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Reconstruction of Chorus Type Whistler Wave Statistics in the Radiation Belts and Inner Magnetosphere Using Ray Tracing

Yuriy Zaliznyak (1,2), Hugo Breuillard (1), Oleksiy Agapitov (1,3), Vladimir Krasnoselskikh (1), and Guy Rolland (4)

(1) LPC2E/CNRS-University of Orleans, Orleans, France(vkrasnos@gmail.com), (2) Institute for Nuclear Research, Kiev, Ukraine, (3) Taras Shevchenko National University, Kiev, Ukraine, (4) CNES, Toulouse, France

The quasi-monochromatic whistler wave packets are formed in the vicinity of the magnetic equator and are frequently observed aboard Cluster spacecraft. The objective of our study is a reconstruction of realistic chorus emissions in radiation belts and in inner magnetosphere. To achieve this aim the data from the electric and magnetic field measurements onboard Cluster satellite is used to determine the major characteristics of the chorus signal around the equator region, namely, its averaged wave vector, wave vector distribution, Poynting flux and polarization. Then the propagation of such a wave packet is modeled in the framework of ray tracing technique using the original code which employs K. Rönnmark's WHAMP to obtain hot plasma dispersion function values along the wave packet trajectory. The observed ("real") rays at the equator are first fitted to the "initial" observed waveform using Cluster observations (initial conditions) and then these rays are propagated numerically through the inner magnetosphere in the frame of the WKB approximation. The density distributions of the magnetospheric particles are taken from the Gallagher et al. GCPM package that is provided by the authors and distributed as free software. Ray tracing allows one to reconstruct the properties of waves such as electric and magnetic fields, the width and the central wavenumber of the packet in k-space along the ray propagation path. The simulations take into account realistic effects of the spreading of the signal due to propagation in the inhomogeneous and anisotropic magnetized plasma, the dependence of signal propagation characteristics upon initial conditions, etc. Our calculations make it possible to follow the wave packets and calculate their properties in the desired regions, e.g. the regions where an efficient wave-particle interaction is expected to occur.