The two-dimensional distribution characteristics of global mode Pi 2 pulsations extracted by ICA and the auroral breakup

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We have attempted to separate mathematically ground-observed Pi 2 pulsations by applying Independent Component Analysis (ICA). ICA is one of the multivariate statistical techniques that started to be used in the 1990s in the field of signal processing [*e.g., Common*, 1994]. Our final goal is to understand the magnetosphere-ionosphere coupling system associated with substorm onset mechanism from a diagnostic point of view. With ICA, source signals are assumed to be non-Gaussian and statistically independent of each other and estimated by maximizing their statistical independence. It has been successful in resolving observed mixed signals including brain imaging data and voice signals into source signals.

As an initial stage of this study, we applied FastICA algorithm suggested by *Hyvarinen and Oja* [1997] to an isolated Pi 2 event on a quiet day observed at CPMN (Circum-pan Pacific Magnetometer Network) stations and successfully decomposed them into two components. One was the global oscillation that occurs from nightside high to equatorial latitudes with the common waveform and has an amplitude maximum at nightside high latitude. Another component was localized at nightside high latitudes. Its amplitudes were quite weak at low latitudes, but were enhanced near dayside dip equator [*Tokunaga et al*., 2007, GRL].

The second stage of this study is to elucidate two-dimensional distribution characteristics of Pi 2 component classified by ICA. In particular, the polarization patterns near auroral breakup have been unclear because Pi 2 pulsations observed in the region are complex mixture of several components. However, since it is widely believed that Pi 2 pulsations are associated with substorm expansion phase, it must be important to elucidate the Pi 2 distribution characteristics near auroral breakups to clarify an essential mechanism of Pi 2 pulsations.

[Event study]
We have selected a well-defined damping Pi 2 pulsation observed at CPMN (Circum-pan Pacific Magnetometer Network) stations on 15:40-16:10UT January 1997. The ICA calculation was done by MILCA algorithm suggested by *Stogbaur et al*., [2004]. In order to extract polarization patterns, H- and D-component of ground-magnetometer data were simultaneously applied to the ICA as input signals. Next, the position of auroral breakup has been estimated by Polar UVI data. During the Pi 2 event, an isolated auroral breakup was recognized around 22.5 MLT.

[Analytical Results]
We have been extracted global mode Pi 2 components from high-latitude Pi 2 pulsations by ICA. The obtained two-dimensional distribution characteristics were as follows:

1. The amplitudes showed a maximum at the station closest to the center of auroral breakup.
2. At nighside high, mid and low latitudes, the orientation of major axes of the polarization roughly directed to the center of auroral breakup.
3. At nighside high and mid latitudes, the characteristic of polarization patterns showed that of elliptically polarized wave.
4. At nighside low latitudes, the characteristic of polarization patterns showed that of linearly polarized wave.
5. There was a latitudinal polarization reversal from clockwise on the poleside to counterclockwise on the equatorside of the breakup latitude.