

## Substorm Onset: Correlation between Ground and Space Observations

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The observations of substorm onset phenomena in the magnetosphere and ionosphere are examined to study their correlation and to understand the substorm onset mechanism. In particular, we examine the Pi2 wave structure, propagation, frequency and growth rate in the magnetosphere observed by the THEMIS satellites in the near-Earth plasma sheet and the structure and propagation of the substorm auroral onset arcs. We show the correlation between the substorm onset wave-like arcs and the Pi2 pulsations in terms of wave structure, propagation, and the exponential growth of arc intensity and Pi2 wave amplitude. In particular, the azimuthal mode numbers of the Pi2 waves and the wave-like arc structure are estimated to be  $\sim 100$ -200. The correlation between the ground and space phenomena strongly supports the kinetic ballooning instability (KBI) as the cause of substorms. KBI is the most natural mechanism for explaining the unstable Pi2 waves in the strong cross-tail current region and the KBI parallel electric field can accelerate electrons along the magnetic field lines into the ionosphere to produce the substorm onset wave-like arcs.

Keywords: substorm, magnetospheric dynamics, THEMIS observation