INTERBALL 1/ALPHA 3 OBSERVATIONS OF THERMAL PLASMA IN THE DUSK SIDE PLASMASPHERE

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1. Introduction.

The ALPHA 3 experiment for cold ion flux measurements is continuously functioning on INTERBALL 1. The description of the instrument could be found in [1]. Due to highly eccentric spacecraft orbit as a rule the instrument provides data on plasmasphere cold ions once per four days. In July – August 1999 the plasmasphere was crossed in the dusk sector (17.40 – 20.30 MLT) between $L \approx 3.5\ R_E$ and $L \approx 4.5\ R_E$. The dusk side is likely to be rather interesting and important region of the plasmasphere from the point of view of its formation and its reaction to geomagnetic activity variations [2]. The dusk side bulge region was intensively studied by whistler observations, geosynchronous satellites and DE-1 satellite [2, 3 and references therein]. But the most attention was put on the plasmasphere structure in this region, variations of plasmapause, bulge formation and movement, and not on the plasma parameter variations with geomagnetic activity. It is generally proposed from the earlier whistler works that the density in the outer plasmasphere can be depressed in the aftermath of magnetic disturbances. However at least sometimes during the development of magnetic storm main phase the density can increase as it was observed on INTERBALL - AURORAL in the day side plasmasphere [4]. It seems useful to analyze more similar cases to achieve understanding of physical mechanisms responsible for plasmasphere parameter variations.

2. Data analysis

The data from 6 successive passes of INTERBALL-TAIL through the outer plasmasphere are analyzed. Ion energy spectra measured along the 3 orbits by retarding potential analyzer RPA are plotted in Fig.1. The middle panel shows the spectra measured on 30 July in the period of very high magnetic activity. The K_p index was equal to 5 in preceding 6 hours and to 8- during the period of the measurements. Simultaneously, nothing extraordinary is seen in Dst variations, while very high auroral activity is observed by AE index variations. All other analyzed data are associated with quiet geomagnetic conditions. Rather well known features of plasmasphere behavior should be mentioned. It is clearly seen the sharper plasmapause boundaries in disturbed conditions. Sometimes highly irregular structure of the outer dusk plasmasphere with patches of dense plasma separated from the main plasmasphere by plasma trough regions (Fig.1, right panel) is observed in quiet conditions [2].

Fig.2 presents H^+ ion temperature and density versus time reduced from the spectra measurements along the orbits. Different symbols correspond to single spectra along an orbit. The time is given in seconds and in every orbit a moment t = 0 was attributed to the point of minimum L observed during the plasmasphere crossing. Firstly it is seen that densities

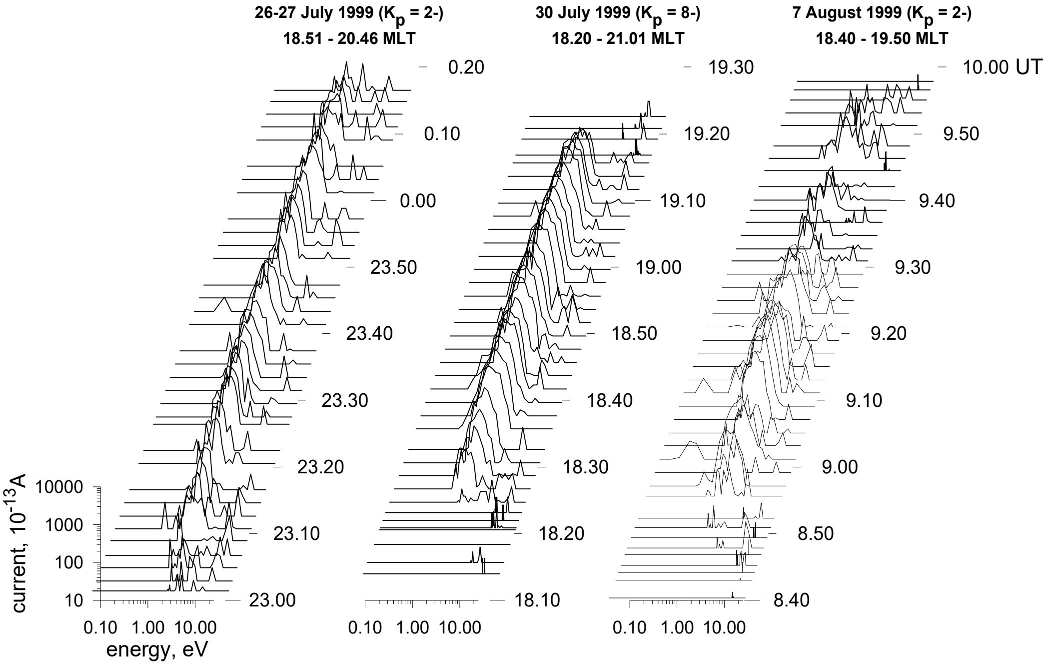

Fig.1 Cold ion energy spectra measured by ALPHA 3/RPA on 26-27 July, 30 July and 7 August 1999 in the Earth's plasmasphere.

measured on the disturbed day (solid circles) are the highest. The dynamics of density variations in the day side plasmasphere during a magnetic storm were considered in [4]. It was demonstrated that H^+ density decreases in the beginning of a magnetic storm and then increases with storm development. Since on 30 July 1999 the measurements were made after ~ 7 hours of enhanced magnetic activity the observed density enhancement might correspond to the similar dynamics.

Secondly, the temperature recorded on the disturbed day remained almost unchanged and also close to the highest detected level in the innermost observed part of the plasmasphere (Fig.2). This fact does not agree with the conclusion made in [5] that on the evening side ion temperatures are usually depressed when K_p is high. This conclusion referred to L between 2 and 3 and INTERBALL observations referred to L ~ 3.5. Observation of enhanced temperature and density simultaneously confirms the correlation between temperature and density structure deduced in [6].

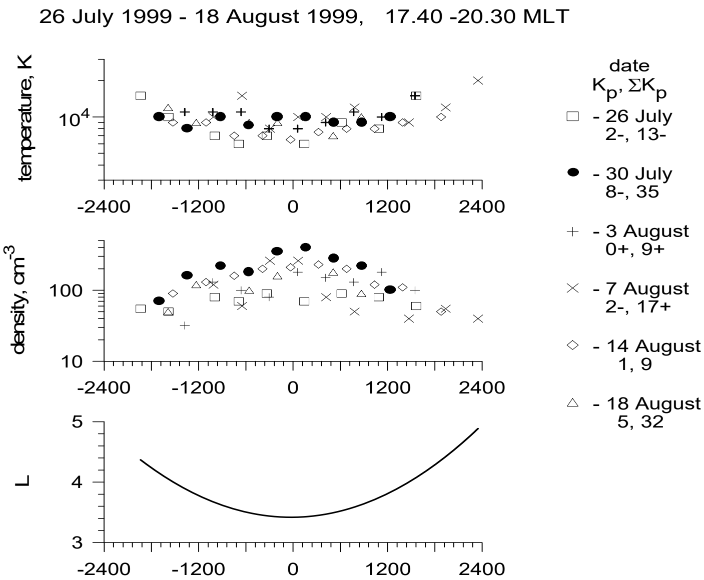

Fig.2. Temperature and density variations along the orbits across the plasmasphere.

In the quiet geomagnetic conditions the temperature tends to increase in the external plasmasphere. This region possibly corresponds to the hot or warm plasmasphere zone observed in the earlier experiments on soviet spacecraft [7].

Fig.3 presents the radial dependencies of ion temperature and

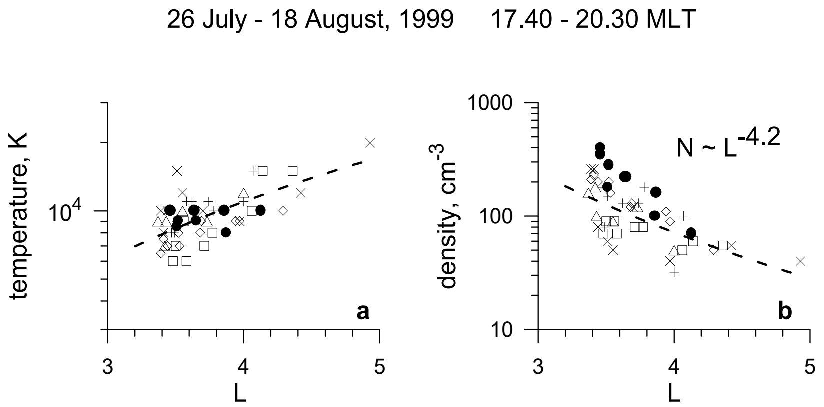

Fig.3. Temperature and density variations versus L-shells.

density in a and b panels, respectively. Dashed curves represent the best fits to the data but excluding the points referred to July 30. For comparison the temperature fitting curve was superimposed on the DE-1 spacecraft data, given in Fig.3b in [6]. Very good coincidence confirms the reliability of ALPHA 3 data. Fig. 3 demonstrates again that temperature and density distributions with L-shells observed in geomagnetically active period, differs substantially from the distributions obtained in quiet conditions. The density fitting dependence $N \sim L^{-4.2}$ is very similar to the one proposed for a 'collisionless' plasma $N \sim L^{-4}$ [8], rather than suggested for a diffusive equilibrium [2]. The obtained N(L) dependence seems to be intermediate between the trough and plasmasphere profiles obtained earlier and generally used for other time sectors [2 and references therein]. But to be reliably used the deduced dependence should be obviously checked with much more data.

3. Concluding remarks.

The data on cold plasma fluxes measured along 6 passes of INTERBALL – TAIL across the dusk side outer plasmasphere in July – August 1999 were analyzed. One of these passes 30 July 1999 occurred in the period of very high auroral activity. In this orbit pass:

(a) the sharp plasmapause was observed, while without essential plasmapause displacement;
(b) the measured H^+ density was 2-3 times higher than that observed in other orbits;
(c) the temperature remained almost unchanged

The density increase could be associated with enhanced convection and reconfiguration of the existing plasma distribution, rather than the refilling process. The heating in the outer plasmasphere is possibly connected with heat flux from the ionosphere as well as with the interactions with ring current particles either by Coulomb collisions or by means of wave particle interactions.

For comprehensive analysis of this case that seems to be quiet interesting, it would be necessary to analyze the behavior of ring current, the situation in the underlying ionosphere and near the bases of magnetic field lines.

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