Particle simulation of rising tone emissions triggered by waves with different amplitudes

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VLF triggered emissions are generated through a resonant interaction by artificially injected triggering wave in the equatorial region of the Earth's magnetosphere [1]. However, the condition for generation of the triggered emissions is less understanding. The simulation study was carried out by full particle code for generation of triggered emissions, which successfully reproduced triggered emissions [2]. In the study, we perform a parametric simulation with different amplitudes of triggering waves and different densities of energetic electrons, and they are compared with a recently developed theory for triggered emissions [3].

Figure 1 shows frequency-time power spectrogram of triggered emission at the equator in the simulation. The whistler mode triggering waves with constant frequency are injected at the equator. The waves show a growth through cyclotron interaction with resonant electrons as propagate away from the equator. Then the phase-organized resonant electrons formed by triggering waves induce a resonant current nonlinearly, and excite newly rising triggered emissions. With different triggering wave amplitudes greater than the threshold for the nonlinear wave growth [3], triggered emissions are successfully excited near the equator. However, triggering waves below a threshold show no excitation of triggered waves. For the triggered emissions, we obtain fine structures of waveforms in detailed time resolution. The time evolutions of amplitudes and frequencies of the triggered emissions are similar in all case that triggered emissions are successfully excited. The frequencies increase as amplitudes of triggered emissions increase gradually, and the amplitudes are saturated eventually. Theoretical study found an optimum amplitude of triggering waves for rising triggered emissions [3]. The amplitudes of the triggering waves satisfy the optimum amplitude condition for which rising triggered emissions can attain the maximum wave growth. We also performed a simulation with different density ratio of the energetic electrons to the background cold electrons, with constant amplitudes of triggering waves. As the density ratio increases, the triggered emissions are more frequently excited and the wave amplitudes grow significantly. The frequency sweep rates drastically increase with increasing density ratio.

The simulation study clearly showed that amplitude and frequency sweep rate of triggered emission do not depend on an amplitude of triggering wave, although depend on density of resonant electrons strongly.

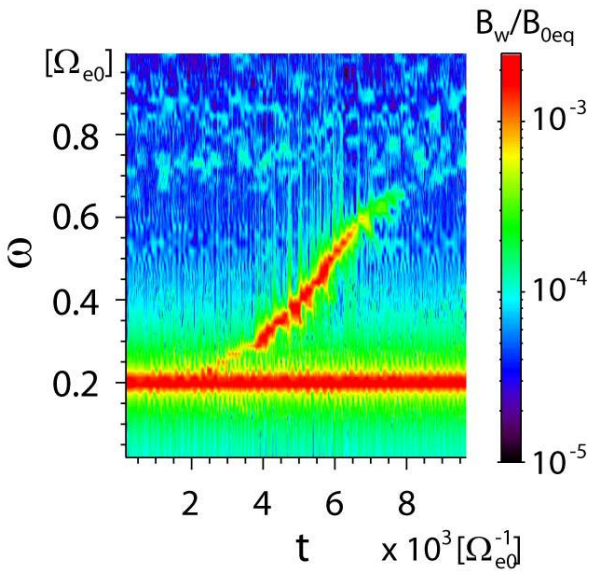

Figure 1: Frequency-time spectrogram of triggered emission.

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2. References

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