EGU22-12904
https://doi.org/10.5194/egusphere-egu22-12904
EGU General Assembly 2022

Three-dimensional Particle-in-Cell (PIC) simulations of non-dipolar minimagnetospheres and comparison to the experiment.

Andrey Divin[1], Ildar Shaikhislamov[2], Igor Paramonik[1], Marina Rumenskikh[2], Daniil Korovinskiy[3], and Jan Deca[4,5,6]

[1]Saint Petersburg State University, Physics department, St. Petersburg, Russian Federation (andrey.div@gmail.com)
[2]Institute of Laser Physics,Laser Physics Department, Novosibirsk, Russian Federation
[3]IWF/ÖAW, Austrian Academy of Sciences, 8042 Graz, Austria
[4]Laboratory for Atmospheric and Space Physics (LASP), University of Colorado Boulder, Boulder, Colorado 80303, USA
[5]Institute for Modeling Plasma, Atmospheres and Cosmic Dust, NASA/SSERVI, California 94035, USA
[6]Laboratoire Atmosph`eres, Milieux, Observations Spatiales (LATMOS), Universite de Versailles a Saint Quentin, 78280 Guyancourt, France

Magnetospheres are formed when plasma flow interacts with an external source of the magnetic field. Objects (with a size comparable to or less than the ion inertial length or ion gyroradius) formed by relatively weak magnetic field sources are called minimagnetospheres since they are rather different from more common large planetary magnetospheres.

Moon surface has regions called Lunar Magnetic Anomalies (LMAs) where the remanent magnetization of the Lunar crust provides sources of the magnetic field strong enough to stand off the solar wind. These fields produce minimagnetospheres of the size of the several ion inertial lengths (or gyroradii) or below, typically having weakly structured topology and mostly non-dipolar nature. In this study, we combine numerical simulations and laboratory experiments to investigate ion scattering and basic properties of a non-dipolar minimagnetosphere. A series of laboratory experiments were carried out on the KI-1 facility (Novosibirsk, Russia) to investigate minimagnetosphere properties for the case of a quadrupolar magnetic field source. The experiment consists of a vacuum chamber, of 5 m length and 1.2 m diameter (with a residual pressure of ~10^{-7} Torr) filled with a moving plasma. The quadrupolar magnetic field is generated by two coils connected in anti-parallel. The experimental results are supported by the Particle-in-Cell (PIC) three-dimensional simulations using code iPIC3D which capture the full kinetic behavior of the interaction.

We report several important results based on both the experiment and numerical simulations: 1) a majority of particles is reflected by the Hall electric field formed due to the formation of the magnetopause electron current; however, a hotter portion of the inbound distribution also experiences magnetic deflection closer to the **B** field source; 2) reflecting electrostatic potential is smaller in the quadrupolar case (if compared to dipolar minimagnetosphere); 3) numerical simulations reproduce well the ion reflection pattern seen in the laboratory experiment, but simulations show slightly less reflected ions which might be attributed to unsteady processes

developing during each laboratory run.