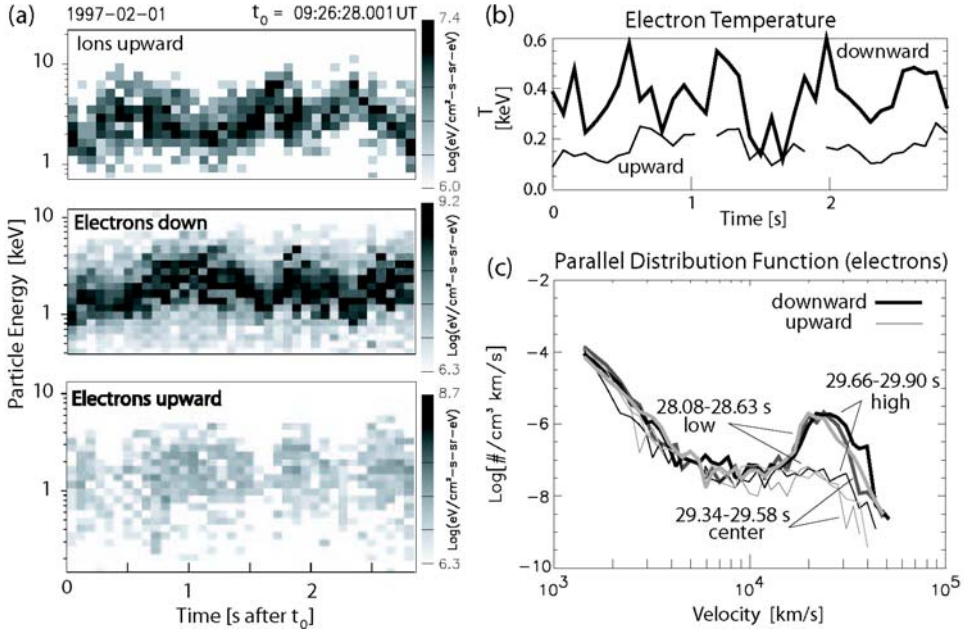
Auroral Acceleration in thin Electric Layers

Extremely high-resolution observations of the space-time variation of the electron and ion energy fluxes in the auroral upward current (inverted-V) region prove that layers of field-aligned electric fields of altitudinal extension ~20 km or less are responsible for the field-aligned acceleration of electrons and ions.

The Figure shows a 3-s sequence of high-space-time resolution measurements of upward ion and electron as well as downward electron energy flux measurements of the FAST spacecraft when in the low altitude auroral magnetosphere during active auroral times. The fluxes are essentially at constant average energy similar for both particle components but exhibiting nearly sinusoidal well expressed oscillations in energy. The striking fact is the anti-correlation between ion and electron energies which suggests that the spacecraft is quasi-periodically crossing a narrow in altitude (presumably parallel electrostatic field) layer which accelerates hot auroral electrons downward along the magnetic field while accelerating cold auroral ionospheric ions



upward along the field. The energy gain in both components is comparable ~3-4 keV yielding a potential drop of ~3-4 kV alternatively experienced by the particle components belonging to an upward directed parallel electric field. From the spacecraft velocity and the undulation period one estimates that the field-aligned extension of the layer is the order of < 20 km, in excellent agreement with theoretical predictions of small-scale double layers in the auroral plasma. Moreover the presence of weak upward electron fluxes (lowest panel left) correlated with the downward electrons points on the backscatter of some downward flowing electrons with magnetic mirror points close to the position of the layer. The full distribution in the high electron energy regions is thus of ring distribution family. The panels on the right show the oscillation of the electron temperature as function of time for the downward and upward electrons (top panel) with the backscattered electrons having relatively low and constant temperature. The parallel distribution function of electrons at three energy positions is shown in the lower right panel expressing the variation in the width of the auroral electron beam.

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