

## Bi-Directional Water Waves and Integrable High Order KDV Equations

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The Boussinesq system, arising as a result of the asymptotic expansion procedure applied to the Euler equations for the shallow water wave motion, is decomposed to a set of coupled equations for the right- and left-moving waves. It is shown that a non-uniqueness of such a decomposition can be used to derive a system, in which, to any order, one of the equations is dependent only on the main right-moving wave and has the form of the KdV equation with higher order corrections but, as distinct from the unidirectional case, with arbitrary coefficients. Some classes of solutions of the right-moving wave equation, which include impacts of all orders of the asymptotic perturbation expansion, are constructed via a new approach to the use of the L1e-Baeklund groups of transformations for the PDEs with perturbations.

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