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POLARISATION (NEAR THRESHOLD) OF THE SPECTRAL LINES λ = 5791/90 Å AND λ = 5770 Å OF MERCURY, EXCITED BY ELECTRON IMPACT

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Earlier research by Skinner and Appleyard [1,2] has shown that radiation emitted by mercury vapour, when excited by a beam of electrons, is polarised. They observed that in most cases the degree of polarisation as a function of the energy of the bombarding electrons approaches zero at threshold. This, however, is contradictory to theory [3-5]. For helium, experiments [6] have suggested that the polarisation does not go to zero at threshold.

By using improved methods of measurement (smaller energy spread in the electron beam and a more sensitive way of measuring small light intensities) we succeeded in measuring the polarisation close to threshold more accurately.

Measuring method. A short description of the apparatus follows here; for a more detailed one see [7,8]. The sealed excitation tube contains mercury vapour, that can be excited by means of a beam of electrons of adjustable velocity. The mercury vapour pressure is the saturated vapour pressure at a given temperature of the tube wall. A narrow cross section of the electron beam is imaged onto the entrance slit of the monochromator in such a way that the light enters from a direction at right angles to the electron beam. The light of a selected spectral line coming from the monochromator passes through a polaroid filter and falls on the photo-cathode of a multiplier tube. Each photo-electron gives a current pulse at the output of the multiplier. These pulses are amplified with a fast amplifier (rise time 0.5 μ sec) and finally recorded with a counting device.

The percentage degree of polarisation P is defined as follows

$$P = (I_{\parallel} - I_{\perp})/(I_{\parallel} + I_{\perp}) \times 100 \ .$$

By rotating the polaroid filter we measure successively the intensity of the light with the electrical vector parallel and perpendicular to the beam, here denoted by $I_{\parallel}$ and $I_{\perp}$, respectively. In our case the polaroid filter is rotated at 25 r/sec. The pulses from the photo-multiplier are supplied to a two-channel electronic switch, which operates synchronically with the rotating

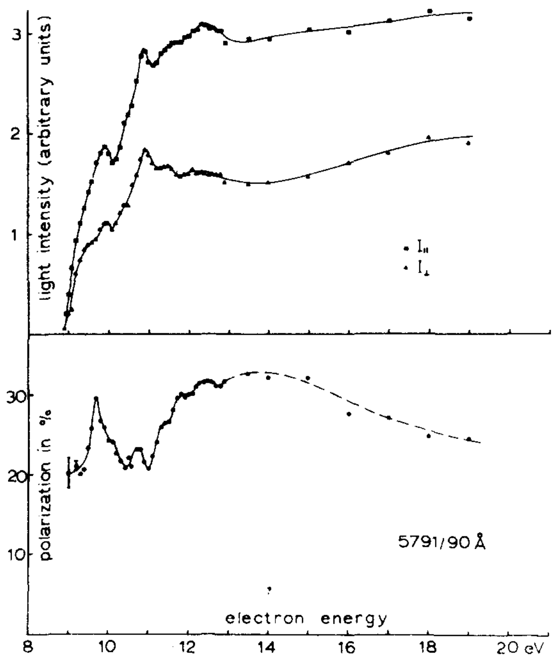

Fig. 1. Excitation and polarisation curves of the line λ = 5791/90 Å. Mercury vapour pressure 10^{-3} Torr; beam current 13 μA. The statistical error in the polarisation close to threshold has been indicated. In the other points the statistical error amounts to a polarisation of 0.5% or less.

filter such that pulses corresponding to $I_\parallel$ and $I_\perp$, respectively, are counted separately. This enables us to measure $I_\parallel$ and $I_\perp$ at practically the same time, and consequently to eliminate errors caused by changes in sensitivity of the photo-multiplier and amplifier or by inconstancy of the mercury vapour pressure.

Results. The figure presents the excitation and polarisation curve of the line λ = 5791/90 Å ($6^1D_2 \rightarrow 6^1P_1$ and $6^3D_1 \rightarrow 6^1P_1$). Of course the measurements are corrected for the polarisation of the apparatus. The measurements were done at a mercury vapour pressure of 1 micron (= 10^{-3} Torr) and with an electron beam current of 13 μA. Close to threshold we find a remarkable structure in the polarisation curve, which appeared to be reproducible in series of measurements. Within 0.3 eV from threshold the measurements are unreliable because of the decreasing light intensities. Anyway, there were no indications that the polarisation tends to zero at threshold.

In the figure the $I_\parallel$ and $I_\perp$ components of the excitation curve have been plotted separately.

It was checked that the polarisation of the spectral line measured was independent of the mercury vapour pressure within the limits of 0.3 and 1 μ.

Also measurements gave been carried out at the line λ = 5770 Å ($6^3D_2 \rightarrow 6^1P_1$) and λ = 4358 Å ($7^3S_1 \rightarrow 6^3P_1$). The polarization function of the λ = 5770 Å line is almost the same as the polarisation function of the λ = 5791/90 Å line. The polarisation of 4358 Å is much smaller.

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