

MICRO AND MESO SCALE PLASMA KINETICS IN THE AURORAL ACCELERATION REGION

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ABSTRACT

The field-aligned acceleration of ions and electrons in regions of field-aligned current is examined. Observations suggest that kinetic Alfvén waves, particle kinetic energy and field-aligned current that propagates earthward from the magnetotail into the auroral zone may drive auroral acceleration. We examine these using a semi-global kinetic plasma simulation that models a region of the auroral zone several Earth radii in length. The simulations are augmented with conjunctive particle and wave data from the FAST and Polar satellites. In particular, cause and effect of plasma acceleration in the auroral region is examined using the simulation model and satellite data.

RESULTS

A data and modeling study has been carried out to examine the acceleration mechanisms that operate in the auroral zone and to identify the magnetospheric drivers of these acceleration mechanisms. The data part of the study involves the use of the Fast Auroral SnapshoT (FAST) and Polar satellites when they were in approximate magnetic conjunction in the auroral region. For these events FAST was in the auroral zone acceleration region and Polar was above the auroral zone in the near-Earth plasma sheet allowing a determination of the conditions in the magnetotail. A long-system particle in cell simulation has been used along with the satellite data to help understand the physics of the magnetotail driver/auroral accelerators. Seven FAST/Polar conjunction events have been examined in detail as follows:

Conjunction	Field Aligned Acceleration			Magnetotail Driver		
	Electrons	UFIB	UFEB	Poynting Flux	PSBL Beam	FAC
June 9, 1997 04:32	~ 1 keV	~ 1 keV	~ 1 keV	X	X	X
July 20, 1997 16:24	.1-1. keV		.1-1. keV	X		X
July 22, 1997 15:21	.1-1. keV					X
July 24, 1997 20:40	.1-1. keV					X
July 26, 1997 14:25	.1-1. keV					X
July 26, 1997 16:45	.1-1. keV					X
August 3, 1997 17:46	~ 1 keV	~ 0.1 keV	~ 0.1 keV	X	X	X

Table 1. Listing of FAST/Polar auroral conjunction events. Electron field-aligned acceleration is earthward directed in all cases as measured by the FAST satellite. UF stands for upflowing beams (away from the Earth), either ions (UFIB) or electrons (UFEB) as detected at the Polar satellite location. Poynting flux and PSBL beams are earthward directed from the magnetotail, and FAC is field-aligned current, usually in the tailward directed sense (net electron flow earthward). All magnetotail drivers are detected above the auroral zone by the Polar satellite.

From the events examined thus far, along with numerical simulations, 3 magnetotail drivers have been identified that can lead to auroral acceleration. Although each driver can cause earthward electron precipitation, they each have other distinguishable characteristics in terms of auroral acceleration. The 3 driver/accelerators are:

- (1) Poynting Flux/Kinetic Alfvén Waves - also accelerates electrons tailward away from Earth.
- (2) PSBL Beam/Large Scale Potential Drop - also accelerates ions tailward away from Earth.
- (3) Field-Aligned Current/Weak Double Layer - weak earthward electron acceleration.

These three driver/accelerators can occur at the same time or separately, with their presence depending mainly on magnetic activity level. The field-aligned current was always present during both quiet and active times. During the most active events the Poynting flux and PSBL beams were also present. For one moderately active event only the Poynting flux was detected (i.e., no PSBL beam).