Independent Component Analysis of Nightside Magnetospheric Forced Pi 2 Oscillations Observed at the CPMN Stations

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From the long-term accumulation of the observational facts, low-latitude Pi 2 pulsations observed at different latitudes and longitudes with a common waveform and frequency (e.g., Yumoto, 1986). Moreover, from a ground-satellite statistical study by Takahashi et al., (1995), it is found that Pi 2 pulsations inside a region of +3 hours of local midnight in the inner (L=2-5) magnetosphere are dominated by the poloidal components, that is, fast-mode waves polarized in the meridian plane. The spatial phase structure support cavity-mode-type resonance excited between two reflecting boundaries. Based on these facts, it has been thought that the plasmaspheric cavity resonance is most likely mechanism for low-latitude Pi 2 pulsations observed on the ground.

On the other hand, high-latitude Pi 2 pulsations consist of different mode oscillations. At high latitudes, the magnetic variations during substorm onset are believed to consist of Pi 2 component and ionospheric and field-aligned current fluctuations. That is, Pi 2 pulsations observed on the ground are a superposition of several different modal components. However, since the realistic mixing system of magnetosphere is unclear, it is difficult to understand the spatial distribution of Pi 2 pulsations observed on the ground. In particular, the relationship of high- and low-latitude Pi 2 pulsations have been unsolved issue. We therefore need some new methods that make it possible to separate such mixed signals as Pi 2 pulsations observed on the ground and classify them objectively and quantitatively by their modal characteristics.

To achieve that, we have experimented an application of Independent Component Analysis (ICA) to Pi 2 pulsations observed at the CPMN (Circum-pan Pacific Magnetometer Network) stations during 13:30-14:00UT on February 17, 1995. As a result, we found that Pi 2 pulsations observed on the ground mainly consist of two components. One was the global cavity-like oscillation observed from high latitudes to equatorial latitudes on the nightside and dayside with the same waveform and frequency. Their amplitudes were largest at TIK (mlat=65.65, mlon=196.90, L=5.98)). In addition, they had a phase reversal near plasmapause and phase shift between TIK and CHD (mlat=64.66, mlon=212.14, L=5.55), which are longitudinally separated stations at high latitudes. This result cannot be explained by existing plasmaspheric cavity resonance model. Thus, we have decided to call this Pi 2 component ‘a nightside-magnetospheric forced oscillation’ by means of ‘a cavity-like oscillation’ or ‘a global cavity mode’. Another component was localized fluctuations at high-latitudes. Hence, they were most likely caused by some local phenomena in auroral region such as westward auroral electrojets and/or oscillations of current wedge.

As a second stage of this research, we have focused on the ‘nightside magnetospheric forced Pi 2 oscillations’ and statistically analyzed them to clarify their generation and propagation mechanisms by means of the ICA.