Oral | Symbol P (Space and Planetary Sciences) | P-EM Solar-Terrestrial Sciences, Space Electromagnetism & Space Environment

[P-EM37_30PM2]Structure and Dynamics of the Magnetosphere

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Wed. Apr 30, 2014 4:15 PM - 5:30 PM 414 (4F)

This session provides an opportunity to present recent results from satellite and ground-based observations, and theoretical and simulation studies, and discuss magnetospheric structures and phenomena including the solar wind-magnetosphere interaction, magnetosphere-ionosphere coupling, magnetic storms, and substorms. Discussion on planetary and satellite magnetospheres, future missions and instrument developments are also welcome.

5:00 PM - 5:15 PM

[PEM37-P02_PG]Generation mechanism of steady-state field-aligned currents: A general theory in terms of plasma convection

3-min talk in an oral session

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Keywords:field-aligned current, dynamo, convection

It is well known that field-aligned currents (FACs) play an important role in that they transfer electromagnetic energy and momentum from the magnetosphere to the ionosphere. Recent global magnetohydrodynamic (MHD) simulations indicate that in almost all cases the pressure gradient force is the major driver of FACs [Tanaka, 2003, 2007]. The inertia force becomes appreciable only in very special cases such as the preliminary impulse (PI) in sudden commencements (SCs) [Fujita et al., 2003]. Thus the pressure gradient mechanism is working universally and represents the essence of the dynamical nature of the magnetosphere. What is less or not at all understood, however, is the role of plasma convection in FAC generation. One misconception is that plasma convection is irrelevant to pressure gradient-driven FACs. In fact, convection plays a vital role in energy conversion. This paper describes a general theory of steady-state FACs, with an emphasis on the importance of plasma convection. FACs are created and maintained through the following two processes that occur spatially contiguously with each other. (1) A "dynamo" process in which plasma thermal energy is converted to electromagnetic energy. A magnetospheric dynamo is necessary in order to sustain a steady-state FAC system. This dynamo is generated by expanding plasma flow ($\mathrm{div}(\mathbf{v}) > 0$) that is characterized by the slow mode in MHD waves. The wave normal is directed to the $-\mathrm{grad}(B)$ direction, and the flow speed in the wave normal direction (the "normal" component) becomes the phase speed of the slow mode wave. Slow mode disturbances do not associate FACs. (2) A process in which field-perpendicular currents transform into field-aligned currents. This process occurs by a mode conversion of the waves from slow to Alfvenic. If the pressure gradient has a component perpendicular to both the wave normal and the magnetic field (the "tangential" component), it produces a magnetic tension and consequently excites Alfven mode disturbances. The flow speed in the wave normal direction becomes the phase speed of the Alfven mode wave. The Alfven mode is associated with tangential plasma flow, and consequently the plasma motion

becomes rotational.**References**Fujita et al. (2003), J. Geophys. Res., 108(A12), 1416, doi:10.1029/2002JA009407.Tanaka (2003), J. Geophys. Res., 108(A8), 1315, doi:10.1029/2002JA009668.Tanaka (2007), Space Sci. Rev., 133, 1, doi:10.1007/s11214-007-9168-4.