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CLUSTER observation of perpendicular ion-cyclotron waves and associated transport at the Earth's magnetopause

E.V. Panov(1,2), J. Büchner(1), M. Fränz(1), A. Korth(1), Y. Khotyainstev(3), K.-H. Fornaçon(4), H. Rème(5)

(1) Max-Planck-Institut für Sonnensystemforschung, Katlenburg-Lindau, Germany, (2) Space Research Institute, Moscow, Russia, (3) Swedish Institute of Space Physics, Uppsala, Sweden, (4) Technical University, Braunschweig, Germany, (5) Centre d'Etude Spatiale des Rayonnements, Toulouse, France

We observed that in many magnetopause crossings the magnetic turbulence surrounding the magnetopause current sheet is in its developed stage, i.e. with the same steepness over the frequency range of our observations (from ion-cyclotron up to lower-hybrid frequency). However, in some cases, the power spectra of the magnetic fluctuations have clear peaks at the local ion-cyclotron frequency and its harmonics. We analyzed the observed high-resolution magnetic and electric field fluctuations, as well as the ion distribution functions measured by the four CLUSTER spacecraft for crossing a magnetopause with a thickness of about 40 local magnetosheath proton gyro-radii. We found that the electromagnetic ion-cyclotron mode harmonics were excited at the whole magnetopause current sheet as well as throughout an adjacent boundary layer. The peak power of the observed fluctuations was up to about 20 nT^2/Hz. It exceeds the expectable one by at least one order of magnitude. Applying the phase differencing technique we have obtained that the waves propagate perpendicular to the magnetopause current sheet, towards the Earth. The ion distribution functions demonstrate that the ions move nearly-perpendicular to the magnetic field direction at a velocity corresponding to the phase speed of the observed waves, this way indicating the ongoing wave-particle interaction.