LEITZ Universal Rotating Stages and Accessories

11534-55

Universal rotating stage UT 4

The universal rotating stages are supplied in two designs which differ in the number of their axes or directions of rotation and have received their designations UT 4 and UT 5.

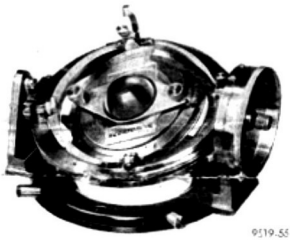
The number 4 or 5 signifies the number of axes. In conjunction with supplementary equipment, our rotating stages may be employed for index measurements of grains in accordance with various methods, e. g. the λ or λ_1 t variation, or, with the aid of the Waldmann holi w glass sphere, they may serve to carry out morphological and crystal-optical measurements on crystals.

For the optical nvestigation of crystals after the Fedorow method, the UT 4 and UT 5 stages fulfil all the requirements. The latter surpasses the former in that it allows of setting the seco d plane of symmetry immediately after the first one has been found, thus facilitating he measuring process.

All universal rotating stages have a practical device for exchanging and mounting the thin sections and allow of a simple and rapid adjustment of the section surface into the intersection of the axes of rotation. For the analysis of specimen structures it is advantageous to equip the stages UT 4 and UT 5 with the auxiliary angular slide (FEGFU) for parallel movement of the specimen which, however, necessitates a special mount of the upper segment (FEGSE).

For the demonstration of the principle underlying the construction and use of the universal rotating stages, indicatrix models of optically uniaxial and biaxial crystals can be accommodated on all types of UT-stages where they take the place of the inner stage plate.

The application of the universal rotating stage methods necessitates the use of special UM objectives which are corrected for a uniform working distance (1.5 mm.) in relation to the UT stage segment and supplied with built-in iris diaphragm. The objectives of higher numerical aperture, UM 20/0.33 and UM 32/0.30 call for a special condenser cap and are ideal for the determination of directions of reference in crystallographic work.



9519-55

Universal rotating stage UT 5 with centring base

Specifications

Universal rotating stage UT 5 (5 axes of rotation), on centring base, with pair of segments $n_D = 1.554$, in case	ICGLI
Universal rotating stage UT 4 (4 axes of rotation), on centring base, with pair of segments $n_D = 1.554$, in case	FEDRO
Interchangeable pair of segments $n_D = 1.554$ (as included above)	KOSID
Interchangeable pair of segments $n_D = 1.649$	FEGNO
Interchangeable pair of segments $n_D = 1.516$	FEGMA
Segments with other refractive index on request.	
For the analysis of structures of materials with the aid of the UT 4 or UT 5 stage the following is required:	
Schmidt parallel guiding slide with mm. scale, for systematically displacing the thin section under the segment	FEGFU
The Schmidt slide necessitates a modification to the normal mount of the upper segments, extra for each segment	FEGSE
For general examination of thin sections on the UT stage without upper segment:	
Auxiliary stage clip	FEKLE
If the universal rotating stages are to be used with the microscope ORTHOLUX-POL required:	
Intermediate slide with clamping screw for raising the microscope tube	POKUN

9508-55

Schmidt parallel slide

Objectives for universal stage methods

Built-in iris diaphragm, free working distance to top of segment 1.5 mm., magnification und aperture values apply to segment $n_D = 1.554$

UM 5/0.10	ICNXI
UM 10/0.22	ICOZI
UM 20/0.33	ICPBI
UM 32/0.30	ICQDI
Auxiliarly setting objective for adjustment of the A_4 axis	PEHOJ
Objective changing ring (required for each objective when the microscope to be used is equipped with an objective centring clutch)	PIZUT
Supplementary condenser for UM 20/0.33 and UM 32/0.30, taking the place of the normal swing-out condenser top	
(a) for UT 5	IITLC
(b) for UT 4	IITNG

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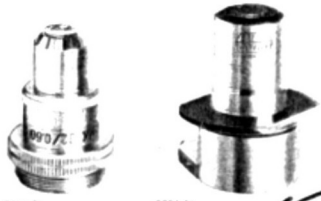
Auxiliary objective **Supplementary condenser**

LEITZ Universal Stage Conoscope



UMK objective

Condenser for universal stage conoscopy

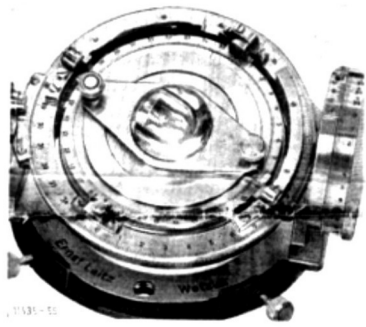
Upper segment for universal stage conoscope

Special equipment has been designed to supplement any model of the universal rotating stage for conoscopic work. The following items are required to build up a universal stage conoscope:

Condenser on dovetail slide with sleeve taking the polarizer (for use in place of the normal microscope condenser) and objective UMK 32/0.60	KOSOF
Upper segment with small hemisphere (11.5 mm. dia.) refractive index 1.516	KOREB
Upper segment with small hemisphere (11.5 mm. dia.) refractive index 1.554	KORIC
Upper segment with small hemisphere (11.5 mm. dia.) refractive index 1.649	KOROD
The lower segment is the same as that supplied for the UT stages:	
Lower segment with hemisphere 25 mm. dia., refractive index 1.516	KORUF
Lower segment with hemisphere 25 mm. dia., refractive index 1.554	KOSAP
Lower segment with hemisphere 25 mm. dia., refractive index 1.649	KOSEC
Objective UMK 32/0.60	IIWUS
Objective UMK 50/0.60	PEHIH
(Special system for the conoscopic examination of small objects)	

The Waldmann Hollow Glass Sphere

The Waldmann hollow glass sphere



The Waldmann hollow glass sphere in position on the UT 4 stage. Case with all the accessories at the right

This accessory to the universal rotating stages which can be mounted on our polarizing microscopes is for the morphological and crystal-optical examination of crystals ranging in diameter from 1 to 11 mm. It consists of a hollow sphere of optical glass, 27 mm. in diameter and with a 12 mm. bore. The space inside this sphere is filled up free from air bubbles with a suitable immersion fluid. The closure cap, with the object holder in place, seals the sphere without extending beyond its surface at any point. This renders the sphere capable of being turned under the microscope without limination in every direction.

Advantages of the hollow glass sphere:

- *Transparent crystals up to the stated maximum size can easily be brought into the centre of the sphere, where they can be examined without the risk of damage, and without preparatory measures.*
- *In the examination of thin sections, as has hitherto been customary, an initial position unfavourable for many components of the section is given by the plane of the section. By contrast, the sphere with its unlimited range of rotation allows a favourable initial position of the grain to be chosen, in addition to which the object can also be transposed on its holder.*
- *The angular space remaining accessible for observation in a plane of symmetry of the cap (about 26°), is considerably larger than in ordinary segments, in which a spherical belt of less than 90° only can be fully utilized for transmitted light microscopy.*
- *The conoscopic examination method can also be employed at any time.*

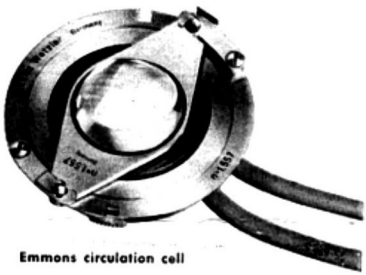
Left: closure cap with fixed glass pin
Centre: closure cap with radially movable glass pin
Right: closure cap with cross pincers

Three different types of closure caps are available for the Waldmann hollow glass sphere:

1. Closure cap with fixed glass pin on which the object to be examined is cemented.
2. Closure cap with radially movable glass pin allowing the object to be brought into the centre of the hollow sphere.
3. Closure cap with cross pincers for crystals of 5 – 11 mm. dia. The pincers are opened and closed by means of a key.

Specification:

Waldmann hollow glass sphere, with tongs, adapter ring, and holder for use on UT stage, key for vertical adjustment of closure caps. 2 wooden rings as supports for the sphere, centring gauge, and 3 closure caps, in case IIRUX

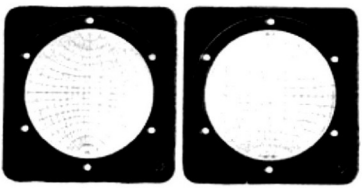


Emmons circulation cell

Emmons Circulation Cell

This supplementary equipment is primarily offered for the determination of refractive indices after the double variation method (λ, t method as described by Emmons).
The equipment consists of a special lower segment for UT stages and a circulation cell surrounding this segment for varying the temperature. A thermostat is also provided for the purpose. For λ variation when carrying out the λ method the linear mirror monochromator must be employed.

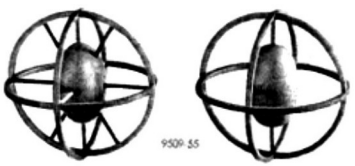
Lower segment with circulation cell, in case PEJAG



Angle-true net ruling **Surface-true net ruling**

Accessories for Universal Stage Methods

For the evaluation of the measurements obtained with the aid of the universal stages the following accessories are available:
Angle-true stereographic net ruling (according to Wulff) with rotating device (according to M. Reinhard) for the tracing paper IVWXI
Angle-true stereographic net ruling, single sheet IZWLI
Surface-true net ruling (according to Lambert) with rotating device (according to M. Reinhard) for the tracing paper IVXZI
Surface-true net ruling, single sheet IZMYI
For the demonstration and explanation of the universal stage methods and the operations involved we supply, as suggested by M. Reinhard, the following indicatrix model of crystals which are accommodated on the universal stage after the stage inset has been removed:
Indicatrix model of an optically biaxial crystal ICSHI
Indicatrix model of an optically uniaxial crystal ICTKI



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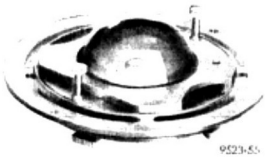
Indicatrix model of an optically biaxial crystal **Indicatrix model of an optically uniaxial crystal**



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Auxiliary arrangement INDEX

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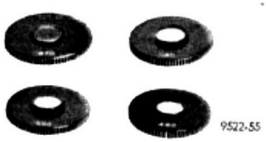
Heating ring for the hemisphere



9522-55

Colour filter

Plano-parallel cover plates

9522 55

special eyepiece INDEX 8 x

Universal Stage Refractometer

This equipment, also known as the Berek microscope refractometer, is designed for the determination of the refractive index of grain preparations after the embedding method and with the aid of a universal stage.
The refractive index of the immersion is adapted to that of the grain by varying the temperature. After a changeover from transmitted to diffused incident light the refractive index results from the setting of total reflection on the UT-stage.

Specification:

Auxiliary arrangement INDEX comprising a lower segment, upper hemisphere with cavity and 3 plano-parallel cover plates, heating ring for the hemisphere with connecting cable, regulating transformer type RT 35 for 110/220 volts a. c.	IDCBI
Special eyepiece INDEX 8x (30 mm. dia.) with cross lines in helical focusing mount and adjustable eyelens	IDEFI
Objective UM 20/0.33	ICPBI
Illuminating stand with opal glass plate and tubular lamp 25 watts for direct mains connection*, fitting to the microscope foot	PEJEH

When using a filament lamp as source of light one of the following filters must be placed on the INDEX eyepiece or the top analyser:

Orange filter	IDKQI
Colour filter 670	IDESI
Colour filter 550	IDUMI
Colour filter 480	IDNWI

*) please specify mains voltage when ordering

Design subject to alterations without notice

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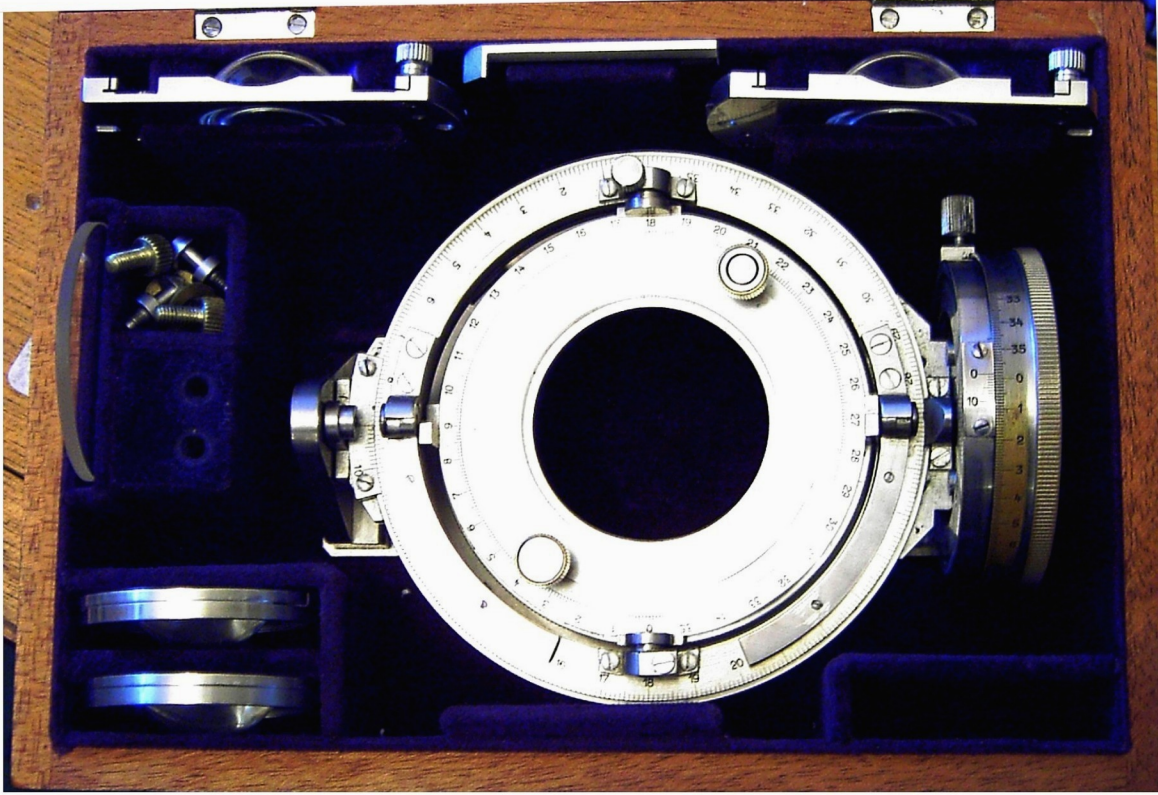


Leitz

Procedure for Examinations with the Universal Rotating Stage

I. Preparations

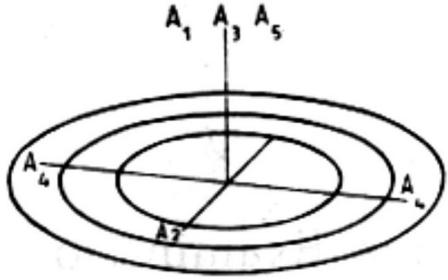
1. (a) Crossing the Nicols.
   (b) Centring the objectives.

2. Estimation of the approximate degree of light refraction of the mineral to be examined as compared with Canada balsam, to permit correct selection of the appropriate segment.

3. Secure the object slide (with the rock section on top) and the spherical segments on the universal rotating stage. The object slide should be between 0.9 and 1.1 mm. thick. A little immersion oil is applied to the lower surface of the object slide and to the cover glass of the specimen; the slide is then placed on the glass plate, which rests loosely in the U-stage, in such a manner that it lies at right angles to the line connecting the two screws fastening the upper segment; these two screws press the upper segment onto the specimen with an elastic pressure. The fastening screw marked with a ring can be screwed in beforehand. The upper segment, which is designed with a corresponding slot in its mounting, is pushed under the spring-mounted socket of the screw, and is finally screwed tight with the second screw. In order to be able to remove the specimen and the upper segment conveniently, this screw is removed, and the screw marked with a ring is then loosened. A little immersion oil is also applied to the lower segment; it is then pressed against the glass plate from beneath, and is held in this position by adhesion.

4. There are 5 different axes of rotation; their varying nomenclature in the literature is listed below. Berek's nomenclature of the axes, i. e. A_1, A_2, A_3, A_4, A_5 corresponds to the sequence of the required operations, from the centre outwards. A_1, A_3 and A_5 (odd indices) are vertical axes of rotation, while A_2 and A_4 (even indices) are horizontal.

Cf. M. Berek „Neue Wege zur Universalmethode" (New Applications of the Universal Method) N. Jb. Mineral. Vol. 48 (1923), pp. 34–62.



Berek (1924)	Nomenclature according to Nikitin-Duparc-Reinhard	(1931) Reinhard	R. C. Emmons
A_1	N (normal axis)	N ( )	I. V.
A_2	H (horizontal axis)	H ( )	N–S
A_3	M (mobile axis)	A (auxiliary axis)	O. V.
A_4	I (immobile axis)	K (control axis)	O. E–W
A_5		M (Microscope axis)	M

5. **Assembly and adjustment of the U-stage on the object stage of the microscope.**

(a) Remove ring plate from the object stage.

(b) Fasten universal rotating stage to the object stage with two screws, so that the graduated drum of the A_4 axis is on the right.

(c) Lock A_3; lock A_2 and A_4 at index "0".
(The centring of the objective used can also be carried out at this point by rotating on axis A_5 and observing the specimen).

(d) Adjusting the A_1 or A_3 axis. Rotate on axis A_1 or A_3. If the axis of rotating of the specimen does not coincide with the point of intersection of the cross-lines, then the two screws securing the U-stage are loosened, and the latter is repositioned accordingly. Centring is correct if the axis of rotation of the specimen still coincides with the point of intersection of the cross-lines on rotating on axis A_5, or A_1 and A_3 respectively. The A_4 axis is now adjusted parallel to the horizontal line of the cross-lines of the eyepiece.

(e) Focus the microscope on the surface of the upper segment. Set the index of A_3 to 270°. Rotate on A_4 and observe whether the dust particles on the surface of the upper segment move exactly parallel to the vertical line of the eyepiece cross-lines; if not, rotate on A_5 until the required effect is achieved. This adjustment must be carried out carefully. The final position of A_5 is the zero position of A_5. Lock, and note down this position.

(f) Turn all axes to the normal position and lock.
$A_1 : 0$ $A_2 : 0$ $A_3 : 270$ (or 90) $A_4 : 0$
A_5 : zero position as determined above.

(g) Adjusting the vertical position of the specimen.
Rotate on A_4 in both directions from the zero position. If on doing so, the plane of the specimen appears to move above the horizontal line of the cross-lines, then the plane of the specimen lies under the axis A_4, and must be raised. This is done with the aid of the ring fitted with four notches, which is located under the centre of the stage; this ring is turned in a clockwise direction, holding the screws securing the upper segment in position at the same time, until the axis A_4 finally lies in the plane of the specimen. Conversely it is also possible to hold the notches in position, and to rotate on A_1.

(h) Close the objective iris diaphragm. Focus the Bertrand lens on same and centre. Centre source of light to the objective iris diaphragm.

(i) For the graphic evaluation of the results of the measurements, we supply **angle-true** (stereographic, Wulff's, Reinhard's) and **surface-true** (Lambert's, Schmidt's) net rulings with a revolving device after M. Reinhard.

(k) It should be noted that when using the Wulff's net ruling, the index of the A_2 axis lies at 270°, where it normally remains arrested, since the graduation of the net ruling is usually marked from the top (North) with 0 : 360°, and lies correspondingly at 270° analogous as with the U-stage.

6. In the 5-axis universal rotating stage, an additional horizontal axis has been introduced between axes A_2 and A_3, and lies vertical to A_2. This axis, which bears the designation A'_2 and has its angle graduation on adjustable arcs, facilitates determination of the position of the indicatrix in the crystal. The advantages of the 5-axis stage in determining the second and third planes of symmetry are described in detail in the book by Rinne-Berek: „Anleitung zu optischen Untersuchungen mit dem Polarisationsmikroskop" (Instructions for Optical Examinations with the Polarizing Microscope), Stuttgart 1953, p. 279.

II. Basic Procedure for Examinations*

Introductory Remarks: Check the centration of the source of light at frequent intervals with the Bertrand lens.

Check the position of axis A_2 frequently with the auxiliary circles.

If the adjustments are disturbed by pronounced dispersion, use a good orange or red filter.

If necessary, use an eyepiece with iris diaphragm and cross-lines.

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* For the first exercises it is advisable to use rock sections orientated vertically to an optical symmetry axis, and to start accordingly with II, 5.

1. **Finding the plane of symmetry.**

   (a) Rotate on A_1 until extinction.

   (b) Test whether on rotating on A_4, extinction is retained.
   Likewise for the other position of extinction.
   For the further operations, use the position with optimum extinction.

   (c) Alternating inclination on A_2 and restoration of extinction through turning on A_1 until extinction is retained on turning on A_4.

   (d) Take readings of the co-ordinates α'_1 and α'_2 (α'_2 is positive if read on the right auxiliary circle, and negative if read on the left).

2. **Finding a second plane of symmetry.**

   (a) Axes A_2 and A_4 in the normal position.

   (b) Index of A_1 at α'_1 —90, if α'_2 positive
   „ α'_1 +90, if α'_2 negative.

   (c) *either:* rotate $A_1 \leftarrow$ to the left and lower A_2 to the left until extinction is reached,
   or: rotate $A_1 \rightarrow$ to the right and lower A_2 to the right until extinction is reached. The smaller / α'_2 /, the smaller should be the rotations on A_1, and incline primarily on A_2 only.
   Continued checking of the extinction by inclining on A_4.
   Take readings of the final co-ordinates α''_1 and α''_2.

3. **Determining the co-ordinates of a symmetry axis.**
   Either: with the aid of Wulff's net ruling.

   (a) Mark the North pole on an auxiliary sheet (tracing paper).

   (b) Mark the angles α'_1 and α''_1 on the outer circle in an anticlockwise direction from the North pole: points P'_1 and P''_1.

   (c) Rotate the auxiliary sheet until P'_1 coincides with the North pole of the net ruling; mark the angle α'_2 at the equator from the centre (to the right if α'_2 is positive, or to the left if α'_2 is negative): point P'_2.
   Repetition of the same procedure for the point P''_1, α''_2 gives point P'_2.

   (d) Mark the point of intersection of the two great circles determined by P'_1 P'_2 and P''_1 P''_2.

   (e) Rotate the auxiliary sheet to the right $\rightarrow$ until S falls on the equator; read the angle of rotation from the North pole on the outer circle: $\bar{\alpha}_1$. Read the inclination of S towards the centre: $\bar{\alpha}_2$ (positive on the right half, negative on the left).
   Or: by calculation with a slide rule.

   (a) $$\tan(\alpha'_1 - \bar{\alpha}_1) = \frac{1}{\sin(\alpha'_1 - \alpha''_1)} \frac{\tan \alpha''_2}{\tan \alpha'_2} - \operatorname{cotan}(\alpha'_1 - \alpha''_1).$$

   (b) Thus giving $\bar{\alpha}_1$.

(c) $\tan \alpha_2 = \frac{\tan \alpha'_2}{\cos (\alpha'_1 = \alpha_1)}$ The signs demand special attention!

α_1 and α_2 are the co-ordinates of a symmetry axis.

4. **Setting a symmetry axis in the direction of observation.**
   Set index A_1 at α_1, index A_2 at α_2, index A_4 at 0.
   Test: After rotating on A_3 in each of the two positions of extinction, the extinction must be retained on inclining on A_4.

5. **Determining the characteristic angle of extinction.**

   (a) Set axis A_4 at 0.

   (b) Rotate on A_3 in the diagonal position.

   (c) Determination of the character of the direction of oscillation SW–NE with gypsum red of the first order, with marked refraction with a quartz wedge or a compensator; note down the results.

   (d) Rotate on A_3 clockwise until first extinction; repeat four times; as accurately as possible: average of the readings α_3.

   (e) Set A_3 at index $\alpha_3 + 45°$.

   (f) Set A_4 at the value $\pm 54.7°$.
   With considerable differences in the light refraction of the mineral (n) and that of the segment (n'), A_4 should be set to the value $\frac{n}{n'}$ 54.7.

   (g) Rotate on A_5 anticlockwise until first extinction; repeat four times; as accurately as possible: average of the readings α_5.

   (h) Characteristic angle of extinction:
   φ = zero position of $A_5 - \alpha_5$.

6. **Determining the optical characteristic.**

   (a) True angle of the optical axes: Determine φ in the standard diagram, read 2 V.

   (b) Character of double refraction: upper sign in the diagram, if in 5c the character of the direction of oscillation was determined as being SW–NE: c (k), but the lower sign if the character determined was a (g).

   (c) Orientate the 1st and 2nd centre lines in relation to the symmetry axis as set according to 4. above, as shown in the diagram. Accurate specification of the position of the centre lines in relation to the rock section normal by means of the angle α_2, and in relation to edges, cleavages, and the border lines of twinnings in the specimen by means of the angle α_1.

7. **Repetition of the determinations (5 and 6 above) in a special diagram.**

   (a) Selection of the test conditions $\bar{\varphi}$ and χ as functions of the angle φ in 5 h:

φ	$\bar{\varphi}$	χ	φ	$\bar{\varphi}$	χ
0 — 2	100	10	88 — 90	10	10
1 — 6	100	20	84 — 89	10	20
5 — 15	100	35	75 — 85	10	35
10 — 23	100	50	67 — 80	10	50
20 — 28	100	65	62 — 70	10	65
27 — 33	105	65	57 — 63	15	65
32 — 37	115	65	53 — 58	25	65
35 — 45	130	65	45 — 55	40	65

(b) Set A_3 at $a_2 + \bar{\varphi}$ (a_3: average from 5 d).

(c) Set A_4 to the value $\pm \chi$ or $\pm \frac{n}{n'} \cdot \chi$.

(d) Rotate on A_5 anticlockwise until first extinction; repeat four times; average a_5.

(e) Extinction angle φ = zero position of $A_5 - a_5$.

(f) Read 2 V from the special diagram. The cases in the same horizontal row of the table (a) above require the same diagram. The construction data for these are given on page 39 of the original paper.

Besides polished thin sections, individual mineral grains or crystals can be examined with the U-stage (see literature under Dimler-Stahmann).

With the method of H. Waldmann, the segments are replaced with a hollow glass sphere, in which grains of 1–11 mm. diameter can be measured morphologically and crystal-optically.

For **examinations in incident light, the UTR 2** is available.

The following **literature** will facilitate introduction to the universal rotating stage methods, or give instructions for carrying out special examinations.

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