ELF PLASMA TURBULENCE IN THE MAGNETOSPHERIC POLAR CUSP ASSOCIATED WITH FLUXES OF THE HIGH ENERGETIC ELECTRONS.

J.Błęcki[1], M. Parrot[2], K.Mizerski[3], S.Savin[4], R.Wronowski[1]
[1]*Space Research Centre PAS 00-716 Warsaw, Bartycka 18A, Poland,*
[2]*LPC2E/CNRS, Orléans, France*
[3]*Institute of Geophysics PAS, Warsaw, Poland*
[4]*Space Research Institute RAS, Moscow, Russia,*

Abstract The main goal of this presentation is discussion of the possible source of the low frequency plasma waves registered by CLUSTER satellites in the polar cusp of the Eaarth's magnetosphere. These waves have been sometimes registered in the polar cusp as emissions with extremely high intensity below the electron cyclotron frequency by Interball 1. They correlate with strong fluxes of high energetic electrons often observed within the polar cusp by Interball 1 and Magion 4. Similar effects have been registered by Polar satellite. Cluster measurements give new insight of these emissions. The observations of the waves at the frequencies close to electron cyclotron frequency done by Cluster satellites associated with strong fluxes of energetic electrons will be presented. The analysis of the wave form registered by STAFF instrument onboard of CLUSTER satellites has been performed with wavelet and bispectral methods, which shown the nonlinear effects present in these registrations. Taking into account the plasma and magnetic field parameters in the polar cusp as well as geometry of the waves propagation, one has found that these emissions can be generated by so called "fan instability". This instability plays important role in the nonlinear wave –particle interactions leading to the isotropisation of the fluxes of the particles and heating of the plasma.

OBSERVATIONS

The observations done in the polar cusp indicate the permanent presence of plasma waves in this region [*1-6*]. These conditions indicate that cusp is an ideal region to study developing of different types of plasma instabilities and nonlinear interactions between different plasma modes. One can say that the polar cusp is an ideal laboratory to study key plasma processes interested from the point of view of geophysics as well as of astrophysics.
One of the discoveries made by the Polar, Interball 1 and Magion 4 satellites in the polar cusp is the presence of high energy particles (ions and electrons) in this region [7,8]. Strong emissions of the plasma waves are associated with these particles [2,4]. The wave data used in this paper originate from the STAFF instrument onboard the CLUSTER satellites [9]. To study the wave processes in the polar cusp we use waveform of the magnetic field measurements recorded by this experiment, which can also provide spectra up to 4kHz. The maximum of the measured frequency of the waveform is 12.5Hz.
Figure 1 and 2 show the example of the wave activity registered by CLUSTER (Figure 1) and DEMETER (Figure 2) in the outer cusp and cusp at the ionospheric altitude respectively together with spectra of the energetic electrons

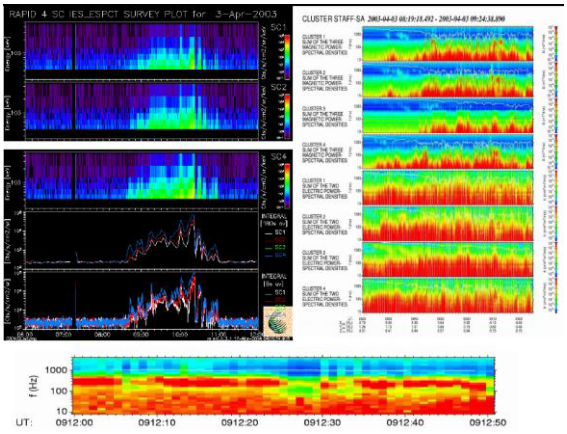

Figure 1.: Energetic electrons spectra and fluxes (upper left panel) and wave spectra gathered by CLUSTER satellites in the outer polar cusp. Lower panel shows the characteristic maximum at 1/3 f_{ce} corresponding to fan instability

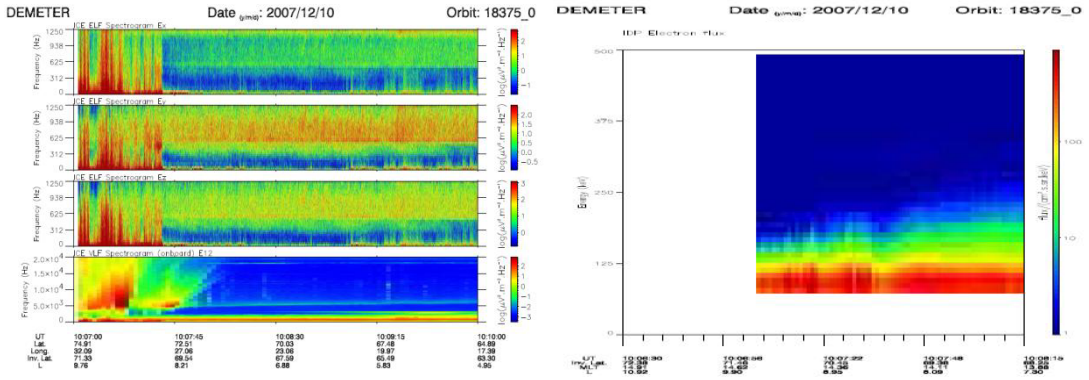

Figure 2. Wave spectra (left panel) and energetic electrons spectra taken by DEMETER in the polar cusp at the ionospheric altitude.

CONCLUSIONS

The characteristic features of the wave spectra most frequently observed are broad band emissions, maxima at the lower hybrid, electron cyclotron frequency and sometimes its harmonics and below the ion cyclotron frequency.
Results presented here are selected from among many other cusp crossings and it was found that certainly not always such strong waves were present in the cusp. It seems that the most intensive waves in the cusp are associated with its boundaries and with the presence of high energy particles.
The waves observed in the cusp region together with energetic particles can be discussed either in the context of the plasma instabilities triggered by these particles or as a cause of the acceleration and energization of these particles.

References

[1] Pottelette, R., M., Malingre, N., Dulouloz, et al., High frequency waves in the cusp/cleft regions, *J. Geophys. Res.*, **95**, 5957, 1990
[2] Pickett, J.S., D.A.Gurnett, J.D.Manietti et al., Plasma waves observed during cusp energetic particle events , *Adv.in Space Res.* **24,** 1, 23, 1999.
[3] Błęcki, J., H. Rothkaehl, K. Kossacki *et al.* , ULF-ELF-VLF-HF Plasma Wave Observations in the Polar Cusp Onboard High and Low Altitude Sattelites, *Phys. Scripta*, **75**, pp. 259-263, 1998 .
[4] Błęcki, J., K. Kossacki, R. Wronowski, et al., Low Frequency Plasma Waves Observed In The Outer Polar Cusp, *Adv. in Space. Res.*, **23,** No 10, 1765, 1999.
[5] Błęcki J., S. Savin, N.Cornilleau-Wehrlin, et al. The Low-Frequency Plasma Waves In The Outer Polar Cusp – Review Of Observations From Prognoz 8, Interball 1, Magion 4, and Cluster Satellites, *Survey in Geophys.*, vol. 26. Nr 1-3 pp.177-191, 2005
[6] Savin S., J. Buechner, G. Consolini, et al., On the properties of turbulent boundary layer over polar cusps, *Nonlinear Processes in Geophysics*, 9, 443–451, 2002b
[7] Chen, J., T.A. Fritz, R.B. Sheldon et al., Cusp energetic particle events: Implications for a major acceleration region in magnetosphere, *J. Geophys. Res.*, **103,** p.69-78, 1998.
[8] Pissarenko, N.F., I. Kirpichev, V. Lutsenko, S. Savin et al., Cusp energetic particles, observed by Interball Tail Probe in 1996, *Phys. Chem. Earth,* 26, p. 241-245, 2001.
[9] Cornileau-Wehrlin N., G. Chanteur, S. Perraut, et al. First results obtained by the CLUSTER STAFF experiment, *Ann.Geophys.*, 21, 437-456, 2003.