

Cluster/RAPID-IIMS observations of energetic ions upstream of the Earth's bowshock

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The Imaging Ion Mass Spectrometer (IIMS) component of the Research with Adaptive Imaging Particle Detectors (RAPID) experiment, onboard each of the quartet of Cluster spacecraft, detects ions with energies of some 30 to 1500 keV. We present a study of protons observed by the RAPID-IIMS instrument during those times when the apogee of the Cluster orbit lay upstream of the bow shock. We extrapolate the upstream magnetic field conditions to a model bow shock to establish connectivity and, if such connectivity exists, the shock geometry is determined, as characterised by the angle between the local shock normal and the interplanetary magnetic field. The majority of upstream energetic ion events appear to be related to a quasi-parallel shock geometry; the mechanism generally invoked to explain energization by quasi-parallel shocks is first-order Fermi acceleration. We subsequently consider possible energization mechanisms for the significant number of upstream energetic ion events that cannot be explained by this mechanism, in terms of shock drift acceleration at quasi-perpendicular shocks, magnetospheric leakage and the presence of ambient energetic ions.