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Wave Turbulence in the Laboratory Flume: Frequency and Wave Number Spectra

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In a large laboratory flume (12 x 6 x 1.5 m) we study turbulence of high amplitude surface gravity waves with the non-linearity γ=0.1-0.2 (γ=$k\ \eta^{-}$, where k is the wave vector at energy maximum and η^{-} is rms of the wave elevation). The wave elevation was measured using simultaneously two different techniques - capacitance wire probes and wave profile images gathered using a fluorescent laser technique similar to (Mukto, Atmane, & Loewen, 2007). The capacitance probes allow us access to statistics on surface elevation and the frequency spectra at a point on the surface, while the images allow access to both of these and also the wave number spectra. A similar approach was used previously by (Lukaschuk, Nazarenko, McLelland, & Denissenko, 2009), however in this latest experiment we were able to gather images at such a frame rate (24 Hz) that the images were not only useful for wave number spectra but also frequency spectra in the gravity range time scale.

Waves were generated by an 8 paddle wave maker in the flume filled to 0.9 m depth. The wave maker controls the directional distribution, frequency and the intensity of the generated waves. Numerous records of data were taken to identify how the wave intensity and directional distribution of the waves affected the systems behaviour.

Two different boundary condition configurations were considered to compare how the spectra are dependent on boundaries and to ensure the repeatability regarding to our previous experiments.

In addition, a comparison between the images acquired and the capacitance probe signal data were made. Capacitance probes require arrays of them in order to measure multiple points and they are also invasive by their nature. The images on the other hand offer us the equivalent of a thousand point-like measurements and are non-invasive. The important point here is that images can offer a non-invasive method of obtaining space-time statistics and access to k-w spectra. The slopes of spectra and statistics of waves are calculated and compared with values predicted by weak wave turbulence theory.

1 References

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