

Nonlinear wave particle interaction of electromagnetic ion cyclotron wave

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Spacecraft observations and simulations show generation of coherent electromagnetic ion cyclotron (EMIC) triggered emissions with rising-tone frequencies. In the inner magnetosphere, the spontaneously triggered EMIC waves are generated by the energetic protons with large temperature anisotropy. We reproduced EMIC triggered emissions in the Earth's magnetosphere by real scale hybrid simulations with cylindrical magnetic geometry. We perform parametric analyses of electromagnetic ion cyclotron (EMIC) triggered emissions on the gradient of the non-uniform ambient magnetic field using a hybrid simulation. According to nonlinear wave growth theory, as the gradient of the ambient magnetic field becomes larger, the theoretical threshold of the wave amplitude becomes larger although the optimum wave amplitude for nonlinear wave growth does not change. With a larger magnetic field gradient, we obtain coherent rising tone spectra because the triggering process of the EMIC triggered emission takes place only under the limited condition of the wave amplitude. On the other hand, with a smaller magnetic field gradient, triggering of the emissions can be caused with various wave amplitudes, and then the sub-packets are generated at various locations at the same time. The concurrent triggerings of emissions result in incoherent waves, observed as "broadband" EMIC bursts. Broadband emissions induce rapid precipitation of the energetic protons into the loss cone since the scattering by the concurrent triggering takes place faster than that of the coherent emissions. The coherent triggered emission causes efficient proton acceleration around the equator because of the stable particle trapping by the coherent rising tone emission.

Keywords: triggered emission, electromagnetic ion cyclotron wave, wave particle interaction, acceleration, scattering