Soliton gas in shallow water: Experiments in 1D and 2D.

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We will present the results of experimental realizations of soliton gas for propagation in 1D and 2D. The 1D soliton gas is observed in a 35 m long waveflume. Several practical concerns impact the generation of solitons. The waves are generated by a piston wavemaker. Shallow water solitons are KdV type of solitons. They require a fast forward motion of the piston to put water in the soliton followed by a slow receding phase so that no waves are generated in this phase. This restrict strongly the rate of generation of soliton. We rather use an alternative generation scheme that is inspired by the fission of a soliton from a sine wave as in the historical work of Zabusky & Kruskal [1]. A second concern is that we use a reflective condition at the end of the flume so that solitons move back and forth in the flume. Thus the theoretical framework is rather the Kaup-Bousisnesq equations [2] rather than KdV. We measure the water elevation resolved in space and time using a set of synchronized cameras over 14 m. We will present the statistical properties of such a soliton gas [3,4,5].

2D soliton gas were investigated in an experimental campaign in the Artelia LHF shallow water wave tank of in Pont de Claix (30 m$\times$ 27 m, 35 cm deep). Wave are generated by a set of 60 piston wavemakers disposed along one of the side walls. The theoretical framework of such 2D configuration is that of Kadomtsev–Petviashvili (KP) solitons [6]. Individual KP solitons are infinite line solitons which profile is similar to KdV solitons. However realization of such solitons in practice has to face several practical concerns when inclined with respect to the wall axes. First, space is limited so that the waves interact with walls. This results in very specific structures (Mach stems) along the walls. Second the extension of the wave maker is also finite so that some sort of nonlinear diffraction is observed at the end of the finite extension line soliton. Ideal KP line soliton do not exist in experiments. Surface elevation is measured using a stereoscopic reconstruction using 2 cameras (space and time resolved) as well as with a set of 30 localized wave gauges. We will present the statistical properties of shallow water wave turbulence when varying the forcing parameters resulting in either weak turbulence of dispersive waves or solitonic regimes. We will show the conditions for the observation of either regimes.

References

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