Nonlinear electron cyclotron growth rates in parallel and obliquely propagating VLF chorus

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A non-self-consistent code has been developed at RISH, Kyoto University to numerically integrate resonant electron trajectories in an arbitrary VLF narrowband wavefield in the earth's magnetosphere in the equatorial region. The propagation angle frequency and wave amplitude may be specified as any desired function of z and t, and the code also embodies an advanced model of chorus wavefield based on the theory of Omura and co-workers. By defining a generalised phase for resonance order n, we may progress previous work and compute resonant particle distribution function, resonant particle current and nonlinear growth rate as functions of z and t.

We assume a wavefield with constant amplitude and propagation angle, with a realistic amplitude profile, and also a chorus element model field. Since nonlinear current is a function of total field and its past history both fields are scaled with a factor Bs. For n=0 and n=1 resonances we compute nonlinear growth rates and integrated trans equatorial amplification in dBs as functions of Bs in order to compare with linear growth rates, determine the amplitude dependence of nonlinear growth rates, and also investigate saturation effects. Total growth rates due to both n=0 and n=1 resonances in the vicinity of half the equatorial gyrofrequency will be examined in order to explain the gap in chorus emissions that occurs at this frequency.

It was shown by Omura et al. [1,2] that an inhomogeneity factor of S = -0.4 maximises nonlinear growth but some recent work claims that higher values of S are more significant. We shall here closely examine S(z,t,V_{perp}) to understand the relationship between inhomogeneity factor and local growth rate.

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[2] Y. Omura, , M. Hikishima, Y. Katoh, D. Summers, and S. Yagitani, Nonlinear mechanisms of lower band and upper band VLF chorus emissions in the magnetosphere, J. Geophys. Res., 114, A07217, doi:10.1029/2009JA014206, 2009.