K S Krishnan.

Investigations on Magne-Crystallic Action. V

(Contd from IV)

Further measurements on paramagnetic crystals.

Oct- 1934.

Contents (Refers are to pages)

Refers to Double Sulphates: within brackets
" " Double Selenates: without brackets

	Na	K	Am.	Rb.	Cs.	Tl.
Fe	×	×	×	(2) ×	(78) ×	(15) 81
Co		64	68	(5) 70	(7) ×	(21) 72
Ni		52	56	(9) 58	(11) 62	(25) 60 (~~Rb~~)
Cu		33	37	(13) 41	(18) ×	(29) 45

Double sulphates 12
Double Selenates 14
26

Other crystals.

$NiSeO_4 \cdot 6H_2O$ 49 (~~49~~)

$CoSeO_4 \cdot 6H_2O$ 75 (~~75~~)

$CoK_2SO_4 \cdot SeO_4 \cdot 6H_2O$ 66

$Ni(NH_4)_2SO_4 \cdot SeO_4 \cdot 6H_2O$ 54. (30)

$Ni(NH_4)_2(BeF_4)_2 \cdot 6H_2O$ 27. (32)

$Co(NH_4)_2(BeF_4)_2 \cdot 6H_2O$ 23

Rare earths

Ceric tetra valent
Cerous tri "

		p.
1. 4.	$Nd_2(SO_4)_3 \cdot 8H_2O$	83
3.	$Pr_2(SO_4)_3\ 8H_2O$	84.
1.4.	$Sm_2(SO_4)_3\ 8H_2O$	86.
1.a	$Er_2(SO_4)_3 \cdot 8H_2O$	93.
	~~$Ce(NH_4)_2(NO_3)_5 \cdot 4H_2O$~~	~~92~~
2.	$Ce\ NH_4(SO_4)_2 \cdot 4H_2O$	92

Trig. Series

1.	$Mg_3Ce_2(NO_3)_{12} \cdot 24H_2O$	101
1.	$Zn_3Ce_2(NO_3)_{12} \cdot 24H_2O$	102
4.? ~~Pr not pure~~ 4.	$Mg_3Pr_2(NO_3)_{12} \cdot 24H_2O$	95 ~~103~~
	$Zn_3Pr_2(NO_3)_2 \cdot 24H_2O$	
1.	$Mg_3Nd_2(NO_3)_{12} \cdot 24H_2O$	109
1.	$Zn_3Nd_2(NO_3)_{12} \cdot 24H_2O$	107
1.	$Mg_3Sm_2(NO_3)_{12} \cdot 24H_2O$	105
1.	Zn_3 " "	

$M_2^{+++} \cdot (C_2H_5SO_4)_6^- \cdot 18H_2O$

		page	
M =	Nd	89	1.
	Pr	98	
	Yb	90	2.
	Sm	91	1.
	Er	97	1.
	Ce	88	1.

$M^{+++}Cl_3 \cdot 6H_2O$

M =	Er	120. (~~STR~~)
	Nd	122
	Sm	124

Other Compounds

$K_3Fe(CN)_6$	112.
$(NH_4)_2Cr_2O_7$	114
K_2CrO_4	116
$(NH_4)_2CrO_4$	118.

Sources of rare earth samples :-

(1) Theodor Schuchardt
(2) Geological survey (purity unknown -
(3) Dr P.B. Sircar Sc. college. Pure
(4) from Prof. Samuel's Laboratory.

Double Sulphates (contd)

$Fe_2SO_4 \cdot Rb_2SO_4 \cdot 6H_2O$.

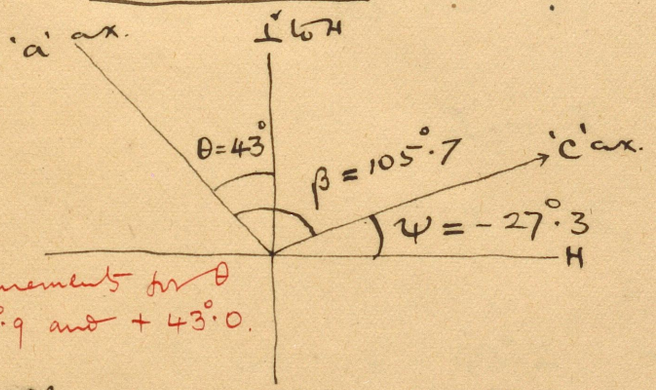
Monoclinic prisms. According to Tutton (see also Groth) (J.C.S. Trans, 63, 367, 1893)

$a : b : c = 0.7377 : 1 : 0.5004$; $\beta = 105° 44'$

$\rho = 2.516$. $M = 526.9$

Cryst form as described in Groth.

'b' ax. vert.



Fresh measurements for θ gave +42°.9 and +43°.0.

Throughout the following measurements

$H = 1390$

$c = .00354$.

$\theta = +43°.0$

$\therefore \psi = -27°.3$.

1st cryst. $\chi_1 - \chi_2 = \frac{\pi \times 1742}{90} \times \frac{1}{.0259} \times \frac{Mc}{H^2} =$ ~~2271~~ 2267

2nd cryst. $\frac{\pi \times 2667}{90} \times \frac{1}{.0397} \times$ " $=$ 2268

Adopt $\chi_1 - \chi_2 =$ ~~2270~~ 2265 . . . (1)

'a' ax. vert. 'b' ax. along f to mer-

$\Delta\chi = \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta$

$= \frac{\pi \times 706}{90} \times \frac{1}{.0259} \times \frac{Mc}{H^2} =$ ~~920~~ 919

$= \frac{\pi \times 1078}{90} \times \frac{1}{.0397} \times$ " $=$ ~~917~~ 915

$\therefore \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta =$ ~~919~~ 917 . . . (2)

Fe Rb. sulp.

(001) pl. horiz 'b' ax. along f so that

$$\Delta\chi = \chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta$$

1st crystal $= \frac{\pi \times 814.5}{90} \times \frac{1}{.0259} \times \frac{Mc}{H^2} =$ ~~1062~~ 1059 ... (1)

2nd $= \frac{\pi \times 1253}{90} \times \frac{1}{.0397} \times$ " $=$ 10654

Adopt. $\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta =$ ~~1064~~ 1062 ... (3)

From (1), (2) and (3)

$\chi_1 - \chi_2 =$ ~~2270~~ 2265

$\chi_1 - \chi_3 =$ ~~144~~ 143

θ cal. $= 43^\circ.2$ which corresponds to

$\psi = -27^\circ.5$

as against $-27^\circ.3$ directly measured.

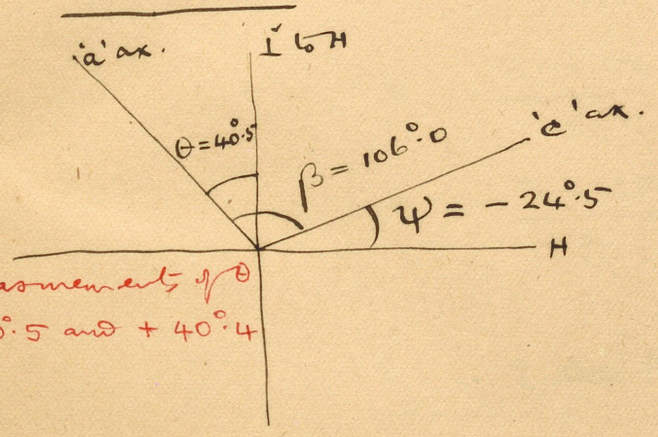
$CoSO_4 \cdot Rb_2SO_4 \cdot 6H_2O$

Monocl. prisme.

$a : b : c = 0.7391 : 1 : 0.5011$; $\beta = 106° \cdot 1'$ $\rho = 2.557$.

$M = 530.0$

'b' ax. vert



Later measurements of θ gave +40°·5 and +40°·4

$\theta = +40°\cdot5$

$\therefore \psi = -24°\cdot5$.

Three crystals were measured.

In all cases, $c = .00354$

$H = 1390$.

$$\chi_1 - \chi_2 = \frac{\pi \times 1921}{90} \times \frac{1}{.0268} \times \frac{Mc}{H^2} = 2430$$

$$2^{nd}\ \text{cryst.} = \frac{\pi \times 1497}{90} \times \frac{1}{.0208} \times \text{"} = 2440$$

$$3^{rd}\ \text{"} = \frac{\pi \times 1883}{90} \times \frac{1}{.0262} \times \text{"} = 2437$$

Adopt $\chi_1 - \chi_2 = 2435$ (2440) - - - - (1)

'a' ax. vert. 'b' ax. ⊥ to H.

$$\therefore \Delta\chi = \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3$$

$$1^{st}\text{-cry.} = \frac{\pi \times 129.5}{90} \times \frac{1}{.0268} \times \frac{Mc}{H^2} = 164 \quad (160)$$

$$2^{nd}\ \text{"} = \frac{\pi \times 99}{90} \times \frac{1}{.0208} \times \text{"} = 162 \quad (154)$$

$$3^{rd}\ \text{"} = \frac{\pi \times 125}{90} \times \frac{1}{.0262} \times \text{"} = 1642 \quad (158)$$

Adopt. $\chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = 163$ .... (2) (159)

(001) pl. horiz. 'b' axis along t.

$$\therefore \quad \Delta\chi = \chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta$$

1st crystal $= \frac{\pi \times 132}{90} \times \frac{1}{\cdot 0268} \times \frac{Mc}{H^2} = 167$

2nd " $= \frac{\pi \times 100}{90} \times \frac{1}{\cdot 0208} \times$ " $= 163$

3rd " $= \frac{\pi \times 125\cdot 5}{90} \times \frac{1}{\cdot 0262} \times$ " $= 162$

$$\therefore \chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \cdot 164 \quad \ldots (3)$$ (160)

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 2435 \quad \| \quad 2449$$
$$\chi_1 - \chi_3 = 1217 \quad \| \quad 1220$$

and $\theta = 41^\circ \cdot 1$ which corresponds to

$$\psi = -25^\circ \cdot 1$$

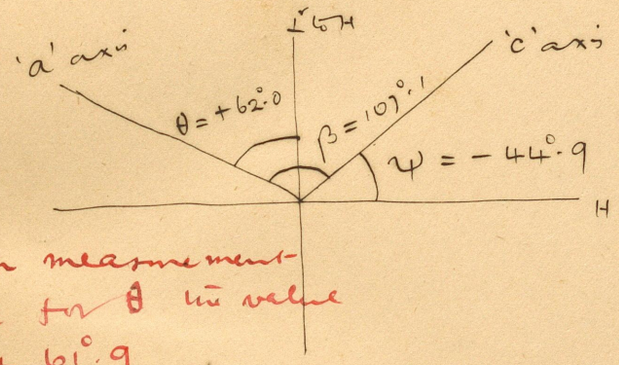
as against $-24^\circ \cdot 5$ directly measured.

$CoSO_4 \cdot Cs_2SO_4 \cdot 6H_2O$

Monocl. prisme. $M = 624.77$ $\rho = 2.844$ (l.c.T)

$a : b : c = .7270 : 1 : .4968$; $\beta = 107^\circ 8'$

'b' ax. vert setting was as below



Later measurement gave for θ the value + 61°.9.

$\theta = +62^\circ.0$

$\psi = -44^\circ.9$

Two crystals were measured

$m_1 = .0636$ gm. $m_2 = .0187$

$C = .00568 \left(\frac{T.5.128}{7.57^2}\right)$; $H = 1.419$ gm

$\Phi_1 = \frac{\pi}{90} \times \frac{MC}{H^2} \times \frac{1}{m_1}$

$\Phi_2 = \frac{\pi}{90} \times \frac{MC}{H^2} \times \frac{1}{m_2}$

$\chi_1 - \chi_2 = \Phi_1 \times 2681 = 2595$
$= \Phi_2 \times 788 = 2594$ } Adopt. $\chi_1 - \chi_2 = 2600$ (2595) --- (1)

(2) 'a' ax. vert. 'b' ax. along field

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \Phi_1 \times 1570 = 1519$
$= \Phi_2 \times 459 = 1511$ } Adopt 1515 --- (2)

(3) c(001) pl. horiz. 'b' ax. along field

$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \Phi_1 \times 82 = 79.4$
$= \frac{\pi}{90} \times \frac{M}{m_2 H^2} \times .000496 = 80.5$ } Adopt 80 --- (3)

$= 1.6718/9.73^2$

From (1), (2) and (3)

$\chi_1 - \chi_2 = 2595$ 2600
$\chi_1 - \chi_3 = 500$ 500

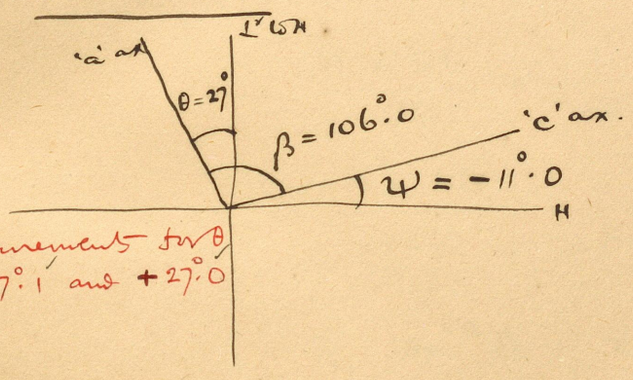
and $\theta = 61^\circ.8$, which corresponds to $\psi = -44^\circ.7$, as against $-44^\circ.9$ directly observed.

$NiSO_4 \cdot Rb_2SO_4 \cdot 6H_2O$

Monocl. prismc. $\rho = 2.586$ I.C.T ~~2.856 Tutton~~ 2.583 Tutton. $M = 529.8$

$a : b : c = 0.7350 : 1 : 0.5022$; $\beta = 106° 3'$.

'b' ax. vert



Later measurements for θ gave + 27°.1 and + 27°.0

$\theta = +27°.0$

$\therefore \psi = -11°.0$.

Throughout $H = 1390$

For 1st + 2nd cryst $c = c_1 = .00354$

for the 3rd cryst $c = c_2 = .00343$.

1st cryst. $\chi_1 - \chi_2 = \frac{\pi \times 357}{90} \times \frac{1}{.0865} \times \frac{Mc_1}{H^2} = 140$

2nd cryst. " $= \frac{\pi \times 355.5}{90} \times \frac{1}{.0828} \times \frac{Mc_1}{H^2} = 145.5$

3rd crys. " $= \frac{\pi \times 421}{90} \times \frac{1}{.0955} \times \frac{Mc_2}{H^2} = 145$.

$\therefore \chi_1 - \chi_2 = 144$ . . . . (1)

'a' ax. vert 'b' ax. ⊥r to f.

$\therefore \Delta\chi = \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3$

1st crys $= \frac{\pi \times 272}{90} \times \frac{1}{.0865} \times \frac{Mc_1}{H^2} = 107$

2nd " $= \frac{\pi \times 255}{90} \times \frac{1}{.0828} \times$ " $= 104$

3rd " $= \frac{\pi \times 310}{90} \times \frac{1}{.0955} \times \frac{Mc_2}{H^2} = 107$.

$$\therefore \chi_1 \cos^2\theta - \chi_2 \sin^2\theta - \chi_3 = 106 \quad \text{---------- (2)}$$

(001) pl. horiz. 'b' ax. again ⊥ to field

$$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3$$

1st cryst. $= \frac{\pi \times 70}{90} \times \frac{1}{.0865} \times \frac{MC_1}{H^2} = 27$

2nd " $= \frac{\pi \times 56}{90} \times \frac{1}{.0828} \times$ " $= 23$

3rd " $= \frac{\pi \times 66.5}{90} \times \frac{1}{.0955} \times \frac{MC_2}{H^2} = 23$

$$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 24 \quad \text{---- (3)}$$

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 144$$
$$\chi_1 - \chi_3 = 1367$$

$\theta = 27°.6$ which corresponds to $\psi = -11°.6$

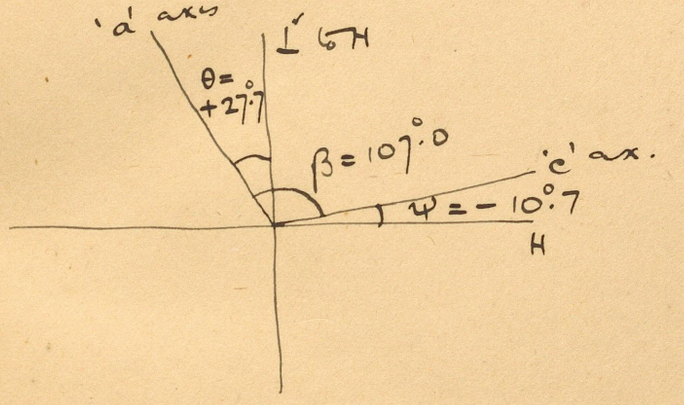
as against $-11°.0$ directly measured.

$NiSO_4 \cdot Cs_2SO_4 \cdot 6H_2O$

monocl. prismc. $M = 624.5$ $\rho = 2.872$ (l.c.T)

$a : b : c = .7270 : 1 : .4982$; $\beta = 107^\circ 2'$.

with 'b' ax. vert. setting as follows.



$\theta = +27^\circ.8$ / $+27^\circ.7$; $\psi = -10^\circ.7$

for all the measurements

$H = 1419$ gauss.

$C = \frac{T \cdot 5128}{7.57^2} = .00568$

2 crystals were used: $m_1 = .1688$ gm. $m_2 = .1070$ gm.

$\Phi_1 = \frac{\pi}{90} \times \frac{MC}{H^2} \times \frac{1}{m_1}$; $\Phi_2 = \frac{\pi}{90} \times \frac{MC}{H^2} \cdot \frac{1}{m_2}$

$$\left.\begin{aligned} \chi_1 - \chi_2 &= \Phi_1 \times 367 = 134 \\ &= \Phi_2 \times 234 = 134 \end{aligned}\right\} \text{Adopt } \underline{\chi_1 - \chi_2 = 134} \quad \text{---(1)}$$

2) 'a' ax. vert 'b' ax. normal to field

$$\left.\begin{aligned} \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 &= \Phi_1 \times 267 = 97 \\ &= \Phi_2 \times 169 = 97 \end{aligned}\right\} \text{adopt } \underline{97} \quad \text{---(2)}$$

3) c (001) pl. horiz. 'b' ax. normal to field.

$$\left.\begin{aligned} \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 &= \Phi_1 \times 68 = <25 \\ \Phi_2 \times 39 &= 22 \end{aligned}\right\} \text{Adopt } \underline{23} \quad \text{---(3)}$$

From (1) (2) and (3) we obtain

$$\chi_1 - \chi_2 = 134$$
$$\chi_1 - \chi_3 = 127$$

and $\theta = 28^\circ.2'$, which corresponds to

$$\psi' = -11^\circ.2'$$

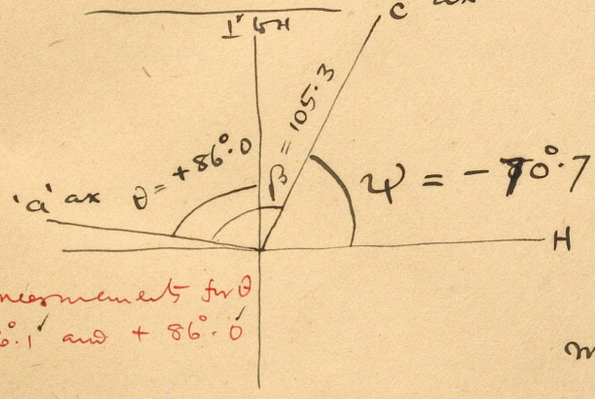
as compared with $\psi = -10^\circ.7'$ directly measured.

$CuSO_4 \cdot Rb_2SO_4 \cdot 6H_2O$

Monocl. prisms. $\rho = 2.570$ $M = 534.7$

$a : b : c = 0.7490 : 1 : 0.5029$; $\beta = 105^\circ 18'$.

'b' ax. vert.



Later measurements for θ gave +86°.1 and +86°.0

$\theta = +86^\circ.0$

$\therefore \psi = -70^\circ.7$.

Throughout the following measurements $H = 1390$

$c = .00373$.

1st cryst. $\chi_1 - \chi_2 = \dfrac{\pi \times 536.5}{90} \times \dfrac{1}{.0552} \times \dfrac{Mc}{H^2} = 350$

2nd " $= \dfrac{\pi \times 615}{90} \times \dfrac{1}{.0632} \times$ " $= 350$

$\therefore \chi_1 - \chi_2 = 350$ --- (1)

'a' ax. vert 'b' ax along f.

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \dfrac{\pi \times 380.5}{90} \times \dfrac{1}{.0552} \times \dfrac{Mc}{H^2} = 248$

$= \dfrac{\pi \times 431.5}{90} \times \dfrac{1}{.0632} \times$ " $= 246$

Adopt. $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 248$ ---- (2)

(001) pl. horiz. 'b' ax. sets normal to f.

Cu Rb sulph

$$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \frac{\pi \times 150}{\text{"} 90} \times \frac{1}{.0552} \times \frac{Mc}{H^2} = 98$$

$$= \frac{\pi \times 168}{90} \times \frac{1}{.0632} \times \text{"} = 96.$$

Assym. $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 98$ ---- (3)

From (1), (2) and ~~(3)~~

$$\chi_1 - \chi_2 = 350$$
$$\chi_1 - \chi_3 = 100$$

and $\theta = 85^\circ.7'$ which corresponds to

$$\psi = -70^\circ.4'$$

as against $-70^\circ.7'$ directly measured.

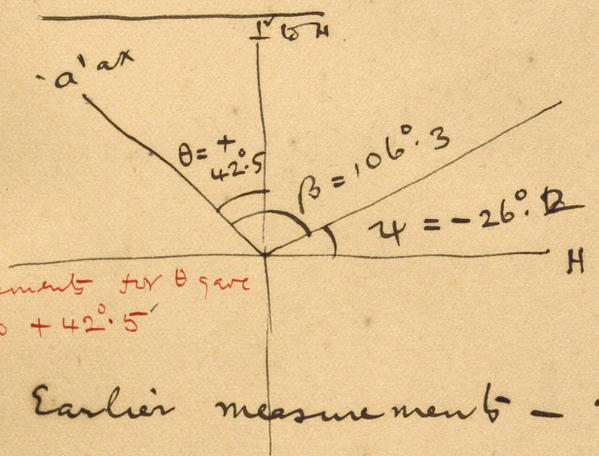
$FeSO_4 \cdot Tl_2SO_4 \cdot 6H_2O$

Monocl. prism. According to Tutton (R.S. Proc. A, 118, 372, 1928)

$a : b : c = 0.7427 : 1 : 0.4999$; $\beta = 106° 16'$

$\rho = 3.650$. The mol. wt. = 764.863 (and not 758.62 as given in Tutton's paper, p. 373. His value for mol vol. should be correspondingly increased).

'b' axis vert-



Later measurements for θ gave + 42°.6′ and + 42°.5′

$\theta = +42°.5'$

$\therefore \psi = -26°.62'$

Earlier measurements — not very accurate

$$\chi_1 - \chi_2 = \frac{2.474 \times 0.574}{.95^2} \times \frac{M}{.0395} \times \frac{.00748}{322^2} = 2200$$

$$= \frac{2.588 \times .688}{.95^2} \times \frac{M}{.0495} \times \text{"} = 2200$$

$$= \frac{\pi \times 402}{90} \times \text{"} \quad \frac{.00748}{859^2} = 2200$$

'a' ax. vert- 'b' ax. along I-

$$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \frac{2.96 \times .40}{1.28^2} \times \frac{M}{.0395} \times \frac{.00748}{322^2} = 1010$$

$$= \frac{\pi \times 184.4}{90} \times \frac{M}{.0495} \times \frac{.00748}{859^2} = 1010$$

c(001) pol. horiz. 'b' ax. along S

$$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \frac{2.35 \times 0.35}{1.00^2} \times \frac{M}{.0395} \times \frac{.00748}{322^2} = 1150$$

$$= \frac{\pi \times 209}{90} \times \frac{M}{.0495} \times \frac{.00748}{859^2} = 1150$$

New measurements

$H = 1419$ $\quad m = .0340$ $\quad c = .00573$

$$\Phi = \frac{\pi}{90} \times \frac{M}{m} \cdot \frac{c}{H^2}$$

$$\chi_1 - \chi_2 = \Phi \times 995 = 2220 \quad \text{- - - (1)}$$

$$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \Phi \times 450 = 1010 \quad \text{- - - (2)}$$

$$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \Phi \times 514.5 = 1150 \quad \text{- - - (3)}$$

$$\therefore \quad \chi_1 - \chi_2 = 2220$$
$$\chi_1 - \chi_3 = 30$$

and $\theta = 43°.2$ which corresponds to

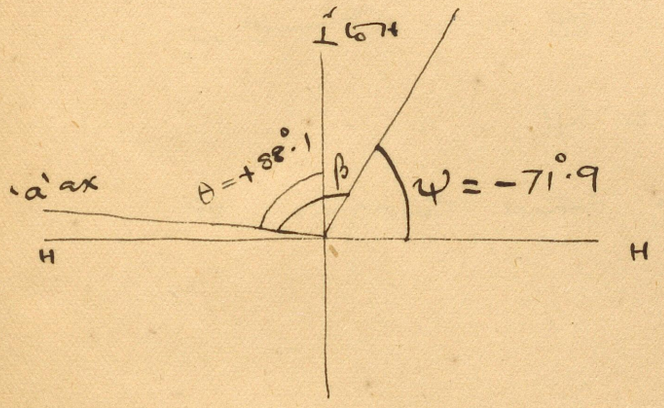
$$\psi = -26°.9$$

as against $-26°.2$ directly measured.

$CuSO_4 \cdot Cs_2SO_4 \cdot 6H_2O$ $M = 629.4$ $\rho = 2.858$ i.c.T.

monocl. prismatic. $a : b : c = .7429 : 1 : .4946$ $\beta = 106° 10'$.

When suspended with 'b' ax. vert. setting is as follows:



$$\theta = \begin{matrix} +88°.2 \\ .0 \\ \hline +88°.1 \end{matrix} \quad \therefore \psi = -71°.9$$

Two crystals were measured.

$H = 1419$ gauss

$C = \frac{7.5128}{7.57^2} = .00568$

$m_1 = .1180$ gm. $m_2 = .0658$ gm.

$\Phi_1 = \frac{\pi}{90} \times \frac{MC}{H^2} \cdot \frac{1}{m_1}$

$\Phi_2 = \frac{\pi}{90} \times \frac{MC}{H^2} \cdot \frac{1}{m_2}$

'b' ax. vert

$$\left.\begin{aligned} \chi_1 - \chi_2 &= \Phi_1 \times 643' = 338 \\ &= \Phi_2 \times 360' = 339 \end{aligned}\right\} \text{Adopt } \chi_1 - \chi_2 = 339 \quad \cdots (1)$$

'a' ax. vert 'b' ax. along field

$$\left.\begin{aligned} \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta &= \Phi_1 \times 425' = 223 \\ &= \Phi_2 \times 240' = 226 \end{aligned}\right\} \text{Adopt } 225 \quad --(2)$$

c(001) pl horiz 'b' ax. normal to field

$$\left.\begin{aligned} \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 &= \Phi_1 \times 215' = 113 \\ \Phi_2 \times 119' &= 112 \end{aligned}\right\} \text{Adopt } 113 \quad --(3)$$

From (1), (2) and (3)

$$\left.\begin{aligned} \chi_1 - \chi_2 &= 339 \\ \chi_1 - \chi_3 &= 114 \end{aligned}\right\}$$

and $\theta = +88°$ which corresponds to

$$\psi = -72°$$

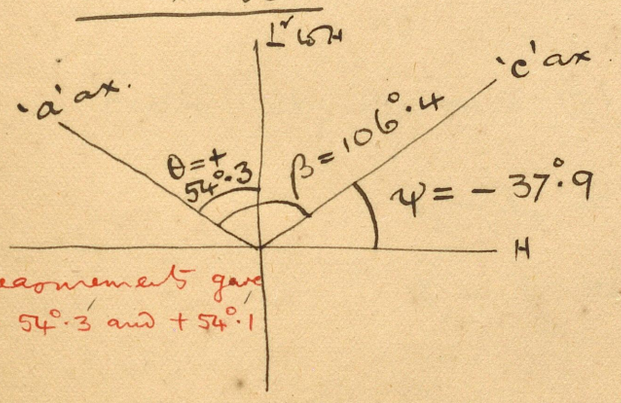
as compared with $-71°.9$ directly measured.

$CoSO_4 \cdot Tl_2SO_4 \cdot 6H_2O$

Monocl. prismc. According to Tutton, Roy. Soc. Proc., A 108, p. 250, 1925, $a : b : c = 0.7413 : 1 : 0.4995$ $\beta = 106^\circ 25'$

$\rho = 3.782$ $M = \cancel{768.0}$ 767.93

'b' ax. vert



Later measurements gave for θ + 54°.3 and + 54°.1

$\theta = +54^\circ.3$

$\therefore \psi = -37^\circ.9$

$c_1 = .0213$ $c_2 = .0124$

$m_1 = .2135$ $m_2 = .1969$

$H_1 = 410$ $H_2 = 859$

$$\chi_1 - \chi_2 = \frac{4.02 \times 1.60}{1.21^2} \times \frac{M c_1}{m_1 H_1^2} = 2000$$

$$= \frac{\pi \times 553.5}{90} \times \frac{M c_1}{m_1 H_2^2} = 2010$$

$$= \frac{\pi \times 880}{90} \times \frac{M c_2}{m_2 H_2^2} = 2010$$

Adopt. $\chi_1 - \chi_2 = 2010$ ...(1)

'a' ax vert 'b' ax. along field.

$$\Delta\chi = \frac{6.00 \times 0.82}{2.59^2} \times \frac{M c_1}{m_1 H_1^2} = 334$$

$$= \frac{\pi \times 93}{90} \times \frac{M c_1}{m_1 H_2^2} = 337$$

$$= \frac{\pi \times \cancel{165.5}\ 146.4}{90} \times \frac{M c_2}{m_2 H_2^2} = 33\cancel{4}\ 5$$

Last value most reliable

Adopt. $\chi_3 - (\chi_1 \cos^2\theta + \chi_2 \sin^2\theta) = 337$ ...(2)

Co Tl Sulphate

(001) pl. horiz. 'b' ax. normal to field

$$\Delta\chi = \frac{7.23 \times .77}{3.23^2} \times \frac{Mc_1}{m_1 H_1^2} = 243$$

$$= \frac{\pi \times 67}{90} \times \frac{Mc_1}{m_1 H_2^2} = 243$$

$$= \frac{\pi \times 106.5}{90} \times \frac{Mc_2}{m_2 H_2^2} = 243$$

$$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 243 \quad (3)$$

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 2{,}010$$

$$\chi_1 - \chi_3 = 958$$

$\theta = 53^\circ.4$ which corresponds to

$\psi = -37^\circ.0$

as compared with $-37^\circ.9$ directly measured.

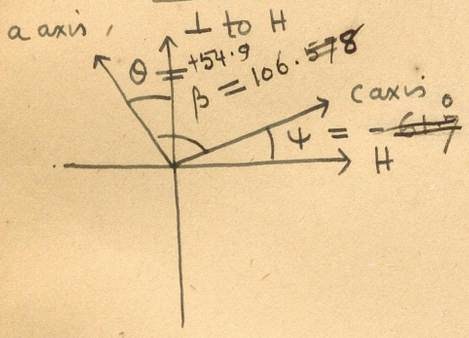
$Co(NH_4)_2(BeF_4)_2 \cdot 6H_2O$

$M = 373 \cdot 16$

Monocl. prism. $a:b:c = 0.7387 : 1 : 0.4909$
$= .740 : 1 : .485$

$\gamma = 106° 34'$
$\beta = 106° 46'$

'b, axis vertical.



$\theta = +55.1$
54.8

Adopt $\theta = 54°.9$

$\therefore \psi = -38°.1$

$H = 1166$
$m_1 = .0639$ gm
$c = .01900$
$m_2 = .0830$ gm.

$$\phi_i = \frac{\pi}{90} \cdot \frac{M.C.}{H^2} \cdot \frac{1}{m_i} \quad ; \quad i = 1, 2.$$

$\chi_1 - \chi_2 = \phi_1 \times 1000$ at $31.4°C = 2952$ at $26.0°C$
$= \phi_2 \times 1294$ " 30.1 " $= 2914$ " "

Adopt $\chi_1 - \chi_2 = 2930 \times 10^{-6}$ at $26.0°C$ ..... (1)

'a, axis vertical. 'b, axis along field.

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \phi_1 \times 128$ at $30.3°C = 375$ at $26°C$
$= \phi_2 \times 166$ " 30.1 " $= 374$ " "

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 375 \times 10^{-6}$ at $26°C$ ..... (2)

(001) pl. horizontal. b axis normal to field.

$\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \phi_1 \times 185$ at $30.3°C = 542$ at $26.0°C$
$= \phi_2 \times 238$ " 30.2 " $= 536$ " "

Adopt $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 539 \times 10^{-6}$ at $26°C$ ..... (3)

From 1), 2) and 3) we have.

$$x_1 - x_2 = 2930$$
$$x_1 - x_3 = 1550$$

and $\theta = 54.1^\circ$ which corresponds to $\psi = -37.3^\circ$

as against directly measured -38.1°

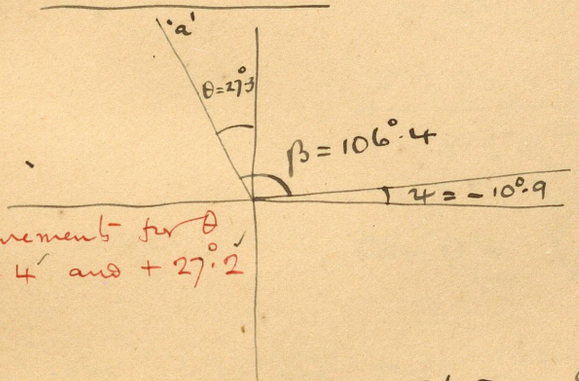
$NiSO_4 \cdot Tl_2SO_4 \cdot 6H_2O$

Monocl. prismc. (Tutton, Roy. Soc. Proc. A 108, 241, 1925)

$a : b : c = 0.7404 : 1 : 0.4997$; $\beta = 106° 23'$

$\rho = 3.770$ $\quad M = 767.7$

'b' ax. vert



$\theta = +27.3$

$\therefore \psi = -10.9$

Later measurements for θ gave +27.4 and +27.2

H throughout was 410 gauss.

$$\chi_1 - \chi_2 = \frac{6.165 \times .365}{2.90^2} \times \frac{\cancel{11} \times .01903}{\times .1963} \cdot \frac{M}{H^2} = 118$$

2nd cryst. $= \dfrac{5.486 \times .276}{2.605^2} \times \dfrac{.01986}{.1742} \cdot \dfrac{M}{H^2} = 116$

3rd " $= \dfrac{12.18 \times 3.86}{\cancel{8.02 \times 4.116}} \times \dfrac{.000857}{.0930} \cdot \dfrac{M}{H^2} = 114$

$= \dfrac{\pi \times 341.6}{90} \times$ " $M/859^2 = 114$

Last value most reliable $\therefore$ adopt $\chi_1 - \chi_2 = 114$ ... (1)

'a' ax. vert 'b' ax. normal to f.

$\therefore \Delta\chi = \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3$

1st cryst. $= \dfrac{6.095 \times .255}{2.92^2} \times \dfrac{.01903}{.1933} \times \dfrac{M}{H^2} = 82$

2nd " $= \dfrac{5.363 \times .203}{2.58^2} \times \dfrac{.01986}{.1742} \times$ " $= 85$

3rd " $= \dfrac{11.46 \times 3.06}{4.20^2} \times \dfrac{.000857}{\pi \times 250/90 \times .0930}$ " $M/859^2 = 84$

Adopt- $\chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = 84$ ✓ . . . . . (2)

(001) pl. horiz. 'b' ax. normal to field

$$\Delta\chi = \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3$$

1st cryst- $= \frac{8.555 \times .085}{4.235^2} \times \frac{.01903}{.1933} \times \frac{M}{H^2} = 18$ ✓

2nd Cryst- $= \frac{6.99 \times .07}{3.46^2} \times \frac{.01986}{.1742} \times$ " $= 21$ (?) ✓

3rd " $= \frac{18.28 \times 1.72}{8.28^2} \times \frac{.000857}{.0930} \times$ " $= 19$ ✓

$= \pi \times 54.8/90 \times$ " $\times \frac{M}{8.55^2} = 18$ ✓

adopt- $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 18$ ✓ . . . . (3)

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 114$$
$$\chi_1 - \chi_3 = 108$$ ✓

& $\theta = 27°.3$ ✓, which corresponds to

$$\psi = -10°.9$$ ✓

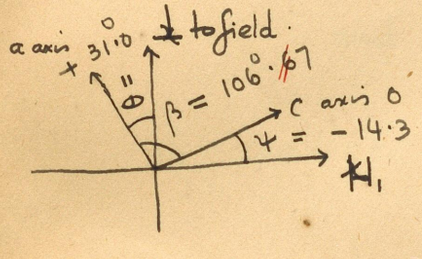
as against $-10°.9$ directly measured.

$Ni(NH_4)_2(BeF_4)_2 \cdot 6H_2O$

$M = 372.906$.

Monocl. $a:b:c = 0.7373:1:0.4491$ $\beta = 106^\circ 40'$

'b, axis vertical.



$\theta = +30.9$
$\quad\quad 31.0$
Adopt $\theta = +31.0$

$\therefore \psi = -14^\circ.3$

$H = 1166$ gaus. $\quad c = .002943$.

$m_1 = .3042$ gm. $\quad m_2 = .1200$ gm.

$$\phi_i = \frac{\pi c}{g_0}\frac{M}{H^2}\cdot\frac{1}{m_i}\ ;\ i = 1, 2.$$

$\chi_1 - \chi_2 = \phi_1 \times 1110$ at $31^\circ.9$ C $= 107$ at 26°C.
$\quad = \phi_2 \times 440$ " 32.0 " $= 107$ " " "

Adopt $\chi_1 - \chi_2 = 107 \times 10^{-6}$ at 26°C ..... (1).

'a, axis vertical. 'b, axis normal to field.

$\chi_1\cos^2\theta + \chi_2\sin^2\theta - \chi_3 = \phi_1 \times 785$ at $30^\circ.8$ C $= 75.0$ at 26°C
$\quad = \phi_2 \times 310$ " $31^\circ.2$ " $= 75.0$ " " "

Adopt $\chi_1\cos^2\theta + \chi_2\sin^2\theta - \chi_3 = 75 \times 10^{-6}$ at 26°C ..... (2).

(001) pl. horizontal. 'b, axis normal to field.

$\chi_1\sin^2\theta + \chi_2\cos^2\theta - \chi_3 = \phi_1 \times 308$ at $30^\circ.9$ ~~at~~ 29 at 26°C
$\quad = \phi_2 \times 121$ " $31^\circ.3$ $= 29$ " "

Adopt $\chi_1\sin^2\theta + \chi_2\cos^2\theta - \chi_3 = 29 \times 10^{-6}$ at 26°C ..... (3).

From 1) 2) and 3) we have.

$$x_1 - x_2 = 107$$
$$x_1 - x_3 = 106$$

and $\theta = +32.3^\circ$ which corresponds to $\psi = -15.6$

as compared to -14.3° directly measured.

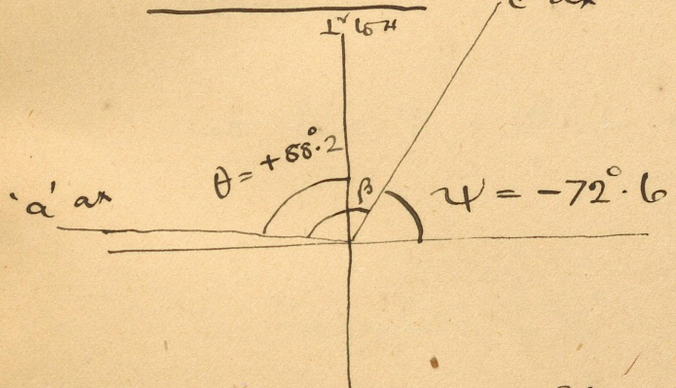
$CuSO_4 \cdot Tl_2SO_4 \cdot 6H_2O$

Tutton, Roy. Soc. Proc. A 118, 350 1928

monocl. prismatic $\rho = 3.728$ $M = 772.6$

$a : b : c = 0.7499 : 1 : 0.5033$; $\beta = 105^\circ 33'$.

'b' ax. vert



$\theta = +88^\circ.2$

$\therefore \psi = -72^\circ.6$

From measurements in Nov. 34 gave $\theta = +88^\circ.1$ & $+88^\circ.0$ in agreement with previous values.

$$\chi_1 - \chi_2 = \frac{26.43 \times 17.31}{4.56^2} \times \frac{M}{.2967} \times \frac{.000828}{410^2} = 282$$

$$= \frac{9.95 \times 2.13}{3.91^2} \times \frac{M}{.4307} \times \frac{.01903}{410^2} = 282$$

$$= \frac{9.90 \times 2.10}{3.90^2} \times \frac{M}{.4283} \times \text{"} = 279$$

$$\frac{\pi \times 172.0}{90} \times \text{"} \quad \frac{.01903}{859^2} = 279$$

Adopt $\chi_1 - \chi_2 = 281$ ... (1)

'a' ax. vert 'b' ax. along f.

$$\Delta\chi = \frac{25.015 \times 15.425}{4.795^2 \cancel{4.56^2}} \times \frac{M}{.2967} \times \frac{.000828}{410^2} = 215$$

$$= \begin{cases} \frac{11.50 \times 1.96}{4.52^2} \times \frac{M}{.4307} \times \frac{.01903}{410^2} = 214 \\ \frac{10.70 \times 1.86}{4.42^2} \times \frac{M}{.4283} \times \text{"} = 208 \end{cases}$$

$$\pi \times \frac{133.6}{90} \times \text{"} \times \frac{.01903}{859^2} = 217$$

$\therefore \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 212$ ... (2)

(001) pl. horiz. 'b' ax. normal to field

$$\Delta\chi = \frac{35.50 \times 15.50}{10.00^2} \times \frac{M}{.2967} \times \frac{.000828}{410^2} = 70$$

$$= \frac{15.12 \times 1.12}{7.00^2} \times \frac{M}{.4283} \times \frac{1903}{410^2} = 70$$

$$\pi \times 44/90 \times \text{"} \times \frac{1503}{859^2} = 71$$

Adopt $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 70$ - - - (3)

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 282$$
$$\chi_1 - \chi_3 = 70$$

$\chi_1 - \chi_2 = 283$
$\chi_1 - \chi_3 = 71$
$\psi = 73^\circ$
} later values see below

and $\theta = 90^\circ$ which corresponds to

$$\psi = -74^\circ.4$$

as against $-72^\circ.6$ directly observed.

Later and more accurate measurement (after the field was carefully calibrated) gave for $\chi_1 - \chi_2$ the value

$$\frac{\pi}{90} \times \frac{M}{.2830} \times \frac{.01838}{1419^2} = 1.5128/4.21^2 = 287 \quad \theta = +88^\circ.2$$

We may ∴ adopt the value $\chi_1 - \chi_2 = 283$

~~$\chi_1 - \chi_2 = 282$~~

$$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 212$$
$$\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 70$$

from which $\chi_1 - \chi_3 = 71$

and $\theta = 87\frac{1}{2}^\circ$ which corresponds to $\psi = -72^\circ$

~~$\psi = 72^\circ$~~

as against $72^\circ.6$ directly observed

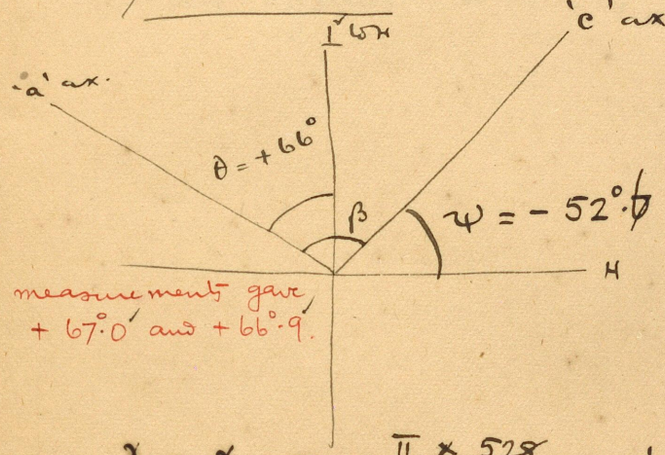
$CuSeO_4 \cdot K_2SeO_4 \cdot 6H_2O$

(Tutton, R.S. Proc. A 98, 68, 1920)

Monocl. prismc. $\rho = 2.539$ $M = 536.3$

$a : b : c = 0.7508 : 1 : 0.5143$; $\beta = 103° 9' 25''$

'b' ax. vert-



Later measurements gave for θ + 67°·0' and + 66°·9'.

$\theta = +66°$

$\therefore \psi = -52°.6$

Throughout $H = 1390$

for two of the measurements $c = c_1 = .00373$

and for the rest $c = c_2 = .00395$.

$$\chi_1 - \chi_2 = \frac{\pi \times 528}{90} \times \frac{1}{.0520} \times \frac{Mc_1}{H^2} = 367$$

2nd cryst. $\dfrac{\pi \times 652}{90} \times \dfrac{1}{.0681} \times \dfrac{Mc_2}{H^2} = 367$

Adopt. 367 ...(1)

'a' ax vert 'b' ax. along field

$$\Delta\chi = \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \frac{\pi \times 318}{90} \times \frac{1}{.0520} \times \frac{Mc_1}{H^2} = 221$$

2nd cryst. $= \dfrac{\pi \times 391}{90} \times \dfrac{1}{.0681} \times \dfrac{Mc_2}{H^2} = 220$

Adopt. $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 220$ ...(2)

(001) pl. horiz 'b' ax. normal to field.

$$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \frac{\pi \times 58}{90} \times \frac{1}{.0520} \times \frac{Mc_2}{H^2} = 43$$

2nd cryst. $= \dfrac{\pi \times 76.5}{90} \times \dfrac{1}{.0681} \times \dfrac{Mc_2}{H^2} = 43$

Adopt. $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 43$ ...(3)

Cu K selenate.

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 367$$
$$\chi_1 - \chi_3 = 95$$

and $\theta = 67^\circ \cdot 9$ which corresponds to $\psi = -54^\circ \cdot 65$

check latter value

as against $-52^\circ \cdot 7$ directly measured.

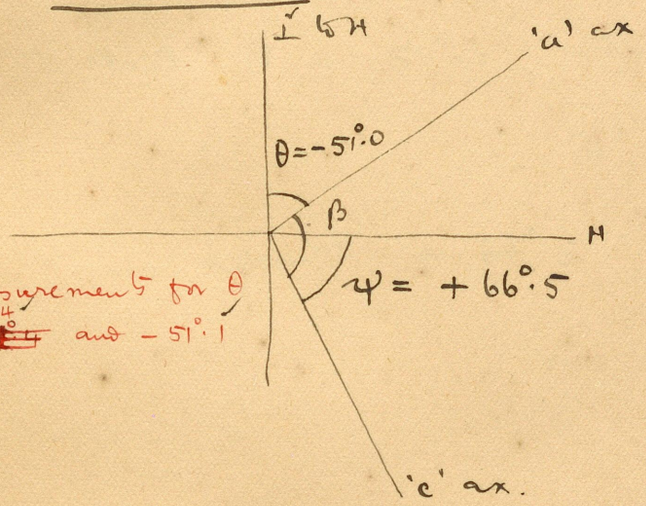
$CuSeO_4 \cdot (NH_4)_2SeO_4 \cdot 6H_2O$

(Tutton, R.S. Proc. 98 A, 81, 1920.)

Monocl. prisms. $\rho = 2.223$ $M = 494.1$

$a : b : c = 0.7476 : 1 : 0.5150$; $\beta = 105^\circ 30'$

'b' ax. vert



later measurements for θ gave −51°.4 and −51°.1

$\theta = -51^\circ.0$

$\therefore \psi = +66^\circ.5$

Throughout the following measurements $H = 1390$

$c = .00354$.

For 1st cryst. $m = m_1 = .1215$

2nd $m = m_2 = .1221$

$$\chi_1 - \chi_2 = \frac{\pi \times 1358}{90} \times \frac{Mc}{m_1 H^2} = 353$$

$$2^{nd} \quad = \frac{\pi \times 1367}{90} \times \frac{Mc}{m_2 H^2} = 354$$

Adopt 353 --- (1)

'a' ax. vert 'b' ax. along field.

$$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \frac{\pi \times 369}{90} \times \frac{Mc}{m_1 H^2} = 96$$

2nd cryst. $\frac{\pi \times 370.5}{90} \times \frac{Mc}{m_2 H^2} = 96$

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 96$ --- (2)

c(001) pl. hori2 'b' ax. along f.

$$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \frac{\pi \times 81}{90} \times \frac{Mc}{m_1 H^2} = 21$$

2nd cryst. $= \frac{\pi \times 83}{90} \times \frac{Mc}{m_2 H^2} = 21$

$$\therefore \quad \chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \underline{21} \qquad \text{---- (3)}$$

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 353 \quad \checkmark$$
$$\chi_1 - \chi_3 = 118$$

and $\theta = -51°.1$ ✓, which corresponds to

$$\psi = +66°.6 \quad \checkmark$$

as against $+66°.5$ ✓ directly measured.

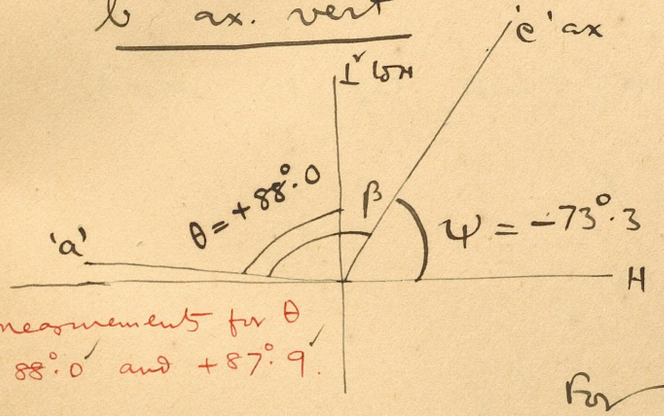
$CuSeO_4 \cdot Rb_2SeO_4 \cdot 6H_2O$

Tutton, R.S. Proc. 98 A, 72, 1920

Monocl. prismc. $\rho = 2.839$ $M = 628.94$

$a : b : c = 0.7495 : 1 : 0.5066$; $\beta = 104°44'$.

'b' ax. vert



Later measurements for θ gave +88°.0 and +87°.9.

$\theta = +88°.0$

and $\therefore \psi = -73°.3$.

Throughout $H = 1390$

$c = .00395_5$

For the 1st crystal $m = m_1 = .0417$

2nd " $m = m_2 = .0339$.

$$\left.\begin{aligned} \chi_1 - \chi_2 &= \frac{\pi \times 329}{90} \times \frac{Mc}{m_1 H^2} = 355 \\ \text{2nd cryst.} \quad & \frac{\pi \times 266}{90} \times \frac{Mc}{m_2 H^2} = 353 \end{aligned}\right\} \text{Adopt } \underline{354} \quad \text{---(1)}$$

'a' ax. vert 'b' ax. along f. $\therefore \Delta\chi = \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta$

$$\left.\begin{aligned} (\text{1st cryst.}) &= \frac{\pi \times 256}{90} \times \frac{Mc}{m_1 H^2} = 276 \\ (\text{2nd cryst.}) &= \frac{\pi \times 209}{30} \times \frac{Mc}{m_2 H^2} = 277 \end{aligned}\right\}$$

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \underline{276}$ ---(2)

c(001) pl. horiz. 'b' ax. sets normal to f.

$$\therefore \Delta\chi = \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3$$

Cu Rb selenate

$$(1^{st}\ \text{crystal}) = \frac{\pi \times 72}{90} \times \frac{Mc}{m_1 H^2} = 78$$

$$(2^{nd}\ \text{"}) = \frac{\pi \times 59}{90} \times \frac{Mc}{m_2 H^2} = 78$$

Adding $\quad \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 78 \quad \text{---- (3)}$

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 354$$

$$\chi_1 - \chi_3 = 78$$

check the setting angle

and $\theta = 90°$ whence $\psi = -75°.3$

as against $-73°.3$ directly observed.

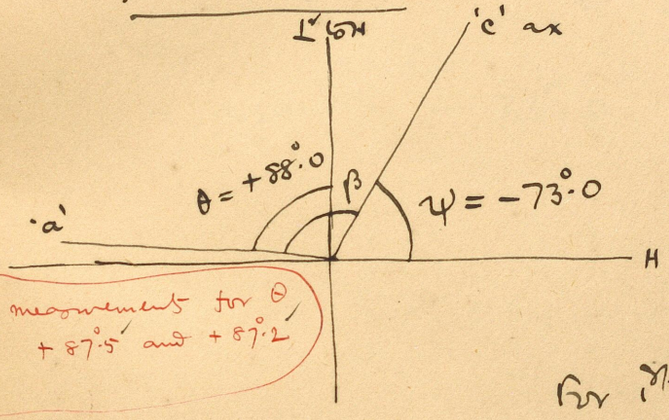
$CuSeO_4 \cdot Tl_2SeO_4 \cdot 6H_2O$

(Tutton, R.S. Proc. A 118, 416, 1929)

Monocl. prisms. $\rho = 3.944$ $M = 866.85$

$a : b : c = 0.7531 : 1 : 0.5048$; $\beta = 104^\circ 59'$

'b' ax. vert.



Later measurements for θ gave $+87^\circ.5$ and $+87^\circ.2$

$\theta = +88^\circ.0$

$\therefore \psi = -73^\circ.0$

Throughout the following measurements $H = 1390$

$c = .00395$

for 1st cryst. $m = m_1 = .0620$

for 2nd " $m = m_2 = .0536$

$$\chi_1 - \chi_2 = \frac{\pi \times 328}{90} \times \frac{Mc}{m_1 H^2} = 328$$

$$2^{nd}\ \text{cryst.} : \frac{\pi \times 284}{90} \times \frac{Mc}{m_2 H^2} = 328$$

Adopt $\chi_1 - \chi_2 = 328$ ...(1)

'a' ax. vert 'b' ax. along f. $\therefore \Delta\chi = \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta$

$$(1^{st}\ \text{cryst.}) = \frac{\pi \times 255}{90} \times \frac{Mc}{m_1 H^2} = 255$$

$$(2^{nd}\ \text{"}) = \frac{\pi \times 221}{90} \times \frac{Mc}{m_2 H^2} = 255$$

Adopt $= 255$ ....(2)

(001) pl. horiz. 'b' ax. normal to f. $\Delta\chi = \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3$

$$(1^{st}\ \text{cryst.}) = \frac{\pi \times 71}{90} \times \frac{Mc}{m_1 H^2} = 71$$

$$(2^{nd}\ \text{"}) = \frac{\pi \times 60}{90} \times \frac{Mc}{m_2 H^2} = 69$$

Adopt $= 71$ ..... (3)

From (1), (2) and (3) we have

$$\chi_1 - \chi_2 = 328$$
$$\chi_1 - \chi_3 = 72$$

and $\theta = 86°.8$ which corresponds to

$$\psi = -71°.8$$

as against $-73°.0$ directly measured.

$NiSeO_4 \cdot 6H_2O$

Tetragonal $a : c = 1.8364$ $\rho = 2.314$.

$M = 309.98$

when suspended with the tetrag. ax. horiz. the ax is set normal to field $H = 1419$ $c = .00422$

1st cryst. $\chi_\perp - \chi_\parallel = \frac{\pi \times 294}{90} \times \frac{MC}{.0743\ H^2} = 90$

2nd cryst. $\frac{\pi \times 158}{90} \times \frac{MC}{.0398\ H^2} = 90$

Adopt. $\chi_\perp - \chi_\parallel = 90$

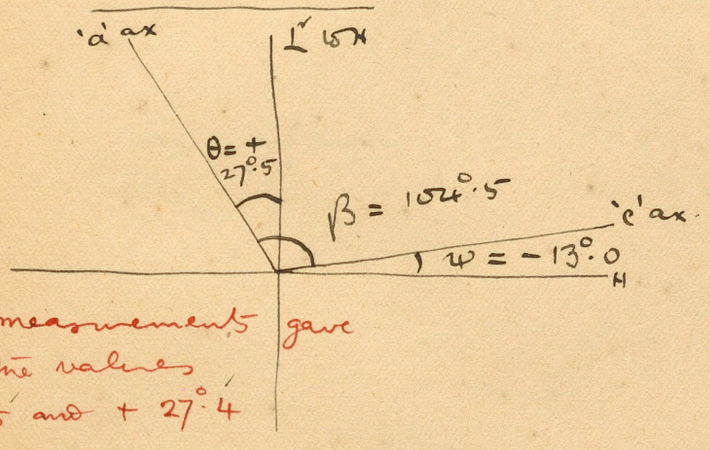
$NiSeO_4 \cdot K_2SeO_4 \cdot 6H_2O$

(Tutton, Phil Trans A, 217, 199, 1918)

Monocl. prismc. $\rho = 2.559$ $M = 531.39$

$a : b : c = 0.7467 : 1 : 0.5059$; $\beta = 104° 27'$.

'b' ax. vert



Later measurements gave for θ the values + 27°·5 and + 27°·4

$\theta = +27°.5$

$\therefore \psi = -13°.0$

Throughout the following measurements $H = 1419$, $c = .50422$

$m_1 = .1063$, $m_2 = .1080$.

$\Phi = \frac{\pi}{90} \times \frac{Mc}{H^2}$

$\chi_1 - \chi_2 = \Phi \times \frac{400.5}{m_1} = 146$

2nd cryst. $= \Phi \times \frac{406}{m_2} = 146$

Adopt $\chi_1 - \chi_2 = \underline{146}$ ... (1)

'a' ax. vert. 'b' ax. normal to f.

$\Delta\chi = \Phi \times \frac{309}{m_1} = 113$

2nd cryst. $= \Phi \times \frac{314}{m_2} = 113$

$\therefore \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = \underline{113}$ ... (2)

c(001) pl. horiz. 'b' ax. normal to f.

$\Delta\chi = \Phi \times \frac{90}{m_1} = 33$

2nd cryst. $\Phi \times \frac{92}{m_2} = 33$

$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \underline{33}$ ... (3)

From (1), (2) and (3) we obtain

$$\chi_1 - \chi_2 = 146$$
$$\chi_1 - \chi_3 = 146$$

and $\theta = 28°.4$ which corresponds to

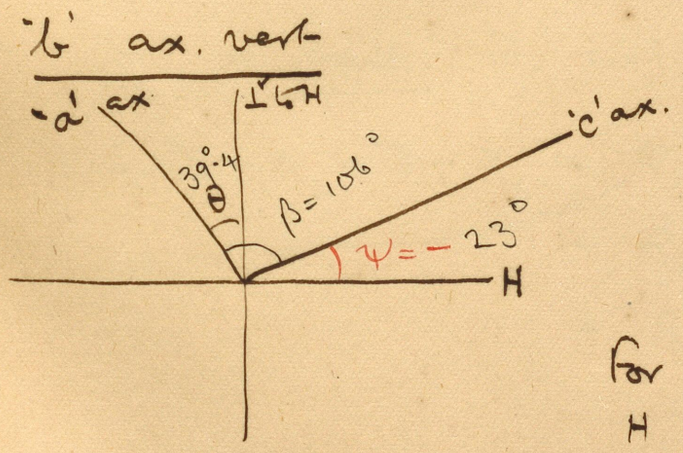
$$\psi = -13°.9$$

as against $-13°.0$ directly measured.

$Ni(NH_4)_2SO_4SeO_4 \cdot 6H_2O$ $M = 441.9$ ✓

Four crystals were studied, two prepared by crystallising from a mixture of $NiSO_4(NH_4)_2SO_4 \cdot 6H_2O$ + $NiSeO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ in aqueous solution and the other two by mixing solutions of $NiSeO_4$ and $(NH_4)_2SO_4$. There was no difference between the two crops of crystals. Crystals I and II in the following measurements are from the 1st crop and III and IV from the 2nd.

Monoclinic prismatic – belong to the Tutton series.



$\theta = +39°.1'.5'.5'.6'$

adopt $\theta = +39°.4'$

For all the following measurements $H = 1419$ gauss except in one measurement for which H was 5102.

$m_1 = .0805$ gms.
$m_2 = .0268$ "
$m_3 = .0745$ "
$m_4 = .1257$ "

$C_1 = C_3 = C_4 = .00595$ $\left(\frac{T.5128}{7.402}\right)$

$C_2 = .00514$ $\left(\frac{T.6718}{9.562}\right)$

$\Phi_i = \frac{\pi}{90} \times \frac{M}{m_i} \times \frac{C_i}{H^2}$ $i = 1, 2, 3, 4.$

with 'b' ax. vert

$$\left.\begin{aligned} \chi_1 - \chi_2 &= \varphi_1 \times 229 = 130 \\ &= \varphi_2 \times \overset{890}{\cancel{358}} = 131 \\ &= \varphi_3 \times 213 = 131 \\ &= \varphi_4 \times 358 = 130 \end{aligned}\right\} \text{Adopt } \chi_1 - \chi_2 = 131 \quad \text{--(1)}$$

2) 'a' ax. vert 'b' ax is normal to field

$$\left.\begin{aligned} \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 &= \varphi_1 \times \overset{113}{\cancel{104}} = 64 \\ &= \varphi_2 \times \overset{430}{\cancel{169}} = 63 \\ &= \varphi_3 \times 104 = 64 \\ &= \varphi_4 \times 169 = 61 \end{aligned}\right\} \text{Adopt } 63 \quad \text{--(2)}$$

3) (001) pl. horiz 'b' ax normal to field

$$\left.\begin{aligned} \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 &= \varphi_1 \times 675 = 30 \\ &= \varphi_2 \times 204 = 30 \\ &= \varphi_3 \times 49 = 30 \\ &= \varphi_4 \times 85 = 31 \end{aligned}\right\} \text{Adopt } 31 \quad \text{--(3)}$$

$H = 5102$

From (1) (2) and (3)

$$\chi_1 - \chi_2 = 131$$
$$\chi_1 - \chi_3 = 113$$

and $\theta = +38^\circ$

as against $\theta = +39^\circ.4$ directly measured.

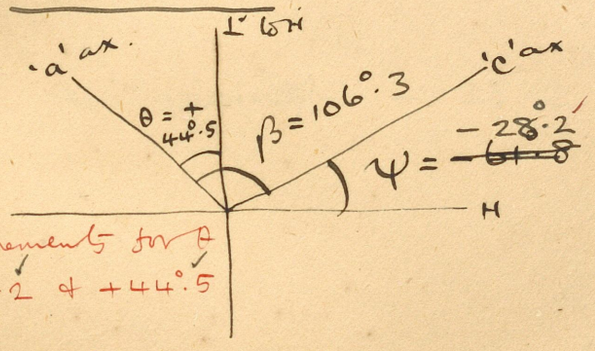
$NiSeO_4 \cdot (NH_4)_2SeO_4 \cdot 6H_2O$

Tutton, Phil Trans 217A, 217, 1918

Monocl. prisme. $\rho = 2.243$ $M = 489.2$

$a : b : c = 0.7395 : 1 : 0.5048$; $\beta = 106° 17'$

'b' ax. vert



Later measurements for θ gave +44°·2 & +44°·5

$\theta = +44°.5$

$\therefore \psi = -28°.2$

$H = 1419$

$m_1 = .0399$ $c_1 = .000589$

$m_2 = .0302$ $c_2 = .0007476$

$\frac{c_1}{m_1} \times \frac{\pi}{90} \times \frac{M}{H^2} = \Phi_1$

$\frac{c_2}{m_2} \cdot \frac{\pi}{90} \cdot \frac{M}{H^2} = \Phi_2$

$\chi_1 - \chi_2 = \Phi_1 \times \frac{E_1}{E_2} \times 929 = 116$

$= \Phi_2 \times 554 = 116$

$\therefore \chi_1 - \chi_2 = 116$ ---(1)

'a' ax. vert 'b' ax. normal to f. $\Delta\chi = \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3$

$\Delta\chi = \Phi_1 \times 345 = 43$

$= \Phi_2 \times 210 = 44$

Adopt $= 43$ ---(2)

(001) pl. horiz. 'b' ax. normal to f.

$\Delta\chi = \Phi_1 \times 251 = 32$

$\Delta\chi = \Phi_2 \times 156 = 33$

Adopt $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 33$ ---(3)

From (1), (2) and (3) we obtain

$$\chi_1 - \chi_2 = 116$$
$$\chi_1 - \chi_3 = 96$$

$\theta = 42^\circ \cdot 5$, which corresponds to

$$\psi = -26^\circ \cdot 2$$

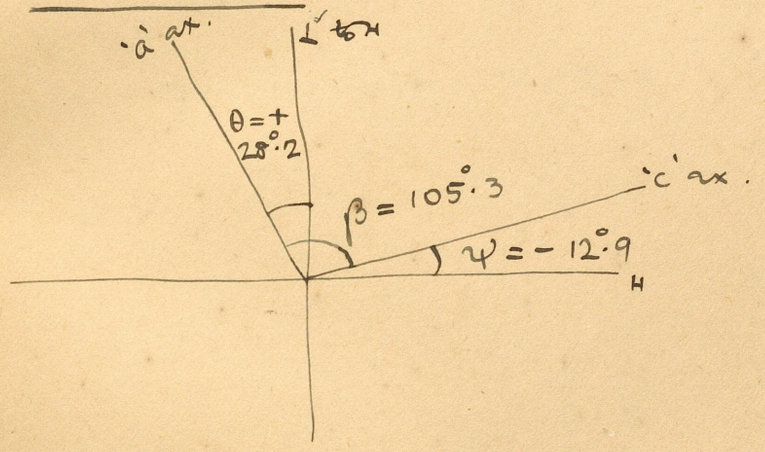
as against $-28^\circ \cdot 2$ directly measured.

$NiSeO_4 \cdot Rb_2SeO_4 \cdot 6H_2O$

Monocl. prismatic M = 624·06 ρ = 2·86

a : b : c = 0·740 : 1 : 0·503 ; β = (74° 40′) 105° 20′

'b' ax. vert-



$$\theta = \begin{array}{r} +\ 28^\circ\cdot 1' \\ 28^\circ\cdot 3' \\ \hline +\ 28^\circ\cdot 2' \end{array}$$

$\therefore \psi = -\ 12^\circ\cdot 9'$

H = 1419 gauss

$C = \frac{T\cdot 5128}{7\cdot 57^2} = \cdot 00568$

$m_1 = \cdot 1315$ gm. $m_2 = \cdot 1215$ gm.

$\Phi_1 = \frac{\pi}{90} \times \frac{MC}{H^2} \times \frac{1}{m_1}$; $\Phi_2 = \frac{\pi}{90} \times \frac{MC}{H^2} \cdot \frac{1}{m_2}$

$$\left.\begin{array}{rcl} \chi_1 - \chi_2 = \Phi_1 \times 337 & = & 158 \\ = \Phi_2 \times 310 & = & 157 \end{array}\right\} \text{Adopt- } \chi_1 - \chi_2 = 157 \quad \text{----(1)}$$

'a' ax. vert- 'b' ax. set normal to field.

$$\left.\begin{array}{rcl} \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = \Phi_1 \times 235 & = & 110 \\ = \Phi_2 \times 215\cdot 5 & = & 109 \end{array}\right\} \text{Adopt- } 110 \quad \text{---(2)}$$

c(001) pl. horiz. 'b' ax. set normal to field

$$\left.\begin{array}{rcl} \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \Phi_1 \times 55 & = & 26 \\ = \Phi_2 \times 52\cdot 5 & = & 27 \end{array}\right\} \text{Adopt- } 26 \quad \text{--(3)}$$

From (1), (2) and (3) we obtain

$$\chi_1 - \chi_2 = 157'$$
$$\chi_1 - \chi_3 = 147'$$

and $\theta = +28°.8'$, which corresponds to

$$\psi = -13°.5'$$

as against $-12°.9'$ obtained directly.

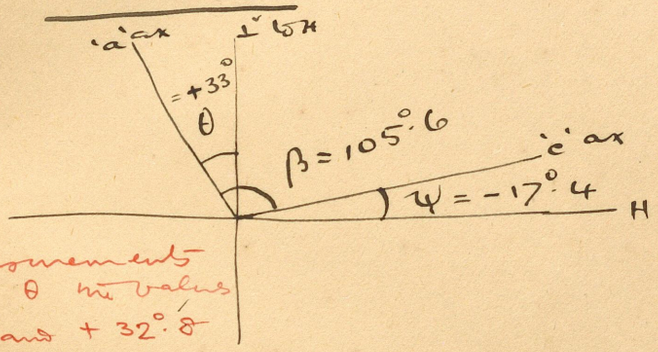
$Ni\,SeO_4 \cdot Tl_2SeO_4 \cdot 6H_2O$

Tutton, R.S. Proc. A 115, 400, 1929

Monocl. prism. $\rho = 3.993$ $M = 861.9$

$a : b : c = 0.7456 : 1 : 0.5019$; $\beta = 105^\circ 36'$

'b' ax. vert



Later measurements gave for θ the values + 32°.5 and + 32°.8

$\theta = +33^\circ.0$

$\therefore \psi = -17^\circ.4$

$H = 1419$

$m_1 = .0716$ $c_1 = .0007455$

$m_2 = .0793$ $c_2 = .00424$

$$\Phi_1 = \frac{\pi}{90} \times \frac{M}{H^2} \times \frac{c_1}{m_1} \; ; \quad \Phi_2 = \frac{\pi}{90} \times \frac{M}{H^2} \cdot \frac{c_2}{m_2}$$

$$\left.\begin{aligned} \chi_1 - \chi_2 &= \Phi_1 \times 782 = 122 \\ &= \Phi_2 \times 154 = 123 \end{aligned}\right\} \quad \text{Accepted} \quad \chi_1 - \chi_2 = 123 \quad \ldots (1)$$

'a' ax vert. 'b' ax. normal to field

$$\left.\begin{aligned} \Delta\chi &= \Phi_1 \times 508 = 79 \\ &= \Phi_2 \times 100 = 80 \end{aligned}\right\} \quad \therefore \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = 80 \quad \ldots (2)$$

(001) pl. horiz. 'b' ax. normal to f.

$$\left.\begin{aligned} \Delta\chi &= \Phi_1 \times 155 = 24 \\ \text{Reject} &= \frac{5.55 \times 1.25}{2.15^2} \times \frac{M c_2}{m_2 H^2} = \cancel{22} \; 33 \end{aligned}\right\} \quad \therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \cancel{23} \; 24 \quad \ldots (3)$$

From (1), (2) and (3) we obtain

Ni Tl selenate.

$$\chi_1 - \chi_2 = 123$$
$$\chi_1 - \chi_3 = 113$$

$\theta = 31.5$ which corresponds to

$\psi = -15.9$

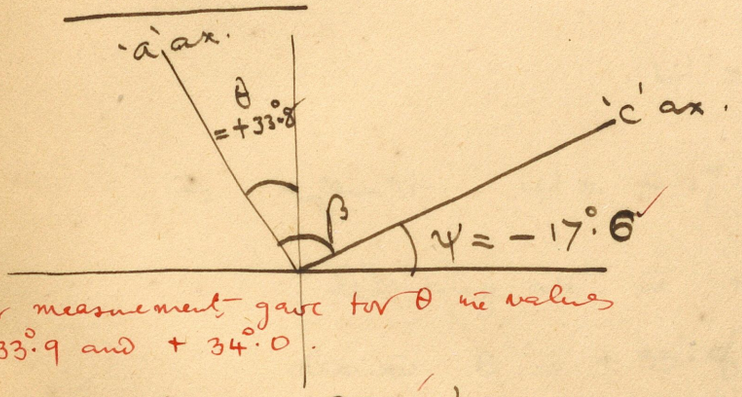
as against -17.4 directly measured.

$NiSeO_4 \cdot Cs_2SeO_4 \cdot 6H_2O$

Monocl. prism. $M = 718.8$ $\rho = 3.114$

$a : b : c = .7288 : 1 : .4993$; $\beta = 106° 11'$

'b' ax. vert-



Later measurement gave for θ the values +33°.9 and +34°.0.

$\theta = +33°.9$, $33°.6$

Adopt- $\theta = +33°.8$

$\therefore \psi = -17°.56$

$m_1 = .0974$
$m_2 = .0527$
$m_3 = .0974$

$C_1 = .00595 \left(\frac{7.5128}{7.40^2}\right)$

$C_2 = .000514 \left(\frac{2.6718}{9.56^2}\right)$

$H = 1419$

$\chi_1 - \chi_2 = \frac{\pi}{90} \times \frac{MC_1}{m_1 H^2} \times 217 = 165$

$= \frac{\pi}{90} \times \frac{MC_2}{m_2 H^2} \times 115 = 162$

Adopt- 163 - - - (1)

2) 'a' ax. vert- 'b' ax. ⊥ to field

$\chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = \frac{\pi}{90} \times \frac{MC_1}{m_1 H^2} \times 110 = 84$

$= \frac{\pi}{90} \times \frac{MC_1}{m_2 H^2} \times 61 = 86$

Adopt- 85 - - (2)

3) (001) pl. hori2 'b' ax. ⊥ to field

$\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \frac{\pi}{90} \times \frac{MC_2}{m_2 H^2} \times 173 = 21$

$= \frac{\pi}{90} \times \frac{MC_2}{m_3 H^2} \times 305 = 20$

Adopt- 21 - - (3)

From (1) (2) and (3)

$$\chi_1 - \chi_2 = 163$$
$$\chi_1 - \chi_3 = 135$$

temp 28°.0 C.

and $\theta = +33°.4$ which corresponds to

$$\psi = -17°.2$$

as against $\psi = -17°.6$ directly measured.

Reducing all the measurements to 26° C.

observed $\theta = +33°.6$ $\psi = -17°.6$

1) 'b' ax vert $\chi_1 - \chi_2 = 164$

2) 'a' ax vert $\chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = 85$

3) (001) pl. horiz $\chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 21$

whence $\theta = +33°.5$ and $\psi = -17°.3$

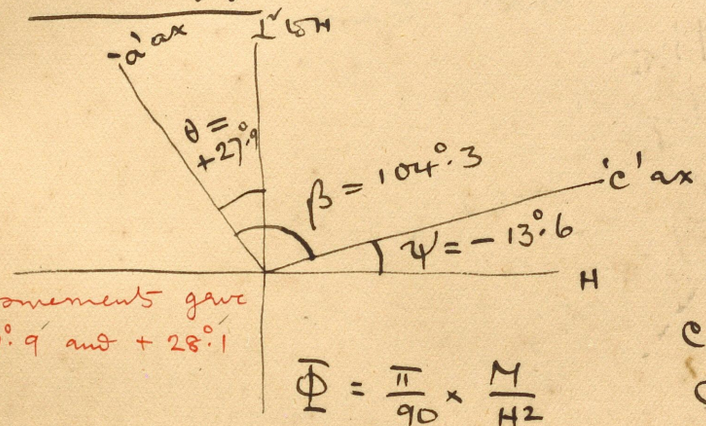
$$\chi_1 - \chi_3 = 135$$

$CoSeO_4 \cdot K_2SeO_4 \cdot 6H_2O$

Monocl. prismatic. $\rho = 2.530$ $M = 531.63$.

$a : b : c = 0.7522 : 1 : 0.5062$; $\beta = 104° 17'$

'b' ax. vert.



$\theta = +28°0 / 27°8 / +27°9$

$\therefore \psi = -13°6$.

Later measurements gave for θ +27°9 and +28°1

$H = 1419$

$C_1 = T \cdot 5128 / 4.956^2$ $m_1 = .0618$

$C_2 = T \cdot 5128 / 7.54^2$ $m_2 = .0246$.

$\Phi = \frac{\pi}{90} \times \frac{M}{H2}$

$\chi_1 - \chi_2 = \Phi \times \frac{C_1}{m_1} \times 1585 = 3135$

$= \Phi \times \frac{C_2}{m_2} \times 1458 = 3130$

$\therefore \chi_1 - \chi_2 = 3130$ ---(1)

'a' ax. vert. 'b' ax. ⊥r to field

$\Delta\chi = \Phi \times \frac{C_1}{m_1} \times 1220 = 2410$

$= \Phi \times \frac{C_2}{m_2} \times 1123 = 2410$

$\therefore \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = 2410$ ---(2)

(001) pl. horiz. 'b' ax. normal to field

$\Delta\chi = \Phi \times \frac{C_2}{m_1} \times 741 = 633$

$= \Phi \times \frac{C_2}{m_2} \times 295 = 633$

$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 633$ ---(3)

From (1), (2) and (3) we obtain

$$\chi_1 - \chi_2 = 3130'$$
$$\chi_1 - \chi_3 = 3090'$$

and $|\theta| = 27°.7'$ which corresponds to

$$\psi = -13°.4'$$

as compared with $-13°.6'$ directly measured.

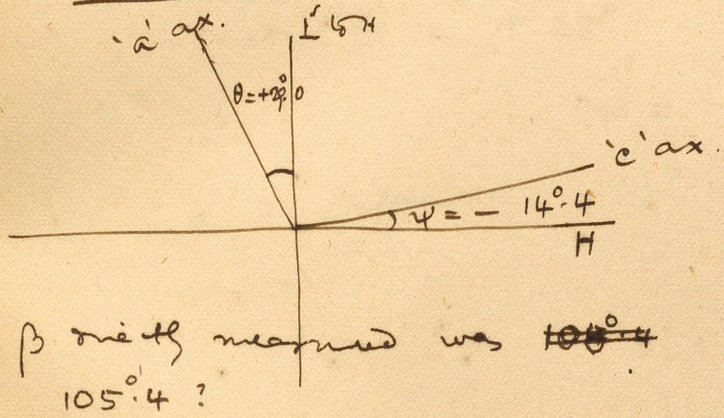
$Co\,K_2SeO_4 \cdot SO_4 \cdot 6H_2O$

$M = 484 \cdot 5$

$\rho =$

Monoc. prism. isomorphous with the other Tutton salts.

'b' ax. vert



β most accurately measured was ~~104°.4~~ 105°.4 ?

$\theta = +29°.0$
$+29°.0$

Taking $\beta = 104°.6$ (mean of the values 104°.9 and 104°.3 for the Co K double sulphate and double selenate respectively)

$\psi = -14°.4$.

Two crystals were studied

$m_1 = .0633$ gm. $m_2 = .0519$ gm.

$H = 1419$ gauss ($H' = 5177$ gauss)

$\Phi_1 = \frac{\pi}{90} \times \frac{M C_1}{m_1 H^2}$

$\Phi_2 = \frac{\pi}{90} \frac{M C_2}{m_2 H^2}$

$C_1 = \frac{T \cdot 5128}{4 \cdot 56^2} = .01566$

$C_2 = \frac{T \cdot 5128}{4 \cdot 21^2} = .01838$

$\left.\begin{aligned} \chi_1 - \chi_2 &= \Phi_1 \times 1425^\circ = 2960 \\ &= \Phi_2 \times 997^\circ = 2965 \end{aligned}\right\}$ Adopt $\chi_1 - \chi_2 = 2960$ ---(1)

'a' ax vert 'b' ax. ⊥ ~~to~~ field

$\left.\begin{aligned} \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 &= \Phi_1 \times 918^\circ = 1906 \\ &= \Phi_2 \times 640^\circ = 1902 \end{aligned}\right\}$ Adopt- 1904 --(2)

c(001) pl. horiz. 'b' ax. ⊥ ~~to~~ field.

$\left.\begin{aligned} \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 &= \Phi_1 \times \frac{\pi}{90} \times \frac{M C_1 \times 1619^\circ}{m_1 \times 5177^2} = 253 \\ &= \Phi_2 \times 86^\circ = 256 \end{aligned}\right\}$ Adopt- 254 -(3)

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 2960$$
$$\chi_1 - \chi_3 = 2560$$

and $\theta = +28°.1'$ corresponding to

$$\psi = -13°.5'$$

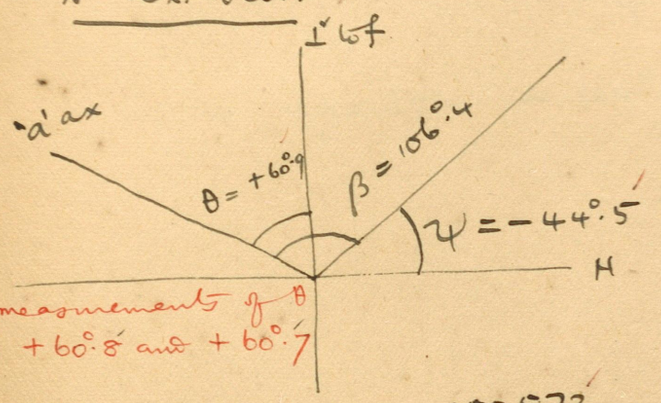
as against $-14°.4'$ nicely observed.

$CoSeO_4 \cdot (NH_4)_2SeO_4 \cdot 6H_2O$

Monocl. prismatic $\rho = 2.228$; $M = 489.51$

$a : b : c = 0.7449 : 1 : 0.5031$; $\beta = 106° 23'$

'b' ax. vert.



Later measurements of θ gave +60°.8 and +60°.7

$\theta = +\ 60°.9$
$61°.1$
$61°.0$
$60°.8$

Adopt. $+60°.9$

$\therefore \psi = -44°.5$

$H = 1419$ gauss. $\frac{\pi}{90} \times \frac{M}{H^2} = A$.

$$\chi_1 - \chi_2 = A \times \frac{.00573}{.0140} \times 900 = 3130$$
$$= A \times \frac{.2215}{.1013} \times 168 = 3120$$
$$= A \times \frac{.00573}{.0183} \times 1175 = 3120$$

$\chi_1 - \chi_2 = 3120$ ... (1)

'a' ax. vert. 'b' ax. along field

$$\Delta\chi = A \times \frac{.01326}{.1013} \times 320 = 356$$
$$= A \times \frac{.00573}{.0552} \times 417 = 367$$

$\therefore \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 362$ ... (2)

(001) pl. horiz. 'b' ax. normal to field

$$\Delta\chi = A \times \frac{.01326}{.1013} \times 1074 = 1194$$
$$= A \times \frac{.00573}{.0183} \times 446 = 1185$$
$$= A \times \frac{.0746}{.1013} \times 191.5 = 1197$$

$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 1195$ ... (3)

From (1), (2) and (3)

$$\chi_1 - \chi_2 = 3120'$$
$$\chi_1 - \chi_3 = 1980'$$

$\theta = 60°$ which corresponds to

$$\psi = -43°.6$$

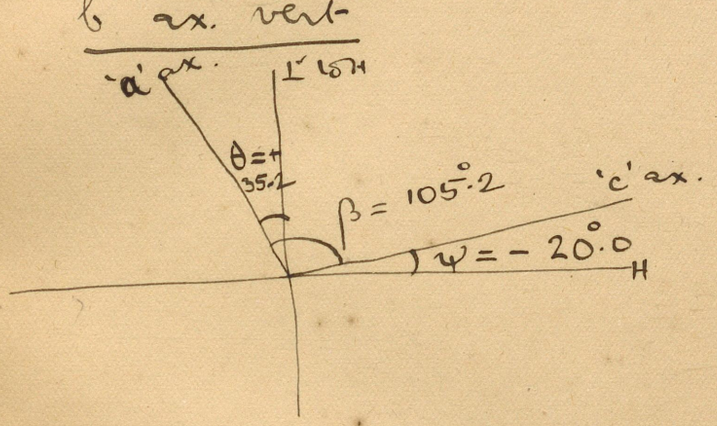
as against $-44°.5$ directly measured.

$CoSeO_4 \cdot Rb_2SeO_4 \cdot 6H_2O$

Monocl. prisms. $M_1 = 624.31$ $\rho = 2.824$

$a : b : c = 0.743 : 1 : 0.502$; $\beta = 105^\circ 14'$

'b' ax. vert



$\theta = +35^\circ.3$
$35^\circ.1$
$+35^\circ.2$ adopt.

$\therefore \psi = -20^\circ.0$

$\dot{c} = .50568 \left(\frac{7.5128}{7.572}\right)$

$H = 1419$

$m_1 = .0461$ gm $m_2 = .0342$ gm.

$\Phi_i = \frac{\pi}{90} \times \frac{Mc}{H^2} \times \frac{1}{m_i}$; $i = 1, 2.$

$\left.\begin{aligned} \chi_1 - \chi_2 = \Phi_1 \times 2175 &= 2902 \\ \Phi_2 \times 1612 &= 2898 \end{aligned}\right\}$ Adopt $\chi_1 - \chi_2 = 2900$ .. (1)

'a' ax. vert 'b' ax. normal to field

$\chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = \Phi_1 \times 955 = 1275$ .. (2)

c(001) pl. horiz. 'b' ax. normal to field

$\left.\begin{aligned} \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = \Phi_1 \times 241 &= 321 \\ \Phi_2 \times 177 &= 318 \end{aligned}\right\}$ Adopt 320 .. (3)

From (1), (2) and (3)

$\left.\begin{aligned} \chi_1 - \chi_2 &= 2900 \\ \chi_1 - \chi_3 &= 2250 \end{aligned}\right\}$

and $\theta = +35^\circ.4$ which corresponds to

$$\psi = -20^\circ.2$$

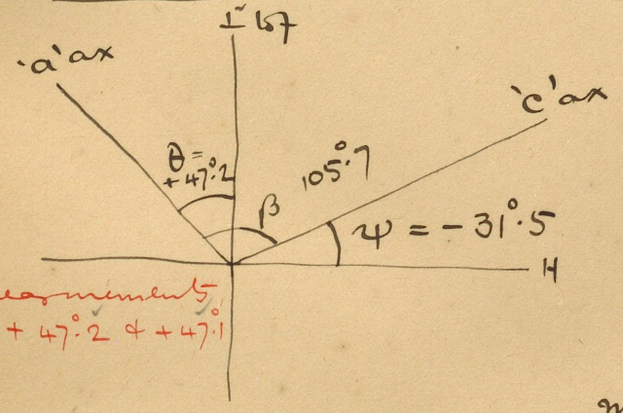
as compared with $-20^\circ.0$ directly measured.

$CoSeO_4 \cdot Tl_2SeO_4 \cdot 6H_2O$.

Monoclinic prisms. $\rho = 3.998$; $M = 862.2$

$a : b : c = 0.7463 : 1 : 0.5021$; $\beta = 105^\circ 40'$

'b' ax. vert.



Later measurements of θ gave +47°.2 & +47°.1

$\theta = +\begin{matrix} 47^\circ.1 \\ 47^\circ.3 \\ \cancel{47^\circ.2} \end{matrix}$ adopt $+47^\circ.2$

$\therefore \psi = -31^\circ.5$

Throughout $H = 1419$ gauss

$C = \frac{T.5128}{7.54^2 \cancel{T^2}} = .00573$

$m_1 = .0508$ $\quad \Phi_* = \frac{\pi}{90} \times \frac{MC}{H^2}$

$m_2 = .0243$

$$\left.\begin{aligned} \chi_1 - \chi_2 &= \Phi \times \frac{1455}{m_1} = 2450 \\ &= \Phi \times \frac{695}{m_2} = \cancel{28}\ 2450 \end{aligned}\right\} \text{Adopt } \chi_1 - \chi_2 = 2450 \quad \cdots (1)$$

'a' ax vert. 'b' ax. normal to field

$$\left.\begin{aligned} \Delta\chi &= \Phi \times 389/m_1 = 656 \\ &= \Phi \times 186.2/m_2 = 657 \end{aligned}\right\} \text{Adopt } \chi_1 \cos^2\theta + \chi_2 \sin^2\theta - \chi_3 = 657 \quad \cdots (2)$$

(001) pl. horiz 'b' ax. again normal to field

$$\left.\begin{aligned} \Delta\chi &= \Phi \times 470/m_1 = 793 \\ &= \Phi \times 225.1/m_2 = 794 \end{aligned}\right\} \therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 794 \quad \cdots (3)$$

From (1), (2) and (3)

Co Tl selenate

$$\chi_1 - \chi_2 = 2450$$
$$\chi_1 - \chi_3 = 1950$$

and $\theta = 46°.6'$, which corresponds to

$$\psi = -30°.9'$$

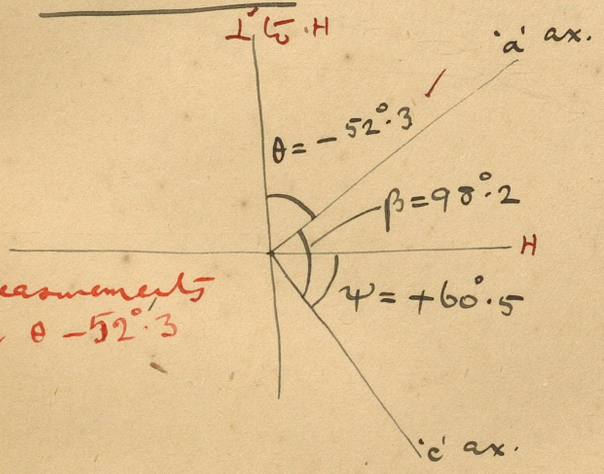
as against $-31°.5'$ directly measured.

$CoSeO_4 \cdot 6H_2O$

Monoclinic $\rho = 2.175$ (2.32) $M = 310.23$

$a : b : c = 1.5709 : 1 : 1.6815$; $\beta = 98° 14'$

'b' ax. vert-



Later measurements gave for θ −52°·3

$\theta = -52°.1$
$-52°.4$
adopted $= 52°.3$
$\therefore \psi = +60°.5$

$H = 1419$

$m_1 = .0392$ $C_1 = \frac{T.5128}{4.956^2} = .01326$

$m_2 = .1710$ $C_2 = \frac{T.5128}{2.09^2} = .0746$

$m_3 = .3240$

$\Phi = \frac{\pi}{90} \times \frac{H}{H^2}$

$\chi_1 - \chi_2 = \Phi \times \frac{C_1}{m_1} \times 2213 = 4030$
$= \Phi \times \frac{C_2}{m_2} \times 1718 = 4030$
$\therefore \chi_1 - \chi_2 = 4030$ ---(1)

'a' ax vert- 'b' ax. along field

$\Delta\chi = \Phi \times \frac{C_1}{m_1} \times 60 = 109$
$= \Phi \times \frac{C_1}{m_3} \times 490 = 108$
$\therefore \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 108$ ---(2)

c(001) pl. horiz. 'b' ax. normal to field

$\Delta\chi = \Phi \times \frac{C_1}{m_1} \times 532 = 968$
$= \Phi \times \frac{C_2}{m_2} \times 412 = 967$
$\therefore \chi_1 \sin^2\theta + \chi_2 \cos^2\theta - \chi_3 = 967$ ---(3)

From (1) (2) and (3)

$x_1 - x_2 = 4039$ ✓ $\quad x_1 - x_2 = 4030$ ✓

$x_1 - x_3 = 2455$ $\quad x_1 - x_3 = 2445$ ✓

and $\theta = -52^\circ.7$ ✓ which corresponds to

$$\psi = +60^\circ.9$$ ✓

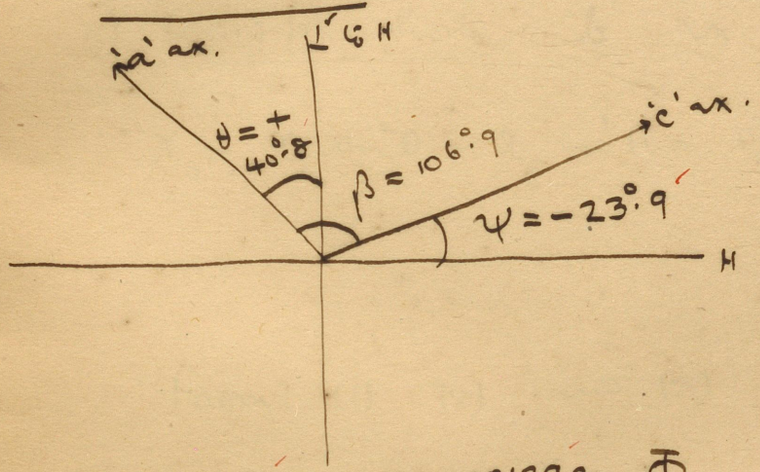
as against $+60^\circ.5$ ✓ directly measured.

$FeSO_4 \cdot Co_2SO_4 \cdot 6H_2O$

Monocl. prism. $\rho = 2.79$ $M = 621.67$

$a : b : c = 0.726 : 1 : 0.495$; $\beta = 106^\circ 52'$

'b' ax. vert.



$\theta = +40^\circ 8'$
$+40^\circ 8'$ adopted

$\therefore \psi = -23^\circ 9'$

For all the measurements

$H = 1419$ gauss

$C = \left(\frac{T.5128}{7.40^2}\right) = .00595$

$m_1 = .0216$ gm.; $m_2 = .0129$ gm. $\Phi_1 = \frac{\pi}{90} \cdot \frac{Mc}{H^2} \cdot \frac{1}{m_1}$; $\Phi_2 = \frac{\pi}{90} \cdot \frac{Mc}{H^2} \cdot \frac{1}{m_2}$

$\chi_1 - \chi_2 = \Phi_1 \times 495$ at $32^\circ.5$ $= 2090$ at 26° C.

$= \Phi_2 \times 335$ at $33^\circ.0$ $= 2070$ at " ($FeSO_4 \cdot K_2SO_4$)

Adopt- $\chi_1 - \chi_2 = 2080 \times 10^{-6}$ ----- (1)

'a' ax. vert. 'b' ax. along field

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \Phi_1 \times 160$ at $32^\circ.5 = 677$ at 26° C.

$\chi_1 - \chi_2 = \Phi_1 \times 825$ at $32^\circ.5$ $= 2490$ at 26° C. 2506 2557

$= \Phi_2 \times 491$ at $33^\circ.5$ $= 2420$ " 2557 2514

Adopt- $\chi_1 - \chi_2 = \frac{2440}{2535} \times 10^{-6}$ ..... (1)

'a' ax. vert. 'b' ax. along field.

$\therefore \chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \Phi_1 \times 163$ at $32°\cdot5$ = ~~474~~ 505 at $26°C$

$= \Phi_2 \times 97\cdot5$ at $30°\cdot5$ = ~~481~~ 499 "

Approx $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = $ ~~470~~ $\times 10^{-6}$ 502 ---(2)

3.) (001) pl. horiz. 'b' ax. along field

$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \Phi_2 \times 176$ at $30°\cdot5$

$= $ ~~869~~ $\times 10^{-6}$ 901 at $26°C$. approx. (3)

From (1) (2) and (3)

$\chi_1 - \chi_2 =$ ~~2410~~ 2535 } 2540
$\chi_1 - \chi_3 =$ ~~530~~ 566 } 566

and $\theta = +40°\cdot5$ which corresponds to

$\psi = -23°\cdot6$

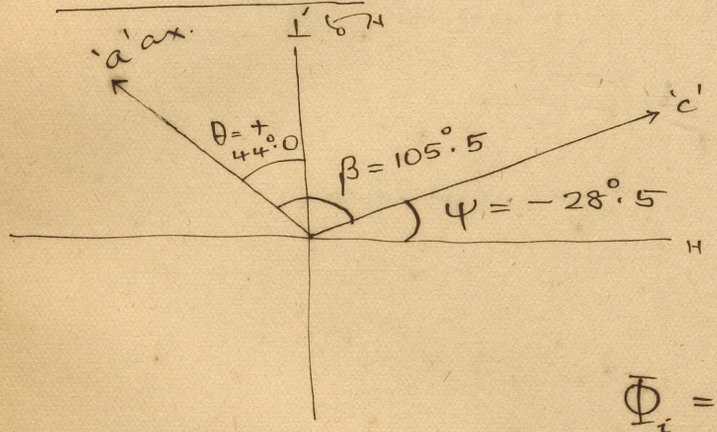
as compared with $\psi = -23°\cdot9$ directly measured.

$FeSeO_4 \cdot Tl_2SeO_4 \cdot 6H_2O$

Monocl. prism $\rho = 3.94$. $M = 859.1$

$a : b : c = 0.745 : 1 : 0.501$; $\beta = 105^\circ 27'$

'b' ax. vert.



$\theta = +44^\circ.0$

$\psi = -28^\circ.5$

For all the measurements

$H = 1419$ gauss $C = .00595$ (T. 5128/7.40²)

$m_1 = .0205$ gm. $m_2 = .0140$ gm.

$$\Phi_i = \frac{\pi}{90} \times \frac{MC}{H^2} \cdot \frac{1}{m_i} \quad , i = 1, 2.$$

$\chi_1 - \chi_2 = \Phi_1 \times 495$ at $32^\circ.3$ = ~~2090~~ 2230 at 26° C.

$= \Phi_2 \times 335$ at $33^\circ.0$ = ~~2070~~ 2221 "

Adopt $\chi_1 - \chi_2 = \frac{\text{~~2080~~}}{2226} \times 10^{-6}$ ---(1)

2. 'a' ax. vert. 'b' ax. along field

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \Phi_1 \times 160$ at $32^\circ.3$ = ~~677~~ 721 at 26°.

$\Phi_2 \times 109$ " $33^\circ.0$ = ~~674~~ 723 "

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \frac{\text{~~676~~}}{722} \times 10^{-6}$ ---(2)

3. c(001) pol. horiz. 'b' ax. along field

$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \Phi_1 \times 175$ at $32^\circ.3$ = ~~741~~ 788 at 26°

$= \Phi_2 \times 120$ at $33^\circ.0$ = ~~742~~ 796 "

Adopt $\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \frac{\text{~~742~~}}{792} \times 10^{-6}$ ---(3)

Fe Tl selenate

From (1), (2) and (3)

$$\begin{aligned} \chi_1 - \chi_2 &= 2080 \\ \chi_1 - \chi_3 &= 330 \end{aligned} \Bigg| \quad \begin{matrix} 2230 \\ 358 \end{matrix} \Bigg|$$

and $\theta = +44°.1$, which corresponds to

$$\psi = -28°.6$$

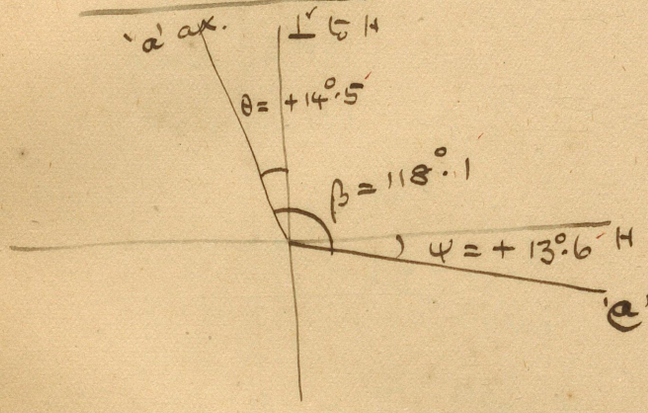
as compared with $-28°.5$ directly measured.

$Nd_2(SO_4)_3 \cdot 8H_2O$ (Th. Schuchardt) $M = 720.8$

$\rho = 2.850$ from Groth

Monocl. prism. $a : b : c = 2.9835 : 1 : 1.9968$; $\beta = 118° 8\frac{1}{2}'$.

'b' ax. vert



$\theta = +14°.6$
$14°.5$
$+14°.5$ adopted

$\therefore \psi = +13°.6$

$H = 1419$ gauss $\quad c = .005948$.

$m_1 = .0616$ gm. $\quad m_2 = .0607$ gm.

$$\varphi_i = \frac{\pi}{90} \times \frac{Mc}{H^2} \times \frac{1}{m_i} \qquad i = 1, 2.$$

$\chi_1 - \chi_2 = \varphi_1 \times 663 = 800$
$= \varphi_2 \times 649 = 795$ } Adopt. $\chi_1 - \chi_2 = 798$ (806 at 30°) --- (1)

'a' ax. vert- 'b' ax. along field $\quad \Delta\chi = \chi_3 - (\chi_1 \cos^2\theta + \chi_2 \sin^2\theta)$

$= \varphi_1 \times 193 = 233$
$= \varphi_2 \times 190 = 233$ } Adopt. $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 233$ (235 at 30°) --(2)

(001) pl. horiz. 'b' ax along ⊥. $\quad \Delta\chi = \chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta$

$= \varphi_1 \times 776 = 936$
$= \varphi_2 \times 763 = 934$ } Adopt. $\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = 935$ (945 at 30°) --(3)

From (1) (2) and (3),

$\chi_3 - \chi_2 = 983$ $\quad \chi_1 - \chi_2 = 798$ $\quad \chi_1 - \chi_3 = -185$ $\quad \theta = +14°.2$ at 31°.5 C.

$\chi_1 - \chi_2 = 806$ & $\chi_1 - \chi_3 = -188$ at 30° $\quad \psi = +14°.0$

or $\psi = +13°.9$ as against $+13°.6$ directly measured

Another specimen of $Nd_2(SO_4)_3 \cdot 8H_2O$ prepared from Nd chloride supplied by Dr Samuel gave ~~X_2~~ ~~X_1~~ with (001) pol. horiz.

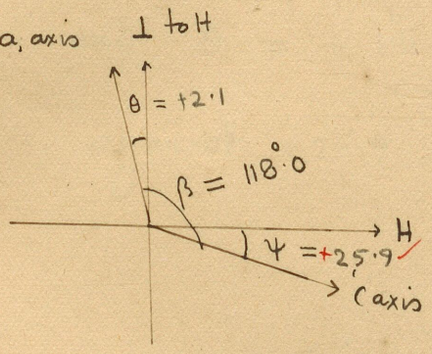
$$\Delta X = 953 \times 10^{-6} \quad \text{at } 30^\circ$$

as against 947 given by the previous specimen.

$Pr_2(SO_4)_3 \cdot 8H_2O$ from Dr P.B. Sircar: presumably very pure.
M = 714.1 ✓

Monoclinic prism. $a : b : c = 2.9863 : 1 : 1.9995$ $\beta = 118°0'$.

'b' axis vertical.



$\theta = +2.0$
$\quad\quad 2.1$
$+2.1$ ✓ adopted.

$\therefore \psi = +25.9$ ✓

H = 1166 gauss. $c_1 = .002877$ $c_2 = .002943$
$m_1 = .0120$ gm. $m_2 = .0127$ gm.

$$Q_i = \frac{\pi}{90} \times \frac{Mc_i}{H^2} \times \frac{1}{m_i} \; ; \; i = 1, 2.$$

$\chi_1 - \chi_2 = Q_1 \times 177 = 778$ at 30·5 C; 780 ✓ at 30°.
$= Q_2 \times 184$ at 30·6 C = 785 ✓ " ".

Adopt $\chi_1 - \chi_2 = 783$ ... (1)

'a' axis vertical. 'b' axis along the field.

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = Q_1 \times 222$ at 29·4 C = 972 ✓ at 30°
$= Q_2 \times 230$ " 30·6 " = 987 (981) ✓ " "

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 975 \times 10^{-6}$ ..... (2)

(001) plane horizontal. 'b' axis along field.

$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = Q_1 \times 400$ at 29·3 C = 1750 ✓ at 30·C
$= Q_2 \times 415$ " 30·1 " = 1763 ✓ " "

Adopt $\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = 1757 \times 10^{-6}$ ..... (3)

~~1760~~

Another specimen of Pr sulphate, prepared from the chloride from Prof. Samuel gave with (001) plane horizontal

$\Delta\chi = 1752 \times 10^{-6}$ at 30°

as compared with 1757 of the previous sample.

From (1), (2) (3) we have

$$\left.\begin{aligned} x_1 - x_2 &= 783 \\ x_1 - x_3 &= -975 \end{aligned}\right|$$

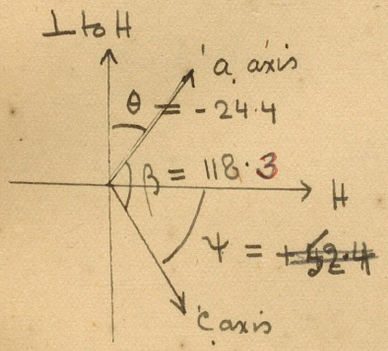
and $\theta = +1.5$ which corresponds to $\psi = +26.5$ as against $+25.9$ directly measured.

$Sm_2(SO_4)_3 \cdot 8H_2O$ (Th. from Schmidt's 100% oxide) $M = 733.16$ ✓

Monocl. prism.

$a : b : c = 3.0030 : 1 : 2.0022$ $\quad \beta = 118°16'$

'b' axis vertical.



$\theta = -24.5$
$\quad 24.3$
-24.4 ✓ Adopt.

$\therefore \psi =$ ~~+42·4~~ $+52.7$ ✓

$H_1 = 4786$
$H_0 = 1166$ gauss. $\quad C = .002943$
$m_1 = .0240$ gm $\quad m_2 = .0252$ gm.

$\Phi_i = \frac{\Pi}{90} \cdot \frac{MC}{H_0^2} \times \frac{1}{m_i}$ $\quad i = 1, 2.$ $\quad \Phi_{3_i} = \frac{\Pi}{90} \cdot \frac{MC}{H_1^2} \cdot \frac{1}{m_i}$ where $i = 1, 2.$

$\chi_1 - \chi_2 = \Phi_1 \times 187$ at 30°.3 C $= 432$ ✓ at 30° C.
$\Phi_2 \times 197$ " 30°.2 " $= 434$ ✓ " "

Adopt $\chi_1 - \chi_2 = 433 \times 10^{-6}$ ✓ at 30° C. ------ (1)

'a' axis vertical. 'b' axis along field.

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \Phi_{3_1} \times 155$ at 30.0 $= 21.2$ ✓ at 30°.0 C.
$= 23.0$ ✓ " " "
$= \Phi_{3_2} \times 177$ " "

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 22 \times 10^{-6}$ ✓ at 30°.0 C ----- (2)

(001) pl. horizontal. b axis along field.

$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \Phi_1 \times 134$ at 30°.2 C $= 310$ ✓ at 30°.0 C.
$= \Phi_2 \times 139$ " 30.1 " $= 306$ ✓ " "

Adopt $\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = 308$ ✓ $\times 10^{-6}$ at 30° C ------ (3).

Another specimen of Sm sulphate from Prof. Samuels chloride, gave ~~for~~

$$\chi_1 - \chi_2 = 431 \text{ at } 30^\circ$$

as against 433 of the previous specimen.

From ① ② & ③ we have.

$$\chi_1 - \chi_2 = 433$$
$$\chi_1 - \chi_3 = 52$$

and $\theta = -24.3$, which corresponds to $\psi = +52.6$ as compared with $+52.37$ directly measured.

$Ce_2(C_2H_5.SO_4)_6.18H_2O$.

Hexagonal. (Crystal data from Inorganic. Ch. Neuth & friend) $M = 1355.4$ ✓

Hexagonal axis horizontal. Hexagonal axis along field.

$\chi_{\parallel} - \chi_{\perp} = \frac{\pi}{90} \cdot \frac{M \times .0029\cancel{43}}{1166^2 \times .0565} \times 161$ at $31.4 = 294.\cancel{4}$ ✓ at $30.0°C$.

$= \frac{\pi}{90} \times 57 \times \frac{M \times .0029\cancel{43}}{.0201 \times 1166^2}$ at $31.6 = 293.\cancel{4}$ ✓ " "

Adopt $\chi_{\parallel} - \chi_{\perp} = 294$ ✓ at 30.0 C

The value of ~~it~~ Fereday and Weisma Leid comm. 237a (1935) Extrapolated ~~at~~ to 30.0 (their last extrap from low temp. to $290°K$) $= -.22 \times 10^{-6}$ per gm

$= 300$ ✓ $\times 10^{-6}$ per gm. mol.

$Nd_2(C_2H_5 \cdot SO_4)_6 \cdot 18H_2O$.

Hexagonal.

$M = 1363 \cdot 43$.

Hexagonal axis horizontal. Hexagonal axis along field.

$$\chi_{\parallel} - \chi_{\perp} = \frac{\pi}{90} \times 440 \times \frac{M \times \cdot 002943}{\cdot 0764 \times 1166^2} \text{ at } 32{\cdot}0^\circ C = 601 \text{ at } 30{\cdot}0^\circ C$$

$$= \frac{\pi}{90} \times 261 \times \frac{M \times \cdot 002943}{\cdot 0453 \times 1166^2} \text{ at } 31{\cdot}6^\circ C = 599 \text{ " " } \rightarrow \text{best Crystal}$$

Adopt $\chi_{\parallel} - \chi_{\perp} = 600 \times 10^{-6}$ at $30{\cdot}0^\circ C$.

Feraday & Weirma's value extrapolated beyond $290^\circ K$ & $303^\circ K$ is $\cdot 44 \times 10^{-6}$ per gm

$= 600 \times 10^{-6}$ per gm. mol.

$Yb_2(C_2H_5.SO_4)_6 . 18H_2O$.

Hexagonal.

M = 1421 ✓.

Hexagonal axis horizontal. Hex. axis along field.

$\chi_{\parallel} - \chi_{\perp} = \frac{\pi}{90} \cdot 310 \cdot \frac{M \times .003181}{.0280 \times 1166^2}$ at 32°.1 C = 1302 at 30° C.

$= \frac{\pi}{90} \cdot 281 \cdot \frac{M \times .003181}{.0255 \times 1166^2}$ at 31°.6 C = 1295 " "

Adopt $\chi_{\parallel} - \chi_{\perp} = 1300 \times 10^{-6}$ at 30° C.

$Sm_2(C_2H_5 \cdot SO_4)_6 \cdot 18H_2O$.

M = 1378.75

Hexagonal.

Hexagonal axis horizontal. Hex. axis along field.

$\chi_{\parallel} - \chi_{\perp} = \frac{\pi}{90} \cdot 71 \cdot \frac{M \cdot 003181}{\cdot 0470 \times 1166^2}$ at 32.0° C = 172 at 30° C.

$= \frac{\pi}{90} \cdot 62 \cdot \frac{M \cdot 003181}{\cdot 0412 \times 1166^2}$ at 32.4° C = 172 " " .

Adopt $\chi_{\parallel} - \chi_{\perp} = 172 \times 10^{-6}$ at 30° C.

Ammonium cero~~nitrate~~ sulphate tetrahydrate

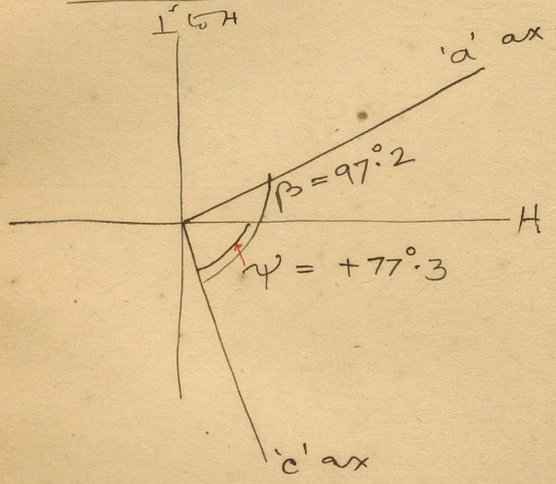
$M = 422.35$

$\rho = 2.523$

$\cancel{Ce(NH_4)_2}$ $Ce\ NH_4 \cdot (SO_4)_2 \cdot 4H_2O$

Monocl. prismc. $a : b : c = 0.3598 : 1 : 0.9340$; $\beta = 97°15'$.

'b' ax. vert



$\psi = +77°.3$
$\quad\quad .2$
$+77°.3$ adopted.

$c = .00688$ $\quad m_1 = .0113$

$H = 5102$ $\quad m_2 = .0116$

$\varphi_i = \frac{\pi}{90} \times \frac{Mc}{m_i H^2}$, $i = 1, 2$.

$\chi_1 - \chi_2 = \varphi_1 \times 390 = 135$ at $32°.0$ C. — 137 at 30°

$= \varphi_2 \times 400 = 134$ at $32°.3$ c. — 136 at 30°.

Adopt $\chi_1 - \chi_2 = 134$ at $32°$ .. (1)

136 at 30°

2) 'c' ax. vert 'b' ax. normal to field

$\Delta\chi = \varphi_1 \times 220 = 76$ at $32°$ — 77 at 30°

$= \varphi_2 \times 232 = 78$ at $32°.3$ — 79 at 30°

Adopt $\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = 76$ at $32°$.

77 at 30°

3) (100) pl. horiz 'b' ax. along field

$\Delta\chi = \varphi_1 \times 140 = 48$ at $32°$

$= \varphi_2 \times 141 = 47$ at $32°.3$

Adopt $\chi_3 - (\chi_1 \cos^2\psi + \chi_2 \sin^2\psi) = 47$ at $32°$

48 at 30

From (1), (2) and (3)

$\chi_1 - \chi_2 = 134$
$\chi_1 - \chi_3 = 82$ at $32°$ C. $\quad$ 136, 83 at $30°.0$

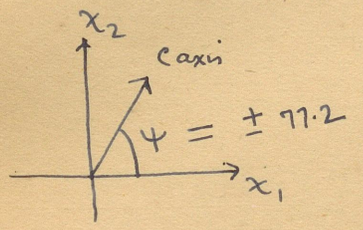
$\psi = +78°.4$ as against $+77°.3$ observed.

$Cr_2(SO_4)_3 \cdot 8H_2O$.

$M = 767.59$

Monocl. prism. $a : b : c = 3.0120 : 1 : 2.0043$ $\beta = 118.5^\circ$

'b' axis vertical.



$\psi = 77.2$, 77.1

± 77.2 adopt.

$\phi_i = \frac{\pi}{90} \cdot \frac{Mc}{H^2} \times \frac{1}{m_i}$ $\quad i = 1, 2$

$H = 1166$
$c = .007478$.
$m_1 = .0102$ gm
$m_2 = .0132$ "

$\chi_1 - \chi_2 = \phi_1 \times 605$ at $32.3^\circ C = 8870 \times 10^{-6}$ at $30^\circ C$.

$= \phi_2 \times 790$ " 30.7 " $= 8870 \times$ " . . . "

Adopt $\chi_1 - \chi_2 = 8870 \times 10^{-6}$ at $30.0^\circ C$ ..... (1)

'c' axis vertical 'b' axis ~~along~~ $\parallel$ $\perp$ to field.

$\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = \phi_1 \times 495$ at $32.2^\circ C = 7250 \times 10^{-6}$ at $30.0^\circ C$.

$= \phi_2 \times 645$ " $30.9^\circ C = 7240 \times 10^{-6}$ " " "

Adopt $\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = 7250 \times 10^{-6}$ at $30.0^\circ C$ ..... (2)

(100) pl. horizontal. 'b' axis along the field.

$\chi_3 - \chi_1 \cos^2\psi - \chi_2 \sin^2\psi = \phi_2 \times 68$ at $30.9^\circ C = 764 \times 10^{-6}$ at $30.0^\circ C$.

Adopt $\chi_3 - \chi_1 \cos^2\psi - \chi_2 \sin^2\psi = 764 \times 10^{-6}$ at $30.0^\circ C$ ..... (3)

From ①, ② and ③ we have

$$\left.\begin{aligned} x_1 - x_2 &= 8870 \\ x_1 - x_3 &= 7680 \end{aligned}\right\} \times 10^{-6}$$

$\Psi = \pm |77.3|$ as against $\pm |77.2|$ directly measured.

$Mg_3 Pr_2 (NO_3)_{12} \cdot 24H_2O$ (from Pr. chloride of Prof. Samuel)

Trig. $M = 1531.3$

Trigonal axis horizontal. Trig. axis felt normal to field.

$$\chi_\perp - \chi_{\parallel} = \frac{11}{90} \times 285 \times \frac{M}{1331} \times \frac{\cdot 007478}{1166^2/k} = 631 \times 10^{-6} \text{ at } 30.0°\text{C}. \quad (\text{at } 30°.5)$$

$$= \frac{11}{90} \times 289 \times \frac{M}{1352} \times \frac{\cdot 007478}{1166^2/k} = 633 \times 10^{-6} \text{ at } 30.0°\text{C}. \quad (\text{at } 31°.2)$$

Adopt. $\chi_\perp - \chi_{\parallel} = 632 \times 10^{-6}$ at $30.0°$C.

$Zn_3Pr_2(NO_3)_{12}\cdot 24H_2O$ (from Pr chloride of Prof. Samuel)

$M = \cancel{1654.6}$ 1654.5

Trigonal.

Trigonal axis horizontal. Trig. axis set normal to field.

$$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times 655 \times \frac{M}{.1599} \times \frac{.003833}{1166^2} \text{ at } 27^\circ.4 = 654 \times 10^{-6} \text{ at } 30^\circ C.$$

$$= \;,, \times 412 \times \frac{M}{.1009} \times \frac{.003833}{1166^2} \text{ at } 27^\circ.3 = 652 \times 10^{-6} \text{ at } 30^\circ.0 C.$$

Adopt $\chi_\perp - \chi_\parallel = 653 \times 10^{-6}$ at $30^\circ C$.

$M = 1410 \cdot 2$

$Er_2 \cancel{Yb_2} (C_2H_5SO_4)_6 \cdot 18 H_2O$ (From Th Schuchardt's nitrate)

Hexagonal

With the hex. axis horizontal it sets ⊥ to field

$$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times \frac{1410 \times \cdot 002943}{\cdot 0109 \times 1166^2} \times 673 \text{ at } 30^\circ.3$$

$$= 6590 \text{ at } 30^\circ.$$

$$\text{also} = \frac{\pi}{90} \times \frac{1410 \times \cdot 01900}{\cdot 0337 \times 1166^2} \times 322 \text{ at } 30^\circ.5$$

$$= 6590 \text{ at } 30^\circ.$$

another crystal (From Prof Samuel's specimen of nitrate)

$$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times \frac{M \times \cdot 007663}{\cdot 0102 \times 1173^2} \times 243 \text{ at } 30^\circ.9$$

$$= 6570 \text{ at } 30^\circ.$$

Fereday and Wiersma's value extrapolated to 303° K (from 290° K) $\chi_\parallel - \chi_\perp = 1.84 \times 10^{-6}$ per gm.

$= 2590 \times 10^{-6}$ per gm. mol.

$Pr_2(C_2H_5SO_4)_6 \cdot 18H_2O$ (from the oxide of Th. Schuchardt)

$M = 1356.7$

Hexagonal.

With ax. horiz. it sets along the field

$$\chi_{\parallel} - \chi_{\perp} = \frac{\pi}{90} \times \frac{M \times .00721}{.0652 \times 1173^2} \times 66 \text{ at } 24^\circ.0 = 242 \text{ at } 30^\circ$$

$$\text{again} = \frac{\pi}{90} \times \frac{M \times .00721}{\cancel{.0651}\ .0199 \times 6096^2} \times 538 \text{ at } 24^\circ.5 = 240 \quad ''$$

$$\frac{\pi}{90} \times \frac{M \times .00766}{.0146 \times 6096^2} \times 360 \text{ at } 30^\circ.1 = 241 \text{ at } 30^\circ$$

Adopt $\chi_{\parallel} - \chi_{\perp} = \underline{\underline{241 \text{ at } 30^\circ}}$

Fereday & Weisman's value extrapolated (from 290°K) to 303°K [In extrapolating we have assumed ~~that~~ our observed ratio ~~for~~ $\Delta\chi_{303^\circ} / \Delta\chi_{290^\circ} = \frac{241.0}{253.4}$]

$= .223 \times 10^{-6}$ per gm

$= 300 \times 10^{-6}$

$Mg_3 Ce_2 (NO_3)_{12} \cdot 24 H_2O$

Trigonal $\alpha = 80° 43'$ $(a : c = 1 : 1.5378)$ $M = 1529.7$

Trig ax horiz Trig. ax. sets normal to field

$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times 217 \times \frac{1529.7}{.0284} \times \frac{.003056}{14192} = 619$ at 34° C

$= \frac{\pi}{90} \times 299 \times \frac{.M}{.0390} \times$ " $= 621$ at 34°.2 C.

Adopt. $\chi_\perp - \chi_\parallel = \frac{620 \times 10^{-6}}{637}$ at 34° C.
" at 30° C.

$Zn_3Ce_2(NO_3)_{12} \cdot 24H_2O$ $M = 1652 \cdot 9$

Trigonal $\alpha = 79^\circ 54'$ $(a : c = 1 : 1 \cdot 5677)$

With trig ax. horiz. it sets normal to field

$$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times 1552 \times \frac{M}{\cdot 1084} \times \frac{\cdot 001456}{1385^2} = 627 \text{ at } 35^\circ \cdot 5 \text{ C.}$$

$$= \text{"} \times 447 \times \frac{M}{\cdot 0312} \times \text{"} = 627 \text{ at } 35^\circ \cdot 4$$

Adopt $\chi_\perp - \chi_\parallel = \underline{\underline{627 \times 10^{-6}}}$ at $35^\circ \cdot 5$ C.

650 " " $30^\circ \cdot 0$ "

$Mg_3 Pr_2 (NO_3)_{12} \cdot 24 H_2O$ $M = 1531 \cdot 3$

Trig. $\alpha =$ $(a : c = 1 :$) no crystal data given in Groth.

with trigonal ax. horiz. it sets normal to field

$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times 220 \times \frac{M}{\cdot 0694} \times \frac{\cdot 003056}{1419^2} = 257$ at $33^\circ \cdot 2$ C.

$= \frac{\pi}{90} \times 275 \times \frac{M}{\cdot 0860} \times$ " $= 259$ at $33^\circ \cdot 0$ C.

Adopt- $\chi_\perp - \chi_\parallel = \frac{258 \times 10^{-6}}{263}$ at 33° C.
" 30° C.

$Zn_3\ Pr_2\ (NO_3)_{12} \cdot 24\,H_2O$ $\qquad M = 1654.5$

Trigonal.

With the trig. ax. horiz. it sets normal to field

H = 11610 gauss.

c = .00610

$$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times \frac{Mc}{H^2} \times \frac{60}{.0580} = 268 \quad \text{at } 34^\circ.5$$

$$= \quad " \quad \frac{129}{.1232} = 271 \quad \text{at } 34^\circ.9$$

Adopt $\chi_\perp - \chi_\parallel = 270$ at 34° C.

275 " 30° C

$Mg_3Sm_2(NO_3)_{12} \cdot 24H_2O$.

$M = 1550.06$.

Trigonal.

Trigonal axis horiz. it sets normal to field.

$c = .002954$

$\chi_\perp - \chi_{11} = \frac{\pi}{90} \cdot \frac{M.C}{H^2} \cdot \frac{84}{.0577}$ at $31.5^\circ C$ $= \frac{173}{179}$ at $30^\circ C$. $H = 1166$.

$= \frac{\pi}{90} \cdot \frac{M.C}{H^2} \cdot \frac{142}{.0941}$ at $31.5^\circ C = 179$ " "

Adopt $\chi_\perp - \chi_{11} = 176 \times 10^{-6}$ at $30.0^\circ C$.

$Mg_3\ Nd_2\ (NO_3)_{12} \cdot 24\,H_2O$ $\quad M = 1538.0$

Trig. $\alpha = 79° 46'$ $(a : c = 1 : 1.5720)$

with trig ax horiz. it sets $\perp^r$ to field

$$\chi_\perp - \chi_\parallel = \frac{11}{90} \times 273 \times \frac{M}{.0790} \times \frac{.00688}{1419^2} = 634 \text{ at } 31°.4$$

$$= \text{"} \quad 550 \times \frac{M}{.1592} \times \text{"} = 634 \text{ at } 31°.0$$

Adopt- $\chi_\perp - \chi_\parallel = 634 \times 10^{-6}$ at $31°$ C.

639 ~~638~~ " $30°$ C.

$Zn_3 \; Nd_2 \; (NO_3)_2 \cdot 24 \, H_2O \qquad M = 1661.1$

Cryst. data not given in Groth. Probably trig. & is omorphous with the other compounds of this series.

Trigonal $a : c = 1 :$ $\alpha =$

With trig. ax. horiz. it sets $\perp^r$ to field.

$$\chi_\perp - \chi_\parallel = \frac{\pi}{90} \times 450 \times \frac{M}{.0675} \times \frac{.003056}{1419^2} = 587 \text{ at } 35^\circ.4$$

$$= \quad " \quad \times 287 \times \frac{M}{.0304} \times \frac{.001456}{1162^2} = 590 \text{ at } 35^\circ.4$$

Adopt $\chi_\perp - \chi_\parallel = 589$ at $35^\circ.4$

611 " 30°

$(NH_4)_3 Cr(C_2O_4)_3 \cdot 3H_2O$ $\quad M = 424.24$

Monoclinic prism. $a : b : c = 0.983 : 1 : 0.387$, $\beta = 95^\circ 18'$.

'b' ax. vert- $\quad |\psi| = \begin{matrix} 28.5 \\ .9 \\ 6 \\ \hline 28.7 \end{matrix}$

$$\chi_1 - \chi_2 = \frac{\pi}{90} \times \frac{M}{.0874} \times \frac{.00929}{4708^2} \times \frac{(69.5-6.7)}{62.8} = 4.5 \text{ at } 35.8^\circ C$$
$$4.6 \text{ at } 30^\circ C.$$

$$\text{"} \quad \frac{M}{.0864} \times \frac{.00220}{4708^2} \times (225-2) = 3.8 \quad 30.1$$

'c' ax. vert- $\quad$ 'b' ax. along field

$$(\chi_3 - \chi_1) + (\chi_1 - \chi_2)\cos^2\psi = \frac{\pi}{90} \times \frac{M}{.0874} \times \frac{.00929}{4708^2} \times (193-2.2) = 13.6 \text{ at } 30.8$$
$$= 13.7 \text{ at } 30^\circ$$

$$= \frac{\pi}{90} \times \frac{M}{.0868} \times \frac{.00929}{4708^2} (191-2.2) = 13.6 \text{ at } 30.8$$
$$= 13.7 \text{ at } 30^\circ$$

$$= \frac{\pi}{90} \times \frac{M}{.0552} \times \frac{.00220}{4708^2} (508-1) = 13.5 \text{ at } 30^\circ.$$

Adopt- 13.6 at- 30° C. (2)

(100) plane horiz. $\quad$ 'b' ax along field

$$(\chi_3 - \chi_1) + (\chi_1 - \chi_2)\sin^2\psi = \frac{\pi}{90} \times \frac{M}{.0866} \times \frac{.00929}{4708^2} (161-2.6) = 11.4 \text{ at } 31.2$$
$$= 11.5 \text{ at } 30^\circ C.$$

$$= \frac{\pi}{90} \times \frac{M}{.0552} \times \frac{.00220}{4708^2} (412-1) = 11.0 \text{ at } 32.9$$
$$11.2 \text{ at } 30^\circ C$$

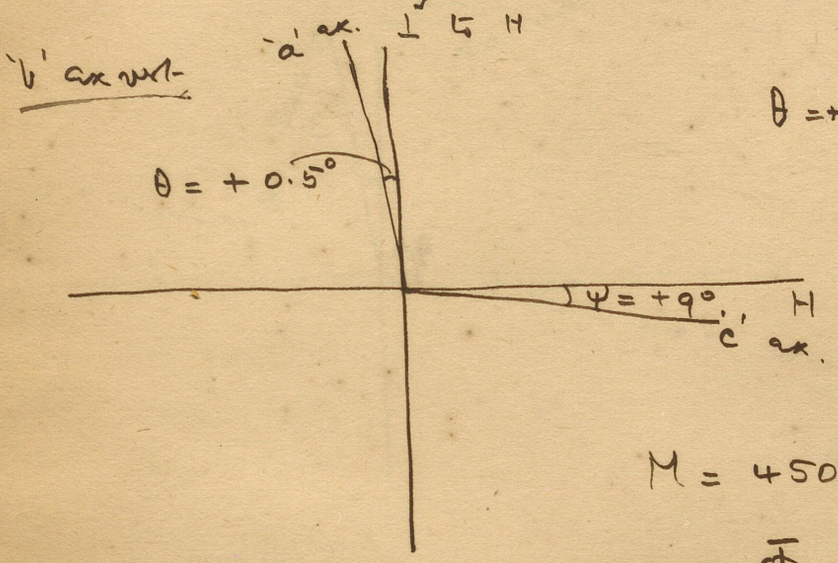
Adopt- 11.3 at- 30° C. — — — (3)

From (2) and (3) and $|\psi| = 28.7$ $\quad \chi_1 - \chi_2 = 4.3$, $\chi_1 - \chi_3 = -10.3$ } Adopt

$Na_3 Al(C_2O_4)_3 \cdot 5H_2O$

Monocl. prisms.

$a : b : c = 1.399 : 1 : 1.198$; $\beta = 99° 28'$.



$\theta = +\frac{1}{2}°$; $\Psi = +9°$.

For the following measurements

$m = .2155$ gms.

$H = 6131 \sqrt{\frac{1665}{2437}} = 5069$ g

$M = 450.0$ $C_1 = (8.19 \text{ sec.}) = .00486$.

$C_2 = .501339$.

$\Phi_1 = \frac{\pi}{90} \times \frac{H}{m} \times \frac{C_1}{H^2}$.

$\Phi_2 = \text{"} \quad \text{"} \times \frac{C_2}{H^2}$

'b' ax. ver.- $\chi_1 - \chi_2 = \Phi_1 \times 355° = 4.89$ (4.9) (1)

'a' ax. ver.- 'b' ax. normal to field

$\chi_1 - \chi_3 = \Phi_2 \times 2226° = 8.46$ (8.5) (2)

(001) plane horiz.- 'b' ax. again normal to field

$\chi_2 - \chi_3 = \Phi_2 \times 956° = 3.63$ (3.6) (3)

(3.6)

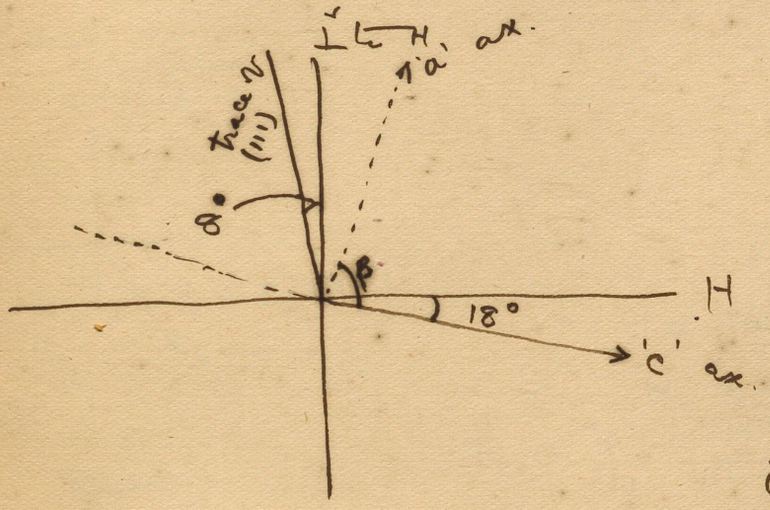
as against 3.57. from (1) and ~~(2)~~

(111)

$K_3 Al(C_2O_4)_3 \cdot 3H_2O$

Monocl. prism.

$a : b : c = 0.999 : 1 : 0.395$; $\beta = 92° 51'$



$\psi = +19°$ $\left(\frac{18+20}{2}\right)$

$H = 5069$ gauss

$c = .001339$

$m = .0481$

$M = 462.3$

$\Phi = \frac{\pi}{90} \times \frac{M}{m} \cdot \frac{c}{H^2}$

1) $\chi_1 - \chi_2 = \Phi \times 395° = 6.9$

2) (100) horizontal 'b' ax. normal to field

$\chi_1 \cos^2\psi + \chi_2 \sin^2\psi - \chi_3 = \Phi \times 707° = 12.4$ (2)

from which

$\chi_1 - \chi_2 = 6.9$

$\chi_1 - \chi_3 = 13.1$

$\psi = +19°$

3) 'c' ax. vert. 'b' ax. again normal to field

$\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = \Phi \times 392 = 6.9$ (3)

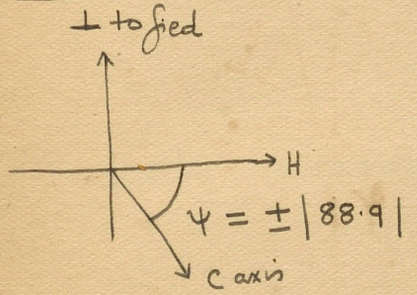
as against 6.9 calculated from (1) and (2).

$K_3 Fe(CN)_6$

M = ~~332·19~~ 329·18

Monocl. prism. $a : b : c = 1·2876 : 1 : 0·8012$ $\beta = 90°6'$

'b' axis vertical.



$\psi = \pm \begin{matrix} 89·0 \\ 88·8 \end{matrix}$

Adopt $\psi = \pm 88°9'$

$H = 1166$ gauss $\quad c = ·006103$

$m_1 = ·0596$ gm. $\quad m_2 = ·0311$ gm.

$\phi_i = \frac{\pi}{90} \times \frac{c.M}{H^2} \times \frac{1}{m_i} \qquad i = 1, 2.$

~~$\chi_1 - \chi_2$~~.

$\chi_1 - \chi_2 = \phi_1 \times 515$ at 31·8°C = 45~~1~~1 at 30°·0 C.

$= \phi_2 \times 269$ " 31·5 C = 45~~1~~1 " " "

Adopt $\chi_1 - \chi_2 = 45~~1~~1 \times 10^{-6}$ at 30°·0 C. ------- (1)

'c' axis vertical. 'b' axis normal to field.

$\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = \phi_1 \times 138$ at 31·8 C = 12~~1~~1 at 30°·0 C.

$= \phi_2 \times 73$ " 32 " = 123 " " " .

Adopt $\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = 12~~2~~1 \times 10^{-6}$ at 30°·0 C ------ (2)

(100) pl. horizontal. 'b' axis along field.

$\chi_3 - \chi_1 \cos^2\psi - \chi_2 \sin^2\psi = \phi_1 \times 372$ at 31·8 C = ~~327~~ 326 at 30° C.

$= \phi_2 \times 196$ " 32° C = 330 " " "

Adopt $\chi_3 - \chi_1 \cos^2\psi - \chi_2 \sin^2\psi = ~~327~~ 326 \times 10^{-6}$ at 30° C ------- (3).

From 1) 2) and 3) we have.

$$\chi_1 - \chi_2 = 455$$
$$\chi_1 - \chi_3 = 123$$
$$\psi = \pm 88^\circ.4$$

as compared to $\pm 88^\circ.9$

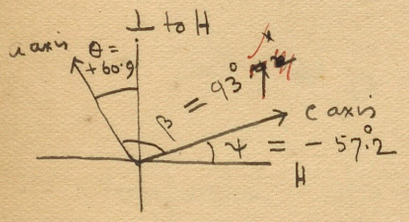
directly measured.

$(NH_4)_2Cr_2O_7$.

$M = 252.\cancel{68}\,1$.

Monoclinic. $a : b : c = 1.0271 : 1 : 1.7665$; $\beta = 93^\circ\ 42'$.

b axis vertical



$\theta = +60.8^\circ$
$\quad\ \ 60.9$

Adopt $\theta = +60.9$

$\therefore \psi = -57.2^\circ$.

$H_1 = 1419$ $\quad c_1 = .001429$ $\quad c_2 = .001429$.

$m_1 = .0756$ $\quad m_2 = .0219$, $\quad H_2 = 5102$

$$\chi_1 - \chi_2 = \frac{\pi}{90} \times 889 \times \frac{M.\ 001429}{5102^2} \cdot \frac{1}{.0219} = 19.6$$

Adopt $\chi_1 - \chi_2 = 19.6 \times 10^{-6}$ at $30^\circ C$. ..... (1)

a axis vertical. b axis ~~normal~~ along the field.

$$\chi_3 - \chi_1\cos^2\theta - \chi_2\sin^2\theta = \frac{\pi}{90} \times 88 \times \frac{M.\ 001429}{1419^2 \times .0756} = 7.3$$

Adopt $\chi_3 - \chi_1\cos^2\theta - \chi_2\sin^2\theta = 7.3 \times 10^{-6}$ at $30^\circ C$ ..... (2)

(001) plane horizontal. b axis normal to field.

$$\chi_1\sin^2\theta + \chi_2\cos^2\theta - \chi_3 = \frac{\pi}{90} \times 43 \times \frac{M \times .001429}{1419^2 \times .0756} = 3.6$$

Adopt $\chi_1\sin^2\theta + \chi_2\cos^2\theta - \chi_3 = 3.6 \times 10^{-6}$ ..... (3)

From (1) 2) and 3)

$$x_1 - x_2 = 19.6$$
$$x_1 - x_3 = 8.0$$

and $\theta = 61.7$ which corresponds to $\psi = -58.0$ as compared to -57.2 directly measured.

K_2CrO_4.

M = 194·2 ✓

Rhombic. $a:b:c = \cdot 5694 : 1 : 0\cdot 7298$.

a axis vertical. c axis along field.

H = 5102 c = ·001429.

$m_1 = \cdot 0320$ gm. $m_2 = \cdot 0541$ gm.

$$\phi_i = \frac{\pi}{90}\cdot\frac{CM}{H^2}\cdot\frac{1}{m_i} \; ; \; i = 1, 2.$$

$\chi_c - \chi_b = \phi_1 \times 83 = \cdot 965$ ✓ at 30·0 C.

$= \phi_2 \times 129 = \cdot 887$ ✓ " "

Adopt $\chi_c - \chi_b = \cdot 93 \times 10^{-6}$ ✓ at 30·0 C. ..... 1)

c axis vertical. b axis normal to field.

$\chi_a - \chi_b = \phi_1 \times 128 = 1\cdot 49$ ✓ at 30·0 C.

$= \phi_2 \times 220 = 1\cdot 51$ ✓ " "

Adopt $\chi_a - \chi_b = 1\cdot 5 \times 10^{-6}$ ✓ at 30·0 C. ..... 2)

b axis vertical. a axis along field.

$\chi_a - \chi_c = \phi_1 \times 52 = \cdot 604$ ✓ at 30° C.

$= \phi_2 \times 87 = \cdot 598$ ✓ " "

Adopt $\chi_a - \chi_c = \cdot 60 \times 10^{-6}$ ✓ at 30° C ..... 3)

From 1), 2) and 3) we have

$$\left.\begin{aligned} x_a - x_b &= 1.50 \\ x_a - x_c &= .60_1 \end{aligned}\right\|$$

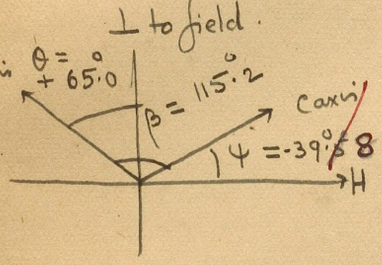
and calculated $x_a - x_b = 1.53$ as compared to

$x_a - x_b = 1.50$ directly measured.

$(NH_4)_2 Cr O_4$ $M = 152.08$

Monoclinic prism. $a : b : c = 1.9603 : 1 : 1.226$ $\beta = 115^\circ 13'$

b axis vertical.



$\theta_{measured} = +65.0$
64.9
Adopt $\theta = 65.0$

$\therefore \psi = -39^\circ.8$

$m_1 = .0238$ $m_2 = .0301$
$H_1 = 5102.$ $C_1 = \frac{\bar{2}.6757}{8.166^2}$
H_2 C_2

$\chi_1 - \chi_2 = \frac{\pi}{90} \times 442. \frac{M \times C_1}{m_1 H_1} = 2.7$ at $30^\circ C$.

$= \,,, \times 520. \frac{M \times C_1}{m_2 H_1} = 2.5$,, ,,

Adopt $\chi_1 - \chi_2 = 2.6 \times 10^{-6}$ at $30^\circ C$ ----------(1).

'a' axis vertical. 'b' axis along field.

$\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = \frac{\pi}{90} . 414 \times \frac{M \times C_1}{m_1 H_1} = 2.52$

Adopt $\chi_3 - \chi_1 \cos^2\theta - \chi_2 \sin^2\theta = 2.52$ at $30^\circ C$ ----(2).

(001) pl horizontal. b axis along field.

$\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = \frac{\pi}{90} \times 156 \times \frac{M \times C_1}{m_1 H_1} = .75 \cdot 95$

Adopt $\chi_3 - \chi_1 \sin^2\theta - \chi_2 \cos^2\theta = .75$ at $30^\circ C$ ----(3).

from 1), 2), and 3)

$$x_1 - x_2 = 2.6$$
$$x_1 - x_3 = -.394$$

and $\theta = 64.4$ which corresponds to $\psi = -39.0°$ as compared to $-39.8°$ directly measured.

$ErCl_3.6H_2O$.

381·7 ✓

M = 382·11

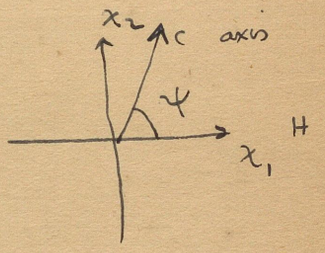
Monocl. a : b : c =

β = 98°5 (estimated under microscope) | vide – A. Pabst. Am. Jour. Sci. Vol-22 p. 427 (1931

m_1 = ·0242
m_2 = ·0121

$\varphi = \frac{\pi}{90} \cdot \frac{M.C}{H^2}$ Here C = 1·5128 / 5·05²
= ·01277
H = 1173

'b' axis vertical. $|\psi|$ = 64°·1, 64°·0 — 64°·1 adopt.



$\chi_1 - \chi_2 = \frac{\varphi}{m_1} \times 1687$ = 8620 ✓ at 31°5 C.

$= \frac{\varphi}{m_2} \times 846$ = 8650 ✓ at 31°4 C.

Adopt $\chi_1 - \chi_2$ = 8650 ✓ at 31°·0 C. (8650) ..... (1)

'c' axis vertical. 'b' axis normal to field.

$\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = \frac{\varphi}{m_1} \times 1155$ = 5900 at 31°2 C.

$= \frac{\varphi}{m_2} \times 575$ = 5870 at 31°1 C.

Adopt $\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3$ = 5900 ✓ at 31°·0 C. (5900) ..... (2)

'b' and 'c' axes horizontal. 'b' axis normal to field.

$\chi_1 \cos^2\psi + \chi_2 \sin^2\psi - \chi_3 = \frac{\varphi}{m_1} \times 128$ (124·7 corrected) = 637 = 655 at 31°2 C. ...

Adopt $\chi_1 \cos^2\psi + \chi_2 \sin^2\psi - \chi_3$ = 655 at 31°·0 C. ..... (3)

(640)

From 1) 2) and 3)

$$\left.\begin{aligned} \chi_1 - \chi_2 &= 8650 \\ \chi_1 - \chi_3 &= 7600 \end{aligned}\right\} \text{ at } 31.0^\circ \text{ C.}$$

~~and $|\psi| = 64.1^\circ$ which as cgm.~~

and $|\psi| = 63.8^\circ$ ✓ as against 64.1° ✓ directly measured.

M = 358.74 ✓

$NdCl_3 \cdot 6H_2O$.

Monocl.

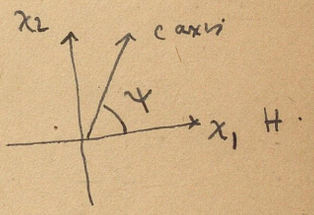
$m_1 = .1102$
$m_2 = .0559$
$m_3 = .0458$
$m_4 = .0981$

$\varphi_1 = \frac{\pi}{90} \cdot \frac{M \cdot C_1}{H^2}$
$\varphi_2 = \frac{\pi}{90} \cdot \frac{M \cdot C_2}{H^2}$

where $C_1 = .008610$
$C_2 = .008810$
and $H = 1173$.

'b' axis vertical.

$|\psi| = 78.5, 78.6, 78.7$ } adopt $|\psi| = 78.6$ ✓



$\chi_1 - \chi_2 = \frac{\varphi_1}{m_1} \times 1208 = 859$ ✓ at 26.4 C

$= \frac{\varphi_1}{m_4} \times 1084 = 866$ ✓ at 25.3 C.

$= \frac{\varphi_2}{m_3} \times \overset{489}{490} = 856$ at 25.6 C.

Adopt $\chi_1 - \chi_2 = 860$ ✓ at 26.0 C. ..... (1)

'c' axis vertical. 'b' axis normal to field.

$\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = \frac{\varphi_1}{m_1} \overset{(319)}{\times} 320 = 227$ ✓ ~~228~~ at 26.2 C.

$= \frac{\varphi_1}{m_2} \overset{(169.6)}{\times} 172 = 238$ ✓ ~~241~~ at 21.0 C

$= \frac{\varphi_2}{m_3} \overset{(127.6)}{\times} 131 = 224$ ~~229~~ at 26.0 C.

Adopt $\chi_1 \sin^2\psi + \chi_2 \cos^2\psi - \chi_3 = 230$ ✓ at 26.0 C. ..... (2)

'b' and 'c' axis horizontal. 'b' axis along the field.

$$\chi_3 - \chi_1\cos^2\psi - \chi_2\sin^2\psi = \frac{\varphi_1}{m_1} \times 788 = 560 \text{ at } 26.0^\circ C.$$

$$= \frac{\varphi_2}{m_3} \times \overset{320}{321} = 560 \text{ at } 26.0^\circ C.$$

Adopt $\chi_3 - \chi_1\cos^2\psi - \chi_2\sin^2\psi = 560$ at $26.0^\circ C$. ..... (3)

From 1) 2) and 3)

$$\left.\begin{aligned} \chi_1 - \chi_2 &= 860 \\ \chi_1 - \chi_3 &= 265 \end{aligned}\right\} \text{ at } 26.0^\circ C.$$

and $|\psi| = 78.4^\circ$ as against $|78.6^\circ|$ directly measured.

$M = 364.90$ ✓

$SmCl_3 . 6H_2O$

Monocl. $a : b : c = 1.4713 : 1 : 1.2182$

$\beta = 93^\circ 26'$ [A. Pabst Amer. Jour. Sci vol. 22. p. 426. (1931)]

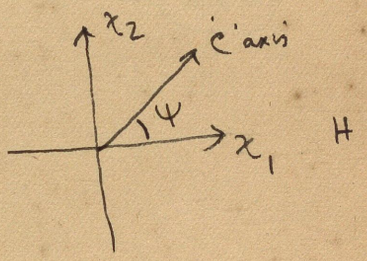
$m_1 = .0134$
$m_2 = .0110$
$m_3 = .0358$
$m_4 = .0205$

$$\varphi_1 = \frac{\pi}{90} \cdot \frac{M \cdot C_1}{H_1^2}$$

$$\varphi_2 = \frac{\pi}{90} \cdot \frac{M \cdot C_2}{H_2^2}$$

where $C_1 = .008610$; $C_2 = .001070$

$H_1 = 6096$; $H_2 = 1173$.



'b' axis vertical. $|\psi| = 59.1$, 59.0

Adopt $59^\circ.1$

$\chi_1 - \chi_2 = \frac{\varphi_1}{m_1} \times 1618 = 356$ ✓ at $24^\circ.0$ C

$= \frac{\varphi}{m_2} \times 1272 = 341$ ✓ " $30^\circ.0$ C.

Adopt $\chi_1 - \chi_2 =$ 342 ✓ at $30^\circ.0$ C ..... 340 ... (1)

'c' axis vertical. 'b' axis along field.

$\chi_3 - \chi_1 \sin^2\psi - \chi_2 \cos^2\psi = \frac{\varphi_2}{m_4} \times 88$ (88 − 4.9 = 83.1) $= 40$ ✓ at $30^\circ.1$ C

$= \frac{\varphi_2}{m_3} \times 154$ (154 − 2.3 = 151.7) $= 42$ at $30^\circ.0$ C

Adopt $\chi_3 - \chi_1 \sin^2\psi - \chi_2 \cos^2\psi =$ 42 at $30^\circ.0$ C . 42 ..... (2)

'b' and 'c' axis horizontal. 'b' axis along field.

$$\chi_3 - \chi_1 \cos^2\psi - \chi_2 \sin^2\psi = \frac{\varphi_2}{m_1} \times \overset{2\log.5}{271} = \overset{199}{\cancel{200}} \text{ at } 30^\circ.0\ C.$$

$$= \frac{\varphi_2}{m_3} \times \overset{723}{724} = 200 \text{ " } 30^\circ.0\ C.$$

Adopt $\chi_3 - \chi_1 \cos^2\psi - \chi_2 \sin^2\psi = 200$ at $30^\circ.0\ C$. 200 .. (3)

from 1), 2) and 3)

$$\left.\begin{aligned} \chi_1 - \chi_2 &= 340 \\ \chi_1 - \chi_3 &= 50\cancel{49.5} \\ \text{and } |\psi| &= 58^\circ.9 \end{aligned}\right\} \text{ at } 30^\circ.0\ C.$$

as against $59^\circ.1$ directly measured.

$Gd_2(SO_4)_3 \cdot 8H_2O$ $\quad M = 746{\cdot}11$

$a : b : c = 3{\cdot}009 : 1 : 2{\cdot}007$; $\beta = 118^\circ\ 2'$

'b' ax. vert $\quad \theta = +12^\circ{\cdot}5$; $\psi = +15^\circ{\cdot}5$

$\chi_1 - \chi_2 = 734$ at- $32^\circ{\cdot}5$ C

$= 747$ at- 30° C.

~~Accpt-~~ Accpt- $\chi_1 - \chi_2 = 750$ at- 30° C.

(001) pl. horiz. 'b' ax. sets along field

$\Delta\chi = 700$ at- $32^\circ{\cdot}5$ C $= 712$ at- 30° C.

accpt- $(\chi_3 - \chi_1) + (\chi_1 - \chi_2)\cos^2\theta = 710$ at- 30° C.

We thus obtain at- 30° C.

$\chi_1 - \chi_2 = \chi_3 - \chi_2 = 750$; $\psi = +15^\circ{\cdot}5$

The mean suscep. χ at $28^\circ{\cdot}0$ C was 70·5 per gm.

$= 52{,}600$.

Now the diamagnetic correctn = $3(SO_4^{--})$ 100·8

$8H_2O$ 103·5

$2Gd^{+++}$ 56

260

$\therefore \chi$ at- 30° C $= (52{,}600 + 260) \times \frac{301}{303} - 260$

$= 52{,}300$ ~~at~~ as would be experimentally observed at- 30°C.

This corresponds to 39·7 Weiss magnetons or 8·01 Bohr magnetons

Theoretical value $= \sqrt{63} = 7{\cdot}94$.

Cu, Ni and Pt derivatives of phthalocyanine — planar structure. obtained by x-ray analysis [see J. M. Robertson J.C.S. 1935, p. 615; Linstead and Dent, J.C.S. 1934, p 1016] would suggest a large paramagnetic anisotropy for the crystals with an axis of symmetry.

For other organic compounds of Cu having a planar structure see Cox and Webster, J.C.S 1935, p. 733.

Cryst. Structure of $Sm_2(SO_4)_3 \cdot 8H_2O$

See Zachariasen Chem. Phys. 3, 197, Mar 1935

Crystals obtained from S. Fried.

The Structure of Cs_3CoCl_5 (tetragonal)

X-ray analysis by H. M. Powell and A. F. Wells, J. C. S (1935) p. 359. + also of Rb_3CoCl_5 which is less stable.

Double magnesium nitrates of the Cerium Group.

$3\,Mg(NO_3)_2 \cdot 2\,M(NO_3)_3 \cdot 24\,H_2O$ $M = $ La, Ce, Nd, Pr. etc.

For analysis see J. Newton Friend and Norman Wheel-; J.C.S 1935 p. 356.

Ethyl sulphates of Rare Earths

$X_2(SO_4 \times C_2H_5)_6 \cdot 18H_2O$

X = Nd, Pr, Er etc. Hexagonal crystals.

R. A. Fereday and E. C. Wiersma, Physica, II (6) p. 575 (June 1935)

The data refer to 290° K.

X =	Mol. wt.	$(\chi_{\parallel} - \chi_{\perp}) \times 10^6$ per gm	$(\chi_{\parallel} - \chi_{\perp}) \times 10^{-6}$ per gm. molec = 2 × vols	Remarks, our values $\chi_{\parallel} - \chi_{\perp}$ at 30°C (303 K) =
Ce	1355	0·285	386	294
Nd	1363·4	0·571	778	600
Er	1410	2·13	+3003	−6590 ↔
Pr	1357	0·234	318	241

For absolute values of $\chi_{\parallel}$ for ethyl sulphates of Pr, Nd, Dy. and Er (~~Dy~~ optical methods) see J. Becquerel Physica, 3, 705 (1936). Le: 5, 857 (1938)