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INVESTIGATION IN THE UV SPECTRA OF K_2 MOLECULE

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ABSTRACT

Band spectra of K_2 has been studied in absorption in the region 3070-3890 A° using 3.4m Ebert Spectrograph in the first order giving reciprocal dispersion of 5.1 A° mm^{-1} . The E-X, F-X, and G-X systems along with a new system named H-X have been recorded but the search of the state, say, B' were not successful. Vibrational analysis of H-X system is presented in this paper.

Key Word: UV Spectra, K_2 molecule

Introduction

Seven electronic states of the K_2 molecules have been studied So far. The first observation of K_2 spectrum was made by McLennan and Ainslie (I) in 1923 in the visible region. Yamamoto (2) studied the C-X system. Later Crane and Christy (3) analyzed the A-X system. Loomis (4) and Nusbaum (5) extended this study to the B-X system in the red region. The D-X system was observed by Sinha (6). Yoshinaga (7) reported several systems named E-X. F-X and G-X in the ultraviolet region. Sinha (8), however, found his analysis unsatisfactory and reanalyzed the E-X system. Lately Robbeck and Youghan (9) observed in low power discharge tube a group of anomalous bands in the region 5605-5725 A°. These bands were reported to be very wide and without any structure even at high dispersion. The F-X and G-X systems were reported by Yoshinaga (7). In the present work a study of the band spectra of K_2 molecule was undertaken in the region 3070-3890 A°. The E-X, F-X and G-X systems were recorded alongwith a new band system named H-X system at 3384 A°.

Experimental

The spectra of K_2 were recorded in absorption. Spectroscopically pure potassium was heated in a 1.5m long furnace to about 600°C in an atmosphere of hydrogen. The spectrogram was taken in the first order of a 3.4m Jarrel-Ash plane grating spectrograph with a reciprocal dispersion of about 5.1 A° mm^{-1}. Exposure time ranged from 20 to 30 min. on Kodak X-Omat X-ray plates. A high current Xenon arc (450 W) was used as the background source. The measurement of the plate was carried out by comparison with the iron arc lines, the iron wavelength being taken from the MIT wavelength tables (10). A polynomial fitting programme was used to obtain the wavelength of the spectrum. The determination of the wavelengths estimated to be accurate to ± 0.5 A°.

Analysis

This work reports the observation of the E-X, F-X, G-X systems and a new system named H-X in absorption. The E-X, F-X, and G-X systems have been recorded and the vibrational analysis given by Sinha and Yoshinaga (8,7) is confirmed. The new system named H-X is found T 3384 Ao. The bands are red degraded just as other systems of K_2 altogether twenty seven bands have been observed in this system.Vibrqational analysis is done using the equation:

$$\nu',\nu'' = \nu_o + \omega'_e (v+½) - \omega'_e x'_e (v+½)^2 - \omega''_e (v''+½)$$

$$+ \omega''_e x''_e (v+1/2)^2$$

Where the values of ω''_e and $\omega''_e x''_e$ were taken from Herzberg (II). There are few band heads which could not be measured because of the diffuse structure. The vibrational constants of the excited state H of K_2 are found to be:

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$T=30603.75cm^{-1}$ $\omega_e=76.83cm^{-1}$ $\omega_e x_e= 0.069\ cm^{-1}$

Discussion

Several systems of K_2 have been photographed and analyzed. Following Sinha (9), the molecular electronic states can be correlated to the atomic states by assuming that one of the potassium atoms remain in the ground ^2S state. As can be seen from the correlation diagram, the F state dissociates in the $4^2D + 4^2S$ where as the G state dissociate into $6^2S + 4^2S$. The newly observed H state is tentatively correlated to $6^2P + 4^2S$ (fig.1). For the D state the dissociation energy was obtained from the convergence limit (II). It is interesting to note that in this scheme, the $5^2S + 4^2S$ would be left vacant, if the anomalous bands (9) are not associated to a new molecular state named B' Separate experiments were carried out in our laboratory in absorption region to search for this state but were not successful. Robbeck and Vaughan suggest that lower state of these anomalous bands could be a triplet state of repulsive nature dissociating into $4^2S + 4^2S$. This supports the fact that why no evidence is found in absorption of this excited molecular state. The Morse potential curves have been drawn from the available data. For some of the states an approximate value of the internuclear distance was used as shown in fig. 2. The intersections of the curves for the C and D states suggest a predissociation of the C state by the D state. The correlation diagram as well as the potential curves put the different pieces of the puzzle together quite nicely and explain various feature of the molecular states. However; further work in the ultraviolet region with high dispersion would be helpful to explore the rotational structure of these bands.

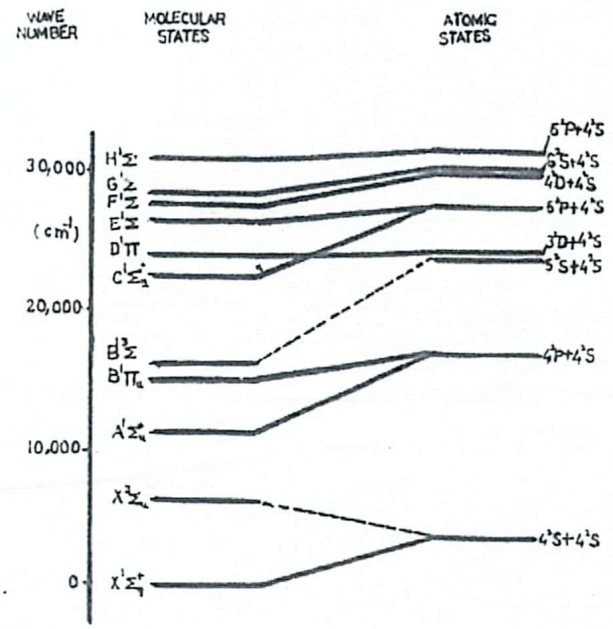


Fig.1 Correlation Diagram for K_2 Molecule

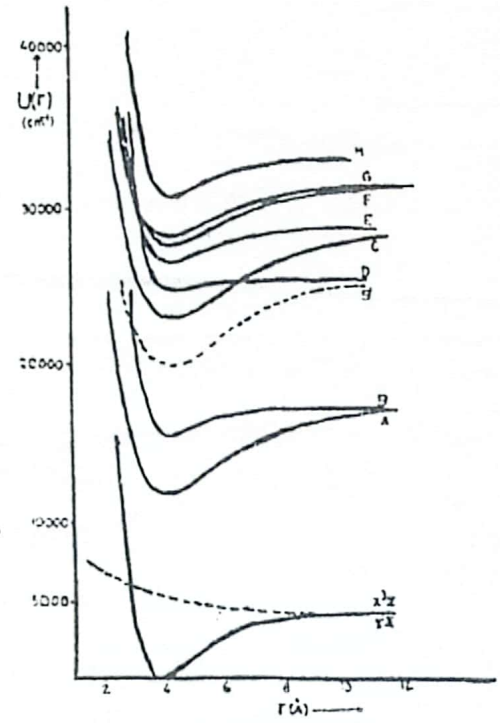


Fig-2 Morse potential curves for K_2 Molecule

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References

1. Mclennan, J.C. and Ainslie, D.S; Proc. Roy. Soc., 103, 304 (1923).

2. Yamamoto, H.; Japan J. Phys., 5, 153 (1929).

3. Crane, W.O. and Christry, A.; Phys. Rev. 36, 421 (1930).

4. Loomis, F.W.; Phys. Rev. 38, 2153 (1932).

5. Loomis, F.W. and Nusbaum, R.E.; Phys. Rev., 39, 89 (1932).

6. Sinha, S.P.; Proc. Phys. Soc. 60, 436 (1948).

7. Yoshinaga, H.; Proc. Phys-Math. Soc. Japan, 19, 847 (1937).

8. Sinha, S.P.; Proc. Phys. Soc. 63, 952 (1950).

9. Robbeck, M.M. and Vaughan, J.M.; J. Phys. B: Atomic. Molec. Phys., 4, 258 (1971).

10. Harrison, G.R.; "Whavelength Tables" MIT Press (1939).

11. Herzberg, G.; Spectra of Diatomic Molecules (New York: Van Nostrand, 1965).

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