Numerical Modeling of the Nonlinear Dynamics of the Ionospheric Wavy Structures and Fractal Vortices

Oleg Kharshiladze

E-mail: oleg.kharshiladze@tsu.ge
Department of Physics, Faculty of Exact and Natural Sciences,
Iv. Javakhishvili Tbilisi State University
3 Chavchavadze ave., Tbilisi 1079
Georgia

Investigation of the dynamics of the planetary scale wave structures is actual problem for the radio wave propagation in the ionosphere and also for generation of the electromagnetic fields. In the paper an interaction of the electromagnetic vortex structures in the magnetized dissipative ionospheric plasma, when the inhomogenenities of the equilibrium density and temperature of the medium, magnetic and collision viscosity and medium friction are taken into account, is investigated. The numerical analysis of such problem is complicated by two types of nonlinearities – scalar (caused by temperature inhomogeneity) and vector (due to convective motion of particles). Numerical experiments show, that dispersion effect and dissipation destroy the initial vortex, the small scale structures are created instead and the complicated distribution image of the perturbations' potential is obtained. Evolution process of the vortex structures in the medium can describe the turbulent state of the ionosphere. For this effect a possibility of Lagrange Chaos (chaotic advection) in two dimensional vortex structures in the ionosphere is studied. Numerical analysis of interaction of the different type structures with non-stationary flows shows that in the ionosphere the formation of the fractal structures is possible. The fractal character of the vortex shape should be taken into account at investigation of transport processes of the particles, heat, charge, field and electromagnetic waves propagation in the ionospheric medium. In ionospheric electromagnetic structures the possibility of the determined chaotic motion is verified by nonlinear Lorentz type system of equations obtained in this paper from the magneto hydrodynamic equations. Numerical analysis of this system gives the parameters of transition mechanisms from the order to chaos in the ionosphere. The obtained results can be used for interpretation of satellite observation data.