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Numerical study of interaction of vortex structures in plasmas and fluids

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The results of numerical study of evolution and interaction of the vortex structures in a continuum and specifically, in plasmas and fluids in 2D approach, when the Euler-type equations are valid, are presented. The set of the model equations $e_i d_t x_i = \partial_{yi}$ H/B, $e_i d_t y_i = -\partial_{xi}$ H/B, $\partial_t \rho + \mathbf{v} \cdot \nabla \rho = 0$, $\mathbf{v} = -(\hat{z} \times \nabla \psi)/B$, $\Delta \Psi = -\rho$ describing the continuum or quasi-particles with Coulomb interaction models, where ρ is a vorticity or charge density and ω is a stream function or potential for inviscid fluid and guiding-centre plasma, respectively, and H is the Hamiltonian, was considered. For numerical simulation the CD method specially modified was used. The results showed that for some conditions the interaction is nontrivial and can lead to formation of complex forms of vorticity regions, such as the vorticity filaments and sheets, and also can be ended to form the turbulent field. The theoretical explanation of the effects is given on the basis of the generalized critical parameter which determines qualitative character of interaction. We investigated the applications of the results to dynamics of vortex structures in the atmosphere, hydrosphere and plasma, namely: evolution of the cyclonic type synoptic and ocean vortices which can be considered as a vorticity front, and interactions in the vortex-dust particles system, and also dynamics of charged filaments which represent streams of charged particles in a uniform magnetic field in 2D model of plasma of Taylor-McNamara. Our approach may be effective in studying of the atmospheric and Alfvén vortex dynamics, and useful for the interpretation of effects associated with turbulent processes in fluids and plasmas.

Biography

Vasily Yu Belashov has completed his PhD in Radiophysics and Doctor of Science in Physics and Mathematics. His main fields includes: 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 Professor in 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 and books: "*Solitary Waves in Dispersive Complex Media: Theory, Simulation, Applications*", Springer-Verlag GmbH, 2005; "*The KP Equation and its Generalizations. Theory and Applications*", Magadan, NEISRI FEB RAS, 1997.

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