4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

Estimation of the Growth Rate of the Chorus Waves in the source region from Multi-Spacecraft Measurements by the Cluster project

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Whistler mode chorus waves play an important role in controlling electron dynamics in Earth's inner magnetosphere as they can accelerate and scatter electron population over a wide energy range from ~ 1 keV up to relativistic energies. It is widely accepted that the chorus wave generation mechanism has two phases. First, the linear phase is due to a cyclotron resonance with a hot anisotropic electron population near the magnetic equator [1,2]. The linear growth phase is followed by a nonlinear growth phase that leads to the formation of the rising tone of the chorus emission. In this study, we examine lower-band chorus wave packets captured by the Wide Band Data receiver (WBD) onboard Cluster spacecraft in the vicinity of the magnetic equator [3,4]. We focus on the events when the same chorus elements are simultaneously detected by multiple spacecraft. We use these multi-spacecraft waveform observations to estimate the wave growth rate in the source region. We compare the growth rate estimated from the wave measurements to the growth rate calculated from the electron measurements using the linear and nonlinear growth rate models. It was found that the growth rate estimated from the wave measurements is substantially higher than the estimated linear growth rate, and is quite close to the estimated non-linear growth rate. In addition, we estimated the growth rate using spectral data collected by the Spatio-Temporal Analysis of Field Fluctuation experiment (STAFF) during the same time interval [5]. It was found that the result is consistent with the growth rate estimated from the WBD data. Both approaches show a similar spatial distribution of the growth rates in the source region with significant wave amplification up to 5 degrees of magnetic latitude, presumably because of nonlinear effects in wave amplification.

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