Diffuse Upstream Ions at the Earth`s Foreshock

Cluster provides for the first time simultaneous measurements of energetic ions upstream of Earth`s quasi-parallel bow shock with several spacecraft. We have analyzed a 10 hour period at large separation distance. From the difference of partial densities between spacecraft 1 and 3 we determine the spatial gradient along the magnetic field and the e-folding distance.

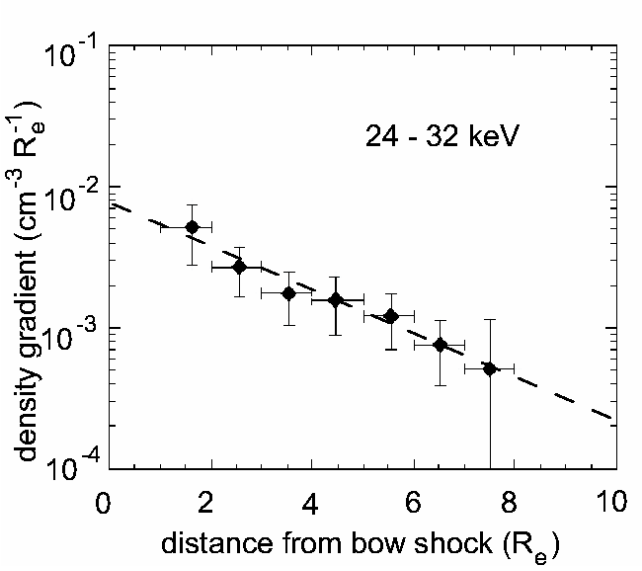

Fig 1: Average partial ion density gradient in the 24-32 keV energy range versus distance from the bow shock.

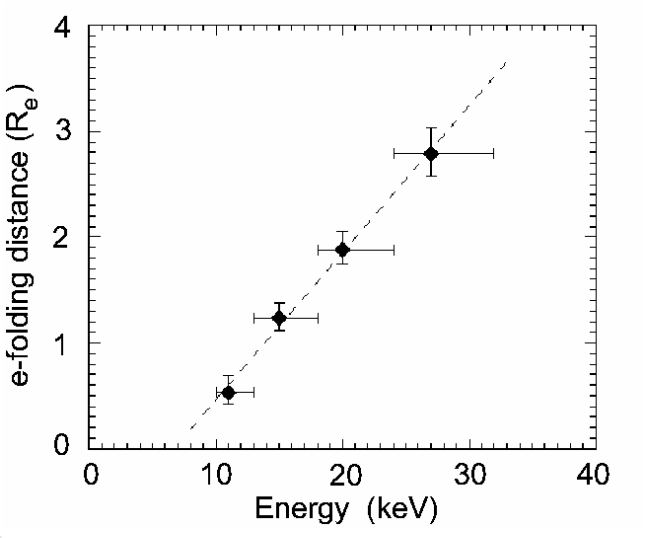

Fig 2: The e-folding distance obtained by fitting an exponential to the partial density gradient in 4 energy channels.

It has been demonstrated in the past that there is a one-to–one correlation between the presence of diffuse upstream ions and the occurrence of hydromagnetic waves in the foreshock region: the waves are excited by the particle streaming and the particles are pitch angle scattered by the waves. This leads to a diffusive particle transport Using a bow shock model we determined the distance of spacecraft 1 and spacecraft 3 to the shock along the magnetic field. Using the differences of the partial energetic ion densities at various distances from the bow shock we determined the spatial ion density gradient. The gradient decreases in the energy range 10-32 keV exponentially with distance from the shock with an e-folding distance from 0.5 Re to 2.8 Re, the e-folding distance depending approximately linearly on ion energy. Figure 2 shows the e-folding distance obtained between 10 and 32 keV. This demonstrates that ion transport in the upstream region is diffusive.

Kis, A., M. Scholer, B. Klecker, E. Moebius, E. A. Lucek, H. Reme, J. M. Bosqued, L. M. Kistler, and H. Kucharek, Geophysical Research Letters, 31, L20801, doi:10.1029/2004GL020759, 2004.

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