URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Analysis of Two-Band VLF Spectra Observed by Van Allen Probe B

David R. Shklyar* [(1)], Elena E. Titova[(2,1)], and Andris A. Lyubchich[(2)]
(1) Space Research Institute of RAS, Moscow, Russia; e-mail: david@iki.rssi.ru
(2) Polar Geophysical Institute, Apatity, Russia; e-mail: lena.titova@gmail.com; lubchich@pgia.ru

The existence of two bands below and above half the electron gyrofrequency in the spectrograms of whistler-mode chorus, with a pronounce gap in between, is a long-standing problem in the theory of chorus emissions. In this report we discuss whistler waves in the VLF range in the frequency bands below and above half the electron gyrofrequency whose spectrum does not have a pronounced time-frequency structure typical of chorus emissions. The analysis is based on Van Allen Probe B measurements of electromagnetic fields and energetic electron fluxes outside the plasmapause.

When the waves are excited due to electron cyclotron instability in the equatorial region of the magnetosphere, and are observed at very low latitudes as it takes place in the case under discussion, the peculiarities of the observed spectrum should be closely related to the local amplification factor. Based on this presumption and aiming at explaining the observed spectrum we have determined the electron distribution function from the measured differential electron flux and calculated the linear growth rate γ and spatial amplification factor γ / v_g (v_g is the magnitude of the group velocity) as functions of frequency and wave normal angle, considering three main cyclotron resonances. Amplification factor calculated from Van Allen Probe B data taken on $L = 4.2$, at a latitude of -0.4^o, with the negative values removed is shown in Figure 1.

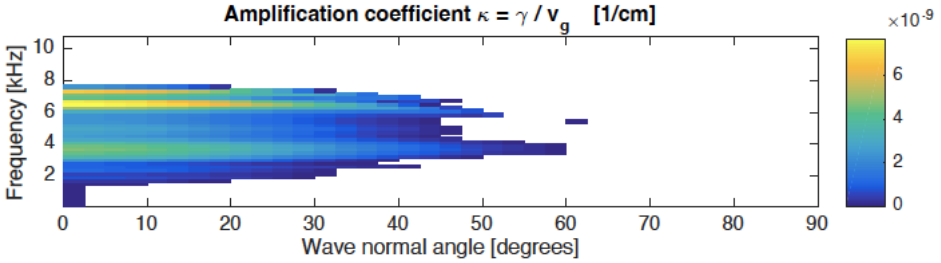

Figure 1. Amplification factor on (θ, f) planes calculated from differential electron fluxes measured on 30 November 2015 at 14:42:45 UT.

Comparison of the amplification coefficient with simultaneously observed VLF spectrum shows their consistency.

As the examination of the electron distribution function $F_0(w, \mu)$ shows (w and μ are particle kinetic energy and magnetic momentum, respectively), in the energy range responsible for wave generation at half the electron gyrofrequency, the derivative $\partial F_0 / \partial w$, which is an important factor determining the growth rate, has the largest in magnitude negative values that leads to suppression of the growth rate at the corresponding frequencies. The consideration performed gives a hint to the understanding of the long-standing problem of the origin of two frequency bands in VLF spectrograms.

The work of D. R. Shklyar and E. E. Titova on this project has been supported by Russian Science Foundation, grant 22-22-00135.