SG-I12 AAPPS-DPP2020

4th Asia-Pacific Conference on Plasma Physics, 26-31Oct, 2020, Remote e-conference

Generation mechanism of lower band and upper band whistler-mode chorus emissions in the inner magnetosphere

Yoshiharu Omura[1], Yi-Kai Hsieh[1]

[1] Research Institute for Sustainable Humanosphere, Kyoto University

omura@rish.kyoto-u.ac.jp:

Whistler-mode chorus emissions are generated at the equator in the parallel direction to the magnetic field, and propagate toward higher latitudes changing the wave normal angle gradually to oblique directions. Interaction between the wave and energetic electrons through Landau resonance becomes effective in the oblique propagation. As observed from the guiding center of a Landau resonant electron moving with the parallel phase velocity, the wave phase becomes stationary. With the perpendicular wave number and the deviation of the gyrating particle position from the guiding center, the electron sees a wave phase of a right-handed circularly polarized wave, which causes efficient acceleration by the perpendicular component of the wave electric field [1]. The interaction time between the resonant electron and the wave packet is maximized with the frequency close to half the cyclotron frequency, because the parallel phase velocity becomes nearly equal to the parallel group velocity. The efficient acceleration of resonant electrons causes damping of the wave at half the cyclotron frequency. Although our previous model assumed that the nonlinear wave damping was due to the parallel wave electric field in the presence of the gradient of magnetic field [2], we have confirmed that the nonlinear trapping due to the perpendicular components of the wave fields plays the major role in the electron acceleration and resultant wave damping in the nonuniform magnetic field [3]. In addition to the nonlinear damping, propagation characteristics of upper and lower band chorus wave packets are much different. The Gendrin angle, at which the group velocity takes the parallel direction, exists only for the lower band chorus, while the group velocity of the upper band chorus takes highly oblique directions [4], and this difference enhances separation of the two bands in space. A single chorus element can be generated at the equator forming a long-lasting rising tone emission covering half the cyclotron frequency. As the wave packet propagates away from the equator, it splits into lower band and upper band wave packets because of the nonlinear damping through Landau resonance at half the cyclotron frequency, and the wave packets propagate in different directions.

References

[1] Omura, Y., Hsieh, Y.-K., Foster, J., et al., (2019), Cyclotron acceleration of relativistic electrons through Landau resonance with obliquely propagating whistler-mode chorus emissions, J. Geophys., Res.: Space Physics, 124, 2795–2810.

[2] Omura, Y., Hikishima, M., Katoh, Y., et al.. (2009), Nonlinear mechanisms of lower band and upper band VLF chorus emissions in the magnetosphere, J. Geophys. Res., 114, A07217.

[3] Hsieh, Y.-K., & Omura, Y. (2018), Nonlinear damping of oblique whistler mode waves via Landau resonance, J. Geophys. Res.: Space Physics,123, 7462–7472.

[4] Hsieh, Y.-K, & Omura, Y. (2017). Study of wave-particle interactions for whistler mode waves at oblique angles by utilizing the gyroaveraging method, Radio Science, 52, 1268–1281.This abstract is important as record of your presentation. So please give comprehensive as much as possible. This will be kept in DPP web for long time.