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Book Review

Advances in Wave Turbulence Eds. V. Shrira and S. Nazarenko, World Scientific Series on Nonlinear Science, Series A, vol. 83, Series Editor Leon O. Chua, World Scientific, 2013; ISBN: 978-981-4366-93-9

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Wave turbulence (WT) is the study of the long-time statistical behavior of a dispersive waves which are involved in random weakly nonlinear interactions over a wide range of scales in various physical systems (Zakharov et al., Kolmogorov Spectra of Turbulence I: Wave Turbulence, Springer-Verlag, 1992; Nazarenko, Wave Turbulence, LNP, vol. 825 Springer, 2011).

The aim of the present book is to discuss the current challenges arising in WT and the attempt to relate more closely the mathematical understanding of the WT theory with the most recent observations in laboratory and Nature.

The book consists of seven lectures. Each chapter has been written by a specialist, or specialists in the respective discipline, and it is devoted to a specific field of applications, where WT is effectively inherent. It is written to be as self-sufficient as possible, broken into a series of 3–7 sections, with some sections divided into concise subsections. I found the text to be well written, relatively easy to read and very interesting. The authors conclude each chapter with remarks or open questions and a list of references.

Chapter 1 by A.C. Newell and B. Rumpf offers an overview of recent developments in the statistical theory of WT, with the detailed discussion of asymptotic closure of the BBGKY hierarchy of moment equations. The main properties of the kinetic equation and the nature of its solutions are briefly summarized. An existing experimental confirmations of WT are presented, including capillary waves, ocean gravity waves, waves on vibrating elastic sheets and photorefractive crystals. Two open questions are formulated dealing with the self-consistent wave turbulence closures. Both the setting up of a problems and their possible solutions are exhaustively discussed. A list of open challenges and two technical appendices close the chapter.

Chapter 2 by by S. Aumâıtre, E. Falcon and S. Fauve concentrates on the energy flux in WT. The striking feature of the cascades across the scales is reported, namely, the measurements show that the power driving gravity and capillary wave turbulence in a statistically stationary regime displays fluctuations much stronger than its mean value. Moreover, the reversed energy flux is observed with a quite significant probability. A thorough explanation of these phenomena requires separate investigations.

The third chapter by S. Galtier focuses on the astrophysical aspects of WT. The recent progress on WT for magnetized plasmas (MHD, Hall MHD and electron MHD) in the incompressible and compressible cases, is reviewed. The multiscale solar wind turbulence, and the coronal heating problem are discussed first. Then, the basic differences between WT in incompressible and weakly compressible MHD are sketched and the suitable kinetic equations are derived and analyzed. Several open questions regarding the Alfve′nic turbulence, the whistler mode turbulence etc., are also formulated.

Chapter 4 by S.K. Turitsyn et al. reviews the recent progress in optical wave turbulence (OWT). Very briefly, the OWT is defined as the WT of light and deals with situations involving the propagation of

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light in nonlinear media. In the OWT context, the characteristics of the one-stage Raman fiber lasers are investigated. Such device presents both an important nonlinear physical system and a photonic apparatus with the remarkable range of practical applications. The impact of OWT on spectra and coherence of radiation generated in fiber lasers is demonstrated. The significance of modulational instability, optical turbulence, and interaction of spectral condensate with turbulence for studying basic properties of such systems is elucidated.

Chapter 5 by G. Düring and N. Mordant pertains to WT in a thin elastic plate. The propagation of elastic waves in such plates is explored, using theoretical methods, numerical simulations and experimental studies. The theoretical background includes the Föppl-von Karman equations and the Boltzmann type kinetic equation for a 4-wave resonance processes. However, the numerical simulations and the experiments on WT on a thin elastic plate show that no wave action cascade is observed and the scaling of experimental spectra is not in agreement with the theoretical expectations. A thorough analysis of these issues needs the additional investigations.

Chapter 6 by R. Bedard et al. is a terse overview of the results on the gravity wave turbulence in laboratory experiments. The wave energy spectral components and the higher order statistics of the wave field are analyzed to describe both random weak waves and other dynamical factors (e.g. connected with the coherent structures, finite size effects, etc.). Also, the new experimental data on non-stationary wave turbulence in its rising and decay stages are presented and interpreted (see also Bedard R., Lukaschuk S., Nazarenko S. 2013. Non-stationary regimes of surface gravity wave turbulence. *Pis'ma v ZhETF* 97:529–535.).

The final chapter by V. I. Shrira and S. Y. Annenkov discusses perspective approaches for describing WT. The promising generalization of the direct numerical simulation (DNS) to describe random wave field is proposed. The analysis is based on the integro-differential Zakharov equation for the ensemble of a moderately large number of finite-size wave packed with random phases. Next, using the DNS formalism, the "fast evolution" of WT is examined. The last section is devoted to derivation of generalized kinetic equation without the assumption of quasi-stationarity. Personally, I found this chapter very good. As the supplementary material I recommend the paper by G. L. Eyink and Y. K. Shi "Kinetic wave turbulence" (2012. *Physica* D. 241 (18). 25; also: arXiv:1201.4067v2 [physics.flu-dyn] 28 May 2012).

As a whole, this book is of high-quality, numerously illustrated and can be recommended for the specialists in the field, the PhD students and all of readers who are interested in WT problems. The typographical aspect of the book is rather of good quality, although some misprints of secondary importance can be found (e.g. on p. vii–viii). The book will also be useful to academic teachers of nonlinear sciences.