Generation of broadband electromagnetic ion cyclotron emissions through nonlinear processes in the inner magnetosphere

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In the inner magnetosphere, electromagnetic ion cyclotron (EMIC) triggered emissions have been observed as coherent rising tone EMIC waves. We have calculated the theoretical threshold and the optimum wave amplitude those are the lower and upper limit of the nonlinear wave growth of the triggered emissions. We have also shown that the triggered emission is the repetition of the generation of sub-packets. To understand the relation between the wave spectra and these amplitudes, we perform the parametric analyses of the EMIC triggered emissions on the gradient of the non-uniform ambient magnetic field by the hybrid simulations. According to the nonlinear wave growth theory, as the gradient of the ambient magnetic field becomes larger, the gap between the threshold and the optimum wave amplitude becomes smaller. With larger gradient of the ambient magnetic field, we obtain clear rising tone spectra. This is because the triggering process of the EMIC rising tone emission takes place under the limited conditions of the wave amplitude. In a case that the theoretical threshold exceeds the optimum wave amplitude, the nonlinear wave growth cannot takes place, and thus we only obtain the linear EMIC wave growth. With the large gap of the amplitudes, on the other hand, the generation of the sub-packets can be caused with various wave amplitudes during the nonlinear wave growth. Then, we obtain broad-band EMIC waves when we assume small gradient.