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A new physical model of the electron radiation belts of Jupiter: on the importance of the wave-particle interaction between Io and Europa

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From 1998 to 2004, ONERA has adapted its 3D physical model of the Earth radiation belts, Salammbô, to the Jovian electron belts. An upgraded Jupiter-Salammbô model will be presented, now taking into account the gyro-resonant interaction with the plasma waves between Io and Europa.

The full spectrum of the electromagnetic waves detected by the Galileo Plasma Wave Science experiment was considered. The WAPI (WAve-Particle Interaction) code, developed by ONERA and implementing the quasi-linear theory, has then been used to estimate the pitch angle and kinetic energy diffusion rates.

Regarding the boundary condition, the Galileo Energetic Particle Detector (EPD) high-resolution data suggests that the electron distribution at a Mc Illwain parameter of L=9.5 is almost isotropic, with a flux ratio between equatorial electrons and those bouncing near the loss cone lower than 5 at all the observed kinetic energies. We therefore adopted an isotropic boundary condition at L=9.5 that relies on the in-situ flux measurements coming from the Pioneer 10, Pioneer 11, Voyager 1 and Galileo missions.

We propose to model the radial diffusion process with a diffusion coefficient $D_{LL} = 10^{-10} L^4 s^{-1}$ for L extending from 1 to 9.5.

The validation of the new model against in-situ and remote (synchrotron emission) observations will be presented. We will then discuss the effect of the wave-particle interaction on the predicted in-situ fluxes. In particular, the observable depletions of the Pioneer and Voyager fluxes near the orbit of Io seem to be predominantly induced by the plasma waves and not by the sweeping effect of Io.