Broadband low-frequency electric field structures in non-thermal auroral plasma

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Broadband electrostatic noise (BEN) have been observed with frequencies fluctuating from the ion cyclotron upto and higher than the ion plasma frequency (frequency range of several hectohertz (hHz) to a few kilohertz (kHz)) in the auroral acceleration region of the Earth's magnetosphere. Several spacecraft missions have reported that BEN has a potential of dynamical characters with small-scale, large-amplitude, magnetic aligned electric fields in different regions of the magnetosphere, e.g., in the auroral acceleration region, the plasma sheet boundary layer (PSBL), polar cup boundary layer (PCBL) , the Earth's high altitude polar magnetosphere, on cusp field lines and magnetosheath, etc. Further investigations revealed that BENs consist of nonlinear, quasi-static, time domain parallel or/and perpendicular electric field structures such as spiky, sawtooth and sinusoidal structures in an electrostatic ion cyclotron (EIC) wave reported by S3-3, Viking, FREJA, POLAR and FAST satellite. Various theoretical investigations of the nonlinear EIC waves that generate spiky electric field structures in both parallel and perpendicular to the geomagnetic field line have been done by several authors.

FREJA satellite instruments have detected the low-frequency electrostatic structures associated with density depletions in the Earth's upper ionosphere. The theoretical explanation of the observed electric field structures is presented in this study. Motivated by the spacecraft measurements, several theoretical attentions have been focused on the interpretation of the mechanism generating density depletion in the observed fluctuation phenomena, in terms of non-thermal distribution function which deviated completely from the Maxwellian (Boltzmann distribution) equilibrium. Example of such velocity distribution are Kappa, Tsallis q-nonextensive and Cairn's non-thermal distribution. For a magnetized auroral plasma system consisting of energetic non-thermal electrons and a cold ion, the nonlinear evolution of low-frequency ion cyclotron and ion-acoustic waves is investigated. The dynamic of the cold ion is governed by the fluid equations and the background electron is treated as energetic hot species withCarin's non-thermal density distribution. Numerical computations appear in a series of periodic oscillations such as signal, sawtooth and sinusoidal waveforms. The present results show an excellent agreement with the spacecraft measurements.

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