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Wave modes associated with suprathermal electrons in the foreshock

Jan Soucek, David Pisa, Ondrej Santolik, Marek Basovnik, and Alexander Tomori
Institute of Atmospheric Physics, Czech Academy of Science, Prague, Czech Republic (soucek@ufa.cas.cz)

The terrestrial bow shock reflects and accelerates the solar wind electrons, strongly modifying the electrons distribution in an upstream region known as the foreshock. The foreshock electron distribution contain electron beams from nearly thermal energies ($\sim$10 eV) to tens of keV as well as loss cone features. The presence of foreshock beams is typically identified in spacecraft data through observation of characteristic electrostatic waves around the local plasma frequency, but also well above and below the plasma frequency. Direct observations of the beams are more difficult due to their transient nature and low density, but the PEACE instrument of Cluster can consistently observe some of the denser field-aligned electron beams and low energy features in the electron distribution.

We analyzed a set of foreshock events where direct beam measurements were possible. We investigated a dependence of beam energy on the location within the foreshock and compared the results with an existing model. We performed a statistical comparison between electric field spectrum and observed electron distributions showing a correlation between beam energy and frequency of the wave emission relative to the local plasma frequency. The experimental results are compared with solutions of the plasma dispersion relation showing a good correspondence.