LETTERS TO THE EDITOR

THE MINIMUM VELOCITY OF PARTICLES IN DOPPLER DISPLACEMENT OF HYDROGEN

The light of canal rays of hydrogen which shows Doppler effect, consists mostly of light due to H_α, H_β, etc., of the Balmer series from neutral hydrogen atoms. The effect for H_α can be represented diagrammatically (*Fig. 1*) as a strip *AB* of varying intensity separated from the sharp line at O, which is H_α itself without change of wavelengtb (*i.e.*, an undisplaced H_α line). The undisplaced line is given out by atoms of hydrogen gas in the space in which the canal rays are moving (since these particles are having velocities negligible compared to the very high speeds of the canal ray particles). Lower edge *A* represents the least displaced end of the Doppler strip and the wavelength displacement OA may, therefore, be represented as $d\lambda_l$ which gives the least velocity of particles of hydrogen represented in the canal-ray-beam. The maximum displacement $d\lambda_{max}$ is represented by B. Its behaviour has been extensively studied.[1] The present communication is concerned with the behaviour of $d\lambda_l$ of A with variation of the potential applied to the discharge tube producing the canal ray.

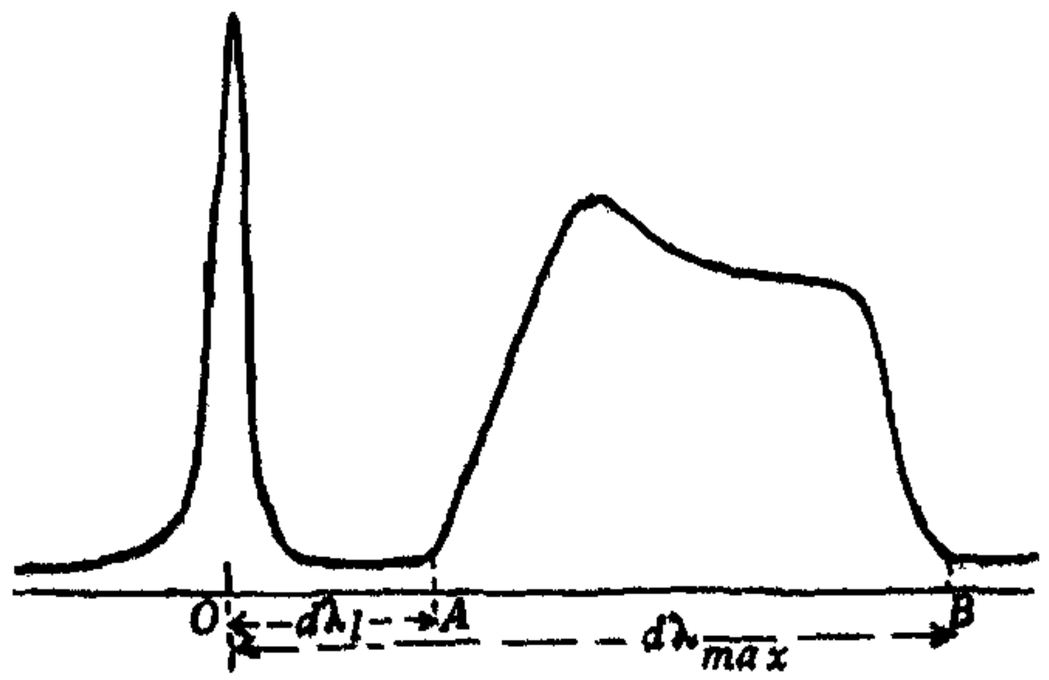

FIG. 1. Sketch of Doppler Displacement to show Undisplaced Balmer Line H_α at 'O' and Doppler strip 'AB' with Displaced Maximum at 'B' ($d\lambda_{max}$) and Minimum at 'A' $d(\lambda_l)$.

Steinheil three-prism glass spectrograph of high light-gathering power, *f*/3, and effective

base of 30 cm. was used. With a tele-objective attachment $f = 250$ cm. to the camera side, the dispersion was 11·92 Å/mm. In order to avoid complications from the background molecular lines and the continuum, we have made observation on H_α. Purity of gas in the discharge tube has been maintained by Wien's method of capillary streaming and continuous pumping.

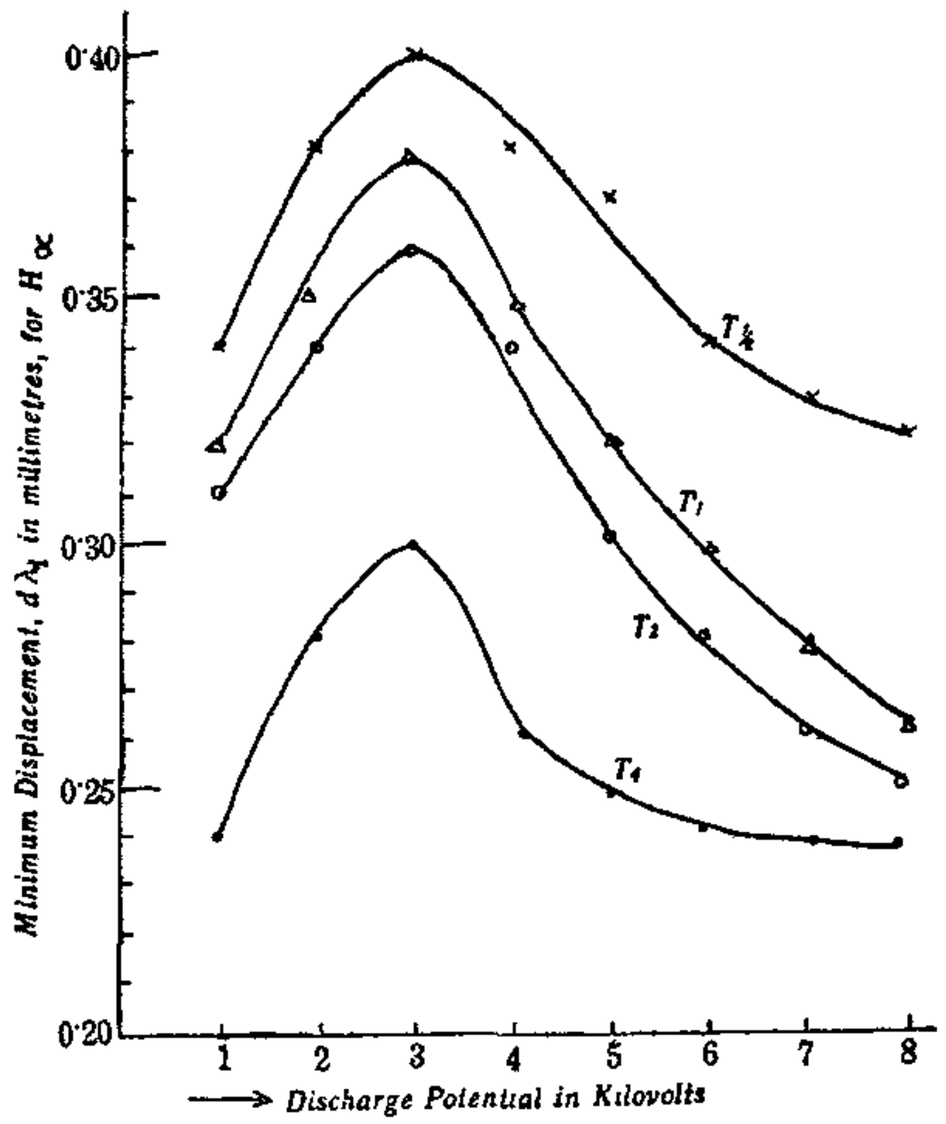

FIG. 2. Minimum Doppler Displacement for Hα.

Results are shown in Fig. 2. On one and the same plate, keeping time of exposure constant (say, 4 hours), photographs were taken at different discharge potentials from 1 to 8 kilovolts, varying by steps of 1 kilovolt. Similar plates were prepared with exposure times, 2, 1 and ½ hours also. All the four curves (T_4, T_2, T_1, $T_{1/2}$ respectively) show a uniform behaviour in their values for d_{λ_t} having first a rise for potentials from 1 to 3 kilovolts, reaching a maximum at 3 kilovolts and then falling gradually with increase of voltage, up to the highest voltage used. The pressure of the gas corresponding to 3 kilovolts is 0·09 mm. Hg.

It was shown by B. Dasannacharya and G. K. Das,[2] as conclusion No. 9 of their paper that a strip due to neutral atoms formed as a result of dissociation from a heavy molecule of hydrogen of mass 4 exists, *only* in the voltage region, 1 to 3 kilovolts. The disappearance of this strip at 3 kilovolts can be regarded as the cause for a fall in the intensity of the lower limit of the Doppler strip, observed in the present result. Further details will be published elsewhere.

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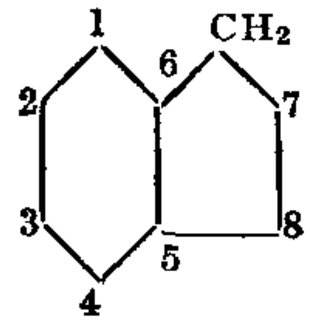
March 17, 1953.

1. Dasannacharya, B. and Das, G. K., *Nature*, 1944, **154**, 21 ; — and Dakshinamurti, C., *Ibid*, 1944, **154**, 22 ; —, *Curr. Sci. Canal Rays Special Number*, 1937. 2. — and Das, C. K., *Phil. Mag.*, 1948, **39**, 966.

ELECTRONIC ENERGY LEVELS OF INDENE

THE electronic energy levels of the Indene molecule have been calculated by the method of antisymmetrised molecular orbitals. The structure of Indene is :



The assumptions made in these calculations are :

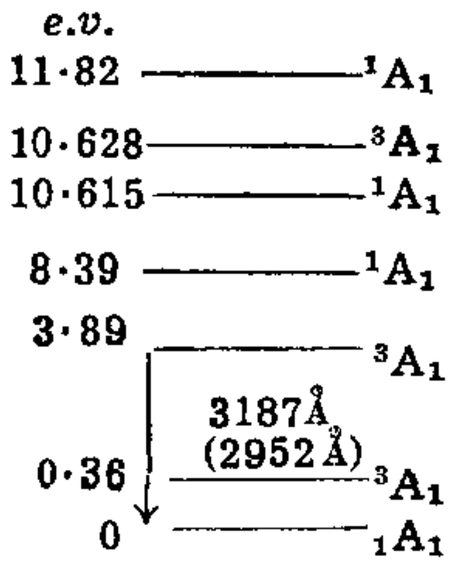
(*i*) Indene has eight π electrons which are responsible for spectroscopic levels ;

(*ii*) The molecular orbitals can be written down as follows :

$$\phi_l = \frac{1}{\sqrt{8\sigma_l}} \sum_{k=1}^{8} e^{\frac{2\pi i l k}{8}} K(\nu)$$

$$(l = 0, \pm 1, \pm 2, \pm 3, 4)$$

σ_l being a normalisation factor, K (ν) being the $2p\pi$ atomic orbital of the kth atom. The numbering of the atoms is indicated above.



(*iii*) The interaction between electrons, partially on non-neighbouring atoms as also that between electrons 1, 2, 3, 4, on the one hand and 7, 8 on the other, is negligible. Effect of the hydrogen atoms and the spin orbit interaction is neglected ;