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Solitary Wave Solutions with Non-Monotone Shapes for the Modified Kawahara Equation

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Abstract

The propagation of stationary solitary waves of the non-linear modified Kawahara equation is considered. The asymptotic boundary conditions admit the trivial solution along with the solitary wave type solution, which is a bifurcation problem. The bifurcation is treated by reformulating the problem into a problem for identification of an unknown coefficient from over–posed boundary data, in which the trivial solution is excluded. Making use of the method of variational imbedding, the inverse problem for the coefficient identification is reformulated as a higher–order boundary value problem. This approach to solving the fifth–order modified Kawahara equation is allowing identification of non–trivial solutions. The obtained boundary–value problem is solved by means of an iterative difference scheme, which is thoroughly validated. New traveling wave solutions with monotone and non-monotone shapes are obtained for different values of the problem parameters.

Keywords: Modified Kawahara equation; Solitary wave solution; Inverse problem; Coefficient identification; Numerical solution; Non-monotone shape

1. Introduction

The modified Kawahara equation was formulated first by Kawahara in [14]. This nonlinear equation has attracted attention due to the numerous applications in science and engineering. It plays an important role in the theory of fluid mechanics, optical fibers, biology, solid state physics, chemical kinematics, chemical physics, and geochemistry.

Lots of methods deal with obtaining exact and approximate analytic solutions of the modified Kawahara equation, see Biswas in [4], Yusufoğlu and Bekir in [21], Jabbari and Kheiri in [12], Araruna, Capistrano-Filho, and Doronin,

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