

Citation:

Siertsema, L.H., Investigation of a source of errors in measurements of magnetic rotations of the plane of polarisation in absorbing solutions, in:

KNAW, Proceedings, 6, 1903-1904, Amsterdam, 1904, pp. 760-763

concerning the quantities of water which from the rainfall penetrates the soil, it need not be further demonstrated that in the sub-soil under the dunes, under the adjacent flat elevated area and under some shallow polders, drinkable water is and will not be lacking, in the main land of the provinces North- and South-Holland, superficially judging so little favoured in this respect, and with two fifths of the population of our country. That the velocity with which the deep underground water can move through the coarse-grained sand, is quite sufficient to make it possible to procure it from the sand in large quantities, a great number of facts prove it. I will mention but one, that of the paper-manufactory at Velsen, of which the six wells, encompassing an area of 0.85 H.A., every 24 hours, on the average, furnish at least 2200 M³ of fresh water or nearly as much as the town of Harlem wants and about a tenth of what Amsterdam consumed during these latter years. And those wells furnish water, which shows no signs as yet of a too slow horizontal motion ere long being likely, by disturbing the natural equilibrium of the underground fresh and salt-water, to convert the pumped fresh into salt-water. On the contrary the water of the oldest well, full six years in use, has grown a little sweeter still.

Physics. — *“Investigation of a source of errors in measurements of magnetic rotations of the plane of polarisation in absorbing solutions.”* By Dr. L. H. SIERTSEMA. (Communication N^o. 91 from the Physical Laboratory of Leiden by Prof. H. KAMERLINGH ONNES.)

(Communicated in the meeting of January 30, 1904).

In a great number of measurements of the magnetic rotation of the plane of polarisation it was found, that this rotation assumes very large values in the neighbourhood of an absorption-band. Similar large values were found by me in an investigation on the negative magnetic rotation of potassium ferricyanide ¹⁾ in dilute solutions. These results agree with the new optical theories which yield for the magnetic rotation the dispersion formula: ²⁾

$$\varrho = \frac{e}{m} \frac{\lambda}{2V} \frac{dn}{d\lambda}$$

since the quantity $\frac{dn}{d\lambda}$ also assumes a large value near a band.

¹⁾ Arch. Néerl. (2) 5 p. 447; These Proc. 1901/02 p. 339; Comm. Phys. Lab. Leiden N^o. 62, 76.

²⁾ These Proc. 1902/03 p. 413, Comm. Phys. Lab. N^o. 82.

Much attention should therefore be paid to the fact that BATES¹⁾ has made measurements with solutions of cyanine, fuchsine, litmus and aniline blue, from which it would follow that these large rotations did not exist, whereas SCHMAUSS²⁾ with these very substances has found very large rotations. According to BATES these large differences are caused by a source of error which arises from the circumstance that for these measurements we make use of light of which the intensity varies with the wave length³⁾. He shows that both with the half-shadow method, and with that where we adjust on a dark or a bright band in the spectrum, great errors may be made as soon as we arrive at a region where the intensity-curve of the light used shows a considerable decrease, and that this may produce apparently large rotations.

As this source of errors might also occur in my measurements with potassium ferricyanide, it seemed important to me to investigate in how far this may have had a disturbing influence, and thus in how far the large rotations then found would have to be ascribed to it.

With the method involving the use of a dark band in the spectrum, the source of above errors comes to this, that as soon as the intensity of the light on the two sides of the band is not the same, we are inclined to wrongly adjust the middle of the band, and to displace it too much towards the dark side. For we may suppose that for an adjustment we, as a rule, search for two points on the borders of the band which are of equal intensity and then adjust between them. It must be noted that attention has been repeatedly drawn to this source of error⁴⁾ although, as far as I know, an experimental investigation of the errors which may so arise was first made by BATES⁵⁾. A theoretical solution would be possible in the manner indicated by BATES, but this requires a knowledge of the intensity-curve of the spectrum which is seen by the observer in the absence of the magnetic rotation. Moreover we ought to know which of the intensities on the edges is used by the observer to determine the middle of the band, and this especially will partly depend on the observer. An experimental determination may easily be made. We need only produce a spectrum with a movable dark band and

¹⁾ BATES. Ann. d. Phys. (4) 12 p. 1091.

²⁾ SCHMAUSS. Ann. d. Phys. (4) 2 p. 280; 8 p. 842; 10 p. 853.

³⁾ BATES. Ann. de Phys. (4) 12 p. 1080.

⁴⁾ GERNEZ. Ann. éc. norm. 1 p. 12 (1864).

VAN SCHAİK. Thesis for the doctorate. Utrecht 1882 p. 30.

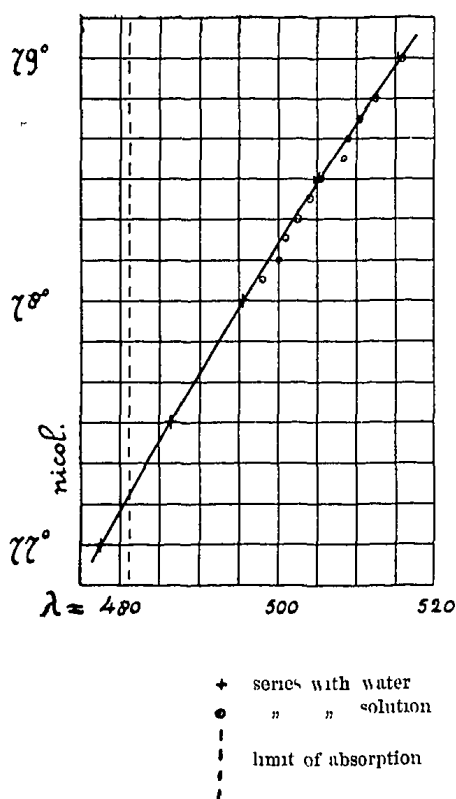
⁵⁾ BATES l. c. p. 1086.

examine it while the light passes or does not pass through an absorbent substance. The apparent displacement of the band near the limit of absorption must then immediately appear.

For my measurements with potassium ferricyanide I have made use of rotations of 11° and higher. A quartz plate 0.4 m.m. thick, cut at right angles to the optical axis was now used and with it a similar rotation is obtained near the limit of absorption. This plate preceded and followed by a nicol was placed between the collimator and the experimental tubes, which moreover were mounted in precisely the same way as they were for measurements of the rotation in potassium ferricyanide. A large number of adjustments have been made by rotating one of the nicols, one set where the experimental tube was filled with a $\frac{1}{2}\%$ solution of potassium ferricyanide, and one with water instead of the salt-solution. The calibration of the spectrum was made as before with a mercury arc lamp. The following values have thus been obtained, as means of pairs of adjustments:

nicol	water	band with in $\mu\mu$ solution
$83^\circ 0'$	629 ^s	630
$82^\circ 30'$	611	612
$82^\circ 0'$	593 ^s	593 ^s
$81^\circ 30'$	577	577 ^s
$81^\circ 0'$	562 ^s	563
$80^\circ 30'$	549	549 ^s
$80^\circ 0'$	538	538
$79^\circ 30'$	525	526 ^s
$79^\circ 0'$	515 ^s	516
$78^\circ 50'$		512 ^s
$78^\circ 45'$		510 ^s
$78^\circ 40'$		509
$78^\circ 35'$		508 ^s
$78^\circ 30'$	505	505 ^s
$78^\circ 25'$		504
$78^\circ 20'$		502 ^s
$78^\circ 15'$		501
$78^\circ 10'$		500
$78^\circ 5'$		498
$78^\circ 0'$	495 ^s	
$77^\circ 30'$	486 ^s	
$77^\circ 0'$	477 ^s	

(limit of absorption, about 481)



The annexed figure represents graphically a part of these readings for both sets. The irregular differences, may apparently be ascribed to errors of observation, which near the limit of absorption will be somewhat larger than at other places, owing to the smaller intensity of the light. They do not amount to much more than $1 \mu\mu$. A deviation of the kind which we might expect from the source of errors supposed by BATES, would reveal itself, near the limit of absorption, in a displacement of the band towards this limit. Such a displacement is not at all indicated by these observations.

Let us consider what apparent displacement must have taken

place, to account for the anomalous rotations which are found in the measurements. This may be found by supposing for a moment that the rotation of the salt is normal, and by putting it equal to that of water. If for instance we start from the value $\varphi_{s_1} = 7.1$ for $\lambda_2 = 606$ ¹⁾ and we call λ_1 the wave-length, where the band ought to have appeared with the solution, if it appeared with water at $\lambda_2 = 519$, then we find by a simple calculation $\lambda_1 = 509$, while we have observed $\lambda_1 = 500$. According to what has been said before a displacement of the band of $9 \mu\mu$ cannot be apparent. Hence the validity of the results obtained before is not affected by the error supposed by BATES.

¹⁾ Comm. N^o. 76 p. 4; Proc. Royal Acad. 1901/02 p. 340.