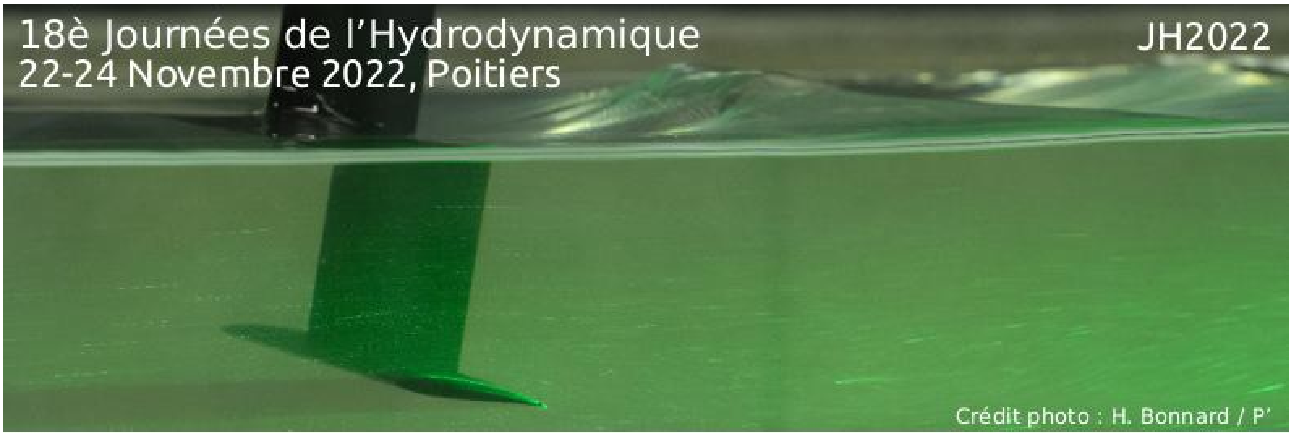

RESONATEUR DE HELMHOLTZ ANALOGUE POUR LES VAGUES

HELMHOLTZ RESONATOR ANALOGUE FOR WATER WAVES

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Résumé

Dans le contexte des vagues à la surface de l'eau, nous présentons une étude théorique et expérimentale sur un résonateur sub-longueur d'onde analogue à un résonateur de Helmholtz en acoustique. Comme son analogue, ce résonateur peut être utilisé comme dispositif capable de contrôler l'énergie de la houle. Nous illustrons, entre autres, sa capacité de réduire le taux de transmission, la rendant poche de zéro pour une fréquence spécifique (proche de la fréquence de résonance).

Summary

In the context of water waves, we present a theoretical and experimental study of a resonator with deep subwavelength resonance, analogue to the Helmholtz resonator in acoustics. As its acoustic analogue, this resonator can be used as the building block of devices able to control the energy flow of the swell. We illustrate its capability to reduce the transmission up to almost zero at a single frequency.

As a Helmholtz resonator in acoustics, our resonator is connected to the exterior thanks to a thin neck providing the mass in the mass-spring picture (see Fig.1). The spring, given by the air compressibility in acoustics, is provided by the dynamical boundary condition at the free surface within the cavity.

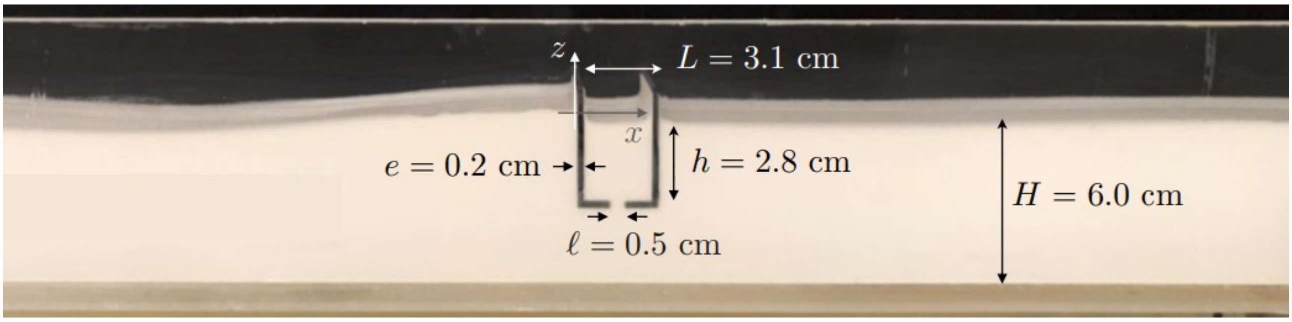

Figure 1. Picture of the experiment showing the resonator geometry in a wave guide. The red arrow indicates the direction of the incident wave.

An experimental demonstration of the shielding effect by a belt made of evenly distributed resonators is given. This shielding effect is shown in Fig.2 with the minimum of the transmission for a specific frequency. We then provide in-depth analysis of the Fano resonance resulting from the interference between the dock scattering (the background) and the resonant cavity scattering. This is done thanks to space–time resolved experiments which provides the complex valued scattering coefficients and amplitude within the resonator.

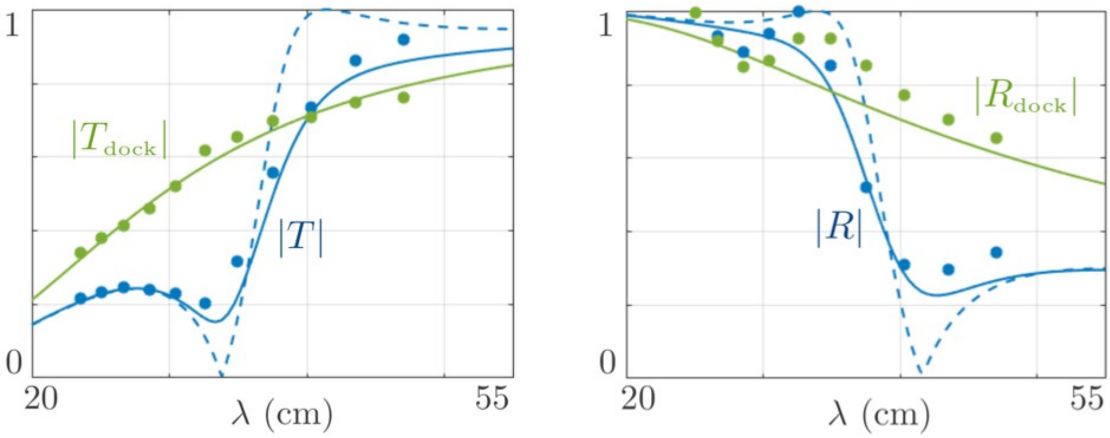

Figure2. Transmission (left) and reflection (right) coefficients versus the incident wavelength. Circles show the experimental measurements; dashed lines show the numerical results without losses and plain lines the numerical results with losses within the cavity.

Finally, we provide a one-dimensional model derived in the shallow water regime owing to asymptotic analysis. The model contains the two ingredients of the Fano resonance and allows us to exhibit the damping due to leakage. When adding heuristically the damping due to losses, it reproduces the main features of the resonance observed experimentally (Fig.2). Those results are reported in Euvé et al. [1,2].

Références

[1] L.P. Euvé, K. Pham, P. Petitjeans, V. Pagneux and A. Maurel, "Time domain modelling of a Helmholtz resonator analogue for water waves", *Journal of Fluid Mechanics*, Vol. 920, A22, 2021.

[2] L.P. Euvé, N. Piesniewska, A. Maurel, K. Pham, P. Petitjeans and V. Pagneux, "Control of the Swell by an Array of Helmholtz Resonators", *MDPI crystals*, Vol. 111, 520, 2021.