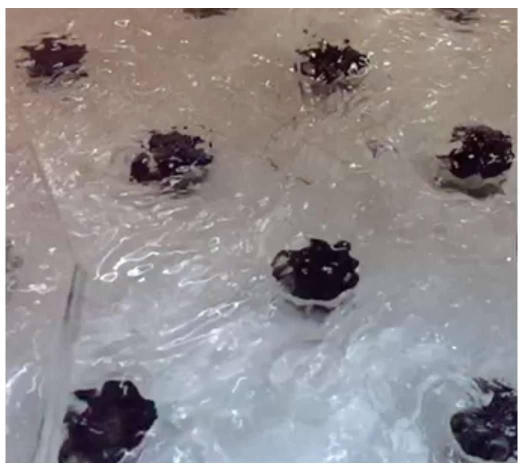
1) Wave-vortex interaction in a wave turbulence configuration:

Wave turbulence is an out-of-equilibrium steady state of nonlinear dispersive interacting waves where some conserved quantity of the wave system cascades through scales from the injection scale towards the dissipation one. One of the most common set-ups displaying such a state is the one where surface water waves propagate. Interestingly, it is also a system where vortex structures appear. Both wave and vortex interact constantly in the nonlinear regime, and have been studied in particular cases in recent years. Regrettably, in the case of the fully nonlinear case where wave turbulence and hydrodynamic turbulence are in interaction several open questions remain open: how does the cascade changes due to wave-vortex interactions? What is the typical scale of the wave turbulence dissipation? How does the vortex field modify its intensity due to wave-vortex energy transfer?

In this project you will measure the surface deformation of a layer of water generated by two wave makers. The container where the fluid rests is a 1 x 1 m^2 basin with an array of 16 impellers creating a vortex flow with a Reynolds number ~ 10^4. The goal of the project is to measure and quantify the effect of the vortex flow on the wave spatiotemporal spectrum and to compute its higher order cumulants (the so-called structure functions) and spectral functions (the so-called N-spectra). If there is enough time, theoretical and/or numerical calculations can be performed to model the observed effect using amplitude equations and/or kinetic equations in the weakly nonlinear regime.



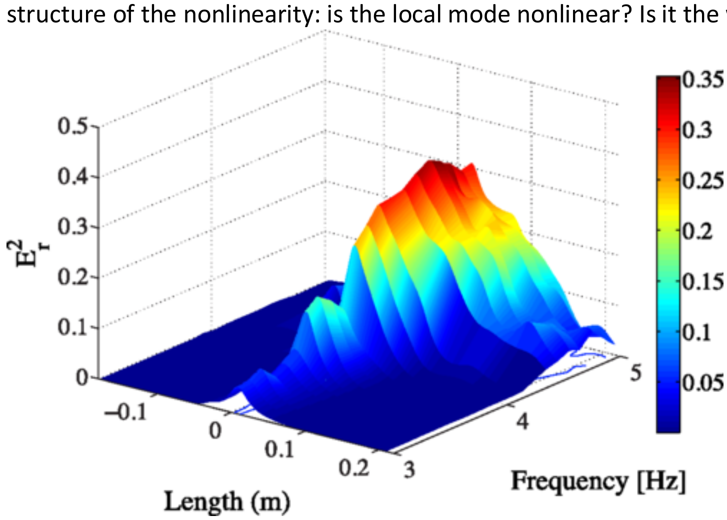
The research will be performed at the Matter Out of Equilibrium Laboratory of the Universidad de Chile (http://www.dfi.uchile.cl/investigacion/infraestructura-facilites/#lmfe).

For some examples of wave turbulence and wave-vortex interaction: Phys. Rev. E 80, 056213 (2009), Phys. Rev. Lett. 103, 174503.

Contact: Claudio Falcón cfalcon@ing.uchile.cl

2) Non-linear Fano resonances in water waves.

Fano resonances are one of the most common wave resonance phenomena in nature, where a localized (discrete) state interacts with an extended (continuum) one. It has been observed first in quantum mechanics, but since then it has been observed in acoustics, classical and quantum optics, plasma physics and geophysics. The typical feature of the resonance is an asymmetric resonance curve, which quantities the changes in the nature of the wave scattering process. In the case where non-linearities are present, the typical response of the coupled system depends strongly on the local structure of the nonlinearity: is the local mode nonlinear? Is it the wave propagation? Are both?.



In this project you will construct a one and two-dimensional periodic obstacle layer which will be deposited in a 1 x 2 m^2 wave tank filled with water up to a given height. In the long wavelength limit, the wave propagation will be determined by the local height of the water layer, generating a band structure. One of the obstacles will have a different height creating a local mode, which can be intrinsically nonlinear when the local depth is small compared with the wave amplitude. You will also measure the surface deformation field and construct the transmission and reflection coefficient as a function of the local nonlinearity.

The research will be performed at the Matter Out of Equilibrium Laboratory of the Universidad de Chile (http://www.dfi.uchile.cl/investigacion/infraestructura-facilites/#lmfe).

For some examples of localized modes: Phys. Rev. E 94, 031101(R) (2016)

Contact: Claudio Falcón cfalcon@ing.uchile.cl