

in the Raman spectra. Woodward⁵ has reported his inability to observe the Raman spectrum of HCl dissolved in benzene, pointing out that the negative result was probably due to the low solubility of HCl in this solvent. In the case of certain other organic solvents,⁶ West and Arthur have overcome this difficulty by studying the Raman spectra at a temperature of -65°C . They were able to observe the Raman spectra of HCl in solution at this temperature for several solvents. Evidently the coefficient of absorption in the infrared of HCl in solution is greater than the coefficient for HCl in the gaseous state, as can be seen from the magnitude of the observed band as shown in Fig. 3. An approximate calculation reveals that the coefficient of absorption of HCl in solution is three to four times greater than in the gaseous state. On account of the variation in

concentration with temperature and errors in cell thickness the coefficient of absorption could not be determined very accurately. This indicates that the change in the electric moment causing absorption in solution is greater than the corresponding change in the gaseous state. These results are in accord with the observation of Fairbrother for the increase of the total dipole moment of HCl when in benzene solution. This increase in change of dipole moment may explain the difficulty of observing the Raman spectra at room temperature.

On account of intense bands of benzene occurring in the regions of 1.76μ and 3.46μ it is difficult to observe the absorption bands of HCl in a benzene solution accurately. However, there are other organic solvents which do not have bands in these regions that may be used. Then the position of the HCl solution band can be determined with greater accuracy than in the present work.

⁵ L. A. Woodward, *Physik. Zeits.* **32**, 777 (1931).

⁶ W. West and P. Arthur, *J. Chem. Phys.* **2**, 215 (1934).

Note on a Band System of Caesium

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A further attempt is made to analyze a band system of Cs_2 at 6250\AA . It has been possible to arrange a number of bands, degraded to the red, into a square array and to assign quantum numbers to the lower state. An assignment reported for this system by Matuyama is shown to be incorrect.

THE molecule Cs_2 gives rise to several band systems in absorption. An analysis has been given¹ for several of these systems, but an extremely complex system whose maximum intensity lies at about 6250\AA has not been satisfactorily analyzed. Rompe² has observed this system in absorption and Matuyama³ has reported an analysis on the basis of Rompe's data. While the data of Rompe agree in a rough way with those of Loomis and Kusch, many close groups of bands are not resolved by him, nor does he make any reference to the blue degraded

bands which appear in this system and were reported by Loomis and Kusch.

It has been possible to find several progressions among the bands degraded to the red and to assign the quantum numbers of the lower state to the bands in these progressions by reference to the accurately known ground state of caesium. These progressions have been fitted into a square array. As was the case with the previously reported¹ bands in this system, degraded to the blue, it has been impossible to follow the system to its origin and therefore to assign quantum numbers to the upper state. Matuyama reports an origin of the system at $15,801\text{ cm}^{-1}$ but this assignment is believed to be incorrect. For certain of Matuyama's progressions may be iden-

¹ Loomis and Kusch, *Phys. Rev.* **46**, 292 (1934).

² Rompe, *Zeits. f. Physik* **74**, 175 (1932).

³ Matuyama, *Tohoku Imp. Univ. Sci. Rep.* **23**, 322 (1934).

TABLE I. *Band heads in the system at 6250A.*

<i>i</i>	ν obs	<i>n'</i>	<i>v''</i>	ν_{obs} $-\nu_{\text{calc}}$	<i>i</i>	ν obs	<i>n'</i>	<i>v''</i>	ν_{obs} $-\nu_{\text{calc}}$
2	16054.05	5	6	-0.39	5	15890.70	8	12	-0.14
2	16029.17	1	4	-0.16	7	15878.13	6	11	-0.23
1	16027.87	4	6	+0.03	3	15877.33	9	13	+0.29
3	16025.26	7	8	-0.44	9	15864.49	7	12	-0.19
2	16015.43	2	5	+0.24	5	15851.60	5	11	-0.30
4	16013.27	5	7	-0.33	7	15850.82	8	13	-0.20
4	16011.81	8	9	-0.46	8	15837.47	9	12	+0.09
4	16001.78	0	4	-0.35	10	15824.70	7	13	-0.15
2	16000.47	3	6	-0.61	3	15824.05	10	15	+0.26
4	15999.03	6	8	-0.35	4	15811.85	5	12	-0.05
5	15988.30	1	5	+0.15	6	15811.06	8	14	-0.30
4	15986.82	4	7	-0.18	5	15797.92	9	15	+0.01
3	15985.01	7	9	-0.18	4	15785.21	7	14	+0.01
1	15974.73	2	6	+0.55	4	15784.50	10	16	+0.02
4	15972.56	5	8	-0.36	9	15771.83	5	13	-0.25
8	15971.19	8	10	+0.18			8	15	-0.06
5	15960.55	0	5	-0.40	6	15758.96	6	14	+0.08
		3	7	+0.31	7	15758.54	9	16	-0.04
6	15946.98	1	6	-0.16	6	15745.44	7	15	-0.29
7	15946.33	4	8	+0.01			10	17	+0.08
4	15945.01	7	10	+0.16	8	15732.42	8	16	-0.15
9	15932.13	5	9	-0.28	7	15719.45	9	17	-0.03
4	15930.82	8	11	-0.02	6	15706.45	10	18	+0.04
1	15919.24	3	8	-0.32	4	15693.40	8	17	-0.06
5	15918.18	6	10	-0.35	6	15680.52	9	18	-0.01
0	15905.99	4	9	+0.19	5	15667.79	10	19	+0.15
4	15904.46	7	11	-0.22	4	15654.75	11	20	-0.03
4	15892.00	5	10	-0.07	4	15641.78	9	19	+0.02
					4	15629.31	10	20	+0.26

tified with ours, but the quantum numbers of the ground state which he assigns to the bands in the progressions differ from the true quantum numbers as determined from the known ground state. Furthermore, a large number of the bands as-

signed by Matuyama cannot be assigned into such an array, while keeping the combination differences constant within experimental error.

The bands, degraded to the red, which have been assigned into a square array are accurately represented by the formula

$$\nu = 16,175.80 + 27.34(n' + \frac{1}{2}) - 0.0733(n' + \frac{1}{2})^2 - [41.990(v'' + \frac{1}{2}) - 0.080051(v'' + \frac{1}{2})^2 - 0.000164266(v'' + \frac{1}{2})^3], \quad (1)$$

v'' is the true quantum number, and n' differs from the true v' by some unknown constant. The ground state is identical to the one previously reported.¹ The observed band heads, their intensities, assignments and the differences between the observed values and those given by Eq. (1) are given in Table I.

The bands in this system, degraded to the blue, and previously reported may be represented by the formula

$$\nu = 16,066.03 + 29.38(n' + \frac{1}{2}) - 0.0796(n' + \frac{1}{2})^2 - [41.990(v'' + \frac{1}{2}) - 0.080051(v'' + \frac{1}{2})^2 - 0.000164266(v'' + \frac{1}{2})^3]. \quad (2)$$

The formula previously reported¹ contained an error.

This band system is extraordinarily complex and a great many observed features have not been explained, even though the two systems, degraded to the red and to the blue, do include the more obvious features of the system.

The Band Spectra of Rubidium and of Its Combinations with Other Alkali Metals

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The magnetic rotation spectrum of Rb_2 has been observed and a vibrational analysis made. The vibrational frequency in the $^1\Sigma$ ground state is 57.31 cm^{-1} and that in the excited $^1\Pi$ state, 48.05 cm^{-1} . The magnetic rotation spectrum of NaRb has also been found and has the vibrational frequencies 106.6 cm^{-1} and 61.5 cm^{-1} in the $^1\Sigma$ ground and excited $^1\Pi$ states, respectively. A band system due to RbCs has been identified.

THE purpose of this investigation is to extend our knowledge of the band spectra of the alkali metals to Rb_2 , the only one of the group not previously investigated by means of accurate methods. Rather complete vibrational analyses

have been made¹ of the spectra of Li_2 , Na_2 and K_2 , and their energies of dissociation determined by means of their magnetic rotation spectra.

¹Loomis and Nusbaum, *Phys. Rev.* (a) **38**, 1447 (1931); (b) **39**, 89 (1932); (c) **40**, 380 (1932).