EPSC Abstracts,
Vol. 4, EPSC2009-8, 2009
European Planetary Science Congress,

Europa's plasma environment: 3D hybrid kinetic simulation

A.S. Lipatov (1), J.F. Cooper (2)

(1) GEST Center UMBC/NASA GSFC, Code 673, Greenbelt, MD 20771, USA, (2) NASA GSFC, Code 672, Greenbelt, MD 20771, USA (alexander.lipatov-1@nasa.gov / Fax: 1-301-286-1648)

Abstract

The hybrid kinetic model approach supports comprehensive simulation of the interaction between different spatial and energetic elements of the Europa moon-magnetosphere system with respect to variable upstream magnetic field and flux or density distributions of plasma and energetic ions, electrons, and neutral atoms. This capability is critical to improved interpretation of the existing measurements for surface and atmospheric composition from previous missions and to planning of future missions.

The simulations are based on recent models of the atmosphere of Europa [1, 2]. The hybrid model allows us to take into account the finite gyroradius effect and to estimate correctly the ions velocity distribution and the fluxes along the magnetic field in opposite the MHD simulation with the Maxwellian velocity distribution for background and pickup ions. The hybrid model also allows us to investigate the effects of the electron pressure on plasma wake structure that was already done for Jovian torus Io interaction. In our model the background ions, all pickup ions, and ionospheric ions are considered as a particles, whereas the electrons are described as a fluid. Photoionization, electron-impact ionization and charge exchange are included in our model. The temperature of the background electrons and pickup electrons was also included into the generalized Ohm's law. We also take into account the collisions between the ions and neutrals. The background plasma contains only the ions with $M = 24$. The pickup ions were created from the atmosphere. The majority of O_2 atmosphere is thermal with an extended non-thermal population [1]. The moon is considered as weakly conducting body.

We use an implicit scheme for the time integration of the electromagnetic equations. For updating the particle's velocity and position we use a trapezoidal numerical scheme [3]. The computational resources were provided by the NASA Ames NAS Division (SGI-Columbia). In this report we discuss the first results of the hybrid kinetic simulation of Europa's environment, namely, the global plasma structures, e.g., the formation of the magnetic barrier, Alfvén wing, pickup ion tail etc., and the computed map for the ion flux on the surface of the moon.

References

[1] Cassidy, T.A., Johnson, R.E., McGrath, M.A., Wong, M.C. Cooper, J.F. (2007), *Icarus*, 191, 755-764.

[2] Shematovich, V.I., Johnson, R.E., Cooper, J.F., Wong, M.C. (2005), *Icarus*, 173, 480-498.

[3] Lipatov, A.S. (2002), The Hybrid Multiscale Simulation Technology. An Introduction with Application to Astrophysical and Laboratory Plasmas, Springer, Berlin, Heidelberg, New York, pp. 403.