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KdV – turbulence and extreme waves in shallow water

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The Korteweg-de Vries (KdV) equation is an etalon equation for nonlinear water waves in shallow water. It is fully integrable model, and its solution with periodic boundary conditions can be presented through theta-functions. Meanwhile some statistical properties of the wave field is convenient to find by direct numerical simulation. There are two kinds of problems. The first is the evolution of the initially random wave field with a Gaussian spectrum shape. The properties of the KdV random wave field are analyzed: transition to a steady state, equilibrium spectra, statistical moments of a random wave field, 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 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.

The influence of the variable depth on the KdV turbulence is also considered. The probability of the extreme waves in shallow water within this model is analysed.