DOI: 10.34854/ICPAF.52.2025.1.1.144

NUMERICAL SIMULATION OF ARTIFICIAL PLASMA ENTITIES IN THE GEOMAGNETIC FIELD *)

[1,2]Losseva T.V., [1,2]Urvachev E.M., [1,2]Goncharov E.S., [1,2]Lyakhov A.N.

[1]*Sadovsky Institute of Geosphere Dynamics RAS, Moscow, Russia, losseva@idg.chph.ras.ru*
[2]*Dukhov Automatics Research Institute, Moscow, Russia*

Interaction between plasma fluxes and geomagnetic field in the topside ionosphere and inner magnetosphere remains the key issue in the problem of solar-terrestrial interactions. The processes above are studied using active rocket experiments with explosive-type plasma generators with further analysis in the numerical experiments.

A number of works have simulated the Al plasma jet dynamics in the ionosphere with only qualitative coincidence with evidence on the geomagnetic field perturbation. The last have been obtained at the late phase of plasma entity evolution.

The efficiency of MHD models depends on the correct setup of the injection scenario, which, in turn, is determined from the inverse problem solution. In the inverse problem, we define initial plasma parameters from the evidence in optical channels[1,2].

We present the results of the 3D MHD simulation of the high-speed Al plasma jet interaction with a geomagnetic field. We use the injection scenario elaborated in our previous work. The results show geomagnetic field depression, excitation of Alfven waves, jet deceleration, and motion induction in the ambient plasma. We present the encouraging comparison of simulated results with ion density and magnetic field measurements in the North Star-II experiment.

The results are compared with an elongated simulation of jet expansion into the rarefied medium without a magnetic field [3].

References

[1]. Losseva T.V., Kosarev I.B., Poklad Yu.V., Lyakhov A.N., Zetser Yu.I., and Urvachev E.M. Numerical Simulations of the First Stage of Dynamics of a High-Speed Plasma Jet in Fluxus and North Star Active Geophysical Rocket Experiments // Plasma Physics Reports, 2022, Vol. 48, No. 10, pp. 1106–1110. DOI: 10.1134/S1063780X2260058X

[2]. Losseva T.V., Golub' A.P., Kosarev I.B., Poklad Yu.V., Lyakhov A.N., Zetser Yu.I. Characteristics of the plasma jet of the explosive type generator in the Fluxus experiments: measurements and numerical modeling // Dynamic Processes in Geospheres. 2021;(13):175-186. (In Russ.) https://doi.org/10.26006/22228535_2021_1_175

[3]. Urvachev E.M., Losseva T.V., Lyakhov A.N., Zetser Ju.I. Numerical Simulation of the Injection of High-Speed Plasma Jets into a Vacuum // Plasma Physics Reports, 2023, Vol. 49, No. 11, pp. 1300–1308. DOI: 10.1134/S1063780X23601426

*) abstracts of this report in Russian