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

Estimating relativistic electrons' source population from the spectral features of chorus emissions

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Juhasz et al. 2019 [1] showed that the bi-Maxwellian parameters of the source population could be derived using single elements of chorus emissions. This chorus inversion method depends on the theoretical work of Omura et al. (2008, 2010) [2,3], which described chorus generation via nonlinear wave-particle interaction between a triggering wave and the source population. Continuing the work of [1], we analyzed 114 chorus emissions detected by the Electric and Magnetic Field Instrument Suite and Integrated Science on board the Van Allen Probes (VAP EMFISIS) from 2012 to 2017.

The plasma conditions during the generation of these choruses cover a wide range of the ratio of the plasma frequency and the gyrofrequency, f_{pe}/f_{ce}, and the frequency sweep rate of the chorus elements, $\partial\omega/\partial t$. The gyrofrequency and the plasma frequency data are from VAP EMFISIS measurements; we approximated the frequency sweep rate with a constant value. The frequency sweep rate of a chorus element and the ratio of the plasma frequency and the gyrofrequency are the two input parameters for our chorus inversion method. Therefore, applying the whole validation process of [1], we got a clear picture of the applicability of the chorus inversion method. Our results show that the evaluated thermal velocities agree with the thermal velocities (parallel and perpendicular) of energetic electrons derived from the unidirectional flux data of the Helium, Oxygen, Proton, and Electron instrument. In contrast, the derived electron densities depend mainly on determining the linear section of a chorus element on a spectrogram, causing 25% uncertainties. We completed the validation process mentioned above by analyzing the effects of theoretical assumptions. We calculated the systematic uncertainties caused by Q, the depth of the electron hole, and $\tau = T_N / T_{tr}$, the ratio of nonlinear transition time and nonlinear trapping period. We concluded that the systematic uncertainties are negligible.

References

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