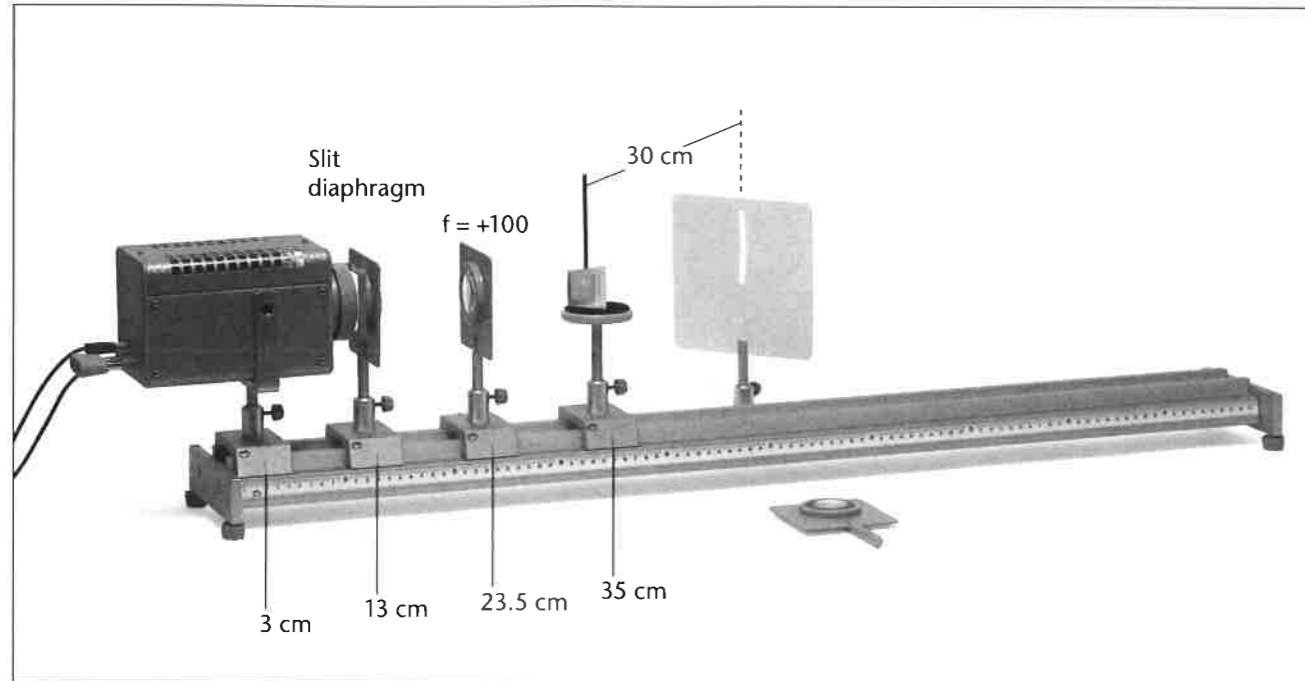


## 19 Dispersion of light



### Material

Rail	1	Slit diaphragm 1 slit	22
Pair of feet for rail	2	Prism table	28
Rider with clamping tube, 5 x	3	Prism	29
Optical lamp	4		
Diaphragm & slide holder	5	<i>Additionally required:</i>	
Screen on rod	8	Power supply, 12 V	
Lens, $f = +50$ mm	13	Plug leads, 50 cm, 2 x	
Lens, $f = +100$ mm	14		

### Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture. They have to be placed exactly at the given positions. The optical lamp, the lens  $f = +100$  mm and the prism table are inserted in the respective clamping tubes.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the optical lamp is adjusted so that the prism table is illuminated with an intensive beam.

The diaphragm & slide holder is inserted in the respective clamping tube. The slit diaphragm with 1 slit is inserted with the slit in a vertical position into the diaphragm & slide holder (the white side facing the optical lamp).

Then the prism is placed on the prism table as shown on the picture. The pencil of ray should meet the prism near to the front.

The screen on rod is fixed at the highest position in the free rider. Then the screen is positioned about 30 cm in an angle of  $45^\circ$  from the rail behind the prism. By slowly turning the prism on the prism table,

the deflected pencil of ray is reproduced on the screen. This reproduction is observed during the process with special attention to the colour aspects.

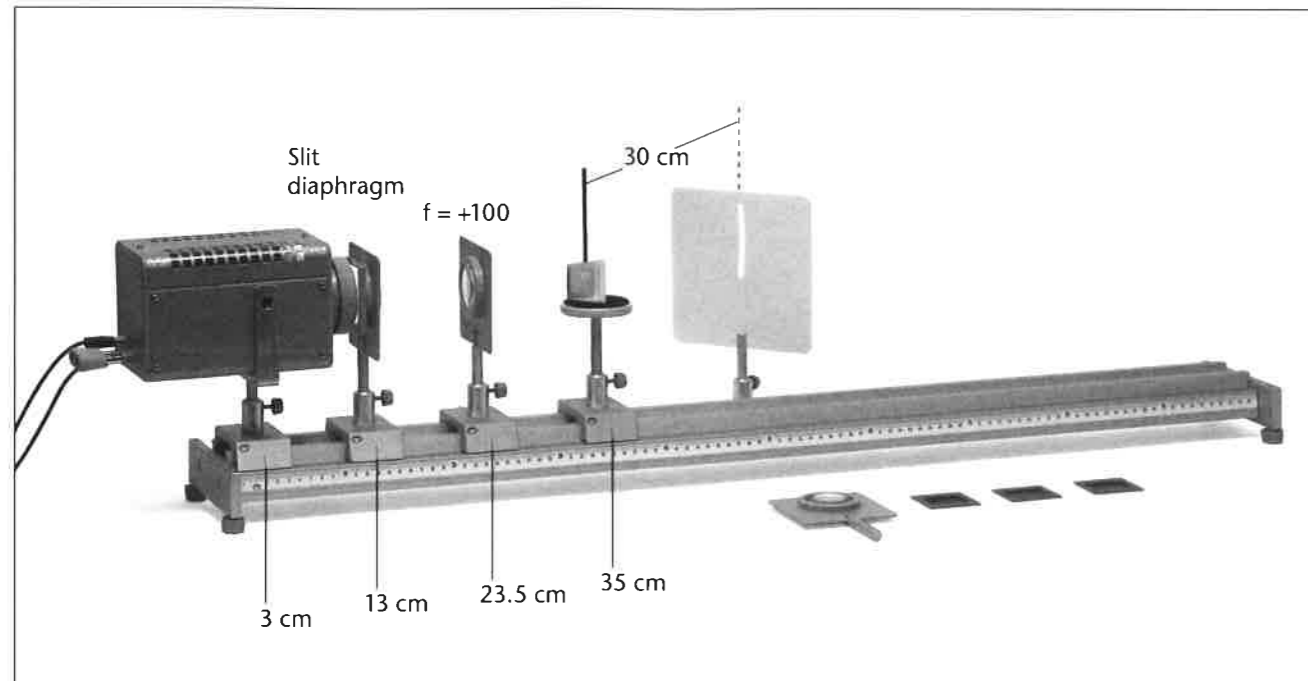
Subsequently the lens  $f = +50$  mm is held at short distance behind the prism and the reproduction on the screen is observed again.

### Result of the experiment

Pencils of ray are refracted when passing through a prism. In this process the light is dispersed into a rainbow schema. This schema is called the visible or optical spectrum of the light.

When this rainbow schema passes a converging lens completely, it is reunited again into white light.

## 20 Absorption of spectral colours



### Material

Rail	1	<i>Additionally required:</i>
Pair of feet for rail	2	Power supply, 12 V
Rider with clamping tube, 5 x	3	Plug leads, 50 cm, 2 x
Optical lamp	4	
Diaphragm & slide holder	5	
Screen on rod	8	
Lens, $f = +50$ mm	13	
Lens, $f = +100$ mm	14	
Slit diaphragm 1 slit	22	
Colour filters (red, green, blue)	24	
Prism table	28	
Prism	29	

### Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture. They have to be placed exactly at the given positions. The optical lamp, the lens  $f = +100$  mm and the prism table are inserted in the respective clamping tubes.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the optical lamp is adjusted so that the prism table is illuminated with an intensive beam.

The diaphragm & slide holder is inserted in the respective clamping tube. The slit diaphragm with 1 slit is inserted with the slit in a vertical position into the diaphragm & slide holder (the white side facing the optical lamp). Then the prism is placed on the prism table as shown on the picture. The pencil of ray should meet the prism near to the front.

The screen on rod is fixed at the highest position in the free rider. Then the screen is positioned about 30 cm in an angle of  $45^\circ$  from the rail behind the prism. By slowly turning the prism on the prism table, the deflected pencil of ray is reproduced on the screen. This reproduction is observed during the process with special attention to the colour aspects.

The different colour filters are held successively into the upper half of the pencil of ray between the prism and the screen. The differences among the upper and the lower half of the reproduction on the screen are observed. Then the lens  $f = +50$  mm is held additionally at short distance behind the prism and the reproduction on the screen is observed again.

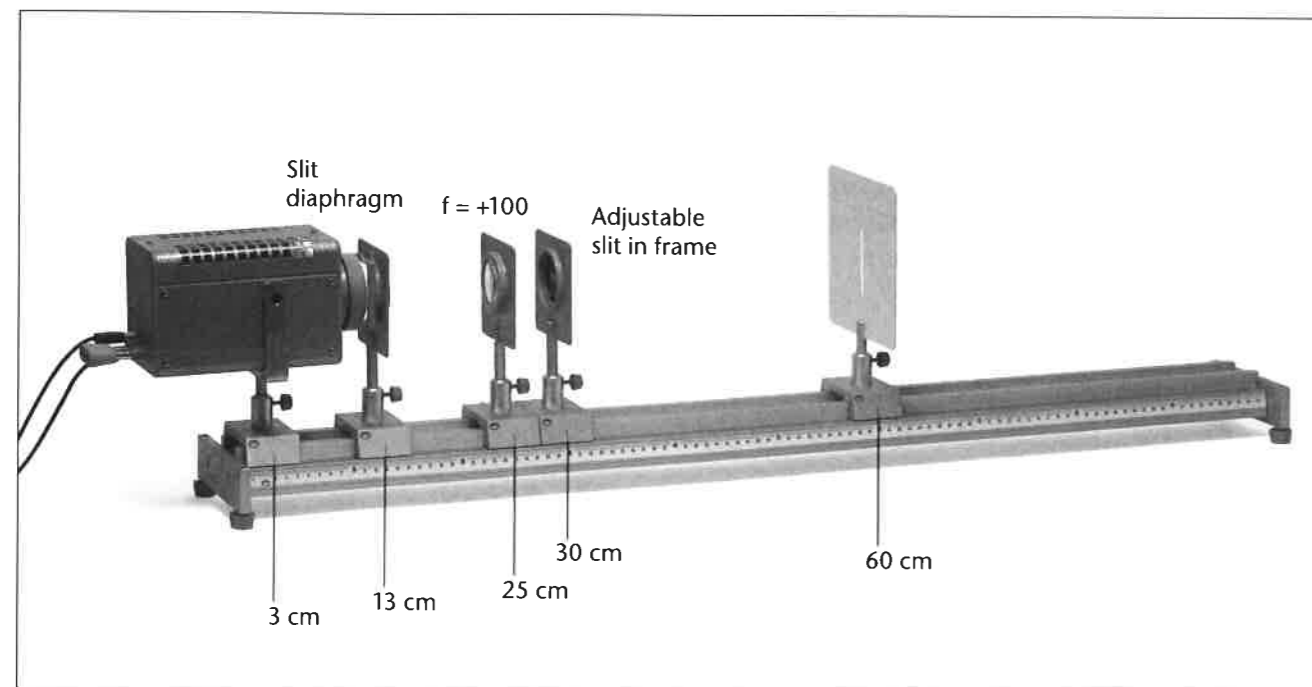
### Result of the experiment

Pencils of ray are refracted when passing through a prism. In this process the light is dispersed into a rainbow schema. This schema is called the visible or optical spectrum of the light.

By inserting a colour filter, a part of the optical spectrum is retained.

When the rest of the optical spectrum passes a converging lens, it is reunited again but the resulting light is not white.

## 21 Diffraction at a slit – interference



**Note:** For the success of the experiment a good obscuration is necessary.

### Material

Rail	1	<i>Additionally required:</i>
Feet for rail	2	Power supply, 12 V
Rider with clamping tube, 5 x	3	Plug leads, 50 cm, 2 x
Optical lamp	4	
Diaphragm & slide holder	5	
Screen on rod	8	
Lens, $f = +100$ mm	14	
Slit diaphragm 1 slit	22	
Adjustable slit in frame	39	

### Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture. They have to be placed exactly at the given positions. The optical lamp and the screen on rod are inserted in the respective clamping tubes. The screen has to be turned into a right angle to the rail.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the optical lamp is adjusted so that the centre of the screen is illuminated intensively.

The diaphragm & slide holder is inserted in the respective clamping tube. The slit diaphragm with 1 slit is inserted with the slit in a vertical position into the diaphragm & slide holder (the white side facing the optical lamp).

Subsequently the lens with the focal length  $f = +100$  mm is placed in its respective clamping tube. To achieve the sharpest possible image of the slit on the screen, slight corrections on the position of the lens may be necessary. Then the adjustable slit in frame with fully opened slit is placed in the respective clamping tube.

Now the adjustable slit is slowly closed and the changes of the picture on the screen during the process are attentively watched.

### Experiment results

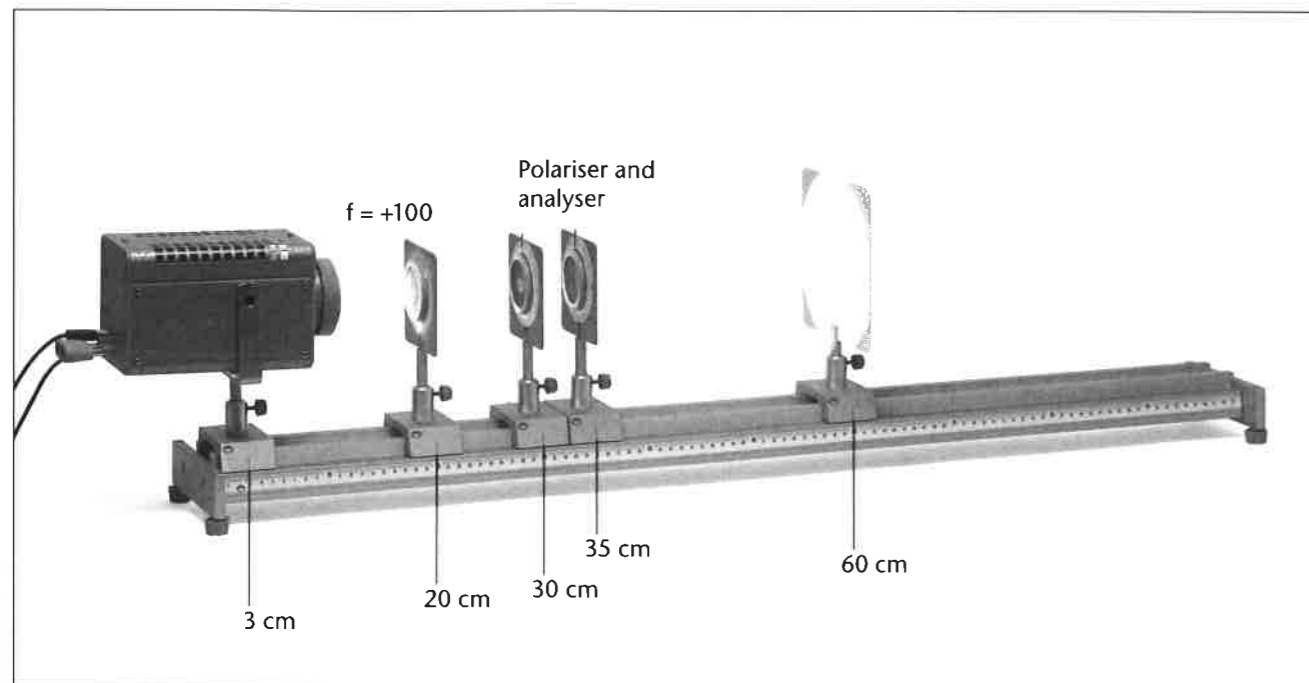
When the slit is adjusted very narrow the picture of the slit on the screen becomes a little bit broader and slightly visible vertical dark and light stripes appear.

When a beam of light meets a sharp edge a deflection from the linear propagation occurs. This deflection is called diffraction.

On the narrow slit there are two sharp edges where the light is diffracted from the linear propagation. The diffracted parts of the light interfere with each other and this interference causes amplification and attenuation of the light.

This behaviour of light can only be understood when the light has characteristics of waves.

## 23 Polarisation



### Material

Rail	1	<i>Additionally required:</i>
Feet for rail	2	Power supply, 12 V
Rider with clamping tube, 5 x	3	Plug leads, 50 cm, 2 x
Optical lamp	4	
Screen on rod	8	
Lens, $f = +100$ mm	14	
Polariser and analyser	31	

### Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture. They have to be placed exactly at the given positions. The optical lamp, the lens and the screen on rod are inserted in the respective clamping tubes. The screen has to be turned into a right angle to the rail.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the optical lamp is adjusted so that the centre of the screen is illuminated intensively.

The polariser and the analyser are adjusted to the  $0^\circ$  position and placed in their respective clamping tubes. The changes of the picture on the screen are attentively watched. Now the handle on the analyser is slowly moved to the position  $90^\circ$  on either side. The changes of the picture on the screen are attentively watched.

Subsequently the handle on the polariser is slowly moved to the position  $90^\circ$  on either side. The changes of the picture on the screen are attentively watched again.

### Experiment results

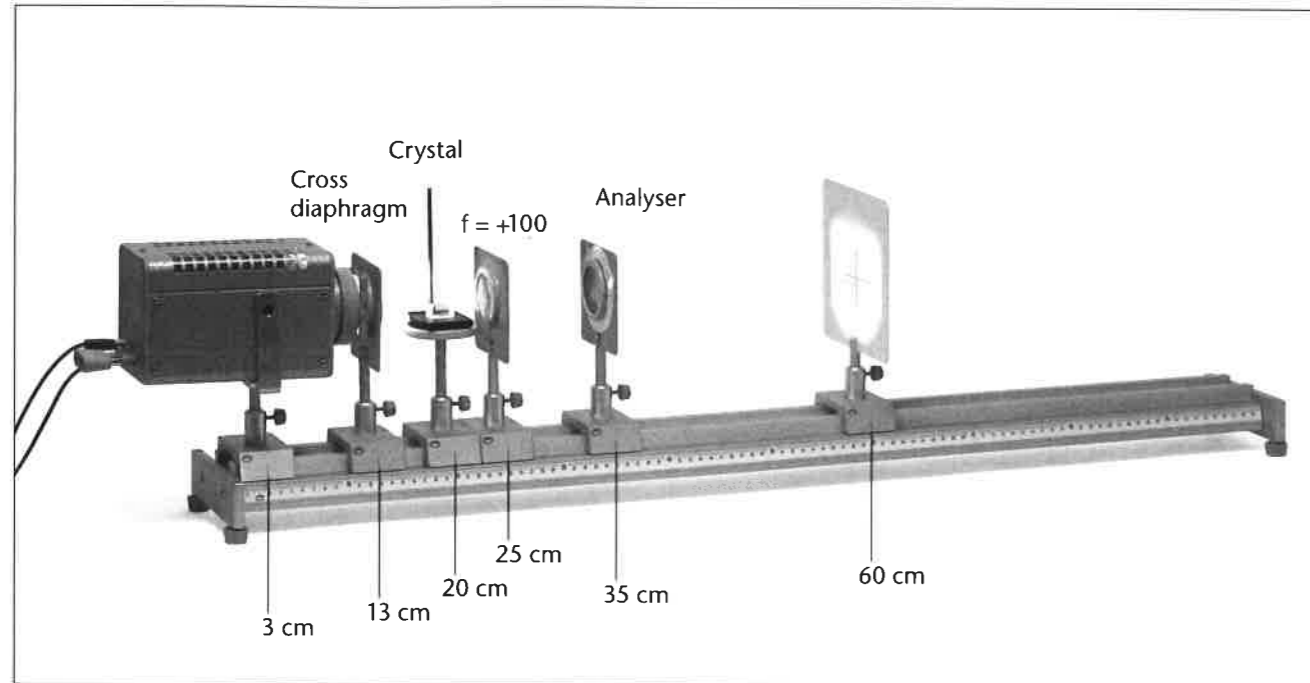
The brightness on the screen changes, when one of the filters is turned into another position relatively to the other filter. The maximum brightness is achieved, when the handles of the filters are set to the same position. When the filters are set to a difference of  $90^\circ$ , nearly no light passes them and the screen remains dark.

Light is an electromagnetic wave with an oscillation at right angle to the direction of propagation. Natural light consists of light which oscillates in all directions. By a polariser, all light is extinguished which do not oscillates in the plane of the polariser.

The part of the light which passes the filter is called polarised light. This polarised light can pass the analyser only, when the filter is set in an appropriate position.

At  $0^\circ$  all the polarised light can pass, at  $90^\circ$  it is extinguished totally. On the other positions of the analyser a varying part of light can pass and cause different brightnesses.

## 24 Polarisation by birefringence



### Material

Rail	1	Cross diaphragm	35
Feet for rail	2	Calcspar crystal	36
Rider with clamping tube, 6 x	3		
Optical lamp	4	<i>Additionally required:</i>	
Diaphragm & slide holder	5	Power supply, 12 V	
Screen on rod	8	Plug leads, 50 cm , 2 x	
Lens, $f = +100$ mm	14		
Cuvette	17		
Prism holder	28		
Analyser	31		

### Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture and initially only the optical lamp, the diaphragm holder, the lens and the screen are mounted in the clamping tubes. They have to be placed exactly at the given positions. The screen has to be turned into a right angle to the rail.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the lamp is adjusted so that the centre of the screen is illuminated intensively.

The cross diaphragm is inserted into the diaphragm holder (the white side facing the optical lamp). To achieve the sharpest possible image of the cross on the screen slight corrections on the position of the lens may be necessary.

The prism holder is mounted on the clamping tube of its rider as high as possible. The black cover of the cuvette is placed on the table of the prism holder first as an elevating base for the calcspar crystal which is set on the cover lengthwise. The crystal is slightly turned and displaced until a sharp double image of the cross diaphragm is seen on the screen.

The analyser is mounted on the rider. The handle on the analyser is slowly moved from the  $0^\circ$  position to the  $90^\circ$  position in both directions and backwards. The changes of the image on the screen are attentively watched.

### Experiment results

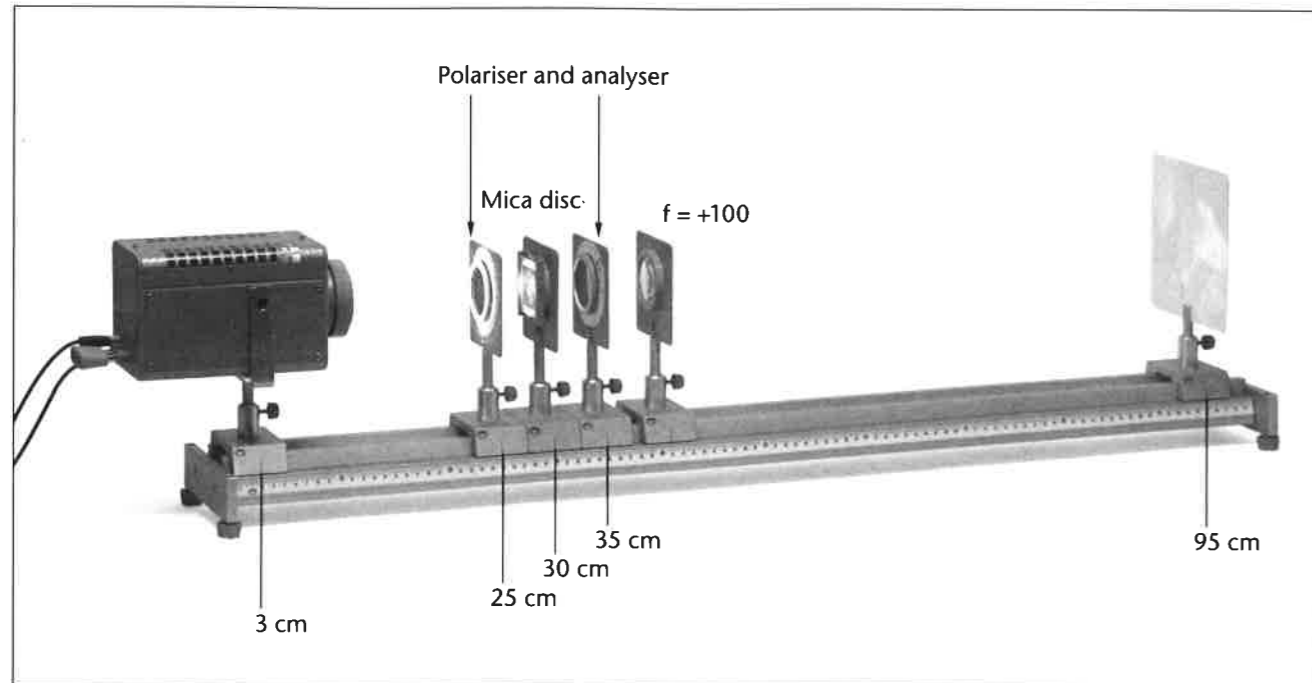
By inserting the calcspar crystal a double image of the cross diaphragm is produced.

The double image of the cross on the screen changes when an analyser is inserted behind the crystal and its rotating position is changed. The image of the cross fades depending on the rotating position of the analyser from a certain image position to another.

Light is an electromagnetic wave with an oscillation at right angle to the direction of propagation. Natural light consists of light which oscillates in all directions. A calcspar crystal allows light to pass only in two oscillating directions – all other directions are extinguished. The calcspar crystal is therefore effective as a polariser for two oscillating directions. The two passage directions are positioned in an angle to another. The incident is called *birefringence*.

The polarising filter used as an analyser let pass the two polarised light fractions of the crystal which are in an angle to another only at the rate as their oscillating directions correspond with the polarisation plane of the filter. At a complete correspondence the respective fraction can pass completely. At intermediate filter positions the double images of the cross are projected with a different brightness.

## 26 Chromatic polarisation



## Material

Rail	1	<i>Additionally required:</i>
Feet for rail	2	Power supply, 12 V
Rider with clamping tube, 6 x	3	Plug leads, 50 cm, 2 x
Optical lamp	4	
Diaphragm- & slide holder	5	
Screen on rod	8	
Lens, $f = +100$ mm	14	
Polariser and analyser	31	
Slide with mica disc	34	

## Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture and initially only the optical lamp, the lens and the screen are mounted in the clamping tubes. The riders have to be placed exactly at the given positions. The screen has to be turned into a right angle to the rail.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the lamp is adjusted so that the centre of the screen is illuminated intensively.

The polariser and analyser are mounted on the respective clamping tubes of the riders and adjusted to a  $90^\circ$  position against each other by turning the handles (eracement).

The diaphragm holder is mounted on the respective clamping tube and the slide with the mica disc is inserted in the diaphragm holder. To achieve the sharpest possible image of the mica disc on the screen slight corrections on the position of the lens may be necessary. The image is examined.

Afterwards one of the polarising filters is rotated starting from its position to both directions. The effect is attentively watched on the screen.

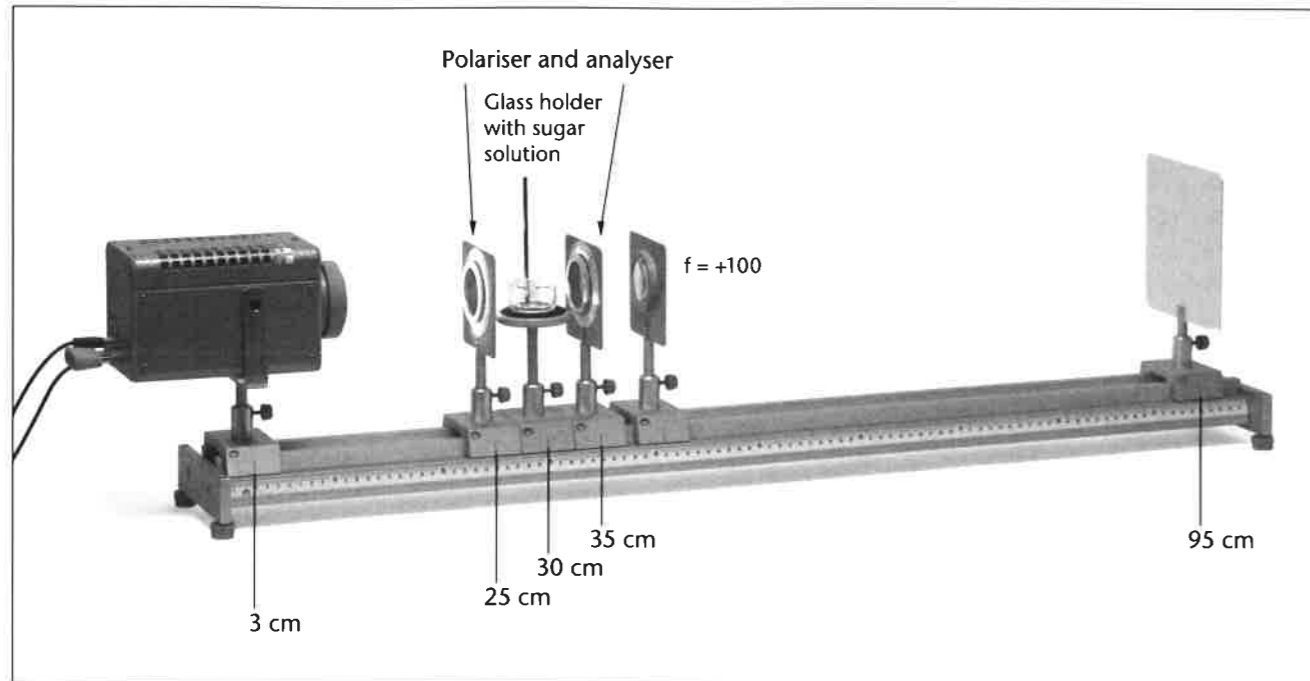
## Experiment results

The inserting of a mica disc in a polarised light beam, which is erased by an analyser produces a coloured bright image of the mica on the screen. Colours and brightness change if the polarisation plane of one of the filters is rotated.

Light is an electromagnetic wave with an oscillation at right angle to the direction of propagation. Natural light consists of light which oscillates in all directions. A polarising filter allows light to pass only if the oscillating direction of the light complies with the polarisation plane of the filter. If the polarising planes of two filters mounted one after another are in an angle of  $90^\circ$  to another no light will pass.

Many crystalline minerals (i.e. mica) have birefringent properties. These properties rotate the plane of polarisation of the light which results in brightness behind the analyser filter. The degree of rotation depends on the thickness and the internal bedding and structure of the mineral which is also liable for the different colour fractions of the light. The brightness and colour appearance of the image reflect the internal compound and formation of the mineral.

## 27 Rotation of the polarisation plane



### Material

Rail	1	<i>Additionally required:</i>
Feet for rail	2	Power supply, 12 V
Rider with clamping tube, 6 x	3	Plug leads, 50 cm, 2 x
Optical lamp	4	Concentrated sugar solution
Screen on rod	8	
Lens, $f = +100$ mm	14	
Prism holder	28	
Polariser and analyser	31	
Holder for tea candle	37	

### Carrying out the experiment

The two feet are plugged into the ends of the rail. The riders are arranged on the rail according to the picture and initially only the optical lamp, the lens and the screen are mounted in the clamping tubes. The riders have to be placed exactly at the given positions. The screen has to be turned into a right angle to the rail.

The optical lamp is connected with the power supply (12 V). By pulling out the adjusting slider at the back side of the lamp (approx. 15 mm), the beam of the lamp is adjusted so that the centre of the screen is illuminated intensively.

The polariser and analyser are mounted on the respective clamping tubes of the riders and adjusted to a  $90^\circ$  position against each other by turning the handles (eracement).

The prism holder is mounted on the respective clamping tube and the glass cup is set on the table of the prism holder. To achieve the sharpest possible image of the glass cup on the screen slight corrections on the position of the lens may be necessary. The image is examined.

Afterwards the concentrated sugar solution is slowly filled in the glass cup. The effect is watched attentively on the screen.

It is tried to find eracement of the light again by rotating the polarisation plane of the analyser.

### Experiment results

A concentrated sugar solution in a polarised light beam, which is erased by an analyser produces a bright image of the solution on the screen. The degree of brightness depends on the concentration of the sugar slution.

Light is an electromagnetic wave with an oscillation at right angle to the direction of propagation. Natural light consists of light which oscillates in all directions. A polarising filter allows light to pass only if the oscillating direction of the light complies with the polarisation plane of the filter. If the polarising planes of two filters mounted one after another are in an angle of  $90^\circ$  to another no light will pass.

Some solutions have the property to rotate the oscillation plane of polarised light which results in brightness behind the analyser filter. The degree of rotation depends on the concentration, the coat thickness and specific properties of the solution. The concentration of a solution can be determined by the rotating angle of the polarised light if the coat thickness of the solution is constant.