# Coordinated observation of Pi2 pulsations by global magnetometer array, all sky imager and satellites in the plasmasphere

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Pi2 pulsations are irregular geomagnetic oscillations that occur with various auroral phenomena, such as substorms, pseudo breakups, and poleward boundary intensifications (PBI). Two generation mechanisms of Pi2, plasmaspheric cavity resonance (PCR) and oscillations of bursty bulk flows that involve oscillating substorm current wedge (SCW), are often discussed as potential driving processes of Pi2. PCR have been mainly supported by electric and magnetic field observations by spacecraft, while SCW oscillation have been supported by polarization distribution of ground magnetic field and periodic modulations of aurora and AKR. However, most past studies of plasmaspheric Pi2 pulsations did not have comprehensive observations at auroral latitudes, and it is not clear how the PCR Pi2s in the plasmasphere are related with SCW oscillation Pi2s. The main goal of this study is to reveal the relation between PCR Pi2 and current oscillations Pi2. We examined spatial and temporal relations between auroras by the THEMIS all-sky imagers, which correspond to an upward field-aligned currents, and Pi2 magnetic oscillations observed globally by ground-based magnetometers and THEMIS and RBSP satellites in the inner magnetosphere.

We found several cases where east-west elongated auroral arcs quasi-periodically intensified near the brightest region of PBI, and each emission propagated both eastward and westward, corresponding to each Pi2 pulse. We focus on two consecutive Pi2 events associated with quasiperiodic PBI auroras around 2013-02-06 07:00 UT. In these events, Z-component magnetic field oscillations reversed with respect to the PBI latitude (GMLat. ~ 72 degrees), indicating that oscillating auroral electrojet drives Pi2s near the PBI. Spatial distribution of horizontal magnetic field in the nightside region lower latitude than PBI latitude is consistent with ground magnetic field produced by oscillating upward and downward FACs located near the PBI location, and the magnetic field did not show substantial positive or negative bays. These observations suggest that a wedge-shaped oscillating current system was generated by PBI-related phenomena without a substorm DC current system. Dayside Pi2s showed a very similar waveform to nightside Pi2 and an amplitude enhancement at the magnetic equator, indicating that dayside ionospheric current was driven by electric field transmitted from the oscillating FAC almost instantaneously. The RBSP-B satellite at ~3Re radial distance observed Pi2s with a similar waveform to ground Pi2 with no significant time delay. On the other hand, RBSP-A at ~6Re radial distance observed a Pi2 that preceded ground Pi2 onset by ~45 s, and its waveform was somewhat different from ground Pi2 and earthward propagation rather than standing waves. The delay time is almost of the same order as the travel time of fast mode waves from the satellite to the ground, and the reason for a different waveform may be some resonance process or a localized disturbance. These observations indicate tha the Pi2 pulsations at RBSP-A in the inner magnetosphere is not due to PCR but driven by quasi-periodic fast-mode waves originating from the magnetotail.

We further investigated how often PCR-type Pi2s in the plasmasphere can be detected as compared to the occurrence of oscillating currents and aurora in the ionosphere, using relation of electric and magnetic fields observed by the THEMIS satellites in the inner magnetosphere. We found 24 events in total and 6 events showed a near 90-degree phase difference between oscillating magnetic and electric fields in the inner magnetosphere, which is an indication of the radial standing compressional wave, and high correlation with ground Pi2s even in the case that show a current oscillation signature determined by ground-based observations and satellite-ground onset delay. The rest of the cases either showed closer to 0 or 180 degrees of phase shifts between electric and magnetic fields, indicating propagating features of plasmaspheric Pi2 waves, or plasmaspheric Pi2 oscillations are not correlated with ground Pi2. These results imply that the radial standing compressional waves only occur in limited occasions and are not likely the major driver of Pi2 pulsations in the inner magnetosphere.