Dr. L. H. SIERTSEMA. *On the effect of pressure on the natural rotation of the plane of polarisation in solutions of cane-sugar.*

The apparatus with which the magnetic rotation in gases has been determined, can also serve for the investigation of magnetic and natural rotations in other matter at high pressure. The determinations which will here be communicated, have been made in consequence of a conversation with Prof. TAMMANN, and relate to the natural rotation in solutions of sugar under various pressures. These determinations will afford materials for verifying the hypothesis of TAMMANN on the effect of the internal pressure of liquids on their molecular properties.

The apparatus needed only some unimportant additions. It appeared to be somewhat difficult to withdraw all the air out of the great nicol-holder, which caused some inconvenience when the pressure was applied and removed. Therefore between the experimental tube and the pressure-tube a reservoir was interposed, partly filled with the solution, so that the surface of the liquid can rise and fall in it when the pressure varies.

The most obvious way for determining the effect of pressure would be a direct measurement of the rotation.

For doing this we should have to fill the experimental tube, after adjusting the nicol so that the light is extinguished, with a solution of such a strength, that in the middle part of the spectrum a black band appears, indicating a rotation of 180°, and then to try to observe a displacement of this band when pressure is applied by means of a reservoir of high pressure, e. g. a filled oxygen-cylinder. An accurate examination of this method however shows, that it is not convenient for the observation of small changes of rotation. For although the rotation is considerable, a small change of the rotation will cause a very small displacement of the band or, in other terms, the mobility of the band is too small. The experiment also showed that in this case no displacement was to be seen.

Better results were obtained with the following compensation-method. Between the nicols a plate of quartz, rotating to the left, was interposed, which nearly compensated the rotation of the sugar. A small change of the rotation α_s of the sugar will now greatly affect the difference $\alpha_s - \alpha_k$ to the rotation of sugar and quartz, and the black band in the spectrum will soon move perceptibly. In this way very small changes of α_s will become visible.

In choosing the concentration of the solution and the thickness of the quartz, we must consider that, when we diminish the remaining dispersion, although the mobility of the band increases, it also widens, and the pointings therefore become less accurate. Experience must teach us to choose the best degree of compensation.

It is obvious that in this way also the difference between

the rotatory dispersion of sugar and of quartz can be accurately investigated. This difference is rather irregular, as appears from the irregular changes of the black band when we turn the smaller nicol. So it was once observed, in a case in which $\alpha_k > \alpha_s$, that the band, at first very narrow, showed no perceptible displacement at the rotation above mentioned, but widened, till at last it almost totally vanished. On turning in the other direction the same thing was observed, and moreover in another part of the spectrum a new band appeared, which on the rotation going on, also vanished.

In order to give a narrow black band the quartz must be made of very pure homogeneous material, and of accurate workmanship. Little impurities, which could not be detected with other methods, here became clearly visible, so that we have here a very effective method for investigating the purity of quartz.

The solutions were prepared by solving a weighed quantity of sugar-candy in distilled water, and filtrating the solution before it was used. The concentration was controlled several times by filling the experimental tube with the solution, the nicols having been adjusted so that they cut of the light, and then the wave-length of the black band was determined.

When we know the thickness of the plate and the concentration of the solution, we can calculate the angle of the principal planes of the nicol, which will afford a band in a selected part of the spectrum. Of course the nicols must be adjusted under this angle before closing the flanges of the nicol-holder.

The wave-lengths were determined by pointings on the Na-lines, produced by putting common salt on the carbons of the arc-lamp.

The application of pressure now caused a considerable displacement of the band. The observations consisted in pointings of the band with and without pressure, four or five times in each case. After applying the ordinary corrections, means were taken of the readings of each set.

From these means was then calculated the number ot degrees $\Delta\alpha$, with which the rotation would have changed at a pressure of 100 atm., assuming this change to be proportional to the pressure. Our being justified in making this supposition appears from the following observations

			change.	
c	λ	p	$\triangle \Phi$	$\triangle \Phi/p$.
9.50	562	48.0	0°.196	0.00408
		98.7	0°.402	0.00407
9.30	562	97.9	0°.455	0.00465
		81.4	0°.382	0.00469

in which c indicates te concentration (G. in 100 cc. of the solution), λ the wave-length, p the pressure in KG. per cM^2.

The angles $\Delta\alpha$, calculated in this way for 100 atm. would be equal to the change of the rotation of the solution, if that of quartz remained unchanged. Now we have $\Delta\alpha = \Delta\alpha_s - \Delta\alpha_k$, where $\Delta\alpha_s$ is the variation of α_s, $\Delta\alpha_k$ that of α_k. In default of direct data we shall deduce the variation $\Delta\alpha_k$ from the coefficients of compressibility, found by Voigt.

The rotation α_k can change:

1⁰ by the thickness of the plate undergoing some alteration,

2⁰ by a change in the rotation per unit of length.

Voigt finds in the case of hydrostatic pressure as coefficient of compressibility in the direction of the principal axis 6.73×10^{-8} (mM^2, G.). For a pressure of 100 atm. the rotation α_k would therefore vary by the first cause with $- 1033 \times 6.73 \times 10^{-8} \alpha_k = - 70 \times 10^{-6} \alpha_k$. Concerning the second cause, we will assume that this variation is determined by that of the density. For this variation we have, according to Voigt, the coefficient $25,97 \times 10^{-8}$ (mM^2, G.), and the variation of the rotation by this cause amounts to $+ 1033 \times 25.97 \times 10^{-8} \alpha_k = + 268 \times 10^{-6} \alpha_k$. Hence both causes together give a variation $\Delta\alpha_k = + 198 \times 10^{-6} \alpha_k$. From this we can then calculate $\Delta\alpha_s = \Delta\alpha + \Delta\alpha_k$.

In this way the following results were obtained:

I. Thickness of the quartz 6.88 mM.

c	λ	$\Delta\alpha$	$\Delta\alpha_k$	$\Delta\alpha_s$	α_s	$\Delta\alpha_s/\alpha_s$	n
9.50	492	+0°.555	+0°.043	+0°.598	231°.4	+0.00258	10
»	528	0 .467	0 .037	0 .504	198 .4	254	6
»	559	0 .423	0 .033	0 .456	175 .0	260	8
»	560	0 .438	0 .033	0 .471	174 .6	270	6
»	561	0 .468	0 .033	0 .501	173 .9	288	9
»	»	0 .413	0 .033	0 .446	173 .9	256	12
»	562	0 .437	0 .033	0 .470	173 .2	271	21
»	589	0 .408	0 .030	0 .438	156 .5	280	22
»	»	0 .392	0 .030	0 .422	156 .5	270	24
9.30	537	0 .483	0 .036	0 .519	187 .0	277	21

concentration 9.47, mean value of $\frac{\Delta\alpha_s}{\alpha_s} = 0.00271 \pm 0.00003$.

II. Thickness of the quartz **13.835** mM.

c	λ	$\Delta\alpha$	$\Delta\alpha_k$	$\Delta\alpha_s$	α_s	$\frac{\Delta\alpha_s}{\alpha_s}$	n
18.45	529	+0°.937	+0°.075	+1°.012	397.1	0.00255	24
»	567	0 .840	0 .064	0 .904	330.7	273	16
18.86	530	0 .942	0 .075	1 .017	391.2	260	24
»	558	0 .777	0 .067	0 .844	349.5	241	24
»	579	0 .755	0 .062	0 .817	323.3	253	12

concentration 18.70, mean value of $\frac{\Delta\alpha_s}{\alpha_s} = 0.00255 \pm 0.00005$

Here n represents the weight of each determination, taken equal to the number of pointings from which it has been deduced.

If β represents the rotation of the solution of sugar per unit of length, and l the length of the experimental tube, we have

$$\alpha_s = \beta\, l$$

from which follows:

$$\frac{\Delta\alpha_s}{\alpha_s} = \frac{\Delta\beta}{\beta} + \frac{\Delta l}{l}.$$

The expansion Δl of the experimental tube was measured with a couple of reading-microscopes, placed on a board entirely detached from the apparatus, and beside from it. These microscopes were pointed each on one of the nicol-holders, and so the displacement of these pieces was observed when the pressure was applied. We found $\Delta l = 0.06$ mM. for a pressure of 100 K.G., and $l = 248$ cM., so that $\frac{\Delta l}{l} = 0.00003$.

After applying of this correction we find for our two means:

c	$\Delta\beta/\beta$
9.47	0.00268
18.70	252

The question whether the proportion $\frac{\Delta\beta}{\beta}$ depends on the concentration, cannot yet be solved from these means. Determinations with greater concentrations, which have yet to be undertaken, will perhaps throw more light on the subject.

Considerations on the change of molecular rotatory power and of the concentration by pressure, in connection with the hypothesis of Tammann, will be deferred till the conclusion of these determinations.