Towards broadband experimental wave index spatiotemporal modulation : Faraday waves in a modified gravity environment

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Finding a material capable of supporting arbitrary broadband spatial and temporal variations of its index would prove important for wave physics and its numerous applications [1]. Time-varying media physics is demanding for experimentalists because of the need for the index change to happen on smaller timescales than a wave period. Photonic and acoustic experiments are currently limited while a few experimental explorations have been fruitful using water waves with electrostriction and vertical vibration [2–5]. However, both methods are limited in either frequency range or integral displacement.

Here, we use a separation of scales method between high and low frequencies to provide a broadband index change actionable fast in front of the low frequency wave timescale. The mechanism is that found in the Kapitza pendulum. We measure and characterize the effect using Faraday waves.

In our one dimensional setup, an additional effect appears : the bath showcases resonances typical of the excitation of an elongated object under periodic excitation. A vibro-equilibrium of the fluid height emerges, and we can observe a gradient of Faraday wavelength.

In addition to time-variations, spatial structuration of the index in water waves was so far only possible using either bathymetry or spatially structuring electrodes with either limitations in damping or modulation amplitude. Lifting this limitation along with unlocking the additional degree of freedom in time opens up exciting new possibilities for broadband spatiotemporal wave physics.

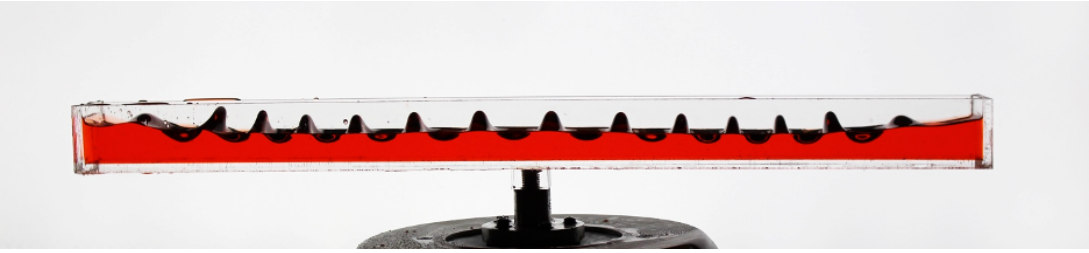

Figure 1. Colored Faraday waves gradient in an elongated 1D bath under high-frequency excitation. Experimental values : Faraday half-frequency at $f_F = f_E/2 = 8$ Hz, high frequency excitation at $f_h = 157$ Hz, bath length $L = 60$ cm.

Références

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