

In-situ observations of nonlinear wave particle interaction of electromagnetic ion cyclotron waves

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A direct measurement method for the electromagnetic wave and space plasma interaction has been suggested by a computer simulation study [Katoh et al., 2013], so-called Wave Particle Interaction Analysis (WPIA). We apply the WPIA to rising tone electromagnetic ion cyclotron (EMIC) waves (so-called EMIC triggered emissions), of which the generation mechanism is essentially the same as the chorus emissions. We use THEMIS observation data (EFI, FGM, and ESA) for this analysis. We calculate (1) the dot product of the wave electric field and the velocity of energetic protons (6.92 keV), W_{int} , (2) the dot product of the wave magnetic field and the velocity of energetic protons (6.92 keV), W_{Bint} , and (3) the phase angle between the wave magnetic field and the perpendicular velocity of the energetic protons. The values of (1) and (2) that we obtained from the THEMIS data indicate the existence of the resonant currents inducing the nonlinear wave growth and the frequency change, respectively. We find the negative W_{int} and positive W_{Bint} at the growing phase of the triggered emission as predicted in a nonlinear wave theory [e.g. Omura and Nunn, 2011, Shoji and Omura, 2013]. The histogram of (3) shows the existence of the electromagnetic proton holes in the phase space generating the resonant currents. We also perform a hybrid simulation and evaluate the WPIA method for EMIC waves. The simulation results show good agreement with the in-situ THEMIS observations.