Freak waves at the surface of deep water

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Abstract

We present generalization of the improved Zakharov equation for the "almost" 2-D water waves at the surface of deep water. When considering waves slightly inhomogeneous in transverse direction, one can think in the spirit of Kadomtsev-Petviashvili equation for Korteveg-de-Vries equation taking into account weak transverse diffraction. Equation can be written instead of classical variables $\eta(x,y,t)$ and $\psi(x,y,t)$ in terms of canonical normal variable $b(x,y,t)$:

$$i\frac{\partial b}{\partial t} = \hat{\omega}_{k_x,k_y} b + \frac{i}{4}\hat{P}^+\left[b^*\frac{\partial}{\partial x}({b'_x}^2) - \frac{\partial}{\partial x}(b^{*\prime}_x \frac{\partial}{\partial x} b^2)\right] - \\ -\frac{1}{2}\hat{P}^+\left[b\cdot\hat{k}(|b'_x|^2) - \frac{\partial}{\partial x}(b'_x \hat{k}(|b|^2))\right].$$

This equation is very suitable for robust numerical simulation. Due to specific structure of nonlinearity in the Hamiltonian the equation can be effectively solved on the computer. It was applied for simulation of sea surface waving including freak waves appearing.