PHY19  Phase and group velocity

In the experiment, the phase and group velocity of an ultrasonic wave in water is investigated. The phase velocity is measured for several frequencies in dependence on the wavelength. The group velocity is determined by the measurement of the time of flight of a short ultrasonic pulse.

Related topics
Wavelength, frequency, phase velocity, time of flight, sound pulse, group velocity, frequency dependence, dispersion

The term dispersion describes the dependence of a wave characteristic of the wavelength and/or frequency. The characteristic/quantity investigated in the experiment is the phase velocity of an ultrasonic wave in water. For this, a hydrophone is moved along the sound axis of an ultrasonic probe. The hydrophone signal is set on an oscilloscope. By measuring the change in the probe-hydrophone distance and the respective number of phase runs at a fixed frequency \( f \), it is possible to determine the wavelength \( \lambda \) and thus the phase velocity \( c_P = \lambda \cdot f \). This measurement is carried out for several spacings and different frequencies.

To determine the group velocity, the ultrasonic generator is operated in pulse mode so that short ultrasonic pulses are generated from the multifrequency probe. By measuring the time of flight \( t \) of an ultrasonic pulse for a certain distance \( s \) between ultrasonic probe and hydrophone it is possible to determine the group velocity \( c_G = s / t \).

Equipment
- cw generator SC600 20100
- Hydrophone set 10451
- Multifrequency probe 20139
- Ultrasonic gel 70200
- Oscilloscope -

Results
For the measurement result shown in the diagram, the phase velocity was determined at 6 different frequencies, each time for 5 different spacings between multifrequency probe and hydrophone. For water, in the investigated frequency range (5-10 MHz), no dependence of the phase velocity on the wavelength was found. A value of 1485 m/s was determined as the group velocity (time of flight of the sound pulse: 67.3 µs, probe-hydrophone spacing: 10 cm).

Related experiments
- PHY04 Acoustic attenuation in liquids
- PHY10 Characteristics of sound field
- PHY20 Determination of focus zone