CHARACTERIZING VELOCITY DISTRIBUTION FUNCTION THROGH MAGNETIC FLUCTUATIONS OF KAPPA DISTRIBUTED PLASMAS

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Abstract: Observed particle distributions in space plasmas usually exhibit a variety of non-equilibrium features in the form of temperature anisotropies, suprathermal tails, field aligned beams, etc. The departure from thermal equilibrium provides a source for spontaneous emissions of electromagnetic fluctuations [1], such as whistler fluctuations at the electron scales. In particular, plasma velocity distributions exhibiting high energy power-law tails are usually measured and can be represented by Kappa distributions [2], in which the departure from thermal equilibrium is quantified by the kappa parameter. Therefore, the shape and properties of these spontaneous emissions should be related to the value of kappa. Here we present comparisons of these fluctuations obtained through 1.5D PIC simulations of a finite-temperature gyrotropic magnetized electron–proton plasma, loaded with thermal Maxwellian and various Kappa velocity distributions. We focus on the relationship between the magnetic fluctuation's spectra and the plasma parameters, such as plasma beta, temperature anisotropy, and the kappa parameter. Our main results show that these fluctuations spread in a bounded region of the frequency and wavenumber space, with a strong dependence on mentioned parameters. Furthermore, our results indicate that the power spectrum of transverse magnetic fluctuation follows a power law on the frequency. The spectral index increases with increasing plasma beta and decreasing kappa parameter, suggesting a clear dependence between the shape of the velocity distribution function and the spontaneous magnetic fluctuations wave spectrum. These features may be used as a proxy to identify the nature of electron populations in space plasmas at locations where direct in-situ measurements of particle fluxes are not available.

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References:

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