

LETTERS TO THE EDITOR

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QUANTUM MECHANICAL THEORY OF THE JOSHI EFFECT

THIS phenomenon,^{1,2} viz., the suppression of conductivity on irradiation of chlorine and some other gases has been interpreted recently by Prasad³ from the standpoint of Kramers' quantum mechanical theory of light dispersion. It is considered that consequent on irradiation the gas is excited to higher vibrational and electronic states. For these, due to the operation of negative terms in the Kramers' dispersion formula, the refractive index n decreases below that for the normal gas. Applying Maxwell's well-known relation, $n^2 = k$, where k is the dielectric constant, it follows that k should diminish. Since k is a measure of the electro-static capacity of the system, Prasad³ considers that the light-effect as defined by Joshi,² represents a decrease of the displacement current as distinct from the conductance or ohmic current. Prasad³ arrives at the same consequence from analogy between the excited and isolated states of a gas; for the latter k is known to be smaller than normal.

The validity of the above deduction was tested experimentally. Alternating electric fields of frequencies f varied in the range 5 to 10 mega-cycles per second, generated by a Hartley type valve oscillator were applied across the annular space of a Siemens' ozoniser, filled with pure chlorine. V , the P.D. across the ozoniser was measured by a therm-

ionic valve voltmeter and the corresponding current with a low resistance Cambridge vacuum-junction connected to a sensitive mirror galvanometer. In an observation, typical of several series of results, at a given input to the system the current produced a steady deflection of 315 units. No detectable change (> 0.5 unit) occurred on irradiating the system with (i) a 500 candle power (glass) bulb, (ii) a large-size quartz mercury vapour lamp and (iii) when both the light sources were used simultaneously. A decrease of the above current which, according to Prasad,³ is of the dielectric or displacement type, should have occurred, since ordinarily, this light-effect is quite considerable, and under optimum conditions as high as 93 per cent.⁴

Series of experiments were next made in which the discharge current in the above range were obtained by exciting the ozoniser at large V and low f . When, for example, the above current deflection was produced at $V=10.7$ kV, $f=50$ cycles per second and the ozoniser was irradiated by any of the above-mentioned light-sources, an instantaneous and reversible light-effect in the range 19 to 27 per cent. was produced.

It would appear that as suggested by Prof. Joshi² an explanation of this phenomenon might, in the first instance, be sought, (i) in a possible decrease of the average ionic velocity and intensity of ionisation, (ii) increased recombination of the opposite ions and (iii) a decrease in the number of the

metastable (and excited) atoms and molecules, produced under irradiation. An important general result established by Prof. Joshi over a wide range of conditions, is that this phenomenon does not occur at potentials less than $V_m^{1,5}$ 'the minimum threshold potential' when the gas breaks down as a dielectric.⁵ In fact, it was from the observation by Prof. Joshi of a photo-increase of V_m^1 that (arguing from the finding that the current depends upon $V - V_m^0$), he predicted that the corresponding current should decrease under light. Whatever be the actual mechanism of this phenomenon, it has significance for the current theories of photo-electric action and represents a hitherto unrecognised factor in conduction under electrical discharge.

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June 20, 1945.

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1. Joshi, (a) *Curr. Sci.*, 1939, 8, 548; (b) *Ibid.*, 1944, 13, 253; (c) *Ibid.*, 1945, 14, 67. 2. —, *Pres. Address, Chem. Sec., Ind. Sci. Cong.* 1943. 3. Prasad, *Nature*, 1944, 155, 362; cf. also Kroff, *Rev. Mod. Phys.*, 1932, 4, 471; Ladenburg, *Ibid.*, 1833, 5, 343. 4. Joshi and Deo, *Nature*, 1944, 153, 434. 5. Joshi, *Ibid.*, 1944, 154, 147. 6. Joshi, *Trans. Farad. Soc.*, 1929, 25, 120.

THE BANDS OF PO MOLECULE

A VIBRATIONAL quantum analysis of the bands of phosphorous monoxide in the region $\lambda 2600$ has been published by Ghosh and Ball¹ and a rotational analysis of some bands of this system has been given by Sen Gupta.² The bands are shown to be due to $2\Sigma \rightarrow 2\pi$ transition. Besides this system, the PO molecule is well known to give rise to other characteristic groups of bands in the region $\lambda 3300$. The vibrational analysis of these bands does not appear to have been published so far. In the course of investigations, in this Laboratory, on the P_2 bands³ excited under different conditions, the above-mentioned bands of the PO molecule have been obtained. These bands are found to be strongly emitted in a wide open heavy current arc between carbon poles containing phosphorous pentoxide. Some of the bands are degraded to the red and some to the violet. Several attempts to include all the bands into one system having failed, the red degraded bands are analysed into one vibrational system and the violet degraded bands into another system. The two systems have presumably a common final level 2π identical with the ground state of the ultraviolet system.

The following vibrational constants for the two systems are obtained.

Violet degraded system	Red degraded system
$\nu_e = 30606.5$	$\nu_e = 30260.8$
$\omega'_e = 1151.9$	$\omega'_e = 1094$
$x'_e \omega'_e = 14.19$	$x'_e \omega'_e = 14.5$
$\omega_e'' = 1223.9$	$\omega_e'' = 1234$
$x''_e \omega_e'' = 6.46$	$x''_e \omega_e'' = 9.5$

A detailed account of the work will be published elsewhere.

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1. Ghosh and Ball, *Zeits. f. Phys.*, 1931, 71, 362. 2. Sen Gupta, *Proc. Phys. Soc.*, (Lond.), 1935, 47, 247. 3. Narahari Rao, K., *Ind. Jour. Phys.*, 1943, 17, 135 and 149.

ON THE ULTRA-VIOLET BANDS OF K

BESIDES the three systems of K., in the infra-red and visible regions studied by a number of workers, Yoshinaga¹ measured about 110 band heads in absorption between $\lambda 4160$ and $\lambda 3480$ A. and arranged them into five different systems, all arising on account of transitions from the $1\Sigma_g$ ground state to different upper states. The only data at wave-lengths below $\lambda 3480$ A. are due to Chakraborty,² who noted some bands of K., accompanying each member of the principal series line of potassium. Since he worked with an instrument of high dispersion, only few bands could be recorded in his spectrogram.

While working with an intermediate quartz spectrograph, a large number of bands, not reported earlier between wave-lengths 3690 and 2920 A., has been noted in the present case. Of these, the bands between $\lambda 3200$ and $\lambda 3100$ A. are much better developed than those lying in the rest of the region. The experimental arrangement consists of an iron tube heated by an electric current flowing through a nichrome wire wound round an asbestos covering over the tube. The ends were closed by quartz windows and were water-cooled. Light from a hydrogen continuum was passed through potassium vapour obtained by heating a purified sample of the metal kept in an auxiliary iron cell inside the furnace tube and analysed by an intermediate quartz spectrograph. Spectrograms were taken at several temperatures and pressures, the value of the latter being regulated by introducing dry nitrogen gas from a cylinder. The bands given in the table below (being more intense than those appearing in the rest of the region) were obtained at 700° C. when the pressure inside the furnace as read by a mercury manometer was 30 cm. The intensities were estimated from a micro-photogram of the spectrum.

ν cm. ⁻¹ vac.	$\nu'' - \nu'$	Int.	ν cm. ⁻¹ vac.	$\nu'' - \nu'$	Int.
31115	10-4	2	31467	5-2	1
31163	10-5	4	31517	5-3	2
31212	9-4	4	31557	4-2	2
31251	8-3	4	31606	4-3	2
31290	7-2	2	31679	2-1	1
31339	7-3	2	31728	1-0	1
31388	7-4	4	31818	0-0	1
31428	6-3	1	31868	0-1	1