Modeling of the Zonal Flow Generation in Nonuniform Ionospheric Flows and Recurrent Analysis of the Satellite Data

Oleg Kharshiadze, Khatuna Chargazia

oleg.kharshiladze@gmail.com

[a] Department of Physics, Faculty of Exact and Natural Sciences, Iv. Javakhishvili Tbilisi State University, 3 Chavchavadze ave., 0179 Tbilisi, Georgia

[b] I. Vekua Institute of Applied Mathematics, Iv. Javakhishvili Tbilisi State University, 2 University str., 0143 Tbilisi, Georgia

[c] M. Nodia Institute of Geophysics, Iv. Javakhishvili Tbilisi State University, 1 Aleksidze str., 0160 Tbilisi, Georgia

Abstract

Near Earth space (ionosphere, magnetosphere) is characterized by complicated dynamics and for modeling of such processes, especially at conditions of external nonstationary impact (bow shock) it is very important an estimation of determined and stochastic parts of the dynamics, as well as the possibility of the generation of large scale wave and fractal structures.

In this work a physical model of the plasma perturbations for experimental data treatment and their physical and theoretical interpretation is obtained. In this model a nonlinear mechanism of interaction of the perturbations with spatially inhomogeneous space flows is considered. From this flows a zonal flow is energetically most important. Numerical simulation of formation of such large scale flows are carried out.

Time series of velocity flow and magnetic field components of the magnetospheric flows observed by THEMIS satellite mission are studied by virtue of nonlinear methods. For numerical treatment of these data a recurrent diagram method is used, which is effective for short data series. Recurrence is a fundamental feature of the dissipative dynamical systems, which is used for analysis of relaxation processes in the magnetotail. The results of nonlinear analysis of plasma perturbations for interpretation is compared with the signals obtained by Lorentz and Weierstrass function. By virtue of recurrent diagram method a fractal nature of experimental signals and dynamical chaos parameters. The results of satellite and numerical simulation data are compared.