ginning. THILORIER [1]), as I found out afterwards, already states in opposition to DEWAR that CO_2 and CS_2 are miscible in all proportions.

The investigations into the connection between the two plaits are now being carried on with carbonic acid and water.

The results communicated here show clearly, how great the influence of retardation may be and of how great a significance careful stirring is for those experiments.

[1]) Ann. Ch. et Phys. 60. p. 430.

Dr. L. H. SIERTSEMA. *The dispersion of the magnetic rotation in oxygen.*

The dispersion of the magnetic rotation follows in most substances pretty much the same law that governs the natural rotation, viz. that the rotation varies inversily as the square of the wave-length. The strongly magnetic substances form an exception to this law. In solutions of iron-salts and a few others the dispersion is, according to BECQUEREL [1]), much greater, the rotation varies inversely as the fourth power of the wave-length. In iron, nickel and cobalt the rotation, according to KUNDT [2]) and LOBACH [3]), increases with the wave-length. Also with the phenomenon of KERR, which is closely connected with the foregoing, KUNDT [2]), RIGHI [4]), DU BOIS [5]) and ZEEMAN [6]) found anomalous

[1]) H. BECQUEREL, C. R. 83. p. 125 (1876); Ann. de Ch. et de Ph. (5) 12. p. 68 (1877).
[2]) KUNDT, Wied. Ann. 23. p. 228 (1884).
[3]) LOBACH, Wied. Ann. 39. p. 347 (1890).
[4]) RIGHI, Ann. de Ch. et de Ph. (6) 9. p. 136 (1886).
[5]) DU BOIS, Wied. Ann. 39. p. 25 (1890).
[6]) ZEEMAN, Dissertatie Leiden (1893); Verslag Kon. Akad. v. Wetensch. Amsterdam Oct. 1892 en Febr. 1893.

dispersion. Oxygen seems to stand between these two groups. BECQUEREL [1]) found the dispersion in this case to be very slight; the rotation for red was somewhat larger than for green, but he himself thinks the measured angles of rotation too small to establish this with sufficient certainty. With other measurements of the magnetic rotation in oxygen made by KUNDT and RÖNTGEN [2]) no dispersion was determined.

This peculiar bearing of oxygen deserves to be more accurately investigated, not only for the fact itself, but also because several theories have been published of late, explaining all optical phenomena with the electromagnetic theory of light. For when in this way the optical properties of a substance are brought into connection with the magnetic, it is by the very deviations, which the strongly magnetic substances show, that we can test these theories.

When, as VON HELMHOLTZ [3]) proves, the ordinary dispersion in the electro-magnetic theory of light can be explained by introducing into the formulae quantities which are related to the molecules (electric moment, friction), it is probable that these considerations, when we take the magnetic properties of the molecules into account, can also explain the magnetic rotatory dispersion. In this case the optical behaviour of a magnetic

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[1]) H. BECQUEREL, Ann. de Ch. et de Ph. (5) 21 p. 289 (1880); Journ. de Ph. (1) 8. p. 198 (1879); 9 p. 265 (1880).

[2]) KUNDT und RÖNTGEN, Wied. Ann. 8. p. 278 (1879); 10. p. 257 (1880).

[3]) VON HELMHOLTZ, Wied. Ann. 48. p. 389 (1893).

gas, whose molecular structure is certainly much more simple than that of a metal, will be of great importance to the theory.

For this reason it is very desirable, that the magnetic rotatory dispersion of oxygen should be more narrowly investigated. Some preliminary results of such an investigation will be communicated here.

The arrangement of the apparatus resembles, in its main features, that of KUNDT and RÖNTGEN. The gas is enclosed with a polarisator and an analysator in a long tube under high pressure, and the rotation is obtained by fixing one end of the tube, and turning the other, so that torsion is given to the tube. The tube lies in a long bobbin, through which circulates the magnetising current.

The apparatus differs from that of KUNDT and RÖNTGEN in so far that instead of tourmalines nicols are used for polarisator and analysator, and that monochromatic light is used sufficiently intense to point at the black line, which can be observed in the field of two nicols with perpendicular principal planes [1]). Moreover the magnetic potential difference at the extremities of the bobbin with a current of 70 amp. is 315000 C. G. S. units, whereas this quantity only reached 90000 C. G. S. with the bobbins of KUNDT and RÖNTGEN. This apparatus not only shows greater rotations than those of KUNDT and RÖNTGEN but also enables them to be measured much more accurately.

The copper tube, which contains the gas, is 2 M. long,

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[1]) LIPPICH, Wien. Sitz.-Ber. 85. II. p. 269 (1882).

3 cM. wide. To the ends are fastened large pieces of coquille-bronze, in which are placed the nicols. These pieces are closed by flanges, in which a piece of glass is inclosed by a nut. The thickness of the walls is calculated for a pressure of 200 atm., with threefold certainty. The tightness of the joints is obtained by rings of lead, which caused no peculiar difficulties. Only at the glass-pieces we had to take care, by means of a little paper ring, that metal and glass did not come in contact with each other. In order to obtain the greatest intensity of light, the nicol which is used as analysator must be so large, that all the light, proceeding from the tube, can pass through it. Owing to this the endpiece at this side of the tube assumes rather great dimensions. When, as will be shown hereafter, iron and steel are excluded, the best material for the construction of these pieces is coquille-bronze, which excels by its peculiar toughness and homogeneity. The described pieces were constructed in the utmost perfection in the cannon-foundery of the Hague by the friendly care of the concerned authorities.

The endpieces are lodged in supports of bronze, so that the greater one is fixed in a six-angled frame, and the smaller one can be turned. To the latter piece is fastened a long rod, by means of which rotations can be given to this piece with the aid of cords and little pullies. The angles of rotation were measured with mirror and scale.

The nicols are provided with perpendicular ends, and are chosen so as to show the black line very distinctly. They are fixed in tubes, so that the gas can pass very

easily on all sides. When this was not attended to, the nicols were observed to move at the entering of the gas. The black line remains very distinct at high pressures. Only once, when the apparatus had been left filled during 4 to 5 days, under a pressure of 100 atm., in order to try the tightness, the nicols had ceased to transmit the light, and an examination showed that the layer of Canada-balsam had become untransparent. When this had been repaired, the gas was let out after every experiment, and never remained longer than half a day in the apparatus; in this way the nicols remained perfectly transparent. The tubes in which the nicols are held, can turn in a ring, which can be adjusted with screws in the endpiece, in such a manner that it is exactly perpendicular to the ray of light.

The nicols are carefully adjusted in perpendicular positions before closing the apparatus.

Through the tube passed parallel monochromatic light, proceeding from an arch-lamp of 30 amp., or from the sun. In a telescope behind the tube is observed the image of the slit in the collimator, which makes parallel the monochromatic light. In a spectroscope of Desaga, placed behind the tube, instead of the telescope, the light covers 3 to 4 divisions, whereas the whole visible spectrum covers 90 divisions. There were also made some observations according to another method, in which is sent parallel white light through the tube; this was resolved into a spectrum after leaving it. By this method the absorption-bands, observed by Liveing and Dewar [1]), could be used to determine the wave-length.

The magnetising bobbin consists of two equal parts, placed one behind the other, each part 1 M. long. They consist of a brass tube, 6 cM. wide, provided with flanges, on which are wound 12 to 13 layers of copper wire, of 6 mM. thick. The total number of windings on both bobbins is 3600, the total resistance nearly 1 Ohm. The current of 70 amp. which can circulate through this bobbin was produced by a dynamo of 75 Volt. The space between the bobbin and the tube enables us to prevent the transition of heat. Without this precaution the heating is soon great enough to excite currents in the gas in the tube, which render the image confused; and all subsequent pointings impossible. All the parts of these bobbins, as well as the whole apparatus, which contains the gas, are made of copper or bronze, and wholly free from iron. The magnetic field is in this way proportional to the intensity of the current, which is of great importance for its calculation and measurement. We find for the magnetic potential-difference with 70 amp., calculated by the known formula $4\pi in$ 320000 C. G. S., whereas from a determinations of the rotation in water is deduced 314000 C. G. S.

With this apparatus were made some preliminary experiments with oxygen out of the commercial iron cylinders, at a pressure of about 100 atm., which gas appeared to contain 94 % pure oxygen. From these

[1]) Liveing and Dewar, Phil. Mag. (5) 26. p. 286 (1888).

experiments it follows that, contrary to the result of Becquerel mentioned before, the constant of magnetic rotation in oxygen decreases regularly with increasing wave-lengths, and that for violet it is twice as large as for red. It agrees tolerably well with the constant, which can be deduced from the determinations of Kundt for white light.