Physical acoustics – Numerical examples with acoustic waves

Vincent Laude

June 6, 2024

1 Relation between velocity and wavelength

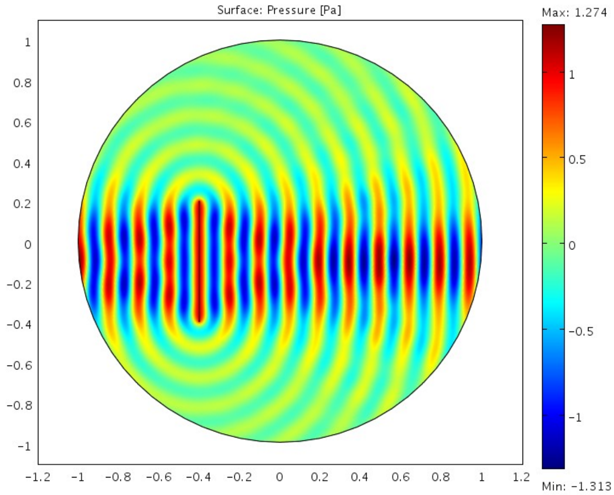
1.1 Please evaluate me

The wavelength is obviously related both to the phase velocity (or slowness) of the wave and to its frequency. Please fill in the following table.

Material	Data	Frequency	Wavelength?
Air	$c = 343$ m/s	1000 Hz	
Water	$c = 1480$ m/s, $\rho = 1000$ kg/m^3	1 MHz	
Mercury	$1/\chi = 28.5$ GPa, $\rho = 13534$ kg/m^3	150 kHz	

1.2 A finite element simulation for lazy scientists

What if I want to know about the acoustic beam emitted by a finite size transducer inside water? Ask the instructor!



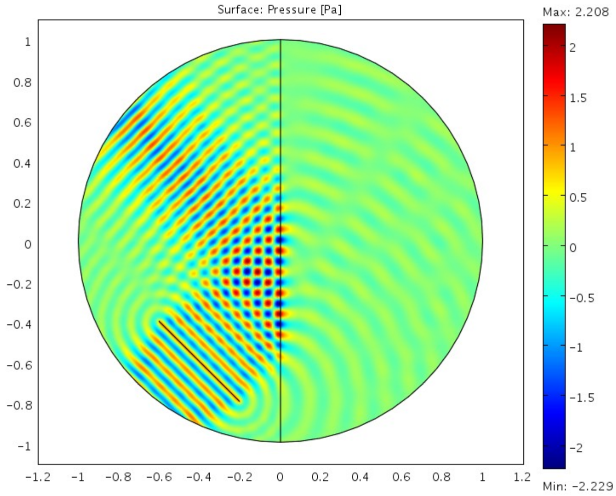
2 Reflexion and transmission

2.1 The traditional way

- Let us consider the interface between two different media A (water) and B (something else with the same density but a different velocity $c = 2000$ m/s). Let us draw the slowness diagram and determine the angle of refraction inside medium B when incidence is from medium A with angle of incidence 45°.
- What is the angle of incidence at which total internal reflection occurs?

2.2 The lazy scientist strikes again

Can the instructor show me what happens in the case of finite beams? Is it really true that there is nothing inside medium B in case of total internal reflection?



3 The simplest waveguide ever!

3.1 Please obtain my dispersion relation

I am a big tube full of air. My diameter is 40 cm. For simplicity, just assume that I am two-dimensional. Can you please draw my dispersion relation? [Note: have a look page 18 of the lecture]

3.2 Do evanescent waves appear that easily in numerical simulations?

Suppose I am exciting the air tube from the left side with an incoming pressure of 1 Pa in the form of a plane wave and that I am tuning the frequency. How can I "see" the evanescent waves that are not allowed to propagate inside the tube?