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Normal forms application for studying solitary wave solutions of non-integrable evolution systems

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Abstract

In this paper the problem of obtaining soliton-like solutions to the non-integrable evolution system is discussed. Self-similarity methods together with the normal forms technique are shown to provide significant information on the possibility that such solutions appear. Qualitative investigations, backed by the numerical simulation, are applied to a reactive hydrodynamic model. It is evidenced that this model has a one-parameter family of solitary wave solutions. In addition, the expressions for coefficients of the normal form, corresponding to dynamic systems with $(0, \pm i\Omega)$ degeneracy of the linear parts, are obtained.

Keywords: Nonlinear evolution equations; Group theory reduction; Normal forms; Localized traveling wave solutions

1. Introduction

There are a number of observations of solitary wave propagation in media possessing an internal structure on a mesoscale [1–5]. In contrast to the classical bell-shaped soliton, a typical localized wave pack, propagating in such media, has many-humped structure and either oscillating front or tail. This is due to non-local effects manifesting when the characteristic sizes of the elements of internal structure are comparable with the characteristic length of an initial perturbation. Mathematical models that include the effects of spatio-temporal non-locality usually contain dissipative terms. Therefore, it is rather impossible to use the inverse scattering problem technique [6], or the Hamiltonian formalism [7,8] to describe solitary waves propagation in structured media.

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