Spectral Interpretation of Radio-Sounder-Stimulated Magnetospheric Plasma Resonances in Terms of Kappa Distributions

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Ionospheric topside sounders stimulate a wide variety of signal returns, which have been labeled plasma resonances, including two sequences that appear between the harmonics of the electron cyclotron frequency f_{ce}. One, known as the Qn sequence, occurs above the upper-hybrid frequency f_{uh}, where $f_{uh}^2 = f_{ce}^2 + f_{pe}^2$ and f_{pe} is the electron plasma frequency; this sequence has been attributed to slowly-propagating electrostatic Bernstein-mode waves [1, 2]. Similar resonances are stimulated by magnetospheric radio sounders. In this case, however, it is often necessary to introduce a non-Maxwellian electron-velocity distribution function into the dispersion equation used to calculate the Qn frequencies to obtain agreement with observations [3]. Interpretations based on bi-Maxwellian [3] and kappa [4] distributions have been proposed. Here we expand on the latter, which requires fewer free parameters, by comparing parametric curves of kappa-derived Qn frequencies with observations from the Radio Plasma Imager (RPI) on the Imager for Magnetopause-to-Aurora Global Exploration (IMAGE) satellite. The calculated Qn frequencies based on a Maxwellian distribution are higher than those based on a kappa distribution and the differences have been found to approach 20% of the ambient f_{ce} value [4]. Applying this radio spectrometry to IMAGE/RPI plasmagrams, after accurate f_{pe}/f_{ce} determinations have been obtained, enables the determination of electron-velocity-distribution function information pertaining to the ambient magnetospheric plasma. Such accurate f_{pe}/f_{ce} determinations can best be made when a sounder generated wave cutoff can be determined in addition to identifying and determining the frequencies of sounder-stimulated plasma resonances. We will demonstrate this procedure using IMAGE/RPI data.

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978-1-4244-6051-9/11/$26.00 ©2011 IEEE