Ocean Wave Turbulence – from Theory to Computation

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Abstract

I seek a first-principle understanding of the stationary and invariant form of ocean wave spectrum based on wave turbulence theory, which describes the statistical property of an ensemble of waves in weakly nonlinear interactions. The starting point of the research is on capillary waves, which dominate the small-scale dynamics of ocean surface, playing important roles in ocean energy dissipation and air-sea interactions. Allowing triad resonant interactions, capillary waves represent a most fundamental system which yields a stationary wave turbulence spectrum. In theory, I reformulate the theoretical stationary solution of the capillary wave spectrum, with a new interpretation and correction on the value of the Kolmogorov constant, quantifying the proportionality between wave steepness and modal energy flux. In computation, I develop a numerical method to simulate the primitive Euler equations of the capillary waves. The simulations confirm the theoretical development, and additionally uncover the mechanism of nonlinear wave interactions at different nonlinearity levels. Inspired by the numerical results, a new model named “quasi-resonant kinetic equation” is developed, which incorporates the effect of nonlinearity level on wave turbulence spectrum.

The framework established in current research on capillary wave turbulence is expected to be extendable to different types of ocean waves. I present my vision in this direction, on the fundamental understanding and prediction of ocean waves.

Date: Monday, February 26th, 2018. 3:00 to 4:00PM
Location: University of Hawaii at Manoa, Holmes Hall Room 244
Parking Available at the UH Lower Campus Structure ($5.00 for the day).

Speaker Bio
Yulin Pan is a postdoctoral researcher in the mechanical engineering department at MIT. He received his Ph.D. in mechanical and oceanographic engineering from MIT in 2016, with a minor in mathematics. His research is primarily concerned with theoretical and computational hydrodynamics, with applications in the coastal and ocean environment. He has made original contributions in nonlinear ocean wave mechanics, tidal flows, propeller and bio-inspired foil propulsion. Alongside research, he is also an active writer on popular science of fluid mechanics.