Effect of Pressure on High Terms of Alkaline Spectra

IN the alkaline spectra, very long absorption series have been observed. Wood and Fortrat have detected 56 terms of the Na, $3S-nP$ series. One might expect that the high terms of the series would be destroyed by adding a foreign gas, as the excited states of high quantum number have such a large volume that the number of molecules of the foreign gas contained in it can be, under experimental conditions, of the order of 10,000.

This argument proves to be untrue, as we have been able to observe the absorption series up to very high terms in sodium-nitrogen and sodium-hydrogen mixtures with a pressure of the perturbing gas of the order of magnitude of an atmosphere.

With nitrogen as foreign gas, only a little broadening of the high terms, but no shift, was observed. Instead, in the case of hydrogen, all the high terms of the series are shifted by an approximately constant amount towards the violet. With a concentration of about $4\cdot8\times10^{19}$ molecules per c.c. of hydrogen, we observed a displacement of $7\cdot5$ cm.$^{-1}$ as is shown in Fig. 1. This shift is approximately proportional to the concentration of the perturbing gas.

One might attempt to explain this shift with the

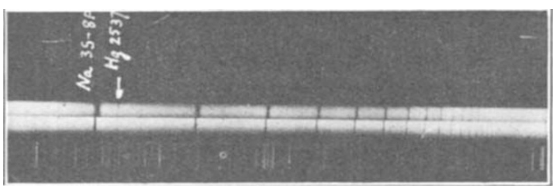

FIG. 1. Absorption spectra of sodium-hydrogen mixtures at higher pressures (above) and at lower pressures (below) of hydrogen. Note the unshifted mercury line 2537, which lies in the background.

aid of the ordinary perturbation theory, considering some average potential for the electron over the very many potential holes, representing the foreign molecules contained inside the electronic eigenfunction. This would give a lowering of the high terms, and therefore a shift of the lines towards the red. However, Prof. Fermi has pointed out that this simple theory cannot be applied, as the first approximation of the perturbation theory is not sufficient for describing the phenomenon. His theory shows that the effect, though having the same order of magnitude as elementary theory, can be also of opposite sign, and explain a shift towards the violet as observed for hydrogen. The magnitude of the effect is connected with the limiting cross section of the perturbing molecules in the Ramsauer effect for zero velocity; the theory can also explain the fact that the high terms are not completely destroyed by the perturbation.

An account of experiments with different gases and absorbing vapours will be published elsewhere.

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Graphical Determination of Contemporaries

LET points representing the years of birth and death of each of a group of individuals—for example, eminent men of science—be plotted with the year of birth as abscissa and the year of death as ordinate on the same scale. Each of these 'life-points' lies above the line $y=x$ since $y>x$, and, if 100 be taken for the limit of age, below the parallel $y=x+100$.

The dotted lines in Fig. 1 show two positions of a 45° set-square of transparent celluloid the hypotenuse of which slides along a straight-edge (not shown) parallel to $y=x$ and at such a distance from it that the apex is always on this line.

At the date given by the position of the apex on the line $y=x$, which may be called the time-line, any individual is not yet born if his life-point is to the right of the vertical edge, and dead if it is below the horizontal edge, while contemporaries are those whose life-points can be seen through the transparent set-square. The ages of these at the date are given by the distances of the points from the vertical edge, and also the ages at death of any of the group are given by the vertical distances of their life-points

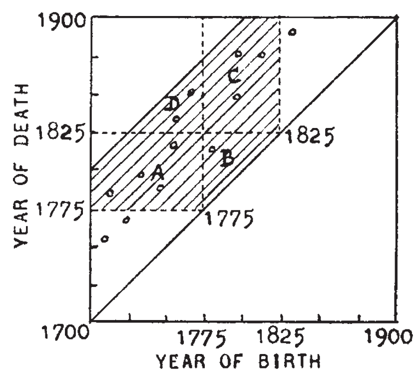

FIG. 1.

above the time-line, so that the life-points of all attaining the same age lie on a line parallel to it.

Suppose, as an example, that the group consists of thirteen individuals, all of whom are born and die between 1700 and 1900, and that their life-points are plotted as in Fig. 1. Then, placing the set-square with its apex at say 1775 on the time-line (the dotted lines show its position), it is seen at a glance that at this date two are dead, six contemporary, and five unborn. Similarly, at date 1825 seven are dead, five contemporary, and one unborn.

All whose life-points are within the shaded area have lived at some time during the period 1775–1825. This area is composed of the parts A, B, C, D. Those with life-points in A were born before and died during the period, in B were born and died in the period, in C were born in and died after the period, and in D were born before and died after the period. When the period is sufficiently long the area D vanishes, and in such case none can be born before and die after the period.

When the number in the group is large the plotting of the life-points is laborious; but, this being done, complete information for any dates and any period can be obtained at once by mere inspection.

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