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Kelvin-Helmholtz instability in the plasma sheet boundary layer

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Processes of non-adiabatic ion acceleration occurring in the current sheet of the Earth's magnetotail produce highly accelerated (up to 2500 km/sec) field aligned ion beams (beamlets) with transient appearance streaming earthward in the plasma sheet boundary layer. Multipoint Cluster observations have led to a new understanding of these phenomena with a spatial rather than a temporal structure. Comparison of data from different Cluster spacecraft allows to estimate the duration of beamlet and confirms their well defined localization across the magnetic field. Moreover it has been revealed the earthward propagation of magnetic perturbations along the beamlet filaments with phase velocities of the order of local Alfven speed. Such Alfven type disturbances may be caused by Kelvin-Helmholtz (K-H) instability triggered by a flow shear between the high velocity beamlet in the plasma sheet boundary layer and surrounding magnetotail plasma. A general stability analysis is performed for the K-H instability in a three-layered system, when a background magnetic field is directed parallel to the plasma flow. Solutions of the dispersion equation for the compressible plasma have shown that there is no upper critical sonic Mach number ($M_S = 2$) even for velocity shear layer of zero thickness, contrary to the classical case of two plasmas. For sonic Mach numbers higher than 2, the instability arises in a limited range of wave numbers, thus fixing the upper and lower cut off frequencies for the wave spectra. It has been found that for plasma parameters typical for the plasma sheet boundary layer the K-H instability can set in through the quasi-antisymmetric mode. The comparison of obtained theoretical results with experimental data have shown that conditions for the development of K-H instability are satisfied for the majority of beamlet observa-

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