Dr. P. ZEEMAN. *The phase in the case of polar reflexion from cobalt and nickel and the angle of reversal of the null-rotation* ψ°_{lp} *according to theory and experiment, (with a diagram).*

In a former communication [1]) I pointed out the great difference between DRUDE's theory and my observations on cobalt, especially as to the angle of incidence at which the null rotation $\psi^{\circ}_{lp} = \psi^{\circ}_{ia}$ is $= 0$ and the direction of rotation is reversed. Now $\psi^{\circ}_{lp} = 0$ only means that the phases of the magneto-optical component (m) and of the metallic reflexion (Φ) are of the same numerical magnitude. Let a line be drawn representing the phase of the metallic reflexion at every angle of incidence. Let also lines be drawn representing the phase of the magneto-optical component according to observation and theory, then the intersections of these lines give us the observed and calculated angles of the reversal of the sign.

Besides, the diagram gives a very clear representation of the whole course of the phase in the rival theories, clearer indeed than any table can give. Therefore, I thought important the actual drawing of these curves

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[1]) Verslagen Afd. Natuurkunde, 29 Oct. 1893. These communications n°. 8.

for cobalt and nickel, partially using the already known data, partially now determining what was wanted.

Experiments on cobalt and nickel are best fitted to distinguish between the rival theories, because the value of SISSINGH's phase for these metals is much lower than for iron.

Cobalt. Fig. 1 represents:

1. The phase Φ of metallic reflexion, calculated according to the formulae of CAUCHY.

2. The phase $m_b + S$ of the magneto-optical component [1]) as calculated according to GOLDHAMMER's [2]) theory.

3. The phase m according to DRUDE's theory. As this theory immediately gives the rotations [3]), I calculated those ones in the first place and hence derived the phases according to known relations.

4. The observed phases, as determined by my former observations [4]). This line in the case of cobalt so nearly coincides with line 2, that it is not drawn in the figure.

The data for the construction of the diagram are given in the following table:

i	Φ	$m_b + S$ (GOLDHAMMER)	m_w (Observ.)	m (DRUDE)
45°	18°38′	20°43′	20°34′	11°39′
60°	36°42′	27°31′	27°40′	29°44′
73°	75°18′	37°47′	37°55′	94°48′

[1]) ZEEMAN. Arch. Néerl. T. 27. p. 296. 1893.
[2]) GOLDHAMMER. Wied. Ann. Bd. 46. p. 72. 1892.
[3]) DRUDE. Wied. Ann. Bd. 46. p. 401. 1892.
[4]) ZEEMAN. l. c. p. 293.

I have adopted for S the value 49°30′, which I have given on a former [1]) occasion.

According to the figure the said reversal according to DRUDE takes place at i about 64°,5.

According to observation and GOLDHAMMER's theory the result identically is $i = 49°24'$.

The course of the phase wholly differs according to GOLDHAMMER and DRUDE, but as was already remarked, the observed line of the phases coincides with that one derived from GOLDHAMMER's theory.

The theory of Prof. LORENTZ, of which GOLDHAMMER's is a modified form, gives a line for the phases, quite parallel to GOLDHAMMER's line, but with ordinates differing to the amount of SISSINGH's phase.

In fig. 2 and 3 I have yet given the representation of a table, in my former communication [2]), showing the observed null- and minimum-rotations and those derived from GOLDHAMMER's and DRUDE's theories. Evidently from these figures we find the same values of the point at which the reversal takes place.

Nickel. The observations of Mr. WIND on the reflexion from nickel don't extend to the region, wherein ψ^{o}_{ip} becomes null. Hence for my purpose an extension of his measurements was necessary; also it was desirable to repeat the observations at $i = 39° 4'$, because, according to the communication of Mr. WIND, different causes of error may have falsified his results obtained as that angle of incidence.

[1]) ZEEMAN. l. c. p. 293.
[2]) Verslagen Afdeel. Natuurk. 29 Oct. '93, Communication n°. 8.

Now I will communicate the results of my measurements on white light, using my former notations. For different particulars as to the precautions used, the method of observations etc., I refer to the publication cited in n° 5.

I.

angle of incidence $i = 39° 4'$ intensity of the field $H = 2190$ C. G. S.

Mean: $\psi°_{lp} = + 2{,}9' \pm 0{,}24'$ $\psi°_{la} = -- 6{,}1' \pm 0{,}24'$.
Mean $I = 75° 26'$ $H = 31°43'$ for light of refrangibility D.

The formula for determining m_l becomes

$$\text{cotg } m_l = 2{,}194 - 4{,}614 \frac{\psi°_{lp}}{\psi°_{la}}$$

Most probable value derived from the observations

$m = 9° 17' \pm 24'$ $10^3 \mu = - 0{,}975 \pm 0{,}050$.

Prof. LORENTZ's theory gives:

$$m^l = - 26° 44'.$$

II.

angle of incidence $i = 25°$ intensity of the field $H = 2190$ C. G. S.

Mean: $\psi°_{lp} = + 0{,}5' \pm 1{,}0'$ $\psi°_{la} = - 8{,}6' \pm 0{,}9'$.
Mean: $I = 75°16'$ $H = 31°15'$ for light of refrangibility D.

The formula for determining m_l becomes:

$$\text{cotg } m_l = 10{,}445 - 10{,}997 \frac{\psi°_{lp}}{\psi°_{la}}$$

Most probable value derived from the observations

$m = 5° 9' \pm 43'$ $10^3 \mu = - 1{,}00 \pm 0{,}12$.

According to Prof. LORENTZ's theory.

$$m_l = - 30° 29'.$$

I also endeavoured to perform null rotations at smaller angles of incidence. However I did not finish these series, because at $i = 22°$ the probable error of the mean

of $\psi°_{la}$ amounts to about $\pm$ 3.1'
» $\psi°_{lp}$ » » » $\pm$ 2,7'.

Hence a determination of the phase in this manner is of no value for the determination of SISSINGH's phase.

Resuming the now obtained results and those found by Dr. WIND at the angles 55° and 75° we have:

angle of incidence.	m observed.	m_b calcul.	S
25°	5°9′ ± 43′	— 30°29′	35°38′ ± 43′
39°4′	9°17′ ± 24′	— 26°44′	36°1′ ± 24′
55°	17°47′ ± 28′	— 18°36′	36°23′ ± 28′
75°	32°25′ ± 30′	— 4°44′	37°9′ ± 30′.

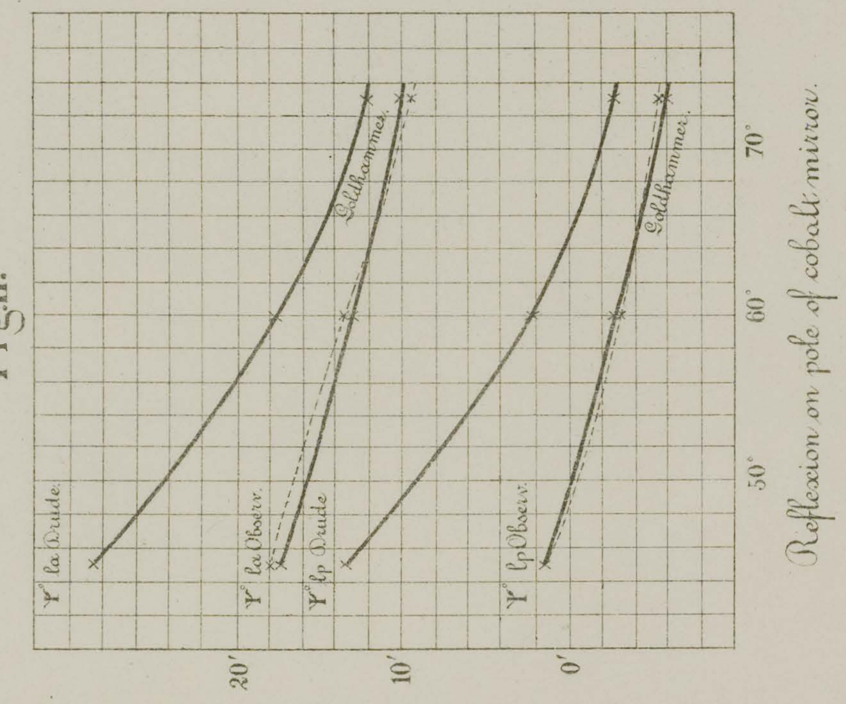
The final result for SISSINGH's phase becomes, if the different weights of the observations are taken into account.

$$S_{Ni} = 36°21' \pm 15' \text{ for } D\text{-light}.$$

In fig. 4 the same 4 curves for nickel are drawn, which were given above for cobalt.

The circles, the centres of which are on the curve 4 give the probable error in m.

Fig.II.



..................observations.

Fig.I.

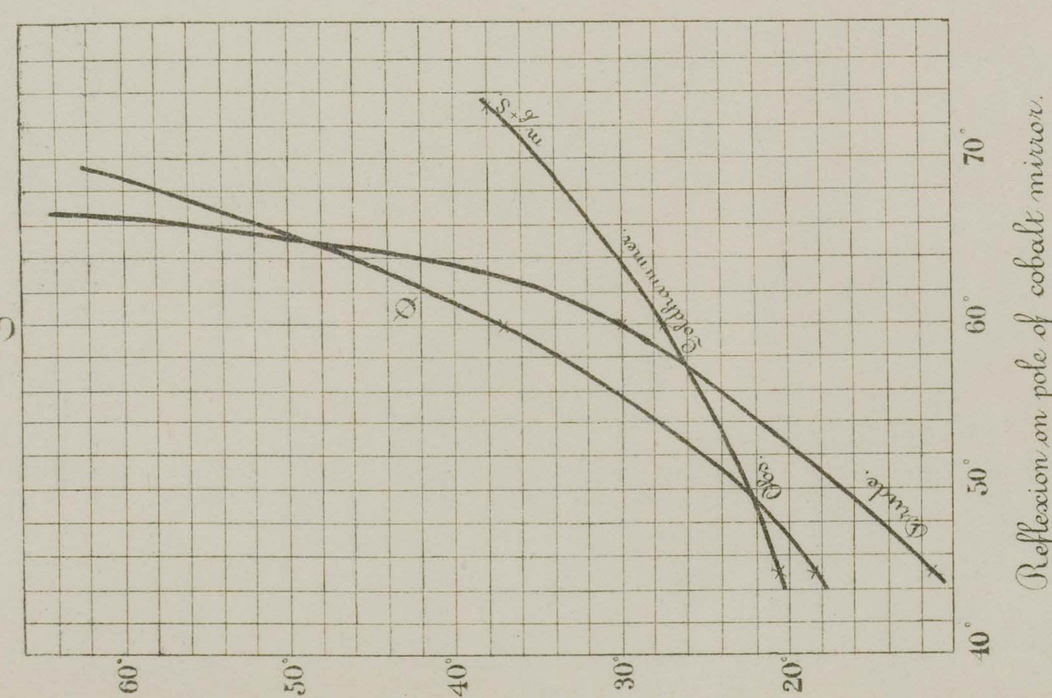
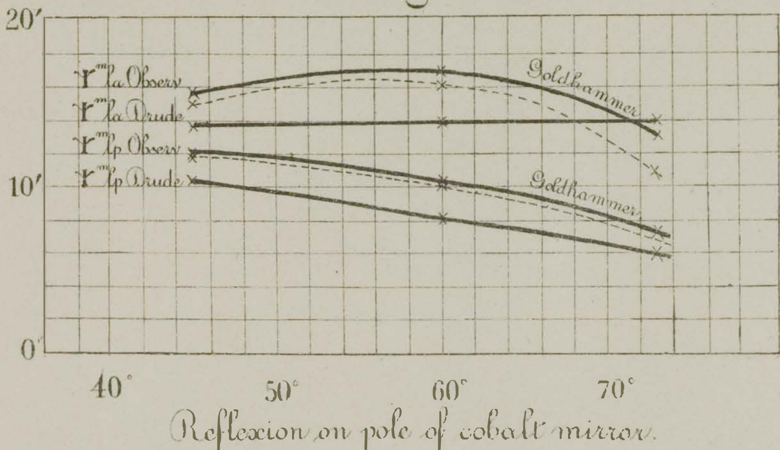
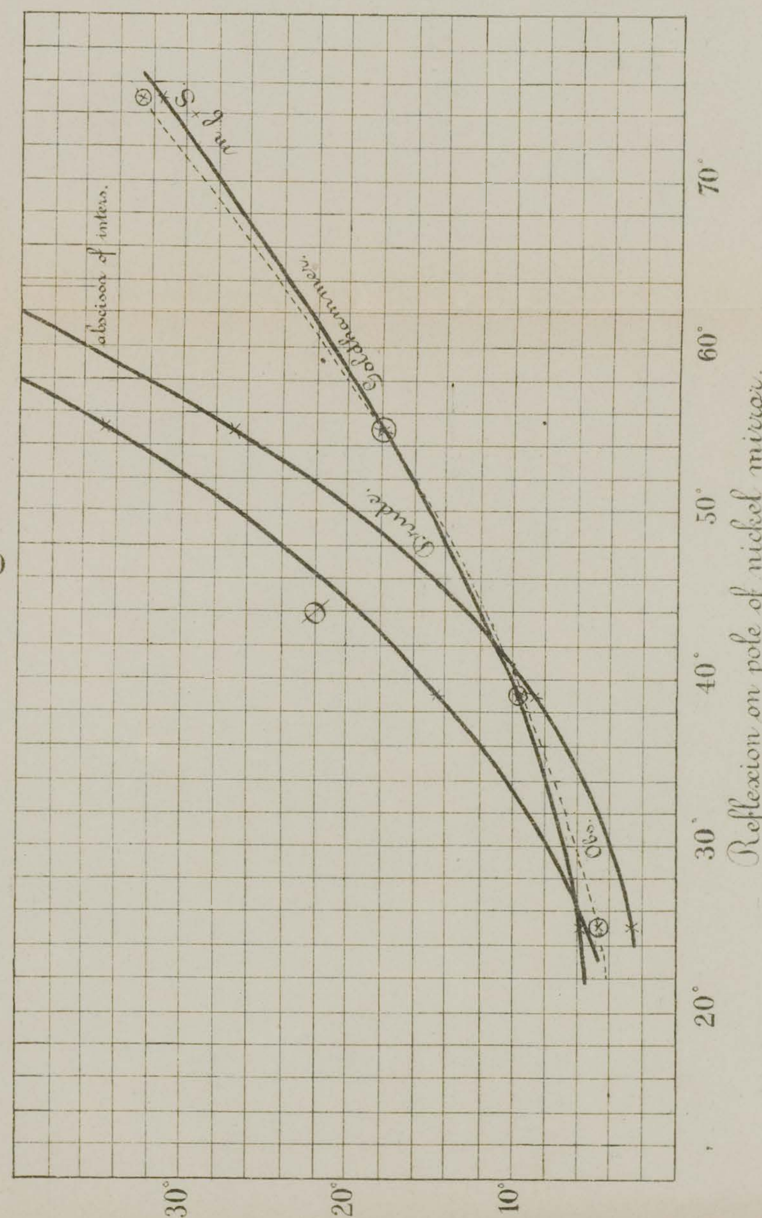


Fig.III.



..............observations.

Fig.IV.



...man, Kerr's phenomenon 1893/94.

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The points of the curves are determined by the numbers given in the following table.

i	Φ	$m_b + S$ (GOLDHAMMER)	m_w (Observ.)	m (DRUDE)
25°	5°30′	5°52′	5°9′ ± 43′	2°58′
39°4′	14°19′	9°17′	9°17′ ± 24′	8°45′
55°	34°14′	17°45′	17°47′ ± 28′	26°58′
75°	84°58′	31°37′	32°25′ ± 30′	115°7′.

The intersection of DRUDE's line with the line Φ gives the reversal of the rotations at $i = 63°30'$.[1])

Observation however gives this reversal at about $i = 24°$.

According to GOLDHAMMER's theory this should be at about $i = 26°$. The difference between the 2 last numbers however does not surpass the limits of the errors of observation, because at $i = 25°$ was found $\psi°_{lp} = +0{,}5' \pm 1',0$. Hence $\psi°_{lp}$ may very well become null at 26°.

The investigation which I am carrying on, concerning the light normally reflected from the polar surface, will decide this point and also the constancy of SISSINGH's phase. But, whatever may be the result of this inquiry, now already we may state that GOLDHAMMER's final formulae describe the phenomena in a very satisfactory way, the remaining differences being of a different order of magnitude than the differences between observation and DRUDE's formulae.

[1]) This value differs somewhat from that given in the assembly of the Acad. of 29 Oct. '93, then being made use of DRUDE's more severe formulae.

This difference of course does not influence our results.

11

COMMUNICATIONS

FROM THE

LABORATORY OF PHYSICS

AT THE

UNIVERSITY OF LEIDEN

BY

PROF. DR. H. KAMERLINGH ONNES.

No. 11.

Dr. J. P. KUENEN. Some experiments regarding the anomalous phenomena near the critical point. (With a plate).

(*Translated from: Verslagen der Afdeeling Natuurkunde der Kon. Akademie te Amsterdam, van* **26 Mei 1894**, *p.* 19—34).

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Dr. J. P. KEUNEN. Further experiments regarding the anomalous phenomena near the critical point.

(*Translated from the same* **30 Juni 1894**, p. 57—62).

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