Backscattering suppression in a twisted water wave channel

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We study experimentally and numerically the propagation of water waves along a channel with two perpendicular turns, as shown in Fig. 1. When the wave reaches the first turn, there is a reflected wave (Fig. 1(left)). We show that it is possible to achieve total transmission in such geometries (Fig. 1(right)), in agreement with a recent theoretical prediction [1]. In order to avoid the reflection that naturally arises at that point of the waveguide, a simple metamaterial made of closely-spaced thin vertical plates is used. This metamaterial acts like a negative-refraction index medium, producing a waveshift across it.

This phenomenon is not restricted only to surface waves but also applies to any type of waves. Furthermore, the efficiency of this arrangement does not depend on the frequency of the incident wave, as long as its wavelength is much larger than the spacing between the plates. A similar problem has been studied before [2], showing that a submerged metabathymetry can be used to produce a reflectionless bent waveguide for small bending angles. The measurements of the free surface deformation are taken using the Fourier Transform Profilometry method [3] and are compared with simulations made with the Finite Element Method, showing a good agreement.

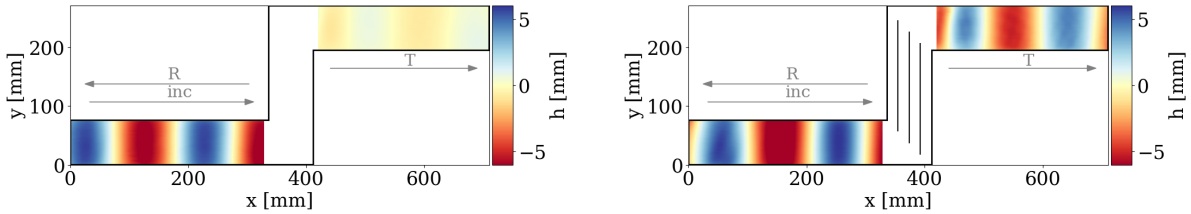

Figure 1: Experimental measurement of the free surface deformation at the forcing frequency for a configuration without (left) and with (right) the plate array metamaterial, showing the directions of the incident, reflected and transmitted waves.

[1] Porter, *Wave Motion* **100**, 102673 (2021).
[2] Berraquero et al., *Physical Review E* **88(5)**, 1–5 (2013).
[3] Cobelli et al., *Exp. in Fluids* **46(6)**, 1037-1047 (2009).