Main Source of Pi 2 Magnetic Pulsations based on Magnetometer Network data

Kiyohumi Yumoto[1]; Yumoto Kiyohumi MAGDAS/CPMN Group[2]
[1] SERC, Kyushu Univ.; [2] -

http://www.serc.kyushu-u.ac.jp/

Auroral substorm is the fundamental and most important disturbance in the earth's magnetosphere. Auroral-substorm morphology documented by Akasofu [1964] has been widely accepted: the early expansion phase of auroral substorms is characterized by sudden brightening of one of the quiet arcs or sudden formation of an arc (Stage I), which is followed by rapid poleward motion of the brightened arc resulting in an auroral bulge within a few minutes (Stage II). Stage I which is not followed by Stage II is called a 'pseudobreakup'. Most recently, there is significant progress in utilizing detailed auroral morphology prior to substorm expansion onset by using the THEMIS all-sky image array. However, the onset mechanism of substorms has become seriously complex. There are several 'external' and 'internal' causes of the substorm onsets, such as the northward turning of IMF [cf. Rostoker, 1983; Lyons et al., 1997], and the impact of the interplanetary shock waves [cf. Akasofu and Chao, 1980], and such as the magnetic reconnection [cf. Hones, 1972], the cross-tail current disruption [cf. Lui, 2004], the ballooning instability[Roux et al., 1991; Cheng, 2004], and the current/current-driven instabilities in the auroral M-I coupling region [Morioka et al., 2010], respectively.

On the other hand, at the onset of auroral substorms, impulsive hydromagnetic oscillations with periods of 40-150 sec, so called Pi 2 magnetic pulsations, are excited globally in the magnetosphere [cf. Saito, 1969; Olson, 1999; Yumoto et al., 2001]. High-latitude Pi 2s in the mid-night region (23-00h LT) must show one-to-one correspondence with onsets of auroral substorms. The source of nighttime Pi 2 pulsations was believed to be a sudden change in magnetospheric configuration or convection during the substorm expansion phase. This change might be caused by earthward plasma flows from the reconnection region and/or a sudden formation of field-aligned currents (FACs) between the polar ionosphere and the magnetospheric plasmasheet in association with the disruption of cross-tail currents [see references in Yumoto, 1986, 1988]. The formation of the substorm current wedge [SCW; McPherron et al., 1973] also causes the magnetic bay variations at mid- and low-latitudes. Ohtani et al. [1999] asserted that the tail current disruption is a unique process rather than a direct consequence of the near-Earth neutral line formation, and took over the near-Earth reconnection process as a major role in the substorm dynamics.

From 1996, the Department of Earth and Planetary Sciences, Kyushu University, deployed the Circum-pan Pacific Magnetometer Network along the 210 degree magnetic meridian (MM) [Yumoto et al., 1996] and the magnetic equator [Tachihara et al., 1996]. Then it was possible to investigate global characteristics of Pi 2 pulsations and one-to-one correspondence between Pi 2s and substorm onsets (i.e. auroral breakups).

In the present paper, we summarized the related characteristics of Pi 2s, and newly analyzed magnetic data from the ground MAGDAS network [Yumoto et al., 2006] and the ETS-8 satellite [Goka et al., 2007]. We will present wave characteristics of Pi 2s, showing the global amplitude distribution, phase relation at the separated stations, and timings of the initial movement of H- and D-component Pi 2 pulsations. From these observational facts, we can conclude that the substorm current wedge (SCW) is a main source of Pi 2 magnetic pulsations, and generates a transient oscillation of lower frequency at high latitudes, a magnetospheric cavity oscillation of higher frequency at lower latitudes, and a FAC oscillation in the mind-night sector.