Ion-acoustic enhancements generated by turbulent interactions associated to electron beams counter-streaming in an auroral cavity

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Wave enhancements with characteristics of ion-acoustic waves, known as ion-acoustic enhancements (IAE), have been observed in the Earth's ionosphere. They can be traveling up or down along the geomagnetic field, featuring 1–2 orders of magnitude over thermal level, and appear at altitudes ranging from ~ 140 km to ~ 560 km. As a general rule, the amplitude of IAE is in general concentrated within a range of $\sim 15^\circ$ relative to the direction of the magnetic field. The generation mechanism for these enhancements is still a matter of debate. In the present analysis, we investigate the IAE in the context of turbulent processes associated to beam-plasma interaction. The analysis assumes counter-streaming electron beams interacting with the background plasma, in an inhomogeneous medium which models the density depletion occurring in an auroral cavity, with physical parameters that characterize typical ionospheric conditions. The study is complementary to previous studies made considering two dimensions in velocity space and a single point in configuration space. The self-consistent equations of electrostatic weak turbulence that include quasilinear, decay, and scattering processes as well as convective and dispersive effects are numerically solved inside the one-dimensional density cavity. By considering different populations of forward and backward propagating electron beams, it is shown that the most significant enhancements of ion-acoustic waves occur in the presence of equal density counter-streaming electron beams. It is also shown that the enhanced ion-acoustic waves are initially localized near the center of the density cavity at large wave lengths. Later in the evolution the enhancement in the spectrum of ion-acoustic waves spreads out toward the edges of the cavity, with a shift to smaller wavelengths, while the enhancement near the center of the cavity tends to decrease in magnitude.