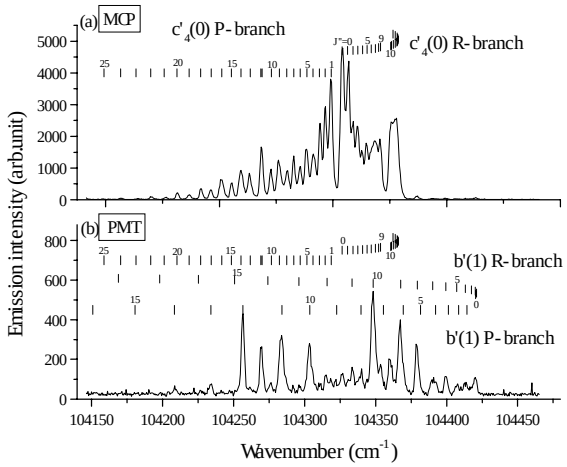

Fig.1 Emission spectra of N_2 c'$_4{}^1\Sigma_u^+$(v=0) and b'$^1\Sigma_u^+$(1)

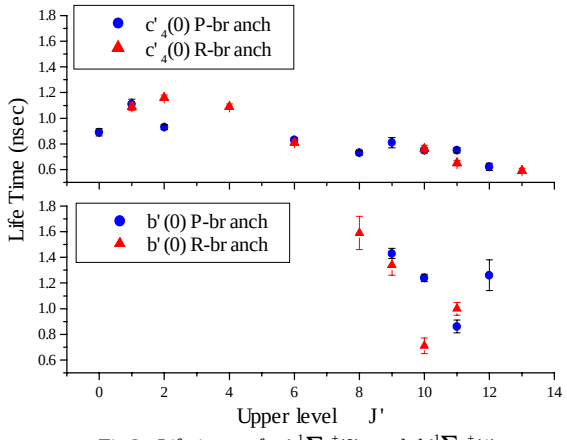

Fig.2 Lifetimes of c'$_4{}^1\Sigma_u^+$(0) and b'$^1\Sigma_u^+$(1)

References

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