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Observational evidence of two types of field-aligned beams in the foreshock region

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A significant number of Field-Aligned Beams (FABs) observed upstream of the Earth's bow shock by the Cluster-CIS experiment are examined in detail. In agreement with previous established results, no ULF waves are present in association with these FABs. The detailed analysis of parallel and perpendicular reduced distribution functions clearly indicates that the FABs could be classified into two types. In a first type, the reduced distribution function is remarkably well fit by a maxwellian functional form. The associated parallel temperature is typically in the order of $\sim 150km/s$, independent of the angle θ_{Bn} between the local shock normal and the magnetic field direction, in agreement with recent results (Wilber et al., 2005).

In the second class of FABs, the peak and the lower energy part of the parallel reduced distribution could be satisfactory fitted by a maxwellian, but a high energy tail is present, which extends to parallel velocities $V_{\|}$ up to $5V_{SW}$ and beyond. We used a strech exponential functional to fit the tail and found that an exponent in the range 1.2–1.5. Perpendicular reduced distributions exhibited a similar tail distributions. Moreover, the three-dimensional angular distributions of these FABs indicate that the protons associated with the high energy tail do not propagate along the magnetic field direction, in contrast to protons associated with the peak of the distribution. Using multispacecraft observations as well some geometrical arguments, we show that FABs with high energy tail are usually located downstream from the Maxwellian FABs.

We will present results from an on-going analysis to determine whether the FABs

with tails originate from Maxwellian FABs as the result of wave particle interactions, or from a distinct source at the shock. These observations provide new quantitative insights of FABs and introduce constraints on models involving shock production mechanism.