From wave turbulence to shock-wave regime: intermittency and Burgers turbulence

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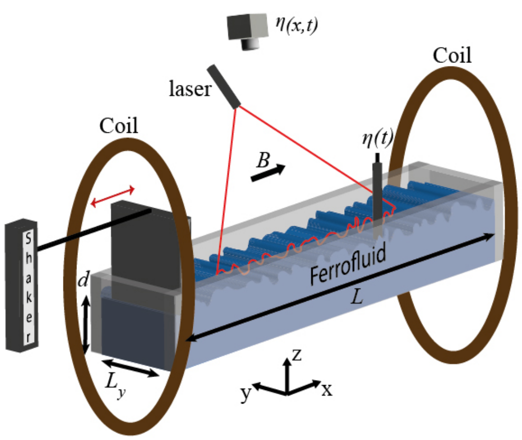
Wave turbulence is a statistical state in which numerous random weakly nonlinear waves interact with each other. It leads to an energy cascade (generally, from large scales down to small scales) driven by resonant interactions between waves [1]. This state has been recently evidenced experimentally in a one-dimensional canal for dispersive capillary waves on the surface of mercury [2].

Here, using a ferrofluid and a high external magnetic field, we report experimentally a transition from dispersive wave turbulence to a nondispersive regime involving coherent structures which are found to be shock-waves [3]. Such acousticlike structures are characterized by a significant steepening with a discontinuity close to shock-waves obtained from the Burgers equation. Because of their discontinuities, these shock-waves are rich in the frequency domain, and carry energy over the canal. They thus become the main mechanism building the wave energy spectrum. Finally, we have also found experimentally that this shock-wave regime generates a strong intermittency [4]. That is well described by the prediction from the Burgers turbulence [5].



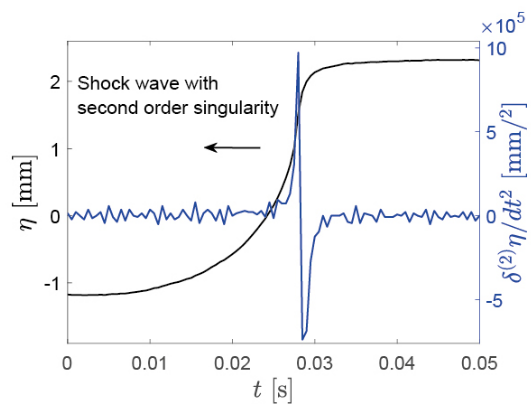


Figure 1. Left: Experimental setup used to obtained the shock-wave regime. Right: Temporal evolution of the surface elevation at a shock-wave, the strong steepening is evidenced by a δ-Dirac on the second-order difference of the signal.

References

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