EPSC Abstracts
Vol. 5, EPSC2010-115, 2010
European Planetary Science Congress 2010

Salammbo : A Physical Model for Radiation Belts of Giant Planets.

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Abstract

For two decades, ONERA proposes studies about radiation belts of the magnetized planets. First, in the 90's, the development of a physical model, named Salammbo, carried out a model of the radiation belts of the Earth.

Then, for few years, analysis of the magnetosphere of Jupiter and in-situ data (Pioneer, Voyager, Galileo) allow to build a physical model of the radiation belts of Jupiter. In this model, many physical processes are including, like the radial transport, the interaction with rings and moons, the interaction with particles of atmosphere and cold plasmas. This model has been validated by comparison with in-situ data and with synchrotron emission [1] [2].
Deriving strength for its experience on the Earth and Jupiter, ONERA is now able to develop a radiation belt model for Saturn environment. Indeed, Saturn is similar to Jupiter in many respects, like composition, rocky nucleus and liquid hydrogen layer, satellites or rings. As a result, some physical processes governing the magnetosphere of Saturn are similar to Jupiter's ones.

In a first time, a library including the main magnetic field models of Saturn has been developed. This library contains also subroutines necessaries for magnetic parameters calculation (L, mlt, mirror point, …) and kronigraphic coordinates transformations.
Then, in-situ data permit to build a boundary condition at 6 kronian radii and physical processes governing the magnetosphere of Saturn have been integrated into the model.
Probes collected informations allow to build a model of the Saturn rings system [3] [4]. Physical processes generated are energy losses, absorptions and pitch angle diffusions of the electrons. Satellite effects have also been integrated to the model, taking into account that satellites are 'absorbent' objects.
Moreover, an OH cloud in the Saturn's magnetosphere was observed by the Hubble Space Telescope (HST) [5]. The Cassini-Huygens probe investigate the "missing" source of the neutral OH torus proposed by Jurac and al. [6]. This neutral torus plays an important part in the modelling of the radiation belts of Saturn.

Results of this preliminary study lead to an electron model of Saturn's radiation belts, including radial diffusion, rings effects, satellites effects and neutral torus effects on the physical processes. In-situ data will permit later to validate the model.

References

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