Interchange and quasi-interchange motions in a dipole magnetic field: numerical animations

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Interchange motion has been introduced in magnetospheric physics by Gold (1959). Plasma confined in a geomagnetic flux tube could move (in one piece) toward another magnetic flux tube without deforming the shapes of the magnetic field lines nor changing the magnetic field energy of the system. Magnetic stresses were assumed to "rigidize" the "interchanging flux tubes" and the plasma they contain. This type of plasma motion has been labeled "Pure-Interchange" (P-I) by Newcomb (1961). The P-I wave mode moves plasma only perpendicularly to magnetic field lines, indeed the wave number parallel to the B-field was assumed to be strictly equal to zero : $k_par = 0$. Dynamical animations corresponding to stationary and propagating P-I waves will be illustrated.

But, besides these essentially transverse modes, Newcomb (1961) identified and studied more general displacements of magnetized plasmas for which the wave number has a non-vanishing component parallel to the magnetic field. Newcomb called these more general interchange motions "Quasi-Interchange" modes (Q-I). Dynamical animations of Q-I modes will be shown for a series of the wave numbers (***k***).

As for magnetosonic MHD waves there are two kinds of Q-I modes: (i) the Type 1 mode which degenerates into the P-I mode when *k_par* tends to zero; this mode is characterized by predominantly transverse plasma displacements, this is why we call it also "*transverse Q-I*"; (ii) the Type 2 mode is characterized by predominantly field-aligned displacements; this is why the Type 2 mode will also be called "*translational Q-I*". In the limit ($k_par \Rightarrow 0$) translational Q-I approaches inter-hemispheric plasma motion. Simulations of inter-hemispheric plasma flow are also graphically displayed in this presentation.

Recently, André and Lemaire (2006) pointed out that, when the temperature of the plasma exceeds few hundred °K, the stability thresholds of both Q-I modes are drastically reduced as a consequence of the curvature of the geomagnetic field lines. As a result, the thermal plasma is driven convectively unstable with respect to Quasi-Interchange in a broad region of the equatorial plasmasphere. This produces a continuous expansion of plasma, a plasmaspheric wind, with a field-aligned flow component, as well as cross-L bulk velocity away from the Earth.

Smooth density transitions from the plasmasphere to the subauroral region observed after geomagnetic activities had been quiet for 2 or more days with Kp primarily less than 3 are commonly observed by the IMAGE spacecraft. Tu et al. (2007) proposed these observations may be an observational evidence of the suggested plasmaspheric wind.

In addition, recent CIS observations from CLUSTER observations have been interpreted by Dandouras et al. (2007) as direct experimental evidence of such a permanent Plasmaspheric Wind. The Plasmaspheric Wind dynamical flow will also be simulated graphically in this presentation.