ZEISS

Micro-spectroscope

and the

6×4 1/2 cm. Camera Attachment

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Mikro 125

ZEISS

Micro-spectroscope

(ABBE-Micro-spectroscopic eyepiece with wave-length scale)

and the

6×4½ cm. Camera Attachment

for use with the Micro-spectroscope.

The **Micro Spectroscope** here described has, in addition to a comparison prism a mechanism for shortening the height of the spectrum, a device which furnishes a **direct reading of the wave-length** on a scale in any part of the spectrum. It provides accordingly a means of obtaining generally applicable and comparable data. The scale comprises the range of the visible spectrum from 0.40 to 0.70 μ. It is carried down to the units of the second decimal (0.01 μ). The tenths of this unit may be estimated.

Another feature of this design is that the Amici prism is distinct from the eyepiece. It has the advantage that it provides a convenient means of passing from direct ocular observation to that with spectroscopically decomposed light.

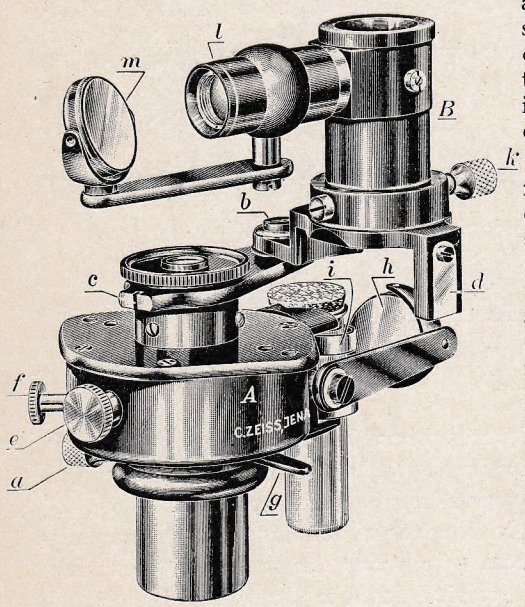
Lithographed blancs, upon which a wave-length scale magnified to a length of 100 mm. is drawn ten times, are supplied for recording observations made with the apparatus.

The micro-spectroscopic eyepiece is shown in Fig. 1. The lower exposed sleeve slips into the tube of the microscope and is clamped in position by means of the screw *a*, so as to prevent the instrument from turning during observation. The sleeve tube contains the field lens of the eyepiece.

The shallow drum *A* above it contains the slit mechanism, the comparison prism and the movable jaws by which the height of the slit can be varied.

Above the drum is closed by the achromatic eye-lens of the eyepiece, which is movable along the direction of the axis.

The eyepiece is surmounted by the sleeve *B* with the Amici prism and the scale tube with the wave-length scale. This sleeve can be swung aside about the pin *b* according to requirement, or retained in its central position above the eyepiece. The figure shows the notch *c* in which the point of the spring catch *d* engages when the upper hinged portion is swung into its central position above the eyepiece.



13087 Fig. 1

The slit jaws are symmetrically movable either way. **The rotation of the milled head** *e* **serves to set the slit wide or narrow.** The slit mechanism is carried on a slider with two openings arranged side by side, the slit being situated above one of these openings. The slider may be pushed to one side by turning back the screw *e*, so as to bring the other opening into the path of the rays. In this position of the slider, with the comparison prism and the Amici prism swung out of the axis, the preparation may be focused and viewed as in the ordinary microscope.

One half of the slit, and accordingly the **height of the spectrum,** may be limited by a diaphragm. The latter is actuated by means of the screw *f*.

The small **comparison prism** contained within the drum may be swung **in front** of the other **half of the slit** by means of the lever *g*. The prism covers this half of the slit completely and cuts off the access through it of any light from below through the microscope tube, while light emanating from an object at the side can enter through this slit half. This arrangement affords therefore a means of placing side by side and comparing the spectra of two different substances.

The comparison prism receives light reflected at the mirror *h* through a lateral opening in the drum *A*. In front of the opening (which does not

appear in the figure) the drum is fitted with a small stage with spring clips *i*. This stage serves for the attachment of preparations, the spectrum of which it is proposed, to view with the aid of the comparison prism. These preparations may be in the nature of liquids. The latter are contained in small tubes held in position in front of the opening with the aid of the clips *i*. The instrument is supplied with six of these small tubes for the reception of fluids to be compared.

The screw *k* serves for the adjustment of the **AMICI prism** and the **wave-length scale.** The latter is fixed at the outer end of the elbow tube *l*. It is illuminated by the upper mirror *m*. The tube *l* moves upon another tube which carries a projection lens. This forms an image of the scale, which in its turn is projected into the eye after reflection at the oblique upper surface of the AMICI prism. The scale may be sharply focused by the displacement of the small tube *l*. The adjustment with the aid of the screw *k* before making an observation should be obtained by turning the screw until the sodium line (the Fraunhofer line *D*) reads 0.589 on the scale. At the same time the scale should be turned that the spectrum lines may appear parallel to the lines of the wave-length scale.

When observing with the micro-spectroscopic eyepiece it is important to note that **the slit** (or the spectrum lines) **and the scale may appear sharply defined at the same time,** and that the image of the object may be in the plane of the slit. This may be achieved in the following manner. Lift the spectroscopic eyepiece out of its case[1]) and insert it in the tube of the microscope in the place of the eyepiece, as explained above. Then, setting the slit as narrow as possible, illuminate it from below through the microscope tube or from the side with the aid of the comparison prism with sunlight or with monochromatic light and, after swinging aside the upper portion *B*, view the bright image of the slit directly through the upper lens of the eyepiece. Set the eye-lens so that the slit may appear sharply defined. Then swing the upper fitting *B* with the AMICI prism into position and, looking through the AMICI prism, see whether the FRAUNHOFER lines or the brightly illuminated monochromatic slit images are still clearly defined. If need be, apply the small necessary readjustment to the eye-lens. Next displace the sleeve of the slit tube until the lines of the scale likewise appear sharply defined without any parallax with respect to the spectrum lines. This will ensure the slit and the scale appearing **sharply defined at the same time.**

Now, place the preparation upon the object stage, fold the AMICI prism aside, illuminate with the microscope lamp, withdraw the plate with the slit from the eyepiece and without displacing the eye-lens, focus the preparation. After moving the slit-plate into position and swinging in the AMICI prism the instrument will be ready for making a spectroscopic examination of the object.

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[1]) When removing the instrument for the first time, note carefully its position in the case. Before replacing it, note in particular that the arm which carries the mirror *h* requires to be folded back.

The micro-spectroscopic eyepiece serves for the **qualitative observation**

a) **of the absorption spectra**

(1) of uniformly coloured objects devoid of morphological structure (e. g. solutions of vegetable or animal dye stuffs, coloured glass, light filters, etc.);

(2) of substances which appear evenly distributed in cells or liquids (e. g. in leaves and in blood);

(3) of scattered particles or corpuscles with coloured contents;

b) **of the emission spectra** of sources of light, especially of those employed in microscopy.

The spectra may be viewed independently or they may be directly compared with those of like substances by attaching these substances at the side of the eyepiece and projecting their spectrum through the comparison prism into the field of view.

Observation falling under the headings (1) and (2) are preferably made without an objective or with a long-focus lens of large aperture, such as the objective **6** (0,17). When observing objects as defined under (2) the structure of the body should not be sharply focused with the objective, as this would cause the spectrum to be disrupted by lines. In the case of objects of the nature defined under (3), however, a sharp image should be formed upon the slit by a suitable objective (e. g. **6** [0,17] or **10** [0,30]). The slit should then be reduced in height as much as possible, until it appears completely covered by the image of the object. Failing this, the preparation should be displaced so that at least the upper or lower boundary of the object may be excluded by the slit. The slit should moreover be set sufficiently narrow that the image of the particle may completely fill its width. Should thereby the intensity be rendered insufficient the only correct remedy will be to employ a more intense source of light.

Apart from the above, the micro-spectroscopic eyepiece can be employed for the **analysis of mixed colours,** including those due to interference. In these observations the usual arrangements for producing interference should be retained, excepting that the eyepiece should be replaced by the micro-spectroscopic eyepiece. If the phenomena in question can only be perceived in polarised light the micro-spectroscopic eyepiece may be surmounted by an analyser.

Literature.

A. Tschirch, Einige praktische Ergebnisse meiner Untersuchungen über das Chlorophyll der Pflanzen. Archiv d. Pharmacie, 9, 129—146, 1884.

6×4½ cm. Camera Attachment

for use with the Micro-spectroscope, which enables the visible spectra to be retained photographically.

1. Uses

The 6×4½ cm. Camera and the micro-spectroscope combined form a very handy micro-spectrograph which is available for a great variety of purposes. It constitutes a necessary supplement to the ABBE micro-spectroscope and serves for photogrammetrically recording any of the **absorption and emission spectra** referred to on page 4, also for measuring the thickness of silver coatings by the method of Prof. BORN, of Göttingen, by determining the displacement of interference bands within the spectrum.

2. Components of the Apparatus

The principal component parts of the apparatus are the following (figs. 2 and 3):

The foot *F* with the attaching screw *b*,

The correction mount *L* containing the optical combination,

The shutter *C* with the wire release, which should be screwed in at *c*,

The direct-vision AMICI prism mounted in position at *P*,

The camera with fittings for the drop-on dark slide (Fig. 2).

The dark slide is inclined at a certain angle to the normal of the centre line of the apparatus, since the intercept of the rays increases with the wavelength, so that the sharply defined image of a red spectrum line is farther away from the image-forming lens than that of a violet line. The obliquity of the dark slide in conjunction with the corresponding inclination of the lens ensures a uniformly sharp definition throughout the entire extent of the visible spectrum (400 to 750 mμ).

For the attachment of the spectroscopic camera the spectroscope is fitted with the split flange *a*. Where (in an older model) this happens to be absent the micro-spectroscope requires to be sent to the works for adding and adapting this flange fitting to the camera.

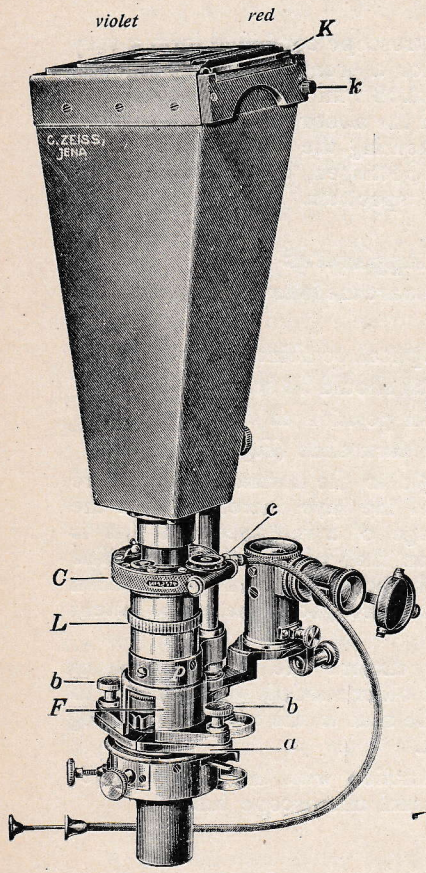
The spectroscope camera is used in conjunction with the ABBE micro-spectroscope, which attaches to any of the usual microscope tubes.

3. Directions

Having identified with the micro-spectroscope all the features of the spectrum which are to be photographed, fold aside the AMICI prism of the micro-spectroscope and place upon the eyepiece a small telescope (astronomical or terrestrial, e. g. the 'Tellup', as specified on p. 8). At the outset this should be sharply focused upon an object at least 50 yds. away. Then displace the eyepiece until the slit of the micro-spectroscope appears sharply defined through the telescope. The eyepiece will then be

sharply focused for "infinity". Remove the telescope and carefully, so as not to disturb the position of the eyepiece, place the camera upon the flange a and fix it in position with the aid of the screws b (Fig. 3).

Insert the clear glass screen into the dark slide bearing K, pressing to this end the button *k* to the left. Then open the shutter and with the aid of a magnifier examine the image of the spectrum which appears on



8420 Fig. 2

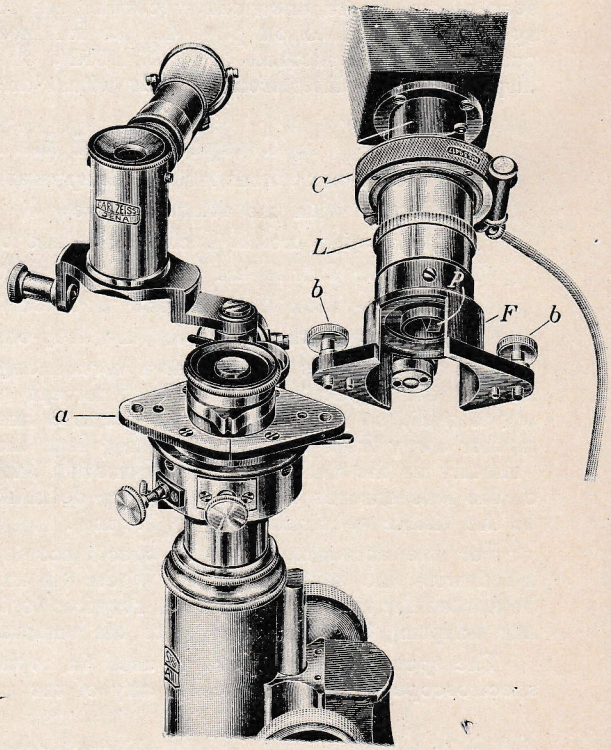


Fig. 3 8417

the lower surface of the clear glass screen. Small improvements in the sharpness of the image may be effected by carefully moving the eyepiece through the excision in the foot of the camera, whilst the final adjustments are made by turning the collar of the correction mount, which causes the image-forming lens to be displaced. In most cases the original setting of the eyepiece to infinity will suffice to obtain sharply defined spectrum lines.

Close the shutter, place the dark slide in position and open it, after which the camera will be ready for use.

For the purpose of ascertaining the correct time of exposure suited to the various spectrum colours and the different kinds of plates it will be found an advantage to employ a Goldberg wedge with its declivity set parallel to the direction of the slit.

As with visual observations, photographs, as referred to in par. 1, 2 and *b* on p. 4. are preferably taken without an objective or at least with an objective having a long focus. In cases of the nature of Example No. 3 the object requires to be sharply projected upon the slit, and the length and width of the slit should be so arranged that the object may completely fill the slit opening.

When it is required to take two photographs on one plate the comparison prism of the micro-spectroscope should be brought into operation in the first exposure and the slit opened to its full width, and in the second the slit should be contracted as much as possible and the comparison prism folded back.

4. Evaluation of wave-lengths

For the evaluation of the photographed spectrum it is advisable to prepare a dispersion curve of the spectrum chamber. To this end photograph a known spectrum containing a large number of lines. Choose a well marked line situated near the edge of the plate as your initial line and plot the distances from this line as abscissae and the corresponding wave-lengths as ordinates. This will furnish a continuous curve giving the wave-length of a spectrum line as a function of its position on the plate.

A good method is to photograph at the side of the spectrum which is to be studied, in the manner explained above, or above it, a known comparison spectrum, such as lines of a mercury vapour lamp. This furnishes the requisite data for the evaluation. The measurement may be made with sufficient exactness with the aid of a half-millimetre glass scale and the magnifier.

The plate appended to this pamphlet furnishes a few photographic specimens.

Example No. 1:

Solar spectrum and spectrum of mercury vapour lamp placed side by side on one plate.

This photogram served to provide a dispersion curve of the spectrum chamber. The violet line of wave-length 405 mμ of the mercury vapour lamp was taken as the initial line.

The following are the numbers found, from which it is easy to reproduce the curve on squared millimetre paper.

Having prepared such a curve it is only necessary to measure the distance of a spectrum band from a known line in order to find the corresponding wave-length.

Spectrum line		W. L. in mμ	Abscissa in cm	Ordinate in cm.
Hg	violet	405	0.0	0.5
"	"	407	2.0	0.7
Sun	G	431	13.6	3.1
"	G¹	433	14.4	3.3
Hg	blue	436	15.8	3.6
Sun	F	486	31.6	8.6
"	b	517	38.2	11.7
"	E	527	40.0	12.7
Hg	green	546	43.2	14.6
"	yellow	579	47.6	17.9
Sun	D	589	48.8	18.9
"	C	656	54.7	25.6
"	B	687	56.6	28.7

Example No. 2:
Photogram of spectrum taken with Goldberg wedge: Spectrum of Beck Copper-carbon arc lamp.

The density limits of the greys and blacks furnish the sensibility curve of the plate with respect to the various spectrum colours.

Example No. 3:
Wedge photogram of a striking filter spectrum with two transparency maxima. The lines of the mercury vapour lamp photographed above serve as a comparison spectrum.

Example No. 4:
Wedge photogram of a filter spectrum with two distinct transparency regions.

Example No. 5:
Thickness of a film of silver measured by determining the displacement of the interference bands in the spectrum. Particulars under the photogram.

No.	Designation	Codeword
12 81 30	ABBE **Microspectroscopic Eyepiece**, in case . .	*Micidiare*
12 81 35	**6 × 4.5 cm. Spectroscopic Camera**, incl. instantaneous shutter with release, two 6×4.5cm. dark slides, Goldberg wedge with frame, clear glass plate and focusing lens, in case	*Mimoseasse*
—	**Small 'Tellup' Telescope**, available for use as a pocket telescope and magnifier. Magnification when used as a telescope 2.5×, as a magnifier 6×	*Medvexatum*
12 64 54	**Glass Rule**, 10 cm. divided into half millimetres	*Miltonie*
12 58 11	**Magnifier Stand II**, without magnifier and without magnifier ring	*Micuissent*
11 63 01	**Magnifier Ring** to the Winkel reading magnifier	*Mictus*
—	**Reading magnifier** (large BRÜCKE magnifier as made by Messrs. R. WINKEL)	*Mintrire*

The illustrations do not necessarily conform in every detail to the actual design.

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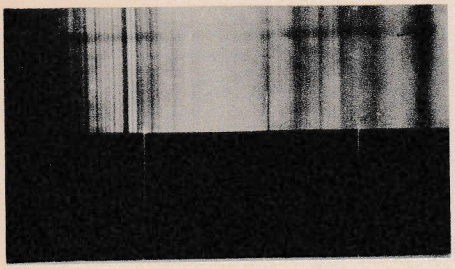
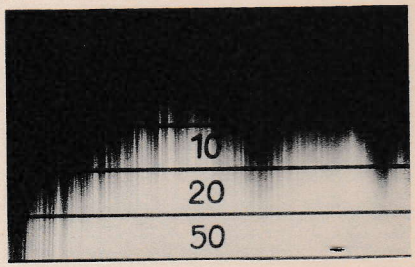
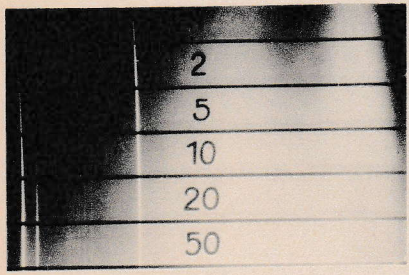
Example 1.



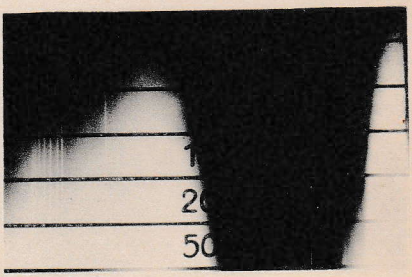
Example 2.



Example 3.



Example 4.



Example 5.

Interfrence Photograph with the $4^1/_2 \times 6$ cm Camera, to the Microspectral Ocular per Abbe.

Müller interferences in the continuous spectrum originating from two bounding layers of air; the lower between glass, and the upper between iodide of silver and glass. According to Born it is possible to determine the **ultra-microscopic** thickness of the stratum of iodide of silver with an exactitude of almost $1^0/_{00}$ from the displacement of the bands. The fine hatching of the interference denotes unevenesses in the iodide of silver layer. The lines are bands of the carbon light arc which served as the source of light. They furnish at the same time an easy mark for the determination of the wave lengths.