If the wave generator moves relatively to the propagation medium, a smaller wavelength than with a wave generator at rest results in front of the wave generator and a larger wavelength results behind the wave generator.

Materials

from the accessory set of 11260-99

1 Wave generator, single
1 Dipper

In addition, the following is also required

1 External vibration generator 11260-10

Method

First, circular waves are produced with a single wave generator (dipper), mounted to the external vibration generator and positioned to the centre of the wave tray. The wave generator is moved in a straight line to demonstrate the change in wavelength due to the Doppler effect.

Setup

The mounting rod with single dipper is fixed to the external generator (see Chapter 0.1). This is then placed on the side opposite the internal generator (Fig. 1) and is connected to the ripple tank with the two connection cables. The dipper is then moved as far as possible in the middle of the wave tank. (The integrated generator is not required in this experiment and can be turned to the side by loosening the generator head.)

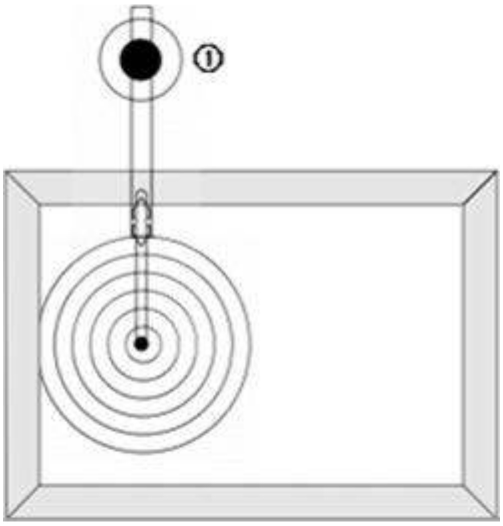

Figure 1: Experimental setup for demonstrating the Doppler effect. The external vibration generator ① with single wave generator is placed on the side of the wave tray.

Procedure

The following settings are made at the ripple tank:

Generator frequency:	5–25 Hz
Generator amplitude:	Step 1–3
Lighting mode:	continuous

The immersion depth of the dipper should be set so that it constantly dips into the water. It is necessary to ensure that the dipper dips into the water with a precise vertical movement in order to avoid distortions in the circular wave patterns. When a clear wave pattern can be recognised the external vibration generator is moved slowly and uniformly sideways (Fig. 2). A wave pattern is observed, as shown schematically in Fig. 2.

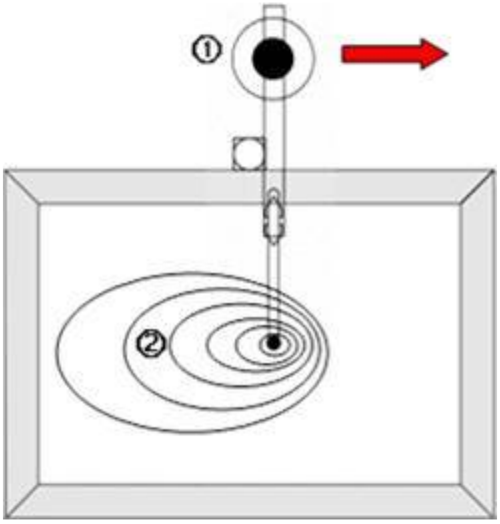

Figure 2: By moving the external vibration generator ① the familiar circular wave pattern alters to be distorted ②.

Results

It can be clearly seen that the waves emitted in the direction of the generator movement are shortened while the waves running in the opposite direction are lengthened (Fig. 3). Perpendicular to the direction of movement the wavelength remains unchanged.

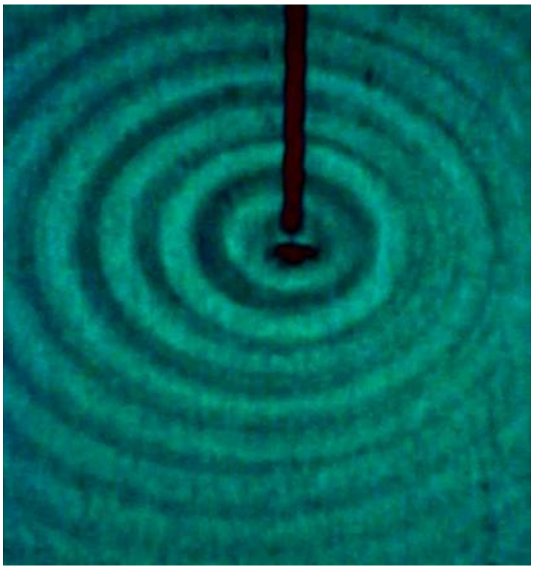

Figure 3: Snapshot as shown in Fig. 2. A wavelength reduction in the direction of movement (to the right) and an extension in the direction opposite to the direction of movement can be clearly seen.

Interpretation

A fixed wave generator which vibrates with frequency f_0 emits a continuous wave train with wavelength $\lambda = c/f_0$ ($c =$ propagation velocity of the wave in the medium). If the wave generator moves with speed v, it travels a distance vT during the period T. The wavelength λ_1 of the wave produced by the moved generator is shortened by this distance in front of the generator and is lengthened by the same distance behind the generator in accordance with

$$\lambda_1 = \lambda_0 \pm vT$$

or

$$\lambda_1 = \lambda_0 \left(1 \pm \frac{v}{c}\right). \quad (1)$$

The negative sign in this formula applies in the direction of movement in front of the generator, the positive sign applies behind the generator. The qualitative experiment result shown in Fig. 3 is compatible with these considerations.

Note

If the strobe lighting mode is applied in the demonstration of the Doppler effect, it is imperative to note that the observed pattern does not correspond to the physical fact reflected in formula (1). The wavelength change for the moved generator for the strobe lighting mode is also calculated from the real propagation velocity c of the water waves and not from the reduced propagation velocity perceived by the eye of the observer.