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Simulation study on wave number dependence of enhanced ion acoustic echoes

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Since the first observations by incoherent scatter radars such as EISCAT radar, a number of enhanced ion acoustic spectra have been detected, which have asymmetry on ion acoustic lines or anormalous enhancement of both lines. The association of the echoes with auroral activity, electron precipitation, ion outflow has been confirmed by a number of event studies. We have approached by PIC plasma simulations the study of details of the phenomena assuming the simplest theoretical model, the electron current driven instability. The characteristics of the asymmetry is explained by a feature of the velocity distribution function of the plasma.

Since the first observations by incoherent scatter radars such as EISCAT radar, a number of enhanced ion acoustic spectra have been detected, which have asymmetry on ion acoustic lines or enhancement of both lines. The backscatter power has been reported as 50 times larger than normal intensity. Statistical studies have revealed their characteristics. The duration of most of the events are shorter than 10s or 5s which is the standard resolution of the radars. The enhanced echoes are observed over the altitude range of 140-1700km though the unstable regions cover a relatively narrow interval,a few tens of kilometers in extent. The features are different from over 250km and under. The ionospheric parameters, such as electron and ion temperatures,ion drift velocity, can not easily be determined from the unusual spectra, therefore from the data around the time

Though three different mechanisms have been proposed as the interpretations on the anormalously enhanced ion acoustic echoes, there are criticisms for each. The first one is a field-aligned electron current driven instability in which parallel electric field produced by precipitating particles is assumed, or horizontal conductivity gradient is assumed. The second is proposed as an interpretation based on ion-ion two stream instability assuming hydrogen beam injection. In addition to these mechanisms, an ion acoustic fluctuation due to parametric decay of Langmuir waves into ion acoustic waves is suggested assuming a downward electron beam as a source of the Langmuir waves.

Our purpose is to approach by an alternative method, particle-in-cell(PIC) plasma simulations, the study of details of the phenomena such as time dependence and wave number dependence. We assume the simplest theoretical model, the electron current driven instability, for the first step of the approach. The differences of the asymmetry characteristics between two different wave numbers can be explained by a feature of the velocity distribution function of the plasma.