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Nonlinear Wave Growth Processes of Whistler-mode Chorus and Hiss Emissions in the Earth's Magnetosphere

Yoshiharu Omura[1]

[1] Research Institute for Sustainable Humanosphere, Kyoto University

e-mail (speaker): omura@rish.kyoto-u.ac.jp

Nonlinear processes associated with the generation process of whistler-mode chorus emissions are summarized [1]. The nonlinear dynamics of energetic electrons interacting with a coherent whistler-mode wave is described in terms of the pendulum equation, resulting in the formation of electromagnetic electron holes or hills in the velocity phase space. There also occurs the anomalous trapping of resonant electrons at low pitch angles. In the presence of the inhomogeneity due to the frequency variation and the gradient of the magnetic field, the electron holes or hills result in resonant currents generating rising-tone emissions or falling-tone emissions, respectively. After formation of a coherent wave at a frequency of the maximum linear growth rate, triggering of the nonlinear wave growth takes place when the wave amplitude is above the threshold amplitude. The wave grows to a level close to the optimum wave amplitude as an absolute instability near the magnetic equator. It is necessary for the triggering point of new emissions to move upstream from the equator. The nonlinear growth rate at a position away from the equator is derived for a subtracted Maxwellian momentum distribution function with correction to the formula in the past publications. The triggering process is repeated sequentially at progressively higher frequencies in the case of a rising-tone emission, generating subpackets forming a chorus element [2]. With a higher plasma density as in the plasmasphere, the triggering of subpackets takes place concurrently over a wide range of frequency forming discrete hiss elements with varying frequencies [3]. The mechanism of nonlinear wave damping due to quasi-parallel propagation from the equator is presented, which results in the formation of a gap at half the electron cyclotron frequency, separating a long rising-tone chorus emission into the upper-band and lower-band chorus emissions [4]. The theoretical formulation of an oblique whistler mode wave and its interaction with energetic electrons at the *n*-th resonance is also presented along with derivation of the inhomogeneity factor.

References

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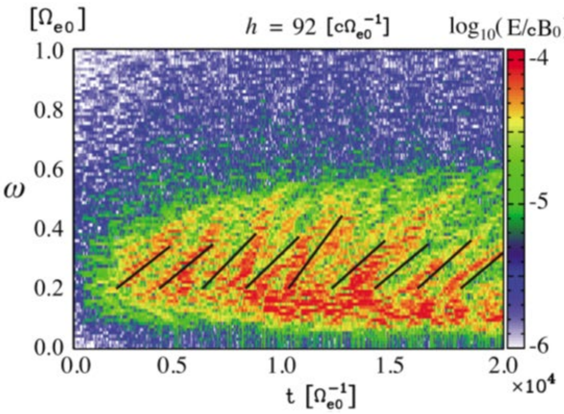

$$\frac{\partial \omega}{\partial t} = \frac{0.4 s_0 \omega}{s_1} \Omega_w$$

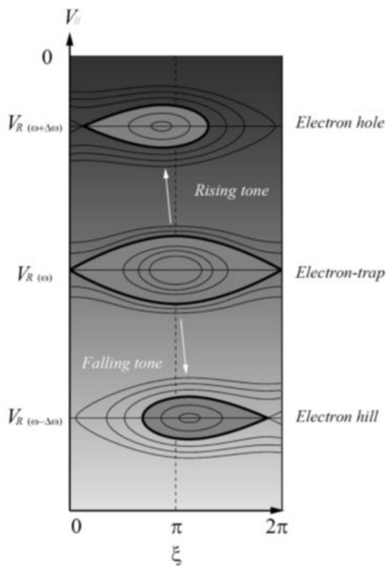

Figure 1. Nonlinear wave growth with frequency variation