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Ion-Bernstein waves in a plasma with a kappa velocity distribution

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Abstract :

Bernstein waves have been observed in many planetary magnetospheres. Particle observations indicate that space plasmas often have charged particles with a strongly non-Maxwellian tail on their velocity distributions. In particular, they often exhibit power law dependence on velocity in the higher energy range. Such velocity distributions may be modelled by the kappa (generalized Lorentzian) distribution with low values of kappa. We have carried out a study of low frequency ion-Bernstein waves in space plasmas, using a Vlasov-Poisson model based on the kappa velocity distribution. The general dispersion relation obtained by Mace [1] for a multi-species kappa plasma is specialised to the case of singly charged ions and electrons. This dispersion relation is solved numerically, without approximations, for the ion-Bernstein mode. It is shown that for low values of the ion-kappa index, the dispersion curves differ significantly from those predicted by Maxwellian theory. Ion-Bernstein waves propagating in the band below the lower-hybrid frequency have frequencies given by $n\omega_{ci}$ at vanishing wave number k_{\perp} and fall to $(n - 1)\omega_{ci}$ as k_{\perp} is increased. It is found that the rate at which this frequency decrease occurs depends strongly on the kappa index of the ions, with lower values of kappa exhibiting a less rapid fall-off. Above the lower-hybrid frequency, ion-Bernstein waves have a different dependence on wave number. While at vanishing k_{\perp} the frequency approaches $n\omega_{ci}$, it then increases with k_{\perp} to a peak at a value $k_{\perp peak}$ before the frequency drops to $n\omega_{ci}$ for large k_{\perp} . It is shown that both the wave number $k_{\perp peak}$ and the peak frequency depend on the ion-kappa value. In the lower-hybrid frequency band, the ion-Bernstein waves exhibit features intermediate between those described above. The dispersion relation of the mode in this band is also affected by the ion-kappa index. References [1] R. L. Mace, Phys. Plasmas, 10, 2181 (2003).

Award :

yes

Level :

PhD

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Paper :

No

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