Independent Component Analysis of Pi2 Pulsations Observed at the CPMN Stations

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By applying an Independent Component Analysis (ICA) method to datasets of magnetic pulsation observed at the Circum-pan Pacific Magnetometer Network (CPMN) stations, we investigated wave characteristics of decomposed independent components of Pi2 pulsations. The ICA is one of multivariate analysis techniques. This method is very useful for revealing hidden factors underlying a set of signals. The ICA defines a statistical generative model for the observed dataset. In the model, the observed variables are assumed to be linear mixtures of some unknown latent variables, and the mixing system is also unknown. The latent variables are called the independent components, and they are assumed nongaussian and mutually independent.

Pi2 magnetic pulsations simultaneously observed at globally-separated ground stations must be mixed signals, reflecting shear Alfven and compressional modes. The former is generated at multiple magnetic shells at high latitudes. The latter propagates towards middle and low latitudes through different paths. If the ICA can decompose an observational dataset into these different source signals, it would become very useful for understanding propagation and generation mechanisms of Pi2 pulsations.

As an early stage of this research, we have analyzed wave characteristics of Pi2 pulsations observed at the CPMN stations by using the ICA. The obtained initial results are as follows.

Case study (A): nighttime Pi2 pulsations at 22:10-22:55LT on Feb.17,1995

(1) Wave amplitudes of the dominant independent component at KTN (69.9MLat, 201.0MLon) and TIK (65.7MLat, 196.9MLon) stations both decrease with decreasing of latitude. These must be the shear Alfven mode excited at each station.

(2) The dominant independent component at CHD (64.7MLat, 212.1MLon) station is found to be the same with that at low- and middle latitude stations. The wave amplitudes are almost constant at low- and middle latitudes, and have its peak at CHD and KTN, but relatively small at TIK. This must be caused by the longitudinal differences of TIK from the 210Magnetic Meridian (MM) stations. This dominant component would be a magnetospheric cavity-like oscillation excited at high latitude.

Case study (B): daytime Pi2 pulsations at 10:05-10:30LT on Feb.23, 1995

(1) When the 210MM is located in daytime, there are no phase delay of Pi2 wave forms between the daytime lower latitude stations and the nighttime stations in South America, except at equatorial station POH (0.19MLat). The equatorial Pi2 pulsation shows a clear phase delay compared with that at other stations.

(2) Wave amplitudes of the dominant independent component show a peak at the equatorial station (POH), and become small with increasing of latitude.

(3) Wave amplitudes of the dominant independent component are larger in the summer hemisphere than that in the winter hemisphere.

The dominant independent component of daytime Pi2 pulsations may be caused by the ionospheric current system, which is directly driven by a pulsation electric field penetrating from high latitude to the equatorial ionosphere.