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Pi 1 PULSATIONS ASSOCIATED WITH SUBSTORMS AND THEIR CONJUGATE BEHAVIOR

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Abstract: Short period geomagnetic pulsations associated with substorms in the frequency range from about 0.1 to 0.4 Hz are investigated using the dynamic spectrum analysis technique, and it was found that these Pi 1 pulsations are excited simultaneously with Pi 2 pulsations and they show a clear conjugate behavior. These results will suggest that Pi 1 pulsations might be ion-cyclotron waves generated in the geomagnetic tail due to a drastic change of geomagnetic field configuration in the course of a substorm.

1. Introduction

It is well known that Pi 2 geomagnetic pulsations observed at the onset of a substorm are hydromagnetic waves excited in the magnetosphere due to a drastic change of magnetic field configuration.

The authors investigated extensively the geomagnetic pulsations associated with substorms observed at Syowa Station (Japanese Antarctic research base) and Husafell (the geomagnetic conjugate of Syowa Station) as well as Fort Smith and Cambridge Bay in the Arctic region using the dynamic spectrum analysis technique, and found that Pi 1 pulsations are excited simultaneously with Pi 2 pulsations and the frequency decreases gradually from 0.4 to 0.1 Hz in the course of a substorm and also these Pi 1 pulsations show a clear conjugate behavior. These results suggest that Pi 1 pulsations associated with substorms might be ion-cyclotron waves generated in the geomagnetic tail at the time of a substorm.

2. Pi 1 Pulsations Associated with Substorms Observed at Antarctic and Arctic Regions

Using the data of an induction magnetometer recorded at Syowa Station of Japanese Antarctic research base, we investigated geomagnetic pulsations associated with substorms, especially short period oscillations in the frequency range from about 0.1 to 0.4 Hz, using the dynamic spectrum analysis technique.

Figures 1 and 2 show two examples of the results of dynamic spectrum analysis of geomagnetic pulsations. It is evident that the short period pulsations, whose frequency range is from about 0.4 to 0.1 Hz occurred simultaneously with Pi 2 pulsations, and the frequency decreased gradually in the course of a substorm. This type of Pi 1 pulsations

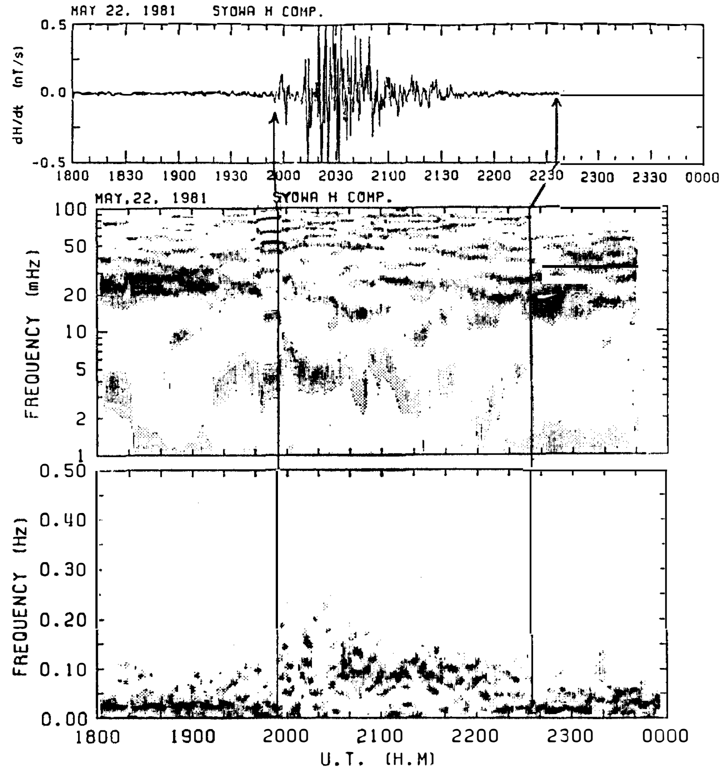

Fig. 1. Dynamic spectrum of pulsations associated with a substorm recorded at Syowa Station. Upper panel: Wave form of Pi 2 pulsations. Middle panel: Dynamic spectrum in the frequency range 1–100 mHz. Lower panel: Dynamic spectrum in the frequency range 0.0–0.5 Hz.

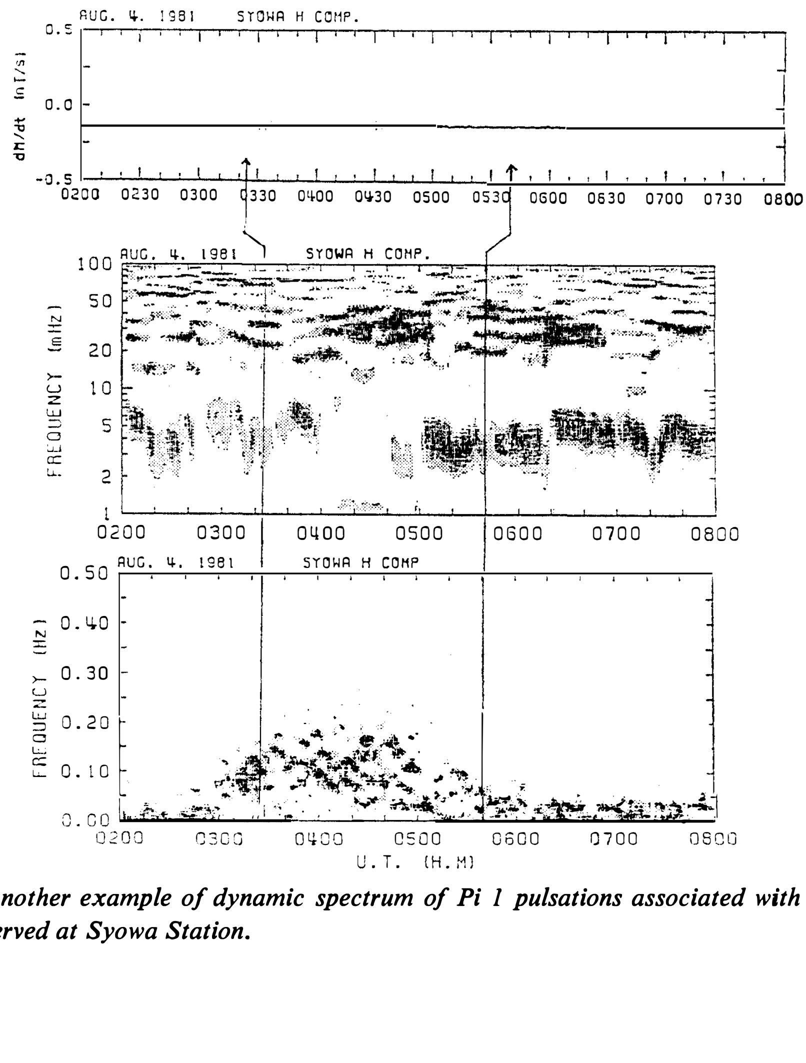

Fig. 2. Another example of dynamic spectrum of Pi 1 pulsations associated with substorm observed at Syowa Station.

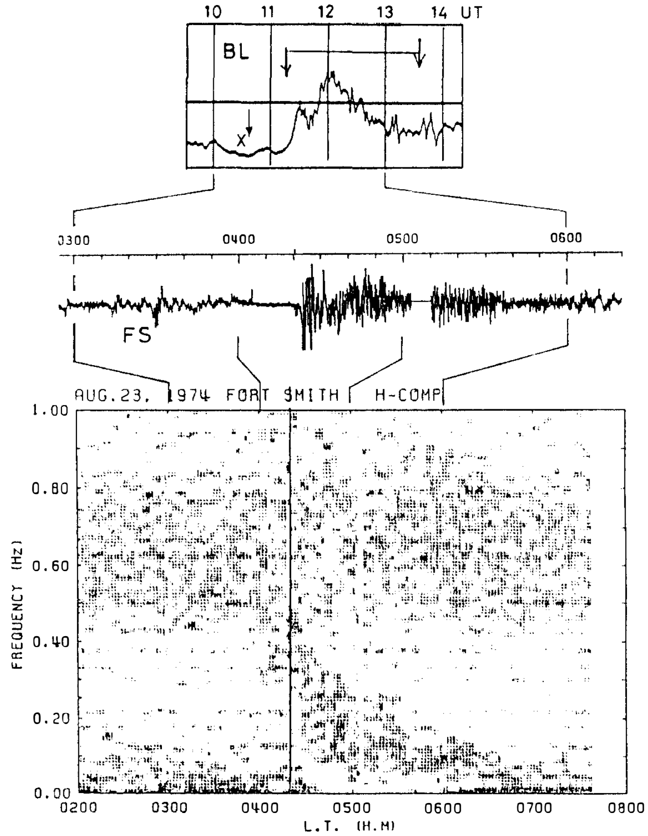

Fig. 3. Dynamic spectrum of Pi 1 pulsations associated with a substorm observed at Fort Smith. Upper panel shows the ordinary magnetometer record at Baker lake, while lower panel shows the dynamic spectrum of Pi 1 pulsations associated with a substorm. It is evident that the frequency of Pi 1 pulsations is higher at onset time of the substorm and gradually decreases during the substorm.

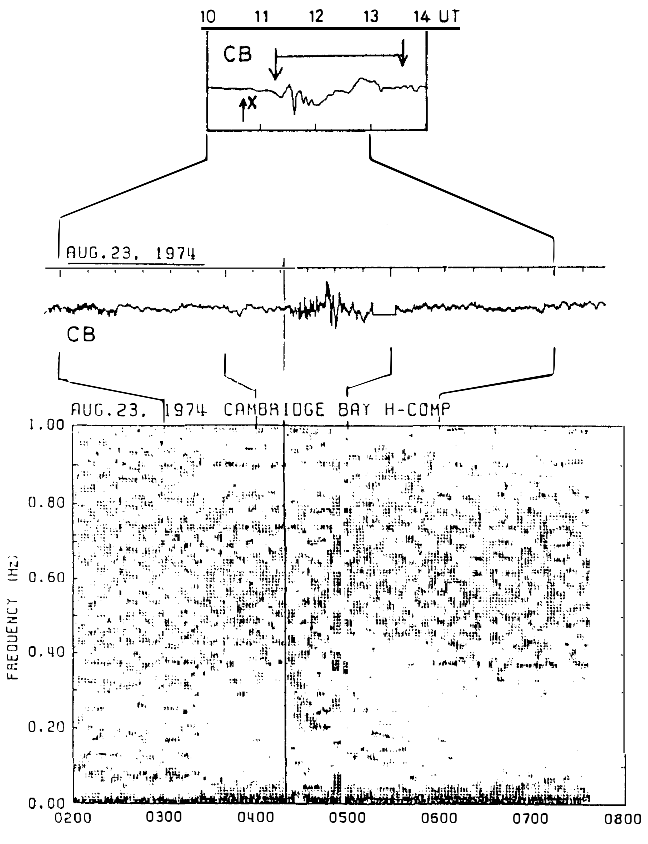

Fig. 4. Dynamic spectrum of Pi 1 pulsations associated with a substorm observed at Cambridge Bay.

is always associated with a substorm activity without exception.

Figures 3 and 4 show also Pi 1 pulsations associated with substorms observed at Fort Smith and Cambridge Bay in the Arctic region. It is clearly demonstrated again that the frequency changes from 0.4 to 0.1 Hz during the course of a substorm.

From this analysis, it is concluded that the frequency changes of Pi 1 pulsations from about 0.4 to 0.1 Hz during a substorm are one of the most essential character of substorm.

3. Conjugate Behavior of Pi 1 Pulsations Associated with Substorms

Figure 5 shows the dynamic spectrum of Pi 1 pulsation associated with a substorm observed at Syowa Station and at Husafell, the geomagnetic conjugate point of Syowa Station.

It is very clear that Pi 1 pulsation associated with a substorm has a clear conjugate behavior. These characteristics are observed for almost all substorm observed at these two stations.

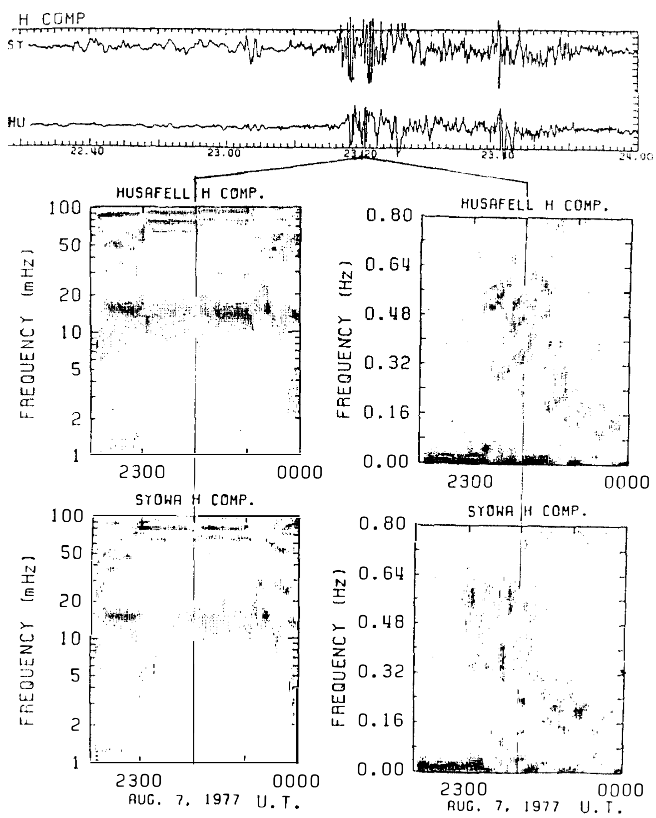

Fig. 5. Conjugate behavior of Pi 1 pulsations associated with a substorm observed at Syowa Station in Antarctica and Husafell in Iceland.

4. Conclusion

It is found that Pi 1 pulsations in the frequency range from about 0.1 to 0.4 Hz are generated simultaneously with Pi 2 pulsations at the time of substorm. The frequency of Pi 1 pulsations associated with substorm is higher at the onset time of substorm than that of the following stage. This result suggests that Pi 1 pulsations associated with substorm might be ion-cyclotron waves generated in the geomagnetic tail at the time of substorm due to a drastic change of magnetic field configuration, since the intensity of geomagnetic tail field seems to be intense at the initial stage of the substorm and the frequency of generated ion-cyclotron wave is proportional to the intensity of magnetic field.

Finally, we wish to express our thanks to the Information Processing Center of the National Institute of Polar Research for the calculation and display using the HITAC M-180 computer system of the dynamic spectra of geomagnetic pulsations.

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