Generation of Alfvenic Electromagnetic Plasma Structures in the M-I Coupling Auroral Current System and a Unified Mechanism of Auroral Particle Acceleration

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Field-aligned potential drops are most powerful to accelerate auroral particles to high energy. However, once the parallel electric fields are produced, they will disappear right away unless the electric fields can be continuously generated and sustained for a fairly long time. Thus, the generation of a long-lasting parallel electrostatic electric field is needed for the acceleration of auroral particles to high energy and for the emission of auroral kilometric radiation (AKR).

Propagation and reflection of Alfven waves in the M-I coupling auroral current system can redistribute reactive stresses, which include mechanical and magnetic stresses, along magnetic field lines, producing localized stress concentration in the auroral acceleration region. We propose that the nonlinear interaction of incident and reflected Alfven wave packets in the reactive stress concentration regions can create Alfvenic electromagnetic (EM) plasma structures in the auroral acceleration region. The Alfvenic Double Layer (DL) is one of the Alfvenic EM plasma structures which consists of localized self-sustained electrostatic electric fields associated with charge separation, which are embedded in the low density cavities and surrounded by enhanced reactive stresses. The enhanced magnetic and velocity fields carrying free energy serve as the local dynamo. The generated electrostatic electric fields will quickly deepen the seed low density cavity, which can further rapidly enhance the generation of stronger electrostatic electric fields, causing auroral particle acceleration to high energy. The Poynting flux carried by Alfven waves can continuously supply energy from the generator region to the auroral acceleration region, supporting and sustaining Alfvenic DLs and constituting a powerful long-lasting electrostatic electric field.

We suggest that the Alfvenic EM Plasma structure is a new type of fundamental dynamical EM plasma states, which can be in quasi-stationary or time-dependent. The structure acts as powerful high energy particle accelerators for the formation of quasi-static and Alfvenic auroras, and as an important source of electromagnetic radiation in cosmic plasmas.

Keywords: Dynamical Theory of Auroral Particle Acceleration, Alfvenic Electromagnetic Plasma Structures: A New Type of Fundamental Dynamical EM Plasma State, Generation of Alfvenic Double Layers by NL Interaction of Incident and Reflected Alfven Wave Packets in Auroral Acceleration Region

