Nonlinear Wave Interaction and Its Application to The Analysis of Measurements of Steep Ocean Waves

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In a steep ocean wave field, the interactions between free-wave components result in bound-wave components, which can have significant effects on resultant wave properties. Since the measurements actually record the resultant properties, the presence of bound-wave components makes it inaccurate to analyze the measurements of steep ocean waves based on linear spectral methods. To overcome this difficulty, Hybrid Wave Models (HWM) were developed recently. They distinguish the bound-wave from free-wave components in the decomposition of an irregular wave field as well as the prediction of its resultant properties. To ensure the convergence, the HWMs selectively use the conventional and phase modulation approaches to address the nonlinear interactions between free-wave components of different frequency ratios. The models are able to decompose a wave field accurately and hence it can predict the wave properties accurately and deterministically based on the time-series measurements at fixed points. Examples of their applications to the analyses of laboratory and field measurements are given to demonstrate the usefulness of HWMs to the analysis of ocean surface waves.