Experimental study of a soliton gas

I.Redor[a*], H.Michallet[a], E.Barthelemy[a] and N.Mordant[a]

a. LEGI, CNRS, Grenoble-INP, Univ. Grenoble Alpes, France
* ivan.redor@univ-grenoble-alpes.fr

We study experimentally water surface gravity wave propagation in shallow water in a 36m long unidirectional glass-wall flume equipped with a piston-type wave-maker. The water depth is constant (h = 12cm) and the far end of the flume is a vertical wall where the waves can reflect. We measure with 7 cameras the water surface elevation along 14 meters with accuracy better than 1 mm at 20 frames per second.

We first compare our measurements to theoretical results in the simple cases of pair interactions between solitons.

Forcing continuously with a sinusoidal stroke at relatively low frequency (typically 0.6 Hz), the monochromatic wave generated at the wave-maker rapidly disintegrates into trains of solitons. The solitons reflect at each end of the flume, losing about half their amplitude through a flume length travelling distance. After multiple reflections of the first train, a soliton turbulence regime is reached (figure 1), in the sense that the wave energy is equally distributed along single straight lines in the wave number / frequency plane.

A similar regime has been observed in the ocean by Costa et al in 1. It can be viewed as a dense soliton gas theoretically described by the fully integrable Kaup-Boussinesq system of equation2.

We discuss the applicability of such a theoretical framework relatively to experimental dissipation.

A set of experiments has been conducted for different stroke frequencies, amplitudes and water depths. We show that the soliton gas regime is obtained in a certain range of the Ursell number.

[1] Costa et al, PRL 113, 108501 (2014)
[2] Dabbs et al, Physical review, E 67, 016306(2003)

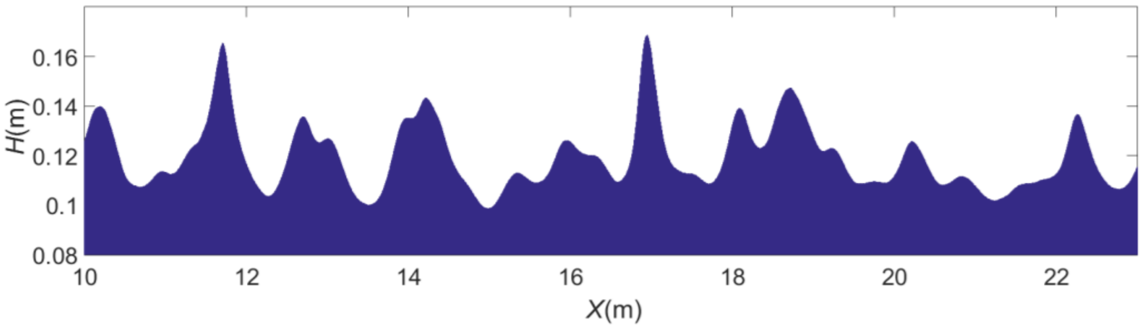

Figure 1: Surface elevation with distance from the wave maker in the soliton turbulence regime