Available online at www.sciencedirect.com
ScienceDirect
Mathematics and Computers in Simulation 82 (2012) 1228–1238
MATHEMATICS AND COMPUTERS IN SIMULATION
www.elsevier.com/locate/matcom

Original Articles

Influence of the condensate and inverse cascade on the direct cascade in wave turbulence

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Received 7 November 2009; received in revised form 29 May 2010; accepted 7 July 2010
Available online 17 July 2010

Abstract

During direct numerical simulation of the isotropic turbulence of surface gravity waves in the framework of Hamiltonian equations formation of the long wave background or condensate was observed. Exponents of the direct cascade spectra at the different levels of an artificial condensate suppression show a tendency to become closer to the prediction of the wave turbulence theory at lower levels of condensate. A simple qualitative explanation of the mechanism of this phenomenon is proposed.

PACS: 47.27.ek; 47.35.−i; 47.35.Jk

Keywords: Wave turbulence; Condensate; Direct cascade

1. Introduction

Description of the water waves appeals scientists attention during several centuries. At the same time, first attempts to explain observed spatial and temporal spectra are relatively recent. One of the first and at the same time most famous works is the paper by Phillips [26] which was, probably, the first attempt to give an explanation for power-like spectra of surface gravity waves observed in numerous experiments. In just one decade statistical theory of water waves, based on the the kinetic equation for waves derived by Hasselmann [15] and solutions of this equation obtained from Zakharov's theory of wave (or weak) turbulence [33,41]. These solutions [37,41] are stationary Kolmogorov solutions of the kinetic equation corresponding to flux of energy from large to small scales (direct cascade) and flux of wave action (waves "number") from small to large scales (inverse cascade). Now the kinetic equation is a base tool for wave forecasting.

The Hasselmann kinetic equation for waves was derived under some assumptions, which include Gaussian statistics for the wave field and prevalence of resonant interactions [41]. These assumptions are subject to confirmation. Modern numerical methods allow us to perform wave field modeling in the framework of kinetic equations faster than the real processes in nature. At the same time, it is still not possible to create a wave forecasting model based on direct numerical simulation of the primordial dynamic equations. Fortunately, in practical applications we do not need to

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doi:10.1016/j.matcom.2010.07.009