



The nonlinear BK system: Structure, stability and interaction of multidimensional solitons in complex dispersive media

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Abstract

The structure, stability and interaction of the multidimensional nonlinear waves and solitons forming on the low-frequency branch of oscillations in complex dispersive media are studied analytically and numerically on the basis of the nonlinear Belashov-Karpman (BK) system which includes the Kadomtsev–Petviashvili (GKP), the nonlinear Schrödinger (NLS) and the derivative nonlinear Schrödinger (DNLS) classes of equations and takes into account the generalizations relevant to various complex physical media including space plasma, atmosphere, hydrosphere and other complex dispersive media, associated with the effects of high-order dispersion corrections, influence of dissipation and instabilities. This is consistent representation of the both early known and new original results obtained by authors and also some generalizations in theory of the nonlinear waves and solitons in complex dispersive media. The analysis of stability of solutions is based on study of transformational properties of the Hamiltonian of the system. The structure of possible multidimensional solutions is investigated using the methods of qualitative analysis of proper dynamical systems and analysis of the solutions' asymptotics. The interaction of multidimensional solitons is studied numerically. So, we have considered the nonlinear wave processes in different complex physical media using general approach basing on the general BK system and have obtained the results on dynamics of the 2D and 3D solitons for different physical systems from uniform positions. Some applications of obtained results in plasmas and atmosphere are presented.

Recent Publications

1. Belashov V Yu, Vladimirov S V (2005) Solitary waves in dispersive complex media. Theory, simulation, applications. Springer Verlag 292.
2. Belashov V Yu, Belashova E S, Kharshiladze O A (2018) Nonlinear wave structures of the soliton and vortex types in complex continuous media: Theory, simulation, applications. Lecture Notes of TICMI. Tbilisi University Press 18:90.
3. Belashov V Yu, Belashova E S, Kharshiladze O A (2018) Classification of multidimensional solitary solutions of the GKP equation by use of qualitative and asymptotic analysis. J. Physical Chemistry & Biophysics 8:38.
4. Belashov V Yu, Belashova E S (2018) Hamiltonian analysis of stability and classification of multidimensional nonlinear wave structures of soliton type in space plasma. J. Astrophys. Aerospace Techn. 6:19.
5. Belashov V Yu, Kharshiladze O A, Rogava J (2018) Interaction of the multidimensional NLS solitons in non-uniform and nonstationary medium: modeling and stability problem. J. Astrophys. Aerospace Techn. 6:38.
6. Belashov V Yu, Belashova E S, Kharshiladze O A (2018) Problem of stability of multidimensional solutions of the BK class equations in space plasma. Advances in Space Research 62:65-70.

Key words: Nonlinear Waves, Multidimensional Solitons, Complex Dispersive Media, Theory, Numerical Simulation, Plasma, Atmosphere, Hydrosphere

Biographies

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Dr. Elena S. Belashova, PhD (Physics of Atmosphere and Hydrosphere). She is Associate Professor at the Kazan National Research Technical University named after A. N. Tupolev – KAI. She is author of 54 publications including 2 monographs. Main books: Solitons as Mathematical and Physical Objects. Kazan, KSPEU, 2006; Solitons: Theory, Simulation, Applications. Kazan, Kazan Federal University, 2016.

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Plenary Oral Talk

Theory and modeling of nonlinear wave processes and solitons in complex dispersive media