

ASTROPHYSICS AND PARTICLE PHYSICS

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Solitons' dynamics in regions with sharp gradients of basic parameters of propagation medium

We consider the problem of dynamics the multidimensional solitons which are described by the generalized Kadomtsev-Petviashvili (GKP) equation in complex continuous media with the varying in time and/or space dispersive parameters $\beta, \gamma = f(t, \mathbf{r})$. This problem is very interesting from the point of view of its evident applications in physics of the real complex media with the dispersion. For example, such situation takes place at propagation of the 2D gravity-capillary waves on surface of "shallow" water when β and γ are defined as $\beta = \frac{1}{2} \rho g (H^2 - 3\sigma^2 / \rho g)$ and $\gamma = \frac{1}{2} \rho g (H^2 - \sigma^2 / \rho g) - \frac{1}{2} \rho g (H^2 - \sigma^2 / \rho g)$ respectively and ρ is the density, σ is the coefficient of surface tension of fluid and $H = H(t, x, y)$ is the depth. In this case β and γ also become the functions of the coordinates and time. Similar situation takes place at evolution of the 3D FMS waves in a plasma in case of the inhomogeneous and/or non-stationary plasma and magnetic field when β and γ are the functions of the Alfvén velocity $v_A = f[B(t, r), n(t, r)]$ and the angle $\theta = \theta(t, \mathbf{r})$, namely $\beta = v_A^2 (c^2 / 2\alpha_0^2) (\cos^2 \theta - \sin^2 \theta / \alpha_0)$, $\gamma = v_A^2 (8\alpha_0^2) [B^2 / \alpha_0 - \cos^2 \theta^2 - \cos^2 \theta] + \cos^2 \theta$. Next interesting example is the dynamics of 2D solitons of the internal gravity waves (IGW) generated at heights of the F region of ionosphere by moving fronts of the solar terminator and solar eclipse (SE). In this case dispersive parameters β and γ are functions of the ionospheric parameters such as electron density, temperature, scale heights for the ions and neutral particles etc. which have sharp gradients in these regions. Here, the problem of study of multidimensional solitons dynamics with $\beta, \gamma = f(t, \mathbf{r})$ was solved in general and for above-mentioned applications. Fig. 1 shows the examples of numerical results for 2D solitons on shallow water with bottom in form of varying in space and time "step" and for 2D IGW soliton at heights of the ionosphere F region for such source as SE spot. The interpretation of results obtained is given in detail.

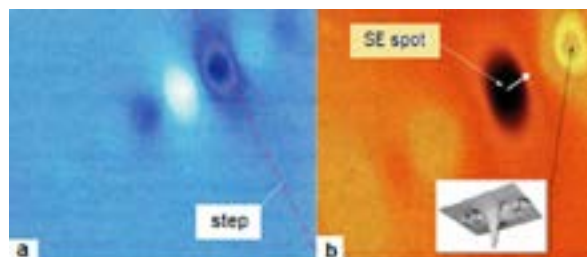


Figure 1: General view of 2D solution of the GKP equation: a) on shallow water with step on the bottom; b) on the frontal region of the SE spot at height of the maximum of the F region of ionosphere.

Biography

Vasily Yu Belashov has completed his PhD in Radiophysics and DSci in Physics and Mathematics. His main fields include theory and numerical simulation of the dynamics of multi-dimensional nonlinear waves, solitons and vortex structures in plasmas and other dispersive media. Presently, he is Chief Scientist at the Kazan Federal University. He was Coordinator of studies on the International Program "Solar Terminator" (1987-1992) and took part in Programs WITS/WAGS and STEP. He is author of 288 publications including 6 monographs.

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