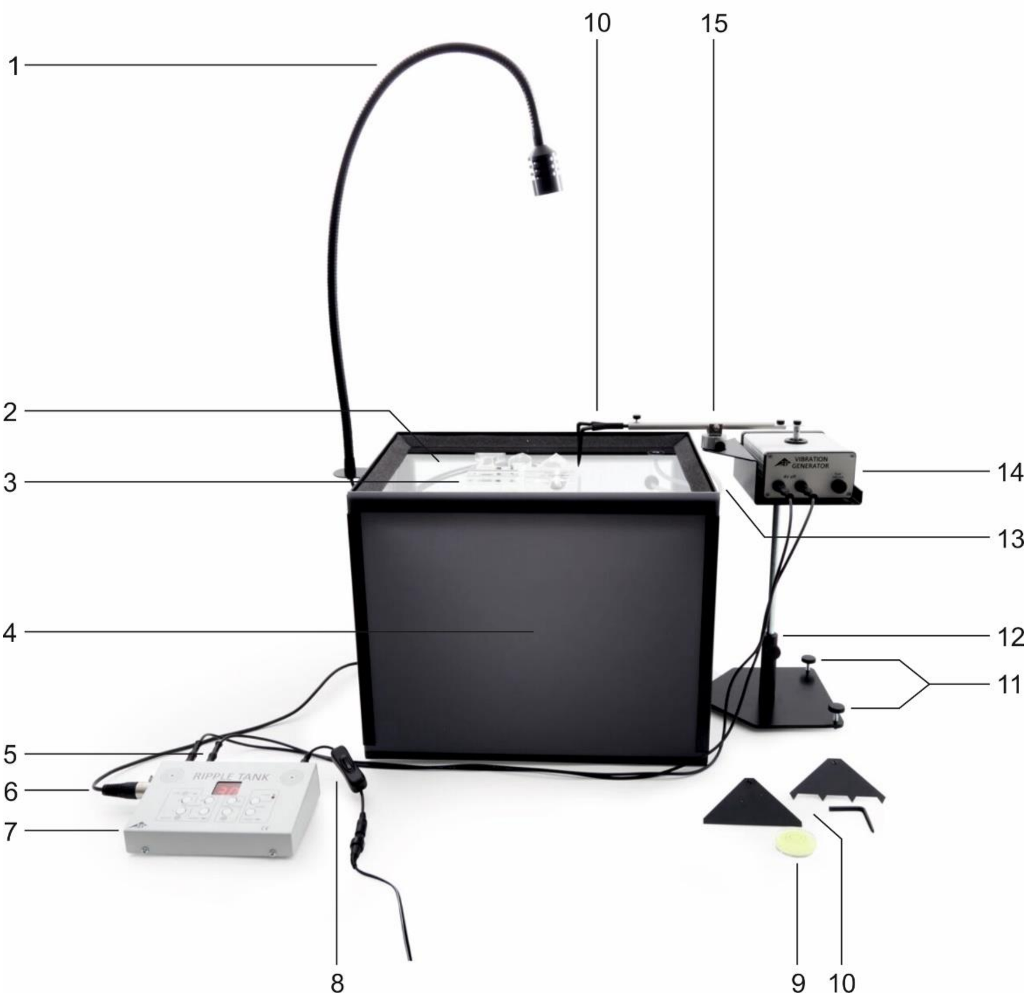
3B SCIENTIFIC® PHYSICS

Ripple Tank 1026082

User Manual

11/25 Alf/GH/UD



1 Flexible LED stroboscope with magnetic holder
2 Water basin
3 Immersion bodies
4 Observation screen
5 Connection cables for vibration generator
6 Stroboscope connection
7 Frequency generator
8 On/Off Switch
9 Spirit level
10 Wave exciters
11 Leveling screws
12 Holder with base for vibration generator
13 Drain hose
14 Vibration generator
15 Connecting arm for wave exciters

1. Safety instructions

The glass components of the ripple tank can be broken if they are not handled properly.

- Do not subject the ripple tank to excessive mechanical forces.

2. Equipment supplied

1 Ripple tank with projection mirror, observation screen, and drain hose

1 Flexible LED stroboscope with magnetic holder

1 Frequency generator

1 Plug-in power supply unit, 12 V DC

1 On/Off Switch

1 Vibration generator

1 Holder with base for vibration generator

2 Connection cables for vibration generator

1 Connecting arm for wave exciters

1 Set of 4 wave exciters (plane waves, circular waves, two / four interfering circular waves)

1 Set of 7 immersion bodies (prism, biconvex lens, biconcave lens, three long cuboids / one short cuboid)

1 Spirit level

1 Storage case

3. Description

The ripple tank is used to clearly demonstrate fundamental wave phenomena such as the generation of plane and circular waves, refraction, reflection, diffraction, and interference, visualized through water waves projected onto an observation screen.

The ripple tank consists of an aluminium frame with a shallow basin featuring a glass bottom. The glass bottom includes an opening with a drain hose for emptying the water. The basin is leveled using a spirit level and four height-adjustable feet at the bottom of the ripple tank. Plane or circular waves are generated in the water through localized mechanical oscillations, with their frequency and amplitude set on the frequency generator.

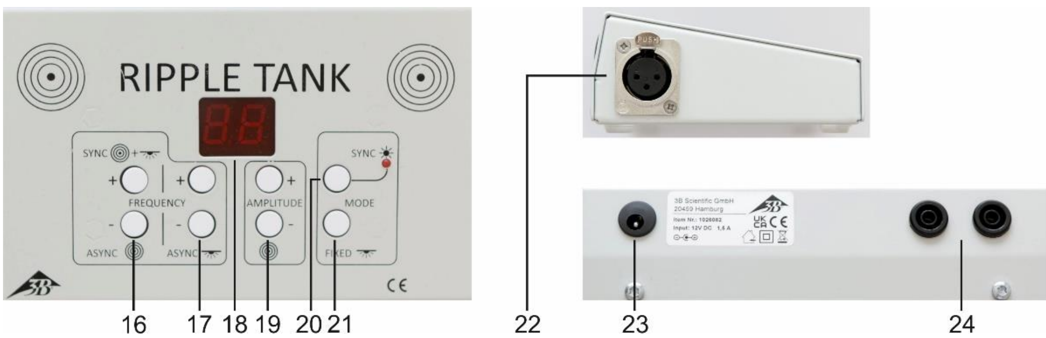
An LED lamp with a magnetic holder illuminates the tank from above, functioning as a stroboscope with either synchronous or asynchronous frequency. The frame contains an angled mirror that projects the waves onto an observation screen. The stroboscope is connected via a three-pin socket on the left side of the frequency generator.

The frequency generator allows separate adjustment of the stroboscope frequency and the frequency and amplitude of wave generation. The set frequency is displayed continuously on the frequency generator, while the amplitude is shown temporarily when changed. Power is supplied via a plug-in power supply unit.

Wave generation is performed using a vibration generator. A holder with a base is used to mount and position the vibration generator. Inside the base's tube is a coil spring that acts as a shock absorber. The wave exciters are mechanically coupled via a connecting arm. Power is supplied through two connection cables via the frequency generator. Various wave exciters and immersion bodies are available for conducting experiments.

There are two side cutouts on the ripple tank for easy handling and transport.

3.1 Operating elements – frequency generator



16 Knobs for adjusting vibrator frequency in synchronous mode

17 Knobs for adjusting vibrator frequency in asynchronous mode

18 Frequency display

19 Knobs for adjusting vibrator amplitude

20 Switch for synchronous / asynchronous operation

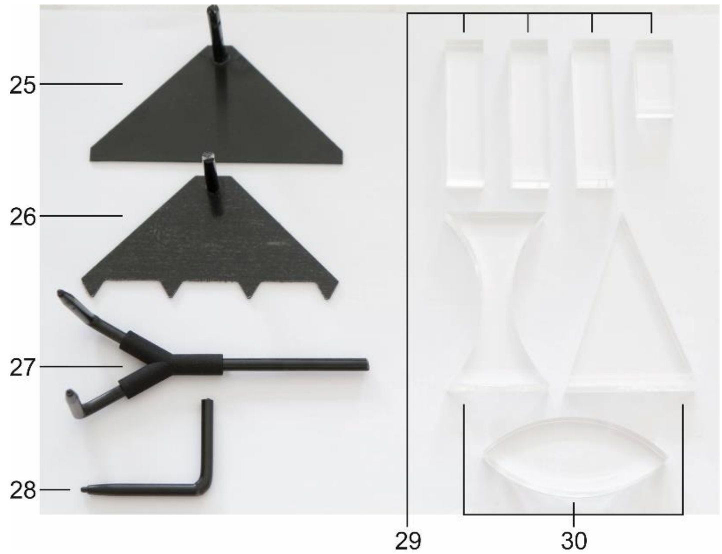
21 On/off switch for strobe illumination

22 Connection socket for stroboscope

23 Connecting socket for plug-in power supply

24 Connection sockets for vibration generator

3.2 Accessories



25 Exciter for plane waves
26 Exciter for four interfering circular waves
27 Exciter for two interfering circular waves
28 Exciter for circular waves
29 Immersion bodies three long cuboids, one short cuboid
30 Immersion bodies prism, biconcave and biconvex lens

4. Technical data

Dimensions

Tank:	approx. 400x300x330 mm³
Water basin (usable glass surface):	approx. 360x260 mm²
Observation screen:	approx. 395x320 mm²
Projection mirror:	approx. 420x395 mm²
Stroboscope lamp	
Light source:	LED 3 W
Diameter:	34 mm
Maximum frequency:	60 Hz
Frequency generator	
Dimensions:	approx. 170x110x50 mm³
Frequency range:	1 – 60 Hz, adjustable in 1 Hz steps
Amplitude adjustment:	1 – 30%
Power supply voltage:	12 V DC / 1 A output 100 – 240 V input
Vibration Generator	
Dimensions:	approx. 110x90x110 mm³
Current:	max. 400 mA
Overload protection:	500-mA-fuse
Connection:	4 mm safety sockets

5. Operation

Additionally recommended:

1	Beaker, 800 ml, tall-form	1025694
1	Wash bottle, 500 ml	1009812
	Water	

- Place the ripple tank with the observation screen facing forward on a level, vibration-free surface.
- Unscrew the four height-adjustable feet at the bottom of the ripple tank so far that you can slide the holder with base for the vibration generator underneath the ripple tank without touching it.
- Use the spirit level and the height-adjustable feet to align the ripple tank horizontally.
- Attach the drain hose in the clamp on the ripple tank so that it points straight upward.
- Slide the holder with base for the vibration generator under the center right side of the ripple tank, with the pointed end of the base facing the tank. If necessary, rotate and secure the holder in the base so that its pointed end also faces the tank.
- Use the spirit level and the two leveling screws on the base to align the holder horizontally.
- Place the vibration generator on the holder with its control panel facing forward.

- Attach the connecting arm for wave exciters onto the tip of the holder using its magnetic base and secure it to the pin of the vibration generator using the knurled screw.
- Insert the desired wave exciter into the arm and secure it with the knurled screw.
- Connect the frequency generator and vibration generator using the two 4 mm safety cables.
- Mount the stroboscope on the outside of the ripple tank using the magnetic holder and connect it to the frequency generator using the three-pin cable.
- Connect the frequency generator to the power supply using the On/Off Switch and the plug-in power adapter.
- Fill the ripple tank with 5 mm of water.

The immersion bodies will then extend above the water surface.

- Adjust the immersion depth of the wave exciter by setting the height of the holder so that the bottom edge of the wave exciter just touches the water surface.
- Switch on the frequency generator.

At startup, the system is preset to synchronous operation with a frequency of 30 Hz and an amplitude of 10%. With synchronous frequencies of the wave generator and stroboscope, standing wave patterns can be visualized; with asynchronous settings, traveling waves appear.

- Adjust the height and position of the stroboscope so that the ripple tank is fully illuminated.
- Conduct the experiment. Adjust water depth, wave exciter position, frequency, and amplitude as needed to optimize the visualization of the observed phenomena.
- After completing the experiment, empty the ripple tank into a beaker using the drain hose.
- Carefully dry the device to prevent limescale buildup.

6. Example Experiments

6.1 Wave Generation

- Ensure that the ripple tank is filled with 5 mm of water.
- Insert the appropriate wave exciter one after the other into the arm until fully seated, secure them using the knurled screw, and generate plane waves, circular waves, or interfering circular waves accordingly (Fig. 1a – d). Adjust the immersion depth of each wave exciter by setting the height of the holder so that the bottom edge of the wave exciter just touches the water surface.

6.2 Refraction

- Ensure that the ripple tank is filled with 5 mm of water.
- Insert the exciter for plane waves into the arm until fully seated and secure it with the knurled screw.
- Place the biconvex lens, biconcave lens, or the prism in the center of the ripple tank, a few centimeters in front of the wave exciter.
- Shield the front edges of the biconcave lens using two long cuboids placed upright (Fig. 2b) to minimize unwanted edge effects such as diffraction and interference phenomena.
- Rotate the prism so that its long side, which faces away from the wave exciter, is parallel to the wave exciter (Fig. 2c).

The long side facing the wave exciter should then form an angle of approximately 40° with it, corresponding to the prism's apex angle.

- Add water so that the immersion body is completely covered.
- Adjust the immersion depth of the wave exciter by setting the height of the holder so that the bottom edge of the wave exciter just touches the water surface.

To observe refraction, the immersion body should be only just covered with water.

- Switch on the frequency generator and observe the display on the observation screen. Use e.g. a wash bottle to remove water from the ripple tank until refraction becomes visible behind the immersion body. Adjust the immersion depth of the wave exciter and if necessary, the frequency and amplitude to optimize the display.
- Repeat the experiment with the other immersion bodies.

Behind the biconvex lens, converging circular waves form, focusing on a point (Fig. 2a). Behind the biconcave lens, diverging circular waves appear to originate from a virtual focal point in front of the lens (Fig. 2b). The prism deflects the plane waves (Fig. 2c).

Above the immersion bodies, the water depth is significantly shallower than in the surrounding area. In these shallow regions, wave speed decreases, resulting in a shorter wavelength. Consequently, as waves transition from deeper to shallower water, they refract, similar to light waves passing from an optically less dense to a more optically dense medium.

6.3 Reflection

- Ensure that the ripple tank is filled with 5 mm of water.
- Insert the exciter for plane waves into the arm until fully seated and secure it with the knurled screw. Adjust the immersion depth by setting the height of the holder so that the bottom edge of the wave exciter just touches the water surface.
- Place the biconvex lens or the biconcave lens into the ripple tank and observe the reflection pattern.

When plane waves reflect off curved obstacles, the biconvex lens acts like a convex mirror (Fig. 3a), while the biconcave lens behaves like a concave mirror (Fig. 3b).

- Place the three long cuboids at a 45° angle in front of the wave exciter to form a straight, continuous obstacle.

When plane waves reflect off a straight obstacle, it behaves like a flat mirror. The reflected waves remain plane, and the wavelength does not change. The law of reflection applies: angle of incidence = angle of reflection (Fig. 3c).

- Repeat the experiment using the exciter for circular waves. Move the straight obstacle closer to the wave generator for this experiment.

When circular waves reflect off a straight obstacle, it acts like a flat mirror. The reflected waves remain circular, with their origin appearing at a virtual point behind the straight obstacle, mirror-symmetric to the point of excitation (Fig. 3d).

6.4 Diffraction

- Ensure that the ripple tank is filled with 5 mm of water.
- Insert the exciter for plane waves into the arm until fully seated and secure it with the knurled screw. Adjust the immersion depth by setting the height of the holder so that the bottom edge of the wave exciter just touches the water surface.
- Using two long cuboids, sequentially create a single slit with three different slit widths: 1) significantly wider than the wavelength, 2) slightly wider than the wavelength and 3) smaller than the wavelength.

In the first case, the plane waves pass through the slit mostly unchanged. Circular waves with weaker amplitude spread into the shadowed region from the edges (Fig. 4a). In the second case, circular waves originating from the slit edges interfere with each other. This produces interference maxima and minima arranged along hyperbolas, with the slit edges acting as sources of wave excitation (Fig. 4b). In the third case, circular waves form and the slit behaves like a point source (Fig. 4c).

- Place a long cuboid in the ripple tank as an obstacle.

The edges of the cuboid act as sources of circular waves that also spread into the shadowed region and interfere behind the cuboid (Fig. 4d).

6.5 Interference

- Ensure that the ripple tank is filled with 5 mm of water.
- Insert the exciters for two and four interfering circular waves into the arm one after the other and secure them with the knurled screw. Adjust the immersion depth of the wave exciters by setting the height of the holder so that the bottom edges of the exciters just touch the water surface.
- Observe the interference patterns.

The interference maxima and minima are located along hyperbolas, with focal points at the positions of wave excitation (Fig. 1c, d).

- Insert the exciter for plane waves into the arm until fully seated and secure it with the knurled screw. Adjust the immersion depth by setting the height of the holder so that the bottom edge of the wave exciter just touches the water surface.
- Use two long cuboids and the short cuboid to create a double slit.
- Observe the interference patterns.

The interference patterns behind the double slit resemble those produced by the exciter for two interfering circular waves. According to Huygens' principle, circular wavefronts with identical frequency and amplitude are generated simultaneously at both slits (Fig. 5).

6.6 Determining the Wavelength

To determine the wavelength, the magnification factor *b* must be considered.

The magnification factor *b* can be calculated, for example, by placing the biconcave lens in the ripple tank and comparing its actual size *A* to the size of its image *A'* on the observation screen:

$b = A'/A$

The actual wavelength λ is then determined from the wavelength λ' measured on the observation screen:

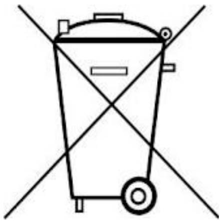
$\lambda = \lambda'/b$

7. Storage and maintenance

- Store the ripple tank in a dust-free place.
- Thoroughly dry the ripple tank after use to prevent it developing water stains and lime scale deposits.

8. Disposal

- The packaging should be disposed of at local recycling points.
- Should you need to dispose of the equipment itself, never throw it away in normal domestic waste. Local regulations for the disposal of electrical equipment will apply.



Appendix: Illustrations of the sample experiments

Wave generation

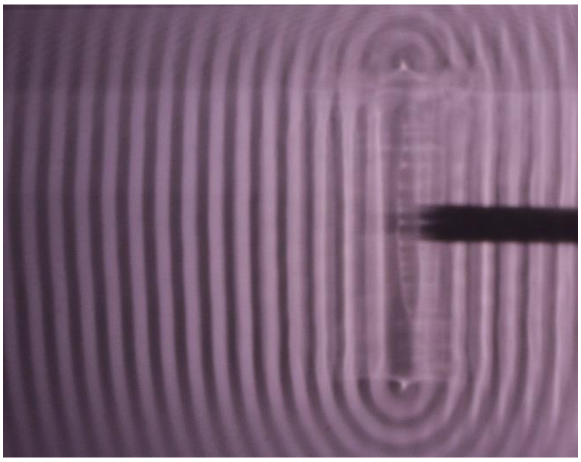


Fig. 1a: Generation of plane waves

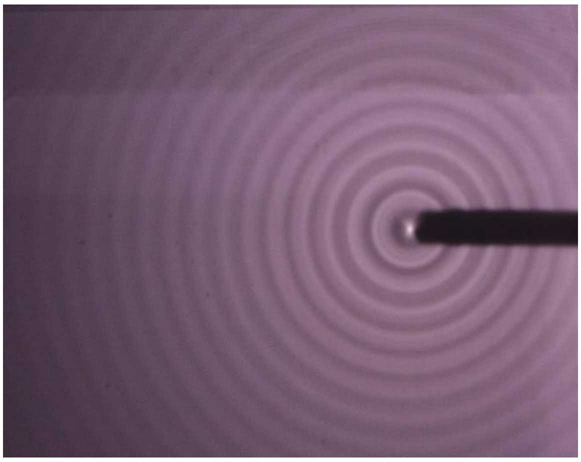


Fig. 1b: Generation of circular waves

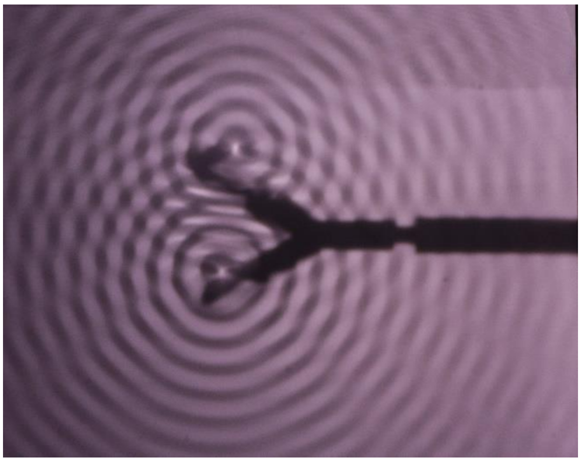


Fig. 1c: Generation of two interfering circular waves

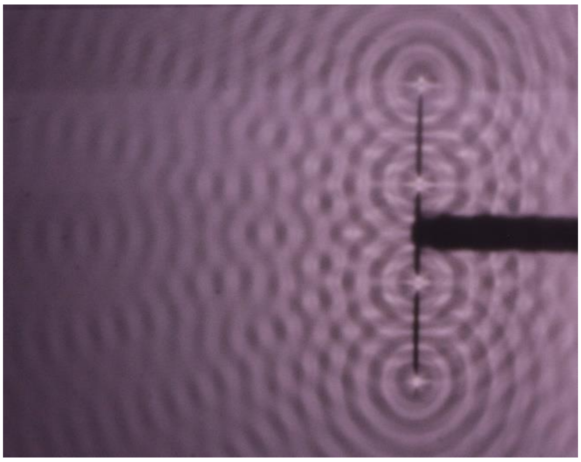


Fig. 1d: Generation of four interfering circular waves

Refraction

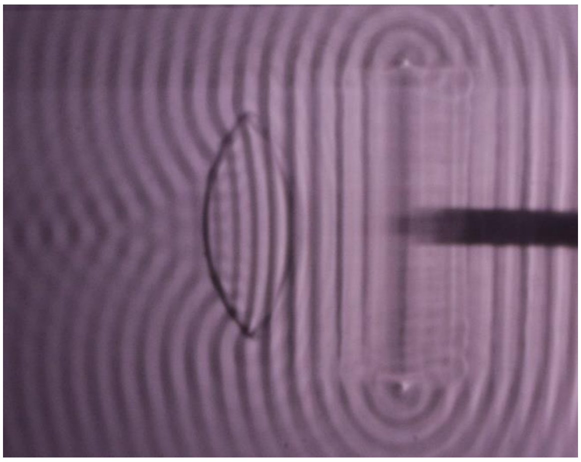


Fig. 2a: Refraction of plane waves at a biconvex lens

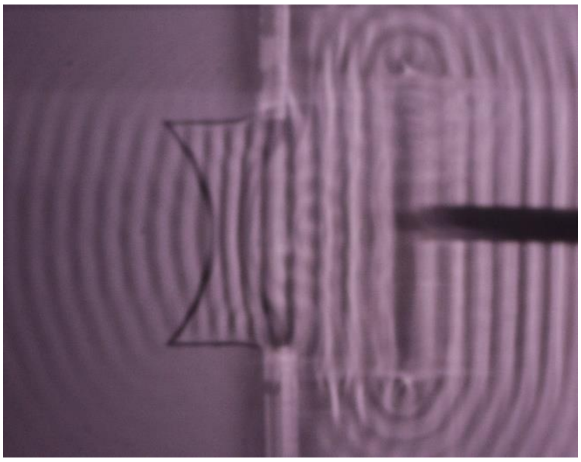


Fig. 2b: Refraction of plane waves at a biconcave lens. The front edges of the lens are shielded by two long cuboids placed upright to minimize unwanted edge effects such as diffraction and interference phenomena

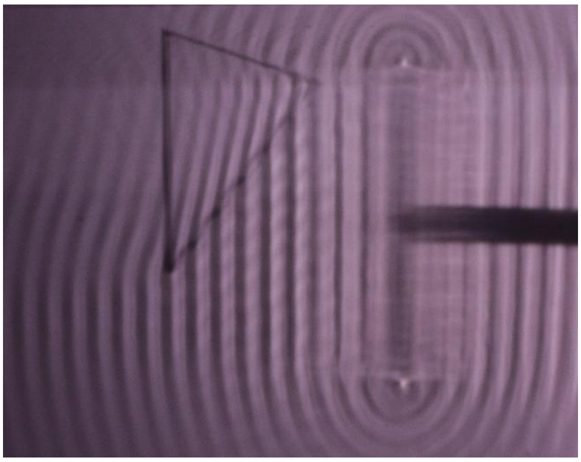


Fig. 2c: Refraction of plane waves at a prism

Reflection

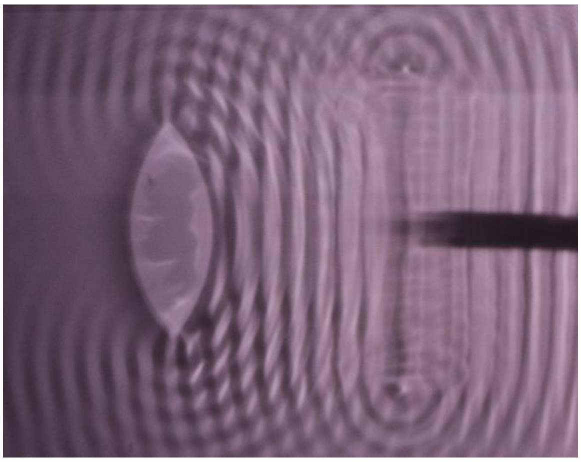


Fig. 3a: Reflection of plane waves at a biconvex lens

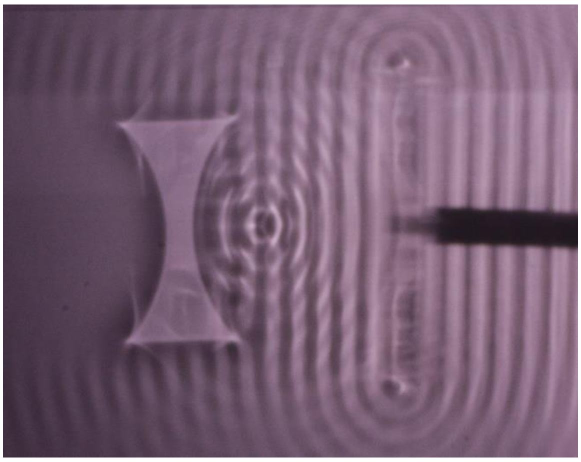


Fig. 3b: Reflection of plane waves at a biconcave lens

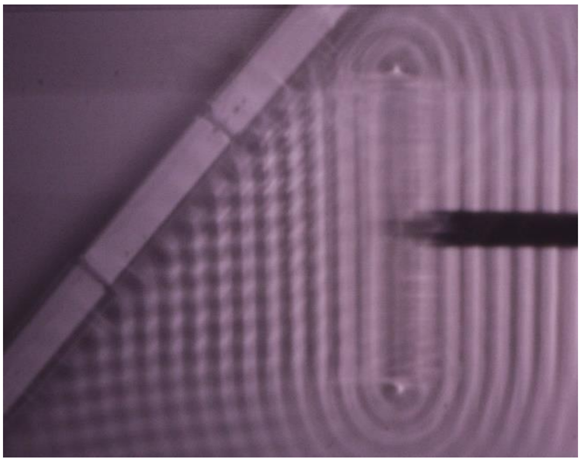


Fig. 3c: Reflection of plane waves at a straight obstacle

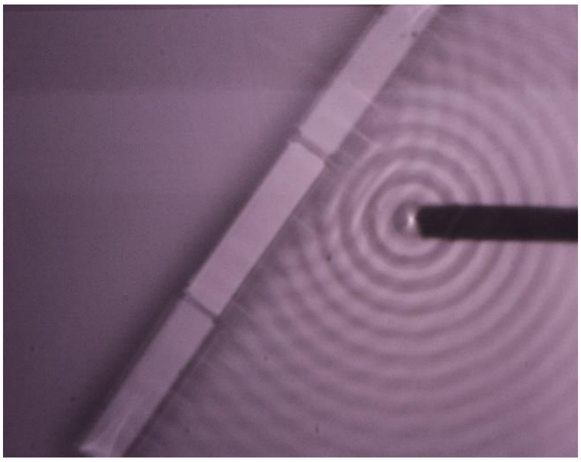


Fig. 3d: Reflection of circular waves at a straight obstacle

Diffraction

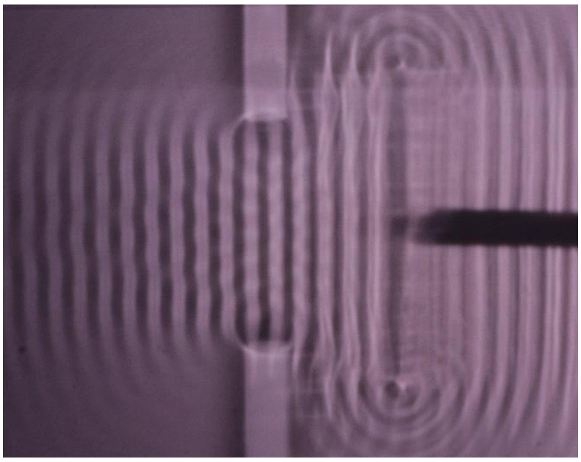


Fig. 4a: Diffraction of plane waves at a slit with a width significantly greater than the wavelength

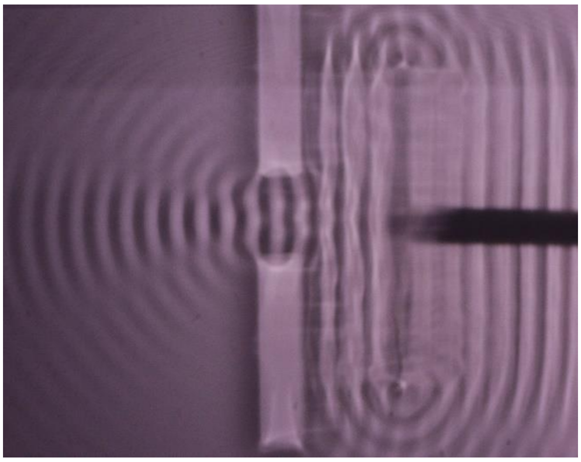


Fig. 4b: Diffraction of plane waves at a slit with a width slightly greater than the wavelength

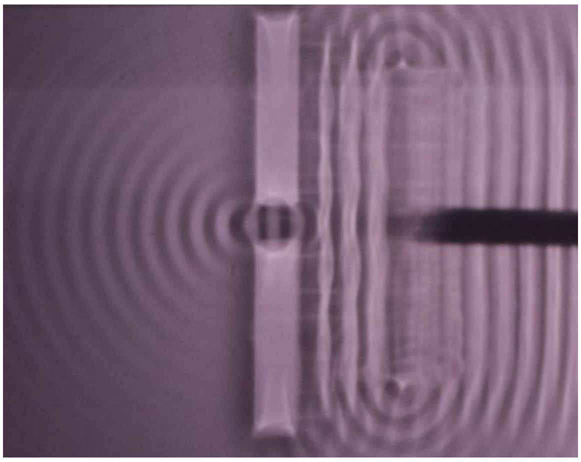


Fig. 4c: Diffraction of plane waves at a slit with a width smaller than the wavelength

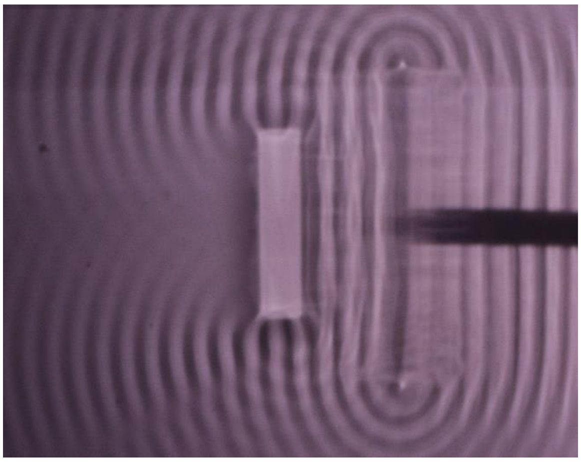


Fig. 4d: Diffraction of plane waves at the edges of a cuboid

Interference

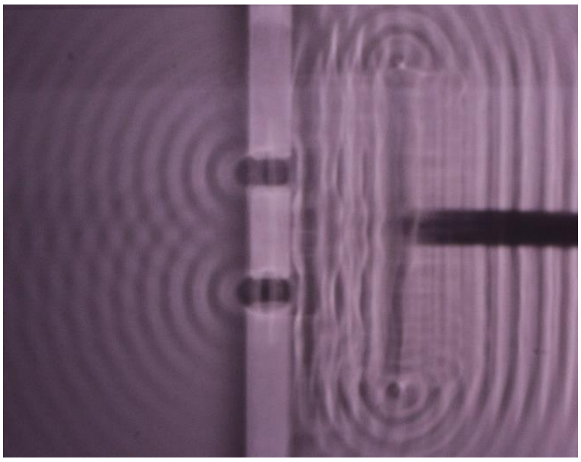


Fig. 5: Interference at the double slit