Collision of Breathers at Surface of Deep Water

A.I. Dyachenko[1,2], D.I. Kachulin[2*], V.E. Zakharov[1,2,3]

[1]Landau Institute of Theoretical Physics RAS, Chernogolovka, Russia

[2]Novosibirsk State University, Novosibirsk, Russia

[3]P.N. Lebedev Physical Institute RAS, Moscow, Russia

[*]e-mail address: d.kachulin@gmail.com

In the paper [1] authors applied canonical transformation to water wave equation not only to remove cubic nonlinear terms but to simplify drastically fourth order terms in Hamiltonian. This transformation explicitly uses the fact of vanishing exact four waves interaction for water gravity waves for 2D potential fluid. After the transformation well-known but cumbersome Zakharov equation is drastically simplified and can be written in X-space in compact way. This new equation is very suitable as for analytic study as for numerical simulation. At the same time one of the important issues concerning this system is the question of its integrability.

This work is devoted to numerical studies obtained in [1] equation. Numerical integration of the equation were conducted on the base of Runge-Kutta method 4th order accurate in time. The algorithm used library FFTW Fast Fourier transform.

Localized in space breather-type solutions with different group velocities and amplitudes were found by iterative Petviashvili method. Some evolution examples of these solutions were presented. Numerical simulations of collisions of such breathers were conducted on the base of implemented program. We study breather collision. Two or more spatially separated breathers with different group velocities and amplitudes were used as initial conditions. The evolution of the Fourier spectra in the collision process breathers shows behavior characteristic of integrable systems. Results of the simulations strongly support hypothesis of integrability of 2-D free surface hydrodynamics.

This work was fulfilled under foundation by Government of Russian Federation (Grant No. 11.G34.31.0035).

References

[1] A.I. Dyachenko, V.E. Zakharov, “On dynamical equation for water waves in one horizontal dimension”, European Journal of Mechanics - B/Fluids, In Press, 32, (2012) pp. 17-21.