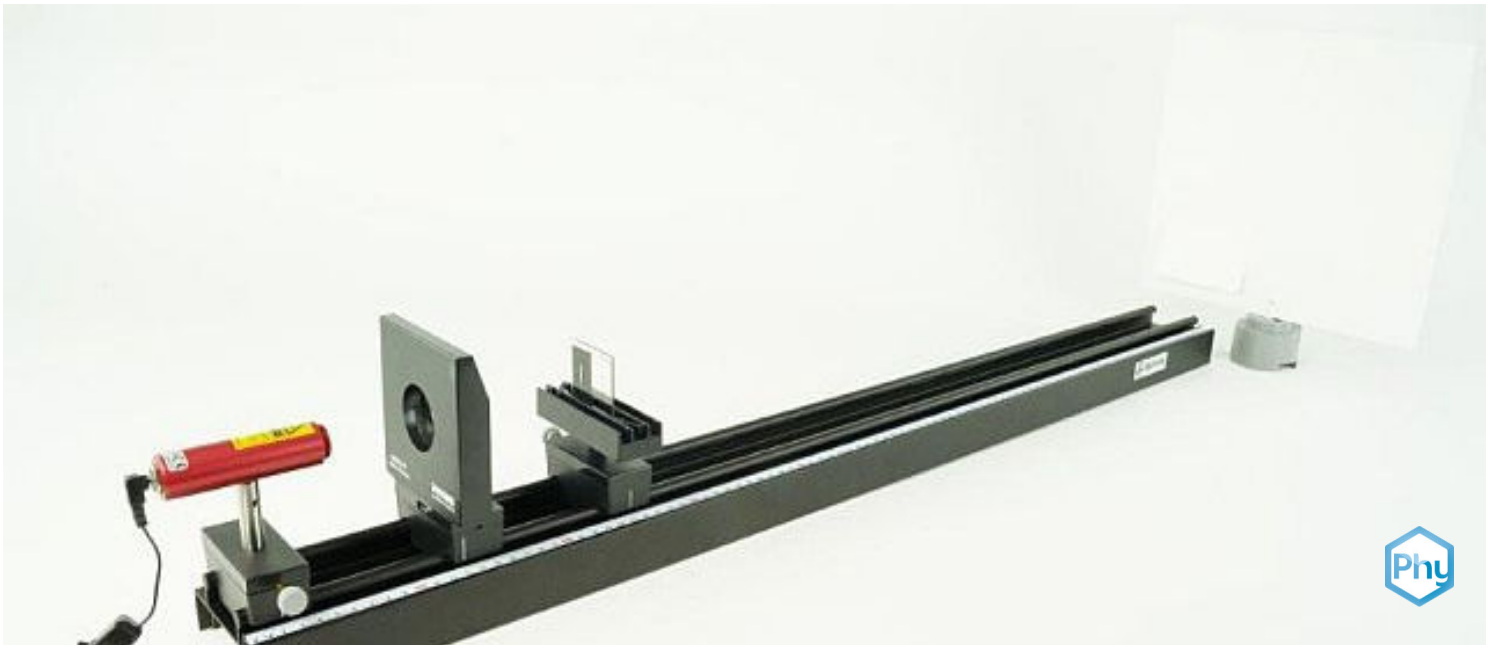
Diffraction at an edge



If a plane wave meets a straight edge of an obstacle, the edge acts as the starting point of secondary waves according to Huygens' principle. These overlap with the wave part passing the edge undisturbed. Interference of both bundles results in a sequence of light and dark interference fringes in the passband.

Physics > Light & Optics > Diffraction & interference

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/6157071cbcbea20003ba0ef5

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General information

Application

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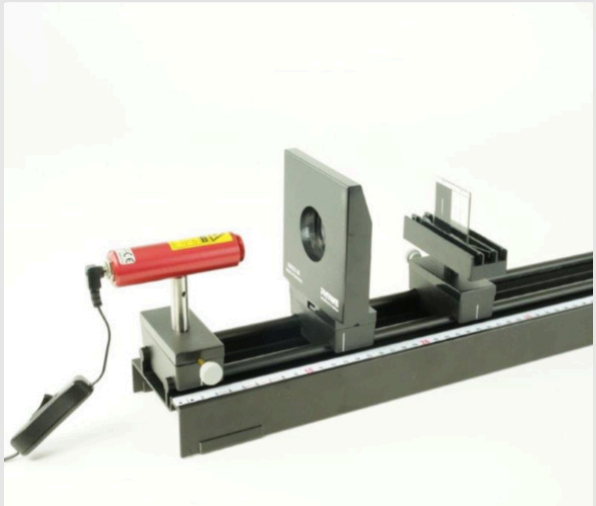

Test setup

If a plane wave meets a straight edge of an obstacle, the edge acts as the starting point of secondary waves according to Huygens' principle. These overlap with the part of the wave passing the edge undisturbed.

Interference of both beams results in a sequence of light and dark interference fringes in the passband.

The phenomenon of diffraction at the edge applies not only to light waves (transverse waves) but also to longitudinal waves (sound waves). Thus, when sound hits an edge, loudness minima and maxima can be observed behind this edge depending on the location.

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Other information (1/2)

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Previous

It should already be known, that diffraction and interference occur at openings as well as at obstacles. For this purpose it is useful to perform the experiment "Diffraction at a bar - Babinet's theorem" beforehand.

Principle

If a wave meets an obstacle, the edge of this obstacle is the starting point of elementary waves according to Huygens' principle.

This circular wave emanating from the edge then interferes with the wave front flowing past the obstacle.

Other information (2/2)

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Learning

Since edges can always be regarded as starting points of elementary waves, interference also takes place where a wave partly meets an obstacle and partly flows past it. Thus, only one edge is needed for interference.

Tasks

- Observing the interference pattern
- Understanding why interference occurs at an edge
- Answering the questions in the protocol

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Safety instructions

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It is imperative that you do not look directly into the laser beam.

The general instructions for safe experimentation in science lessons apply to this experiment.

Theory

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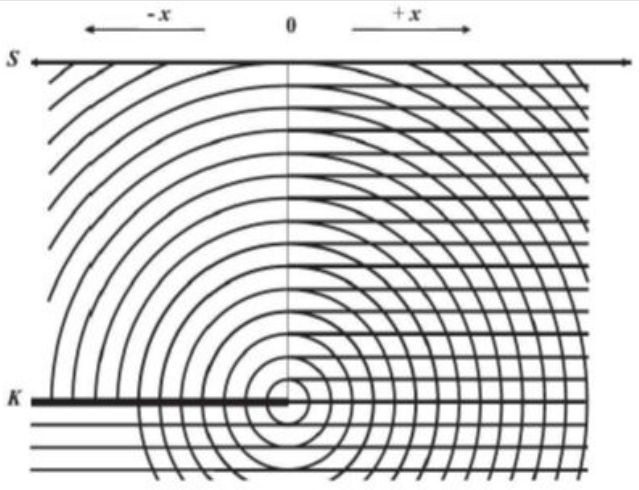
If a light bundle with plane wave fronts meets an edge, a part of the bundle is cut off while the other part can pass it unhindered. According to Huygens' principle, elementary waves emanate from the edge, which also propagate into the shadow area with decreasing intensity.

In the passband, these scattered waves overlap with the unobstructed plane waves. These two waves can then either cancel or amplify each other on the screen, depending on the path difference.



schematic propagation of the waves

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Equipment

Position	Material	Item No.	Quantity
1	Optical profile-bench, l = 1000 mm	08370-00	1
2	Slide mount for optical bench	09822-00	2
3	Plate mount for three objects	09830-00	1
4	Diaphragm with single slit, bar and edge	08521-00	1
5	Lens, mounted, f +50 mm	08020-01	1
6	Mount with scale on slide mount	09823-00	1
7	Screen, metal, 300 x 300 mm	08062-00	1
8	Barrel base expert	02004-00	1
9	Diodelaser, red, 1 mW, 635 nm	08761-99	1

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Equipment

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Position	Equipment	Quantity
1	Adhesive tape	1
2	white sheet of paper	1

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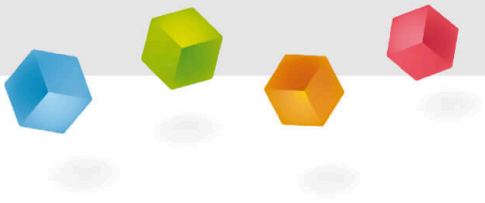

Structure and implementation

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Set-up

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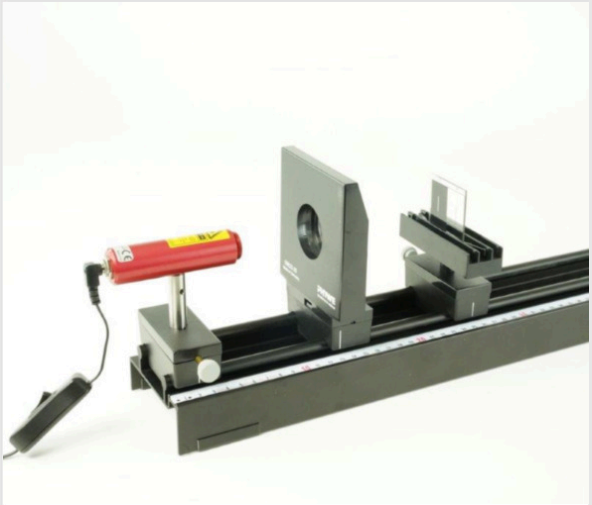

Experimental setup

The experimental setup is as shown in the figure, with the tally marks of the tabs to hold the components on the optical bench to the following positions:

- Slide mount with diode laser at 2cm
- Mount with scale and inserted converging lens $f = +50mm$ at 13cm
- Slide mount with plate holder and diaphragm at 25cm

The barrel base with screen is located at a distance of between 1.5 and 2 metres from the bar screen.

Procedure

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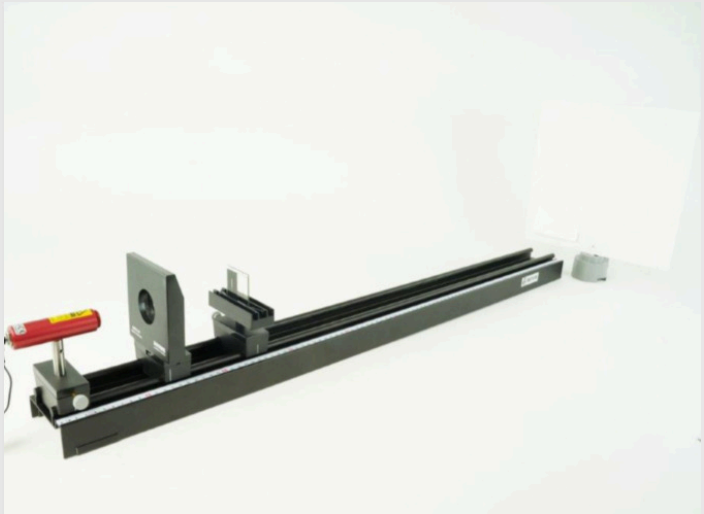

Set-up with screen

A white sheet of paper is attached to the screen with adhesive tape, and the point of impact of the unobstructed laser beam is marked with a felt-tip pen. A vertical line is drawn through the point of impact.

Afterwards, the mount with the inserted converging lens is mounted to expand the laser beam.

Finally, insert the diaphragm with bar into the plate holder and position it so that about 2/3 of the beam is covered by the diaphragm and the remaining part can hit the screen past the edge.

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Evaluation

Evaluation (1/3)

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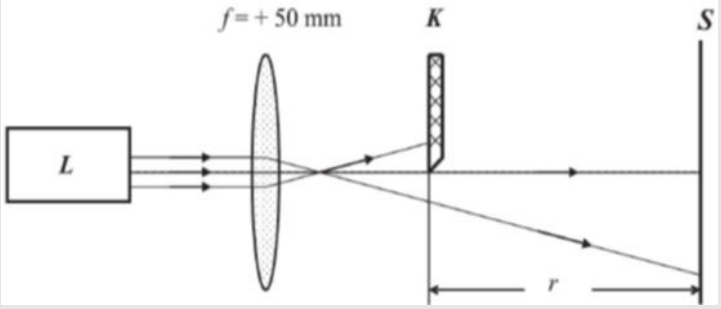
The nearly parallel light beam of a laser L is directed through a converging lens ($f = +50mm$) is made divergent and then hits a straight edge of an obstacle.

On a screen S at a distance r on the edge K an enlarged image of bright and dark interference fringes can be observed in the free passband.



The very demanding theoretical treatment of diffraction at an edge must be omitted here.

However, it would show that the maximum is not at the geometric shadow boundary, but already in the passband.

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Evaluation (2/3)

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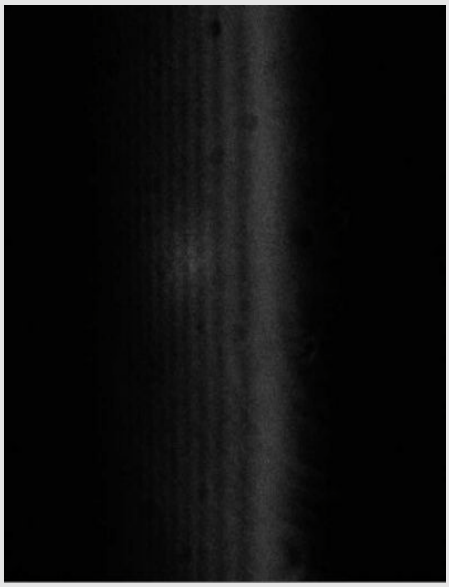

Where is the brightest intensity maximum?

- Perpendicular behind the edge.
- Shifted a little into the shadows.
- Shifted a little into the passband.

Evaluation (3/3)

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At which of these objects does interference occur?

- [ ] Polarizing Filter.
- [ ] Obstacles whose diameter is small enough.
- [ ] Openings whose diameter is small enough.
- [ ] Edges that cut off some of the light.

Check

Which waves interfere in this experiment?

- The waves cut off by the obstacle with the continuous wave front.
- The continuous wave front with the elementary waves generated at the edge.

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Slide	Score / Total
Slide 14: Intensity maximum	0/3
Slide 15: Multiple tasks	0/4

Total score 0 / 7

Show solutions Repeat

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