Dr. L. H. SIERTSEMA, *Measurements on the magnetic rotatory dispersion in gases.*

The observations with the apparatus described in the former communications [1]) are continued, and the magnetic rotatory dispersion is measured in nitrogen, carbonic acid and nitrogen monoxide.

The construction of the apparatus and the method of observation have undergone no further changes of any importance. A plate is added of the whole apparatus and some details, as an illustration to the formerly given description.

On this plate Fig. 1 represents the whole apparatus, seen from above. In this figure *A* is the collimator, *B* the smaller nicol-bearer, *C* and *D* the two coils [2]), *E* the greater nicol-bearer, *F* the prism with the telescope, in which the spectrum is observed. The pointing of the smaller nicol is obtained by the screw *G* and the steel-wire *HH* [3]). Fig. 4 shows the handle to which the wire is fixed, seem from the collimator. At *J* (Fig. 1) a weight is hanging at the wire. The rotation of the nicol is measured with the telescope *K*, the vertical glass scale *L*, and the mirrors *M* and *N*.

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1) Communications etc. N°. 7, 15.

2) " " N°. 7, p. 14.

3) " " N°. 15, p. 18.

Fig. 2 represents the greater nicol-bearer [1]) on a larger scale. The upper part of the figure is drawn in section, the lower part in aspect. In this figure *a* is the nicol, which is held in a ring with adjusting-screws *b*, *c* the glass-plate fixed in the flanges by the nut *d*. The packings are here and at other places indicated by black lines. The gas can enter the apparatus by a tube which is fastened to the nut *e*, and to which also the manometer is connected. *f* is the experimental tube, which is fixed to the nicol-bearer by the nut *g*, *h* is the section of the level on the greater nicol-bearer, *i* are the tubes through which water circulates for equalizing the temperature, *k* the supply-tube thereof with the thermometer *l*. A similar tube with thermometer serves for the outlet of the water. In fig. 1 both tubes are visible. Between the experimental tube and the water-tubes we find a layer of indiarubber.

Fig. 3 represents the smaller nicol-bearer, drawn in the same way as fig. 2. The meaning of *a*—*d*, *f*, *g*, *i* is the same as in the former figure; *e* is the beam to which the steel wire is fixed (see also fig. 4.)

The wave-length is always determined by a calibration of the spectrum with lines of FRAUNHOFER.

The gases are taken from commercial steel and iron cylinders, and are analysed by HEMPEL's pipetts.

With carbonic acid and nitrogen monoxide only a moderate pressure could be used. Close to the condensing point the image of the slit was too much confused to admit good pointings, a consequence of the great

[1]) Communications etc. N°. 7, p. 12.

variability of density with temperature. With these gases it became necessary to envelop the ends of the experimental tube and the nicol-bearers in cotton-wool. At these moderate pressures the manometer-readings were found not to be sufficiently accurate. The measurements shall be repeated with better determinations of the pressures; the now obtained results are to be considered as preliminary ones.

Now the method of observation and of calculation shall be explained more detailed.

The measurements of the rotations are always divided in sets of four pointings. At the beginning of each set the direction of the ray of light was corrected. Then the telescope was pointed to that part of the spectrum, at which a determination should be made, and its position read on a divided circle. Then readings were made on the manometer, the thermometers which give the temperatures of the gas, and those from galvanometer and shunt. Hereafter follow four pointings, with current-directions which can be represented by (+ — — +), which pointings are made in this manner, that the black band in the spectrum, which already is made visible by a preliminary turning of the nicol, now by more turning is adjusted exactly on the vertical wire in the telescope, after which immediately the galvanometer is read, and the current is opened. Then follow readings of the zero of the galvanometer, the position of the nicol, and the level. After such a set of four pointings the manometer and thermometers are read again, and then a new set begins with another wave-length.

At the beginning and the end of the observations the reducing factor of the galvanometer is usually determined, and also the distance of the mirror which serves for the measurement of the rotation of the nicol.

At the beginning of the calculations corrections are added to the four mirror-readings, which determine the position of the nicol, in order to obtain quantities proportional to the rotations, and then corrections for the rotation of the greater nicol, which is measured with the level. When we call the so obtained quantities Φ_1, Φ_2, Φ_3, Φ_4, and the corresponding galvanometer-deflections a_1, a_2, a_3, a_4, it will easily be seen that the two quantities $\frac{\Phi_1 - \Phi_2}{a_1 + a_2}$ and $\frac{\Phi_4 - \Phi_3}{a_4 + a_3}$ ought to be equal, and proportional to the constant of rotation for the given pressure, temperature and wave-length.

These two quantities are therefore calculated, and when they differed more than 2%, which did not often happen, the set was cancelled. Usually they differed less than 1%, and the mean of both was taken. The reducing factor of the galvanometer and the density of the gas were calculated, with due regard to the deviations from the laws of Boyle and Gay-Lussac. Also from the dimensions of the apparatus a preliminary factor was calculated, by which the rotations were expressed in minutes, for unity of length and magnetic force, and for a pressure of 100 KG. pro cM².

In this manner the following numbers were obtained In the first place the measurements with air and oxygen are once more communicated, on account of a better

determination of some constants, which till now were only preliminarily measured.

The wave-lengths λ are expressed in $\frac{1}{1000}$ mM., the rotations n in minutes.

Air (100 KG., $t = 7.°0$). During the observations the pressure was 91.5 KG.

λ	$n.10^6$	λ	$n.10^6$	λ	$n.10^6$
0.678	441	0.519	731	0.445	994
627	508	500	787	434	1038
583	587	477	857	423	1103
549	658	460	924		

Oxygen (100 KG., $t = 7.°0$). Admixtures 1.4%, probably nitrogen. Pressure during the observations 88.5—97.8 KG.

λ	$n.10^6$	λ	$n.10^6$	λ	$n.10^6$	λ	$n.10^6$
0.684	484	0.604	547	0.507	696	0.450	818
667	484	603	542	506	690	446	838
666	485	578	590	505	690	445	840
664	483	578	582	503	698	439	870
660	493	578	580	477	755	433	875
630	515	578	577	477	756	423	922
630	512	578	577	477	760	423	918
630	515	549	624	477	757	423	922
630	516	539	635	460	797	423	926
606	543	538	635	460	803		
604	545	527	653	456	818		

Nitrogen (100 KG., $t = 14.°0$). Composition: N 93.95 %, O 4.80 %, CO_2 1.25 %. Pressure during the observations 90.0—109.2 KG.

λ	$n.10^6$	λ	$n.10^6$	λ	$n.10^6$	λ	$n.10^6$
0.656	448	0.583	585	0.517	728	0.431	1069
656	444	554	626	517	723	431	1068
656	440	554	619	486	836	431	1072
643	486	554	624	486	833	423	1102
620	488	543	667	486	821	423	1115
619	496	527	702	477	849	423	1085
619	497	527	705	456	938	423	1110
589	563	527	695	455	950		
589	557	518	732	454	944		
589	554	517	731	436	1033		

From the results for those wave-lengths, which are nearly equal, the means are taken, and with these are calculated formulae for interpolation of the formerly announced form, in which a weight p is given to each number equal to the number of set, from which it is deduced. At the same time the rotations calculated with these formulae are compared with the observed rotations.

Air (100 KG., 7.°0).

$$n.10^6 = \frac{200.2}{\lambda} + \frac{47.68}{\lambda^3} = \frac{200.2}{\lambda}\left(1 + \frac{0.238}{\lambda^2}\right)$$

λ	$n.10^6$ Calculated	$n.10^6$ Observed	Diff.
0.678	448	441	7
627	513	508	5
583	584	587	—3
549	653	658	—5
519	727	731	—4
500	782	787	—5
477	859	857	2
460	925	924	1
445	991	994	—3
434	1044	1038	6
423	1103	1103	0

Oxygen (100 KG., 7.°0).

$$n.10^6 = \frac{274.5}{\lambda} + \frac{20.04}{\lambda^3} = \frac{274.5}{\lambda}\left(1 + \frac{0.0730}{\lambda^2}\right)$$

λ	p	$n.10^6$ Calculated	$n.10^6$ Observed	Diff.
0.684	1	464	484	—20
664	4	482	486	—4
630	4	516	514	2
604	4	545	544	1
578	5	579	581	—2
549	1	621	624	—3
538^5	2	638	635	3
527	1	658	653	5
505	4	699	693	6
477	4	760	757	3
460	2	803	800	3
453	2	821	818	3
455^5	2	843	839	4
436	2	871	872	—1
423	4	914	922	—8

If the admixture is supposed to be only nitrogen, we find for pure oxygen:

$$n.10^6 = \frac{275.7}{\lambda} + \frac{19.52}{\lambda} = \frac{275.7}{\lambda}\left(1 + \frac{0.0708}{\lambda^2}\right)$$

Nitrogen (100 KG., 14.°0).

$$n.10^6 = \frac{177.9}{\lambda} + \frac{52.18}{\lambda^3} = \frac{177.9}{\lambda}\left(1 + \frac{0.293}{\lambda^2}\right)$$

λ	p	n.10⁶ Calculated	n.10⁶ Observed	Diff.
0.656	3	456	444	12
643	1	473	486	—13
619	3	507	494	13
587^5	4	560	565	—5
554	3	628	623	5
543	1	654	667	—13
527	3	694	701	—7
517	4	722	728	—6
486	3	821	830	—9
477	1	854	849	5
455	3	945	944	1
432	4	1059	1060	—1
423	4	1110	1103	7

For pure nitrogen we find:

$$n.10^6 = \frac{172.5}{\lambda} + \frac{53.45}{\lambda^3} = \frac{172.5}{\lambda}\left(1 + \frac{0.310}{\lambda^2}\right).$$

If we reduce the results for nitrogen to 7.°0 and then calculate the formula for air from those for oxygen and nitrogen, we find:

$$n.10^6 = \frac{198.0}{\lambda} + \frac{47.51}{\lambda^3} = \frac{198.0}{\lambda}\left(1 + \frac{0.240}{\lambda^2}\right).$$

which formula agrees sufficiently with that which was found above.

The observations with carbonic acid, and with nitrogen monoxide lead to the following formulae:

Carbonic acid (1 atm., 6°.5). Pressure during the observations 18.9—24.7 KG.

$$n.10^3 = \frac{284.3}{\lambda} + \frac{87.68}{\lambda^3} = \frac{284.3}{\lambda}\left(1 + \frac{0.308}{\lambda^2}\right).$$

Nitrogen monoxide (1 atm. 0°.0). Pressure during the observations 25.0—32.9 KG.

$$n.10^8 = \frac{228.6}{\lambda} + \frac{68.46}{\lambda^3} = \frac{228.6}{\lambda}\left(1 + \frac{0.300}{\lambda^2}\right).$$
