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BAND SPECTRA OF F-X SYSTEM OF K_2 MOLECULE USING HIGH PRESSURE XENON ARC

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Abstract

An ultraviolet band spectra of K_2 molecule has been recorded in the first order on a 3.4m Ebert Spectrograph giving reciprocal dispersion of 5.1Å/mm. In this system twelve bands have been observed and measured. This work presents the vibrational analysis of the F-X system. Computer methods are used to evaluate the vibrational constants.

Keywords: Band spectra, k_2 molecule, xenon arc

Introduction

The ground state of potassium is $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^1$ when one electron of the outer most shell combines with an other atom of the same element, one would expect singlet or triplet state. However only singlet states have been observed so far. Seven states of the bands have been investigated of K_2 molecule and analysed. The first band spectra of K_2 molecule were photographed by McLennan and Ainslie (1) in the visible region. Crane and Christy (2) recorded the A-X system of $_2$ molecule. Loomis (3) and Loomis and Nusbaum (4) reported the B-X system in the red region. Yamamoto (5) studied the C-X system. The D-X system was observed by Sinha (6). Yoshinaga (7) worked in the ultraviolet region and reported the several systems such as E-X, F-X and G-X and made the vibrational analysis of these recorded bands in absorption. Later Sinha (8) worked in the same region and reported two regions 3924-3686Å and 3640-3430Å and found the analysis of Yoshinaga unsatisfactory. The analysis of the first region was carried out successfully and named it as the E-X system but later systems were left without analysis. Sinha did this work on a Hilger Ed quartz spectrograph and used 6 volts motor headlamp as background source. Lately Robbeck and Youghan (9) observed in low power discharge tube a group of anomalous bands in the region 5605-5725Å. These bands were reported to be very wide and without any structure even at high dispersion. The aim of the present work is to restudy the reported regions on a high resolving power 3.4m Ebert Spectrograph using high pressure xenon arc as background source and to do the analysis left out by Sinha (8). Khalid *et al.* (10) have recorded the E-X, F-X, G-X and H-X systems of K_2 molecule in ultraviolet region. The present work reports that five new bands have been observed in the F-X system. The analysis has been carried out to evaluate the molecular constants using computer methods.

Experiment

The experiment was done in absorption by heating the pure potassium in a 1.5m long resistance heated furnace, directly heated by a 10KVA transformer, to about 600°C. The heating is done in an atmosphere of hydrogen at a pressure of 400 torr. The high pressure xenon arc (450W) was used as background source. It provides a continuous spectrum in the ultraviolet as well as in visible regions. The spectrum was taken in the first order of a 3.4m Ebert plane grating spectrograph giving

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reciprocal dispersion of 5.1Å/mm. The spectrum was recorded on Kodak X-omat X-ray plates with exposure time ranged from 20 to 30 minutes. The measurement of the plates was recorded by comparison with the iron arc lines, the iron wave lengths being taken from MIT wave length tables (11). A polynomial fitting programme was used to obtain the wave lengths of the spectrum. The measurements of the band heads were observed on Zeiss Abbe Comparator by comparison with iron arc lines, estimated to be accurate to ±0.5Å. The vacuum wave number of the wave lengths were obtained from the data of Coleman *et al.* (12).

Result and Discussion

This work reports that the E-X, F-X and G-X systems of K_2 molecule have been reproduced. Vibrational analysis of E-X system given by Sinha (8) is confirmed. The F-X system lies in the region 3694 to 3559Å and contains twelve bands (Table-1). Five new bands have been discovered. All the bands are degraded towards red and provide sharp heads for reliable measurements to the first decimal place of the angstrom.

As mentioned earlier, this band system was also recorded by Sinha (8) but the vibrational analysis and assignment of quantum number were leftout. The vibrational analysis was done keeping in view the direction of degradation and the ground state vibrational constants accurately known from Herzberg (13). (Table-1) gives the comparison of band positions of authors with those of Sinha (8). The vibrational assignment for the bands (Table-2) has been carried out. It shows the good agreement between the measured and calculated values.

Table: 1. Shows comparision of band spectra.

S. No	λ Authors Å	λ Sinha (1950) Å
1	3693.9*	-
2	3685.8*	-
3	3660.2*	-
4	3652.0*	-
5	3640.1	3640.3
6	3632.2	3632.2
7	3620.5*	-
8	3611.7	3612.7
9	3603.8	3603.5
10	-	3600.0**
11	-	3594.8**
12	-	3590.7**
13	-	3586.4**
14	-	3583.5**
15	3575.7	3575.8
16	3568.0	3568.4
17	3559.9	3560.9
18	-	3557.0**

* New bands observed
** Too weak to be measured

Table: 2. Shows vibration of bands.

Band (v', v")	ν´meas. (cm^{-1})	ν´ calc. (cm^{-1})
(1, 6)	27070.11	27077.58
(2, 6)	27123.79	27138.82
(2, 4)	27313.13	27316.64
(3, 4)	27374.50	27377.39
(3, 3)	27463.92	27467.15
(4, 3)	27523.89	27527.43
(4, 2)	27612.35	27617.76
(5, 2)	27679.84	27677.56
(6, 2)	27739.97	27736.88
(13, 4)	27958.59	27958.59
(11, 2)	28018.90	28026.28
(12, 2)	28082.65	28082.72

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