Dr. P. ZEEMAN. *Comparison of measurements on the reflexion of light from the polar surface of a magnet with the theories of* GOLDHAMMER *and* DRUDE.

According to DRUDE (Wied. Ann. Bd. 49, p. 696. 1893) the formulae of his theory on the magneto-optic phenomena are a particular case of the results of GOLDHAMMER's theory [1]), that is to say, that GOLDHAMMER's complex constant b is in DRUDE's theory a real quantity. Hence it follows, that SISSINGH's phase [2]) may be calculated in the manner given by GOLDHAMMER and also followed by DRUDE [3]).

It was communicated to the Academy 29 October 1892, that my measurements on the reflexion of polarised light from the polar surface of a magnetized cobalt-mirror [4]) are not in accordance with this view.

DRUDE's theory gives the following values of SISSINGH's phase for.

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[1]) GOLDHAMMER, Wied. Ann. Bd. 46, p. 72. 1892.

[2]) ZEEMAN, Archiv. Néerl. T. XXVII. p. 254, 1893 and Diss. Leiden 1893. p. 3.

[3]) DRUDE, Wied. Ann. Bd. 48, p. 124. 1893.

[4]) Vide also ZEEMAN, l. c. p. 296.

	iron	cobalt	nickel	
	(D-light)	(red light)	(D-light)	
	76°16′	61°26′ [1])	60°	
I have found	80°	45°32′	30°	(preliminary determination).

It is wholly impossible to attribute the discordances to errors of measurement.

It seems however that DRUDE is not convinced by the calculation of SISSINGH's phase from the observations and still prefers to calculate the rotations with mean values of the magneto-optic constants, deduced from the observed rotations. In the following communication I will make use of the latter manner of calculation. The refutation of DRUDE's remarks on my measurements (Wied. Ann. Bd. 49 p. 490. 1893) is hereby simplified.

DRUDE himself pays in his theory a particular attention to the angles of incidence, whereby, the incident light being polarised *perpendicular* to the plane of incidence, the so-called null rotation of the polarisator is = 0. ($\psi^0{}_{||} = \psi^0{}_{ia} = 0$) [2]). At angles of incidence, greater or smaller than those just named, the sign of the rotations is opposite. The value of that particular angle is indeed a very suitable criterium for the exactness of the proposed theories.

From DRUDE's theory in the case of polar reflexion

[1]) In a communication to the Academy of Amsterdam 29 Oct. '92 this value was erroneously given 80°.

[2]) Vide for notation. SISSINGH. Phil. Mag. April 1891.
ZEEMAN, l. c. p. 262.

it follows, when the calculations are made with the values of the optical constants as given by him, that a reversal in the sign of the rotations may be expected

for iron at the angle of inc. $i = 67°6′$ (D. light)
» cobalt » » » » » $i = 64°50′$ »
» nickel » » » » » $i = 60\ 35′$ »

Wholly different GOLDHAMMER's theory gives a reversal of sign

for iron at $i = 64°$ ($S = 80°$)
» cobalt » $i = 50°$ ($S = 49°5°$)
» nickel » $i = 35°$ ($S = 36°$).

In the calculation the values of SISSINGH's phase closed in brackets were made use of. In the case of iron the value of S is known from SISSINGH's measurements on the reflexion from the aequatorial and from my measurements from the polar surface of a magnet. In the case of cobalt my polar measurements give the value; whereas for nickel, accepting according to analogy that also in this case the value of SISSINGH's phase will be found nearly constant within wide limits, I determined a preliminary value of $S = 30°$ (deduced from observations at the angle of incidence $i = 50°$). If the value of S were $= 32°$, then there must be at an angle of incidence of 10° a reversal of the null rotations, whereas for values of S, less than 31°, there cannot be according to GOLDHAMMER's theory a reversal, when the incident light is polarised perpendicular to the plane of incidence.

An accurate determination of SISSINGH's phase for nickel was therefore much wanted. Some measurements made by Mr. WIND in the Leiden laboratory, point to the fact, that S is nearly equal to 36° and that $\psi^0_{lp} = 0$ at about 35°. This result confirms GOLDHAMMER's theory, but it is impossible to account for it by DRUDE's

	For D-light ψ^0_{lp} must be = 0 for	
	iron	cobalt
according to DRUDE's theory at	67°6′	64°50′
whereas observations gave	63° (RIGHI)	51°,5 (ZEEMAN).

What has been said above wholly confirms my former [1]) result about DRUDE's theory.

Not only that particular rotation, treated above, but also the rotations at other angles, are duly predicted by GOLDHAMMER's theory. No doubt there is a misunderstanding on the part of DRUDE in his considerations [2]) on this point.

He makes the supposition, that the rotations as observed by me, were made at the same magnetisation. The contrary was however l. c. [3]) expressly stated. I have, using the proper magnetisations, recalculated the rotations according to DRUDE's and GOLDHAMMER's theories. The tables exhibit the rotations, reduced to the same magnetization in minutes, the result of the 2 theories

[1]) ZEEMAN, l. c. p. 296.
[2]) DRUDE, Wied. Ann. Bd. 49. p. 690. 1893.
[3]) ZEEMAN, Dissertation p. 40 and p. 43 and Archiv. Néerl. p. 288, 293.

(G and D) and the differences between observation and theory. The notation of the minimum and null rotations is the same as that used and quoted in the beginning. The angle of incidence is indicated by ϕ.

	ψ^m_{la}			$-\psi^m_{lp}$			$-\psi^0_{lp}$			ψ^0_{la}		
ϕ	obverv.	D	diff.	observ.	D	diff.	observ.	D	diff.	observ.	D	diff.
45°	+ 15.0	+ 13.9	+ 1.1	+ 11.8	+ 10.6	+ 0.8	— 1.4	— 13.4	+ 12.0	+ 17.5	+ 28.6	— 11.1
60°	+ 16.2	+ 14.2	+ 2.0	+ 10.3	+ 8.9	+ 1.4	+ 3 2	— 2.2	+ 5.4	+ 13.4	+ 17.3	— 3.9
73°	+ 11 2	+ 14.1	— 2.9	+ 6.1	+ 6.1	+ 0.8	+ 5.3	+ 3.0	+ 2.3	+ 9.5	+ 12.3	— 2.8

GOLDHAMMER's theory gives:

	ψ^m_{la}			$-\psi^m_{lp}$			$-\psi^0_{lp}$			ψ^0_{la}		
ϕ	observ.	G	diff.	observ.	G	diff.	observ.	G	diff.	observ.	G	diff.
45°	+ 15.0	+ 15.6	— 0.6	+ 11.8	+ 12.1	— 0.3	— 1.4	— 1.4	— 0.0	+ 17.5	+ 17.1	+ 0.4
60°	+ 16.2	+ 16.7	— 0.5	+ 10.3	+ 10.5	— 0.2	+ 3.2	+ 3.0	+ 0.2	+ 13.4	+ 12.9	+ 0.5
73°	+ 11.2	+ 12.5	— 1.3	+ 6.9	+ 7.2	— 0.3	+ 5.3	+ 5.8	— 0.5	+ 9.5	+ 10.1	— 0.6

Again it follows, that great differences remain between DRUDE's theory and observation. With GOLDHAMMER's theory there is no discrepancy between theory and observation, especially when it is considered, that the measurements were made in the first place for the determination of the phase, whereby there is no influence of possible errors in the determination of the magnetization [1]).

Undoubtedly now the determination of the phase at

[1]) ZEEMAN, l. c. p. p. 14 and 27.

normal incidence from a normally magnetized mirror becomes of great interest, in order to decide whether SISSINGH's phase has the same value at all incidences. This investigation, of great importance to judge on the exactnes of the description of the phenomena by GOLDHAMMER's theory, is therefore prepared in the physical Laboratory of the Leiden University.

Dr. J. P. KUENEN *On the abnormal phenomena near the critical point.*

Various phenomena are seemingly opposed to ANDREWS's clear conception of the connection between the liquid and the gaseous states of matter and the signification of the critical point [1]. In the first place the disappearing and reappearing of the liquid surface at other volumes than the critical volume, the explanation of which phenomenon STOLETOW [2]) finds in the smallness of the difference between the indices of refraction. Accurate observation of the phenomenon suffices to render this hypothesis improbable: at a given moment independent of the illumination the surface is seen to lose its clearness and to change into a layer of transition, as with two liquids mixing. Moreover the disappearing-temperature would not alter with the volume, which on the contrary it does (vid. below).

CAILLETET et HAUTEFEUILLE [3]) and CAILLETET et COLARDEAU [4]) conclude from their experiments with a solution of iodine in carbonic acid, that the liquid and vapour

[1]) cf. RAMSAY Pr. R. S. of L. 30 p. 323.
[2]) Physik. Revue II Juli 1892. p. 44. 73.
[3]) C. R. 92 p. 840, 1086.
[4]) C. R. 108 p. 1280.