Electron Bernstein waves in the Saturnian magnetosphere: a dual kappa distribution model.

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Electron Bernstein waves are important because they are believed to be responsible for banded emissions that are observed in most planetary magnetospheres and the Saturnian magnetosphere in particular. It has recently been shown [1] that the electron velocity distribution in the Saturnian magnetosphere can be fitted with a sum of two kappa distributions. Adopting such a kinetic model for the electrons, we investigate the electrostatic electron Bernstein modes for a wide range of parameters.

Using a newly developed technique, the general dispersion relation for electrostatic Bernstein waves in a multi-species plasma is derived without the use of infinite sums of Bessel functions. The dispersion relation is specialised to the case of a plasma of singly-charged ions and two electron components distinguished by their respective temperatures, number densities and kappa indices. This dispersion relation is solved numerically for the electron Bernstein modes with varying parameters to simulate the radial variations expected in the Saturnian magnetosphere.

The numerical results show that Bernstein modes with frequencies below the upper hybrid band exhibit a distinctly non-monotonic variation in frequency. This contrasts strongly with the single electron component case, which does not have this behaviour. For frequencies both in and above the upper hybrid band, there is a simultaneous emergence of two frequency maxima. The first maximum arises from the hot electron contribution, while the second is from the cool electron component. Each extremum marks the wave number and frequency at which Bernstein waves have zero group velocity.

Such points, where the group velocity vanishes, can be expected to play an important role in determining the microstructure of naturally occurring banded emissions in the Saturnian magnetosphere. Traditionally such points have been important for the interpretation of long-duration echoes (resonances) observed in sounder experiments. The application of our results to the interpretation of waves observed in the Saturnian magnetosphere will be briefly discussed.

References
