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A Physical Model of Electron Radiation Belts of Saturn

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Radiation belts causes irreversible damages on on-board instruments materials. That's why for two decades, ONERA proposes studies about radiation belts of magnetized planets. First, in the 90's, the development of a physical model, named Salammbô, 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. Enrolling on the Cassini age and thanks to all information collected, this study permits to adapt Salammbô jovian radiation belts model to the case of Saturn environment. Indeed, some physical processes present in the kronian magnetosphere are similar to those present in the magnetosphere of Jupiter (radial diffusion; interaction of energetic electrons with rings, moons, atmosphere; synchrotron emission). However, some physical processes have to be added to the kronian model (compared to the jovian model) because of the particularity of the magnetosphere of Saturn: interaction of energetic electrons with neutral particles from Enceladus, and wave-particle interaction. This last physical process has been studied in details with the analysis of CASSINI/RPWS (Radio and Plasma Waves Science) data. The major importance of the wave particles interaction is now well known in the case of the radiation belts of the Earth but it is important to investigate on its role in the case of Saturn. So, importance of each physical process has been studied and analysis of Cassini MIMI-LEMMS and CAPS data allows to build a model boundary condition (at L = 6). Finally, results of this study lead to a kronian electrons radiation belts model including radial diffusion, interactions of energetic electrons with rings, moons and neutrals particles and wave-particle interaction (interactions of electrons with atmosphere particles and synchrotron emission are too weak to be taken into account in this model). Then, to valid the model, Salammbô results have been compared with in situ data (Pioneer 11, Voyager 2 and Cassini data). In addition, Salammbô kronian model has been compared to an empirical radiation belts model named SATRAD (for SATurn RADiation model) based on Pioneer 11 and Voyager 2 data. Comparisons of Salammbô with in situ data and empirical model confirm that Salammbô is a good mean model for Saturn electrons radiation belts for energies from about hundred keV to a few MeV.