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Variations in spectral characteristics of VLF chorus elements: measurements by Cluster spacecraft and comparison with the backward wave oscillator model

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A mechanism of chorus generation was suggested by V. Yu. Trakhtengerts (1999) on the basis of the backward wave oscillator (BWO) regime of magnetospheric cyclotron maser. According to this mechanism, a succession of whistler wave packets is generated in a small near equatorial region owing to the absolute instability of whistler-mode waves in the presence of a step-like distribution function of energetic electrons in parallel velocities with respect to the geomagnetic field. In this report we compare the spectral characteristics of VLF chorus detected by the Cluster spacecraft near the geomagnetic equator, i.e., in the source region of these emissions, with the magnetospheric BWO model.

In the previous study (Macusova et al., 2009), we showed that the mean frequency sweep rate of chorus elements for different orbits of Cluster spacecraft increases with a decrease in the mean value of the cold plasma density along the orbit, in accord with the BWO theory. Here, we focus on significant variations of the frequency sweep rates which are observed during each Cluster flyby in the generation region. We analyze the possible relationship of such variations with the measured plasma density for several Cluster orbits using the chorus wave packets detected by the Wideband Data instrument onboard the Cluster spacecraft and the electron density obtained from the WHISPER active sounder data.

We compare results of this analysis with the BWO model. In particular, by using the measured frequency sweep rate and the cold-plasma density in the generation region we estimate a dimensionless parameter Q quantifying the excess of the energetic-electron flux over the absolute-instability threshold. We also compare the results with numerical simulations based on the BWO model.

References

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