Applicability of weak turbulence theory to capillary wave

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Abstract:

In this talk, new experimental results in parametrically driven capillary waves will be reported. We present experimental tests of the weak turbulence theory (WTT) of capillary waves [1] which include tests of the main assumptions of the WTT, scaling of the frequency spectrum of the surface elevation, the dependence of the spectral power density on the energy flux (forcing), and calculation of the energy transfer due to three-wave interactions.
The experimental setup is similar to that described in Ref.[2]. Waves are excited parametrically in a vertically shaken container. A circular container of the inner diameter of 14 cm filled with distilled water to a height of 17.5 mm is mounted on the top plate of the 4kN electrodynamic shaker (Brüel & Kjær Model TV 5550/LS 4KN). The container is shaken at the frequency of $f_0 = 60$ Hz which parametrically excites waves at the frequency of the first subhamonic $f_1 = 30$ Hz and many of its harmonics of smaller amplitudes. The forcing is varied in the acceleration range of $a = (0.5 - 3)g$. The surface elevation of the fluid is measured using the light diffusion technique and fast imaging of the fluid surface [3].
The frequency spectrum of the surface elevation agrees with the power law given by the WTT with the accuracy better than 5%. However, the integrated spectral power changes linearly with forcing, which contradicts the predicted $P_f \sim P^{1/2}$ scaling of the WTT. The spectral energy transfer analysis shows no nonlinear energy transfer in the generation of continuous spectrum, which contradicts to predictions of the WTT. The reason WTT is not applicable here may be the high dissipation in the capillary wave range. Energy input into the system due to the parametric excitation is distributed in the spectrum through the generation of higher harmonics. With the increasing energy input into the harmonics, their spectral width broaden, dissipating more energy locally. At higher accelerations, droplets are formed which may be the alternative energy dissipation mechanism. The continuous spectrum is generated as a result of the nonlinear broadening of the harmonics, possibly due to the interactions between quasisolitons.

References:

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