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A new system of equations for nonlinear shallow water waves running simultaneously in the different horizontal directions

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This paper deals with the new approach to the evolution description of moderately long planar surface waves of small but finite amplitude. It is assumed that liquid is incompressible, its stationary flow is absent, characteristic horizontal lengths of disturbances and of the topography are larger and the thickness of unsteady viscous boundary layer is smaller than the fluid depth.

The input system of the hydrodynamics equations was reduced to one basic evolution equation for nonlinear perturbations of the free surface and two linear elementary auxiliary equations for a determination of the liquid horizontal velocity vector averaged over the layer depth. The velocity is contained in the main equation only in the terms of the second order of smallness. The suggested model is suitable for nonlinear waves running on any angles. Even in the case of an ideal liquid this approach is in essence easier than the known systems of equations, in which all equations contain both linear and nonlinear items (see, e. g., [1, 2]).

A validity of this procedure to the solution of a number of planar problems of the nonlinear disturbance transformation including the case of liquid with variable depth is shown with the help of numerical experiments. In particular the evolution of a cylindrical symmetrical solitary wave on the water with a constant depth was calculates. As expected, the water-level goes down behind the front of the wave and then slowly arises. Some solutions for other initial perturbations were found in basins with different topography. This work is supported by INTAS – SB RAS (Grant 06-9236), SB RAS (Program 4.2.2-07), and RFBR (Project 07-01-00574).

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