KdV turbulence in shallow water

Efim Pelinovsky, Anna Sergeeva, Tatiana Talipova, and Ekaterina Shurgalina
Department of Nonlinear Geophysical Processes, Institute of Applied Physics and Department of Applied Mathematics, Nizhny Novgorod State Technical University, Nizhny Novgorod, Russia
email: pelinovsky@hydro.appl.sci-nnov.ru

Abstract:

The Korteweg-de Vries (KdV) equation is fully integrable model, and its solution can be obtained for infinity or periodic domain. Meanwhile some statistical properties of the wave field is convenient to find by direct numerical simulation of the KdV equation. There are two kinds of problems. The first is the evolution of the initially random wave field presented by the Fourier superposition of spectral components with deterministic amplitudes and random phases. The properties of the KdV random wave field are analyzed: transition to a steady state, equilibrium spectra, statistical moments, and the distribution functions of the wave amplitudes. Numerical simulations are performed for different Ursell parameters and spectrum width. It is shown that the wave field relaxes to the stationary state (in statistical sense) with the almost uniform energy distribution in low frequency range (Rayleigh-Jeans spectrum). The wave field statistics differs from the Gaussian one. The growing of the positive skewness and non-monotonic behavior of the kurtosis with increase of the Ursell parameter are obtained. The probability of a large amplitude wave formation differs from the Rayleigh distribution.
The second one is the study of the turbulence of soliton gaz. The characteristics of the solitons are not changed due to integrability of the KdV equation. But the statistical characteristics and the distribution functions of the wave field include extreme distribution vary with time. It is demonstrated that two soliton interaction decreases the third and forth moments characterized the skewness and kurtosis. Increasing of the density of solitons leads to the normalization of random processes.
The influence of the variable depth on the KdV turbulence is also considered.
Our publication in this field [1-4].

References:

1. E.Pelinovsky and A. Sergeeva (Kokorina), European Journal of Mechanics - B/Fluid 25, 425-434 (2006)

2. E. Pelinovsky and A. Sergeeva, Radiophysics and Quantum Electronics, 49, 7, 540-546 (2006)
3. A. Sergeeva, E. Pelinovsky and T. Talipova, Natural Hazards and Earth System Science 11, 323-330 (2011)
4. E. Pelinovsky, E. Shurgalina, A. Sergeeva, T. Talipova, G. El and R. Grimshaw, Physics Letters A 377, 272-275 (2013)