Relative Intensities of Band Lines in the Infra-red Spectrum of a Diatomic Gas.

IN a previous theoretical discussion of the relative intensities of band lines in the infra-red vibration-rotation spectrum of a diatomic gas by one of us (E. C. Kemble, *Proc. Nat. Acad. Sci.*, 10, 274, 1924, and *Phys. Rev.* 25, 1, 1925) the formula

$$\alpha = \text{Const.} \frac{\bar{p}}{\nu^3} e^{-E''/kT} \quad (1)$$

was derived. Here α denotes the area under the absorption coefficient curve for the line in question when plotted on a frequency scale, and $\bar{p}$ is the mean statistical weight of the two states involved in the transition; E'' is the energy of the lower energy level or initial state for absorption; ν denotes the frequency of the line. Comparison of this formula with the experimental absorption curves then available for the HCl band at 3.5μ indicated fair agreement between theory and observation, provided that $\bar{p}$ was calculated from the statistical weight formula

$$\bar{p} = 2m + 1 \quad m = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \dots \quad (2)$$

in which m denotes the nuclear rotational quantum number.

Fowler (R. H. Fowler, *Phil. Mag.* 49, 1272, 1925) and Dieke (G. H. Dieke, *Zeit. f. Phys.* 33, 161, 1925; cf. also E. C. Kemble, *Zeit. f. Phys.*, 35, 286, 1925) have shown that the summation rule leads to the above formula, but with the restriction that the statistical weight formula must be

$$\bar{p} = 2m \quad m = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \dots \quad (3)$$

thus giving $\bar{p}$ the series of values 2, 3, 6, 8,

In order to obtain a decisive test of the statistical weight formula, and also to verify the asymmetry of intensity of the two branches implied in formula (1) (the *R* branch should be more intense than the *P* branch in absorption), the writers have just completed a series of observations on the HCl band mentioned above, using very short absorption tubes. The data permit the determination of the integral absorption coefficients α for the lines observed, and the values thus obtained are in complete harmony with the summation rule.

Using a quartz prism spectrometer we have measured the absorption curves for six absorption paths ranging in length from 0.1 cm. to 3 cm. Curves were drawn of the areas of individual absorption lines plotted against tube length. The initial slopes of these curves give the desired values of α . The accompanying table shows the relative values of α deduced from the experiment, taking the value for the third line of the positive branch arbitrarily as unity. The absolute value of α for this line is $49 \times 10^{10} \text{ sec.}^{-1}$. With the exception of the line -6, which is doubtful on account of the strong absorption in the quartz prism, the agreement between the experimental values of α and those computed from the theoretical formulæ (1) and (3) is within 4 per cent. of the absorption of the line +3. For all but two of the lines it is within 3 per cent. The maximum error becomes 10 per cent. if we use formulæ (1) and (2), and we are convinced that (2) is incorrect.

TABLE.

Line	+1	+2	+3	+4	+5	+6	+7		
	0.500	0.853	1.000	0.959	0.774	0.542	0.333		
Line	+8	+9	+10	-1	-2	-3	-4	-5	-6
	0.185	0.094	0.048	0.485	0.765	0.842	0.768	0.605	0.460

One surprising result of the investigation was the magnitude of the absorption with very short tube-lengths. The maximum observed absorption with a 1 mm. absorption path and a relatively broad slit was 16 per cent. From the shape of the area—tube length

curves we can obtain at least a rough idea of the shapes of the lines, which are clearly very much narrower and deeper than previously supposed. Calculation indicates that radiation of wave-length corresponding to the centre of the strongest line is almost completely wiped out by the absorption in the first few millimetres of gas. The variation in shape of the area—tube length curves from line to line gives clear evidence of isotopic doubling and of the change in the doublet spacing due to the rotational isotope effect.

E. C. KEMBLE.
D. G. BOURGIN.

Jefferson Physical Laboratory,
Harvard University,
Cambridge, Mass.

Examination of Dead Sea Water for Eka-Cæsium and Eka-Iodine.

SEVERAL years ago it occurred to me that if eka-cæsium (element 87) is capable of permanent existence, it ought to be found in the Dead Sea. For ages rivers, streams, and rain, all charged with various salts, have poured into that sea, with practically no outlet save evaporation, so that an exceptionally high concentration of salts has resulted. It was not until July 1925 that I was able to visit Palestine and the Dead Sea. Summer is a particularly suitable time to obtain the water, as the enormous evaporation of surface water under the blazing sun causes a marked depression in the level of the Dead Sea, the water evaporating more rapidly than it is replenished by the Jordan, the rate of evaporation being thus estimated as exceeding six million tons of water per diem. Hence the accessible surface waters are more highly charged with dissolved salts than at other periods. This is reflected in their density, for which published data give values round about 1.1546 during the cooler months (Stutzer and Reich, March 1907). My sample was collected at the northern end of the Sea, at a depth of 2 feet, about 50 yards from the shore, and several miles west of the mouth of the Jordan. Its density at 18° C. was 1.2089, and thus more nearly approached the value given by Bernays for a depth of 300 metres, namely, 1.253.

Numerous analyses of Dead Sea water have been published from time to time and the presence recorded of the following ions: Na, K, Mg, Ca, Fe, Al, Cl, Br, I, SO₄, CO₃, and NO₃. My sample contained small but appreciable quantities of strontium, which does not appear to have been observed before. The amount of iron in the waters near the northern shore may now be expected to increase, in view of the erection of a number of crude dwellings on the beach, constructed of wood and flattened-out petrol tins. Many such tins lie also in pools and ditches hard by, imparting a deep ochreous stain to the salt that has crystallised out.

Assuming eka-cæsium to manifest in its salts the same gradation in properties as the other alkali metals, the chloride should be more soluble than the corresponding potassium salt and the chlorplatinate less soluble. After removal of all metals save those of the alkali group from a portion of the sea water, sodium chloride was fractionally crystallised out and potassium chlorplatinate precipitated from the concentrate. Gravimetric analyses showed that if any eka-cæsium were present, its amount was too small to be detected in this way with my limited supply of material. A sample of the chlorplatinate was accordingly sent to Messrs. Adam Hilger, Ltd., who submitted it to X-ray analysis in their laboratory. Several photographs were taken and good lines obtained in the region where eka-cæsium *L* radiations