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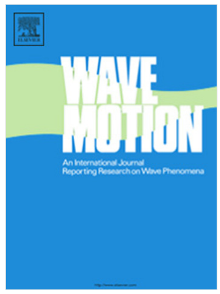

Wave turbulence and intermittency in directional wave fields

Elmira Fadaeiazar, Alberto Alberello, Miguel Onorato, Justin Leontini,
Federico Frascoli, Takuji Waseda, Alessandro Toffoli

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Wave turbulence and intermittency in directional wave fields

Elmira Fadaeiazar[a], Alberto Alberello[b,c,*], Miguel Onorato[d,e], Justin Leontini[a], Federico Frascoli[f], Takuji Waseda[g], Alessandro Toffoli[b]

[a] *Department of Mechanical and Product Design Engineering, FSET, Swinburne University of Technology, 3122, Hawthorn, VIC, Australia*
[b] *Department of Infrastructure Engineering, The University of Melbourne, 3010, Parkville, VIC, Australia*
[c] *School of Mathematical Sciences, The University of Adelaide, 5005, Adelaide, SA, Australia*
[d] *Dipartimento di Fisica Generale, Università di Torino, 10125, Torino, Italy*
[e] *INFN, Sezione di Torino, Via Pietro Giuria 1, 10125 Torino, Italy*
[f] *Department of Mathematics, FSET, Swinburne University of Technology, 3122, Hawthorn, VIC, Australia*
[g] *Department of Ocean Technology, Policy, and Environment, Graduate School of Frontier Sciences, The University of Tokyo, Tokyo, Japan*

Abstract

The evolution of surface gravity waves is driven by nonlinear interactions that trigger an energy cascade similarly to the one observed in hydrodynamic turbulence. This process, known as wave turbulence, has been found to display anomalous scaling with deviation from classical turbulent predictions due to the emergence of coherent and intermittent structures on the water surface. In the ocean, waves are spread over a wide range of directions, with a consequent attenuation of the nonlinear properties. A laboratory experiment in a large wave facility is presented to discuss the sensitivity of wave turbulence on the directional properties of model wave spectra. Results show that the occurrence of coherent and intermittent structures become less likely with the broadening of the wave directional spreading. There is no evidence, however, that intermittency completely vanishes.

Keywords: wave motion, wave turbulence, intermittency, structure functions, ocean waves

1. Introduction

A continuous energy cascade from large to small scales characterises isotropic and homogeneous turbulent hydrodynamic flows [1, 2, 3]. At small scales, away from the boundaries and in the limit of infinite Reynolds numbers, turbulence can be described by the scaling properties of the structure functions S_p. These are determined as the moments of the distribution of longitudinal velocity increments $\delta u(\tau) = u(t+\tau) - u(t)$ over small time separations τ [1, 2]: $S_p(\tau) = \langle|\delta u(\tau)|^p\rangle$, where u describes the flow velocity, t is the time, p denotes the order of the statistical moment and $\langle\cdot\rangle$ is the ensemble average. Note that reference to the time domain is made upon the Taylor's frozen turbulence hypothesis [4].

*Corresponding author
Email address: alberto.alberello@outlook.com (Alberto Alberello)