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The characteristics of Pi2 pulsations at Zhongshan Station of Antarctica

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Abstract In this paper Pi2 pulsations at Zhongshan Station of Antarctica are analyzed from October 1 - 31, 1996. Their characteristics e.g. occurrence frequency, frequency, and polarization are studied. The characteristics of Pi2 pulsations are summerized as follows: (1) Pi2 pulsations at Zhongshan Station usually take place from 2000 MLT to 0200 MLT; the main frequencies are between 6.79 mHz and 13.58 mHZ; (2) Pi2 pulsations with low frequencies are dominent. The range of main frequencies becomes narrow at midnight; (3) The polarization of Pi2 pulsations are almost linear; (4) About the orientation of major axes the NW-SE direction is dominent before 2200 MLT and NE-SW is dominent after 2200 MLT. The generation mechanism of Pi2 pulsations at Zhongshan Station is discussed theoretically.
Key words Antarctica, Pi2 pulsations, Zhongshan Station.

1 Introduction

Pi2 pulsations are closely related to the magnetospheric substorms (Sakurai and Mcpherron 1983). The research of Pi2 pulsations is helpful to understand the generation process, and it is important for catching the information of space magnetic environment in the magnetail. The Pi2 pulsation is a kind of attenuation pulsation whose period is 40 - 150 s, and its duration is usually 5 - 7 min. This phenomenon is observed probably at high-latitude and low-latitude. However, the characteristics of Pi2 pulsations in different area are different(Yang 1994).

In this paper occurrence frequencies, frequencies and polarization characteristics of Pi2 pulsation at Zhongshan Station from Oct. 1 to Oct. 31,1996 are analysed mainly. And the excitation mechanism of Pi2 pulsations recorded in Zhongshan Station is studied theoretically.

2 Method

Fig. 1 expresses an example of Pi2 pulsations selected from the data recorded at Zhongshan Station. Three standards are used for selection of Pc3 pulsation. Firstly, the waveform of Pi2 pulsation is attenuation oscillation. Secondly, their main frequency is 6.67 - 22.22 mHz. At the last, their duration usually is 5 - 20 min. There are 49 selected Pi2 pulsation events (Table 1).

Table 1. Browse table of Pi2 pulsations from 1 to 31 October, 1996

Date	Time/MLT	Duration/min	Frequency/mHz	Ellipticity	Polarization	Axial/(°)
Oct. 1	20:47	7	9.7	3/28	RH	−51
Oct. 1	21:04	6	9.7	2.9/17.9	RH	−49.4
Oct. 1	22:02	15	9.7	6.9/36.6	RH	−15.12
Oct. 1	23:50	7	12.61	3/11	LH	−54.7
Oct. 2	00:40	13	6.79	5.7/13.0	LH	78.43
Oct. 4	04:28	5	6.79	11/20	RH	80.53
Oct. 4	21:02	4	7.76	9/19	LH	−45
Oct. 4	21:13	15	6.79	4/9	RH	−41.11
Oct. 4	21:35	7	6.79	3.6/6.0	RH	−45.45
Oct. 4	22:29	5	8.73	1.6/3.7	RH	−18.13
Oct. 5	22:59	7	11.64	5.9/24.8	LH	80.53
Oct. 5	23:16	13	7.76	4/9	RH	−45.0
Oct. 5	23:33	4	6.79	3.7/15.3	RH	44.26
Oct. 5	01:00	7	12.61	9.0/23.4	LH	−47.58
Oct. 5	01:38	12	6.79	1.1/3.3	RH	42.2
Oct. 6	21:10	9	9.7	3.8/39.5	LH	−46.12
Oct. 6	21:21	6	6.79	3.8/39.3	LH	−66.46
Oct. 6	23:38	8	10.67	4/63	LH	−57.82
Oct. 6	22:51	7	8.73	4/17	LH	48.97
Oct. 7	00:20	10	10.67	6/22	LH	−58.39
Oct. 7	01:15	10	11.64	6.5/60.6	LH	−52.86
Oct. 9	21:45	7	16.49	7.8/32.3	RH	−34.03
Oct. 9	21:22	8	9.7	24.8/35.8	RH	−88
Oct. 9	21:35	7	15.52	13.7/23.8	RH	−72.43
Oct. 10	21:57	11	16.49	4.5/19.2	RH	−59.2
Oct. 10	22:21	9	18.43	8/11	RH	−38.81
Oct. 13	21:25	5	11.64	3.8/23.8	RH	38
Oct. 13	21:32	6	12.61	4.9/14.9	RH	47.5
Oct. 13	21:48	5	12.61	3/4	RH	−46.8
Oct. 13	21:57	5	11.64	5.7/24.5	LH	−66.7
Oct. 13	22:10	15	7.76	5.7/15.5	LH	82.8
Oct. 16	20:20	9	12.61	3/8	RH	−4.2
Oct. 16	20:43	12	10.67	2.0/2.5	LH	−84
Oct. 16	21:05	14	7.76	3.3/9.9	RH	−71.23
Oct. 18	02:31	10	6.79	1/11	RH	79.47
Oct. 19	20:15	13	19.4	2/3	RH	−77
Oct. 19	20:53	15	8.73	1.8/4.1	RH	−64.24
Oct. 19	00:33	5	9.7	1.3/3.8	RH	−83.44
Oct. 21	19:38	12	13.58	1.6/2.6	RH	−73
Oct. 22	18:53	11	16.49	1.2/5.6	RH	−32.71
Oct. 22	22:25	10	14.55	2.4/6.3	LH	75.46
Oct. 24	20:55	5	7.76	7.6/20.9	RH	56.91
Oct. 24	22:22	6	7.76	2.0/4.5	LH	23.89
Oct. 25	03:05	11	14.55	9.2/24.5	RH	−30.8
Oct. 25	03:16	10	14.55	3.7/17.0	RH	−51.2
Oct. 25	23:37	7	8.73	1.2/1.4	RH	−21.57
Oct. 27	21:44	9	10.67	1/14	LH	−53.9
Oct. 28	00:32	11	8.73	1.8/8.0	LH	−37.31
Oct. 31	01:29	10	12.61	9/16	RH	−62.47

3 Occurrence frequency characteristics of Pi2 pulsation at Zhongshan Station

The diurnal variation of the occurrence frequency as shown in the Fig. 2 is drawn through the statistics of Pi2 pulsations recorded at Zhongshan Station in magnetic locate time of every day.

Firstly, there are 49 Pi2 pulsations all together from Oct. 1 to Oct. 31, 1996 in all. Secondly, 34 Pi2 pulsations are concentrated in 2000 MLT to 0000 MLT, and they are 69 % of total number. Finally, 15 Pi2 pulsations are recorded between 2100 MLT and

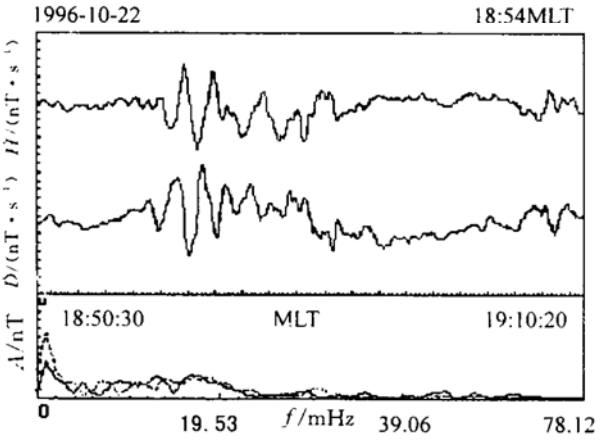

Fig. 1. An example of Pi2 pulsations and Fourier spectra.

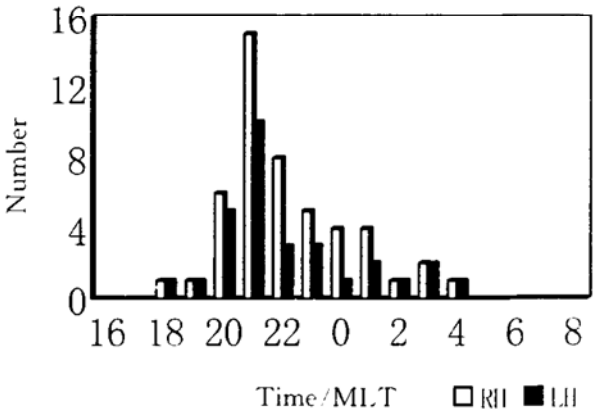

Fig. 2. Diurnal variation of occurrence frequency for Pi2 pulsations.

2200 MLT, and they are 16.7 % of total number. These show that Pi2 pulsations usually take place at night.

4 The frequency characteristics of Pi2 pulsation

All Pi2 pulsations in the period are analyzed by Fourier spectrum technique. 512 samples whose sampling rate is 0.5 Hz are collected from the starting point of the Pi2 pulsations. Then they are analyzed with FFT spectrum. In Fig. 1, there are Fourier spectra of H and D components of Pi2 pulsation. The biggest peak values in the figure of the frequency spectra are called the main frequency of Pi2 pulsation.

In Fig. 3, X-axis indicates the magnetic local times, and Y-axis expresses the main frequency of Pi2 pulsations. Fig. 3 shows the distribution of frequencies of Pi2 pulsation in the magnetic local time. In Fig. 3 the range of main frequencies is between 6.79 mHz and 19.4 mHz before 2200 MLT. The range of main frequencies is between 6.79 mHz and 12.61 mHz near midnight. The range of main frequencies is between 6.79 mHz and 14.55 mHz after 0100 MLT. It is concluded that the range of main frequency becomes narrow at midnight at Zhongshan Station.

There are 42 Pi2 pulsations whose main frequencies concentrate primary between 6.79 mHz and 12.61 mHz. And the main frequencies which are between 6.79 mHz and 7.76 mHz spread all over night. The low frequencies of Pi2 pulsations are dominant at Zhongshan Station.

5 The polarization characteristic of Pi2 pulsations at Zhongshan Station

Fig. 4 expresses the filtered waveform and polarization ellipse. The waveform is got by five points smoothing. The X-axis indicates D component and the Y-axis indicates H component.

In the Fig. 2, the solid pillar is the left handed polarization. In Fig. 2, there are 49 Pi2 pulsations all together, including 29 right handed polarization and 20 left handed

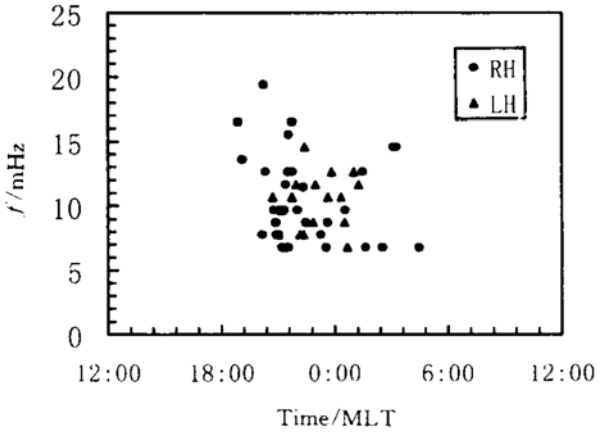

Fig. 3. The main frequency variation of Pi2 pulsations with the magnetic local times.

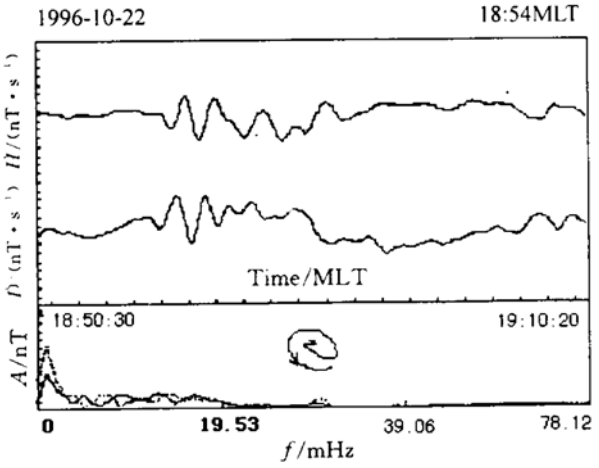

Fig. 4. The filtered waveform and polarization ellipses.

polarization. It indicates that the occurrence frequency of the left handed polarization is similar to the one of the right handed polarization of Pi2 pulsations.

Fig. 5 shows the variation of the polarization ellipse in the magnetic local time. NW-SE direction is primary before 2200 MLT and NE-SW is dominent after 2200 MLT at Zhongshan Station. The generation of Pi2 pulsations at Zhongshan Station of Antarctica could be explained probably by the electric current wedge thoery of magnetospheric substorm.

Fig. 6 shows the ellipticity distribution of Pi2 pulsations at Zhongshan Station. The left handed polarization of Pi2 pulsations distribute between -0.1 and -0.72, and the right handed polarization distribute between 0.06 and 0.85. There are 39 Pi2 pulsations whose polarization ellipticities are mainly between -0.5 and 0.5. And they are 89.5 % of total number. It indicates that the polarization of Pi2 pulsations at Zhongshan Station are almost linear.

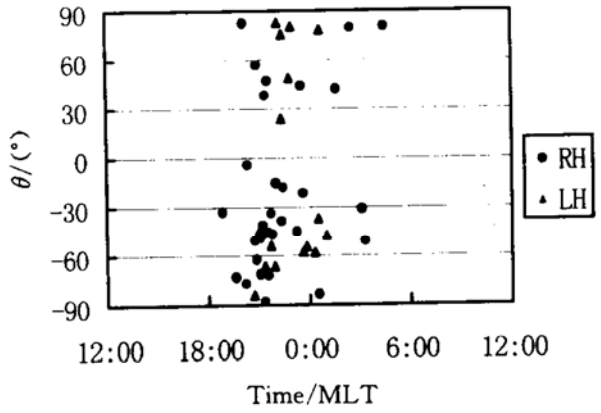

Fig. 5. The diurnal orientation variation of major axes for polarization ellipses.

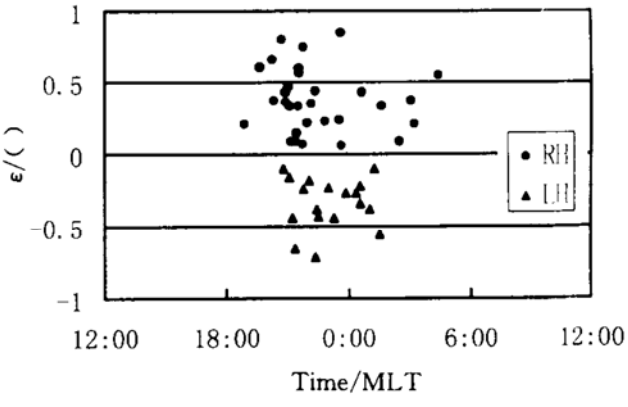

Fig. 6. Ellipticity distribution of Pi2 pulsation at Zhongshan Station.

6 Discussion and conclusions

According to above mentioned analysis of Pi2 pulsations at Zhongshan Station of Antarctica, some characteristics of Pi2 pulsations are summerized as follows: (1) Pi2 pulsations at Zhongshan Station usually take place from 2000 MLT to 0200 MLT; the main frequencies are between 6.79 mHz and 13.58 mHZ; (2) Pi2 pulsations with low frequencies are dominent. The range of main frequencies becomes narrow at midnight; (3) The polarization of Pi2 pulsations at Zhongshan Station are almost linear; (4) About the orientation of major axes the NW-SE direction is dominent before 2200 MLT and NE-SW direction is dominent after 2200 MLT at Zhongshan Station.

The phenomena of Pi2 pulsations usually occur at night show Pi2 pusations is related to magnetospheric substorm. Due to effect of the global disturbance and Pc pulsation in day, some Pi2 pulsations are probably disappear.

The generation of Pi2 pulsations at Zhongshan Station in Antarctica is explained probably by the electric wedge thoery of magnetospheric substorm (Yang 1991). We need to further investigate theoretically to understand the formation of Pi2 pulsations at Zhongshan Station in Antarctica.

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