



## **Pi2 detection using Empirical Mode Decomposition (EMD)**

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Empirical Mode Decomposition has been used as an alternative method to wavelet transformation to identify onset times of Pi2 pulsations in data sets of the Scandinavian Magnetometer Array (SMA).

Pi2 pulsations are magnetohydrodynamic waves occurring during magnetospheric substorms. Almost always Pi2 are observed at substorm onset in mid to low latitudes on Earth's nightside. They are fed by magnetic energy release caused by dipolarization processes. Their periods lie between 40 to 150 seconds.

Usually, Pi2 are detected using wavelet transformation. Here, Empirical Mode Decomposition (EMD) is presented as an alternative approach to the traditional procedure. EMD is a young signal decomposition method designed for nonlinear and non-stationary time series. It provides an adaptive, data driven, and complete decomposition of time series into slow and fast oscillations. An optimized version using Monte-Carlo-type noise assistance is used here. By displaying the results in a time-frequency space a characteristic frequency modulation is observed. This frequency modulation can be correlated with the onset of Pi2 pulsations. A basic algorithm to find the onset is presented. Finally, the results are compared to classical wavelet-based analysis. The use of different SMA stations furthermore allows the spatial analysis of Pi2 onset times.

EMD mostly finds application in the fields of engineering and medicine. This work demonstrates the applicability of this method to geomagnetic time series.