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# Generalized magnetosphere model for planets possessing intrinsic magnetic field.

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## Abstract

In this presentation we present a summary of the results obtained during the work on the project "Developing a model of the magnetosphere of the solar system planet or an exoplanet with the participation of research organizations and universities of EU countries in the framework of multilateral cooperation in the Horizon 2020 program" (Europlanet 2020 Research Infrastructure). Four solar system planets have been chosen – Mercury, Earth, Jupiter and Saturn, which possess their own intrinsic magnetic fields which form a cavity free (or almost free) from the solar wind plasma - the magnetosphere. For several years all these planets had artificial satellites orbiting them and making direct measurements of the magnetic field.

## 1. Introduction

We present planetary magnetospheres models for all four planets in the Solar System which possess intrinsic magnetic field using the Paraboloid Model of the planetary magnetosphere, developed in SINP MSU.

Planetary magnetospheres retain their specificity, determined by both physical dimensions and specific details of the planetary system structure. In the small Mercury magnetosphere there is no ring current and radiation belts. On Earth, a plasma captured in a magnetic field forms a ring current around the planet, sometimes creating a strong decrease of the magnetic field horizontal component near the equator – the so-called magnetic storms. On Jupiter, one of the Galilean satellites, Io, which is the most volcanically active body in the Solar System, constantly ejects gas into the magnetosphere, forming the plasma torus, which evolves to the equatorial plasma disk. This effect becomes very important for the global structure of the magnetosphere. The plasma disk strongly distorts the dipole magnetic field of Jupiter, increasing the size of its magnetosphere by almost 2 times.

## 2. The Paraboloid model

The paraboloid model of the magnetic field is based on simple theoretical models of the interaction of the solar wind plasma with the planetary magnetic field. In addition to the possibility of experimental verification, the successful solution of the problem of constructing a universal model of the planet's magnetosphere is based on the universality of the interaction of the solar wind with the planetary field. In all four of the above cases, the magnetic field of the planet in the daytime magnetosphere is well described by the dipolar approximation. It has been successfully applied for all planets – Mercury [1], Earth [2], Jupiter [3], [4] and Saturn [5].

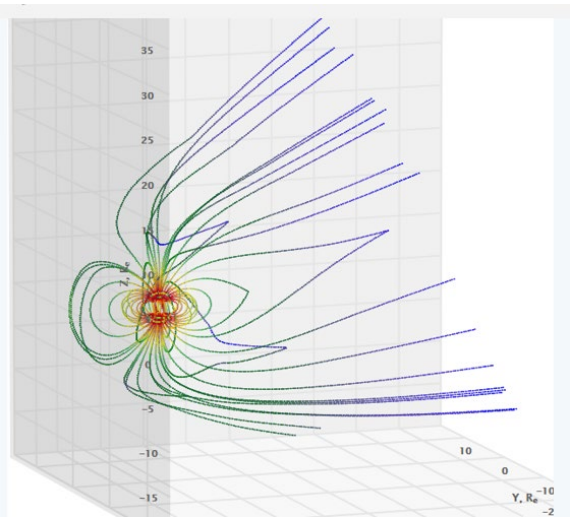


Figure 1: 3D model of the Earth magnetic field lines calculated with the Paraboloid model of the magnetosphere.

The paraboloid model has modular structure, which includes several magnetic field sources. These sources include: internal magnetic field, global current systems – magnetotail current sheet, magnetopause screening currents, ring current / magnetodisk and penetrating interplanetary magnetic field. For the particular planet the specific set of sources is chosen. This model allows one to calculate the magnetospheric response to variations in the solar wind dynamic pressure and magnetic field. For this reason, the magnetospheric global current systems are constructed depending on a small number of parameters, each with a clear physical meaning.

The models for all planets is available on the web-site: http://www.magnetosphere.ru/

## 3. Summary and Conclusions

Methods and technical principles for constructing a generalized model of the magnetosphere of the solar system planet with its own magnetic field have been created using the Paraboloid model of the magnetic field in the magnetosphere.


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## References


[1] Alexeev, I. I., Belenkaya, E. S., Yu. Bobrovnikov, S., Slavin, J. A., and Sarantos, M. (2008), Paraboloid model of Mercury's magnetosphere, J. Geophys. Res., 113, A12210, doi:10.1029/2008JA013368.

[2] Alexeev, I.I., Belenkaya, E.S., Bobrovnikov, S.Y. et al. Space Science Reviews (2003) 107: 7. https://doi.org/10.1023/A:1025542915800

[3] Alexeev, I. I. and Belenkaya, E. S.: Modeling of the Jovian Magnetosphere, Ann. Geophys., 23, 809-826, https://doi.org/10.5194/angeo-23-809-2005, 2005.

[4] Pensionerov, I. A., Alexeev, I. I., Belenkaya, E. S., Connerney, J. E. P., & Cowley, S. W. H. (2019). Model of Jupiter's current sheet with a piecewise current density. Journal of Geophysical Research: Space Physics, 124, 1843– 1854. https://doi.org/10.1029/2018JA026321

[5] Alexeev, I. I., Kalegaev, V. V., Belenkaya, E. S., Bobrovnikov, S. Y., Bunce, E. J., Cowley, S. W. H., and Nichols, J. D. (2006), A global magnetic model of Saturn's magnetosphere and a comparison with Cassini SOI data, Geophys. Res. Lett., 33, L08101, doi:10.1029/2006GL025896.