155. Geomagnetic Micropulsations, Associated with Sudden Changes in the Magnetic Field in the Interplanetary Space and the Geomagnetic Tail

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(Comm. by Mankichi HASEGAWA, M.J.A., Oct. 12, 1965)

Recently Ness et al. [1964, 1965] published very important results of measurements of the magnetic field in the interplanetary space surrounding the earth, including the distortion of the magnetic field in the tail of magnetosphere, performed by the satellite, Imp-1 (Interplanetary Monitoring Platform, No. 1).

The geocentric distance of the apogee of the satellite was 197,616 km = 31.7 Re (Re = earth radius) and the useful lifetime of the satellite extended over a period of approximately 6 months while the satellite apogee varied from a solar ecliptic longitude of 335° to 155°. This permitted mapping of the boundary of the closed geomagnetic field formed by the interaction of the solar wind with it in the daytime side of the earth, and also of the topology of the distorted geomagnetic field on the night side of the earth.

Fig. 1 shows a summarized illustration of the results of experiments of Imp-1, reproduced from the papers of Ness et al. As seen in Fig. 1 the space surrounding the earth is divided into three characteristic physical regions:

1. the interplanetary medium
2. the turbulent transition region
3. the magnetosphere

The measurements of the distorted geomagnetic field on the night side of the earth by the satellite revealed the extension of the geomagnetic field far behind the earth, forming a geomagnetic tail, and it has been discovered that there is a magnetically neutral surface, separating regions of oppositely directed fields over a thin planar region of space. This was referred to as a neutral sheet and was correlated with enhanced particle fluxes illustrating to form a pressure balance between the field and the particle population.

The author read these interesting publications carefully, and noticed some close relations between geomagnetic micropulsations and the sudden changes in the magnetic field in the interplanetary space. In this article he wishes to report an example of the relation briefly.

Fig. 2 is reproduced from the paper showing the magnetic
Fig. 1. Projection of magnetic field topology on noon midnight meridian plane, showing some sample orbits. (Reproduced from the paper of Ness et al.)

Fig. 2. Magnetic data from orbit 2 on Dec. 1, and Dec. 2, showing the sudden changes of the magnetic field in the interplanetary space. (Reproduced from the paper of Ness et al.)


In the figure, $F$ is the magnitude and two angles $\theta$ and $\phi$ are the solar ecliptic latitude and longitude respectively in solar ecliptic coordinates.

The sudden changes in the interplanetary magnetic field is seen clearly at 22h22m, Dec. 1, 21h12.8m, Dec. 2, and 22h14.6m, Dec. 2, 1963 in the figure.
As the results of examining geomagnetic records, the author found a very interesting fact that the geomagnetic micropulsations (si) were associated with every one of these abrupt changes. Fig. 3 shows the occurrence of micropulsations in Onagawa, Japan and Wingst, Germany at 22\textdegree 25.1\textsuperscript{m}, Dec. 1, which is related to the above sudden changes at 22\textdegree 22\textsuperscript{m}, Dec. 1. These micropulsations were no doubt excited by si (sudden impulse of geomagnetic field).

The author considered that these sudden changes in the magnetic field in the interplanetary space is caused by the front of the shock wave, generated by the movement of the plasma beam emitted from the sun, and the micropulsations (si), observed on the earth are generated by the hydromagnetic wave excited by the sudden compression at the boundary of magnetosphere due to the arrival of the above mentioned shock front at its boundary.\textsuperscript{4)

The time interval between these two phenomena is about 2.7 minutes, suggesting that the approximate propagation velocity of the associated plasma front is about 1200 km/sec.

Fig. 4 shows another example of the magnetic data from the orbit on May 1, 1964, which was obtained when the satellite was in the tail of magnetosphere.

The author found also an interesting correlation between the magnetic disturbance in the magnetic tail field and the geomagnetic micropulsations on the earth's surface which is shown in Fig. 5, illustrating that the significant change in micropulsations, pi 2, was observed on 11\textdegree 04\textsuperscript{m}, May 1, 1964 which is associated with the sudden changes in the magnetic tail field nearly at 11\textdegree, May 1, 1964.
There are more examples of associated micropulsations (pi 2) which are closely correlated to the changes of the magnitude of the tail field.

The conclusion obtained from these studies is as follows: The increase of the magnitude of the tail field can be interpreted to be resulted by extension of formerly closed field lines into the tail during the magnetic disturbance, and then the pressure balance between the field and particle flux in the neutral sheet will be broken and some kind of burst of particles can be expected in the neutral sheet due to its instability. The magnetohydrodynamic shock wave excited by this burst will travel toward the earth along the neutral sheet, and reach the outside of the cavity surrounded by closed lines of the geomagnetic field, on which the hydromagnetic wave will be excited by this shock wave and will be propagated to higher latitudes along the lines of force, and the micropulsations pi 2 will be observed.

The repetition of occurrence of pi 2 with an interval of about 5–6 minutes is explained by the bouncing travelling of the hydromagnetic wave, thus generated, along the lines of force between...
the conjugate points in both hemispheres.

Acknowledgement: The author expresses his sincere thanks to Prof. Mankichi Hasegawa, M.J.A., for his kind encouragement and comments.

References


