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PRELIMINARY RESULTS OF MEASUREMENTS CARRIED OUT BY MEANS OF CHARGED PARTICLE TRAPS ON THE INTERPLANETARY STATION ZOND-2

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To be Presented to the VI-th International Space Sciences Symposium in Buenos Aires in May 1965

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I. Some information about the experiment

On the interplanetary station Zond-2 launched on November 30, 1964, several traps of charged particles were mounted. They were designed for measuring charged particle fluxes near the Earth and for determining the values of solar plasma fluxes and their energy spectra. Fig. 1 gives the projection of the near the Earth portion of the trajectory of Zond-2 to the plane of ecliptic. For comparison the appropriate portion of the trajectory of Lunik-2 launched on September 12, 1959 is shown. Both trajectories are situated approximately symmetrical with respect to the Sun-Earth line, over the Earth's night side. In geomagnetic coordinates these trajectories are also close to each other, in particular, both rockets crossed the plane of the geomagnetic equator approximately at the same geocentric distance.

In the present communication preliminary data of measurements are given carri-d out at the station Zond-2 by means of the modulation trap and one of the integral traps of charged particles during the first half of December 1964.

whole interval with the exception of the small section of the trajectory near the Earth on which zero values of the current were recorded. The direct component of the collector current as a function of the Zond-2 geocentric distance is shown in Fig.3. The data given in the figure are corrected by the value of the reverse photoelectron current in the collector circuit ($\sim(1 \div 2)\ 10^{-10}$a) which could be estimated by the change of the current at the section when the Zond-2 left the shadow of the Earth. Small negative currents appeared beginning from $R = 4R_E$ and began to grow rapidly beginning from $R = 5.5R_E$. By the moment of the end of the measurement session the value of negative currents reached a significant value $(6 \div 7) \cdot 10^{-10}$ which corresponds to the flux of electrons $\sim 3 \cdot 10^8$ cm^{-2}/sec^{-1} (within the body angle limited by the input diaphragm of the modulation trap ± 30° by the level of half-intensity). Apparently if the measurement session had continued the region of recording soft electron fluxes also would have continued as it was the case in 1959 for Lunik 2 [1]. The regions of recording soft electron fluxes from Zond-2 and Lunik-2 are given in Fig. 1 by hatching. The zone, in which fluxes of low-energy electrons began to be observed, on Zond-2 is situated symmetrically to the similar zone crossed by the Lunik-2 trajectory and is adjacent to the zone in which low-energy electron fluxes were observed from the satellite Explorer-12 in 1961 [4,5]. Thus the data given confirm once more that fluxes of low-energy electrons beyond the radiation belts exist not only in the direction of the Sun where they were repeatedly observed from different space vehicles (Lunik 1 [6], Explorer-12 [4,5], IMP-I [7,8], but in the opposite direction over the Earth's night side where the fluxes are the most intense and extended at low latitudes near the plane of the geomagnetic equator (Lunik-2 [1]), Explorer-12 [4,5], Zond-2).

Four years ago at the Second International Space Science Symposium in Florence the intermediate region between the outer radiation belt and undisturbed interplanetary space filled with charged particles with concentrations exceeding the corresponding concentrations in the outer radiation belt was called the outermost belt of charged particles [1]. The only direct experimental evidence of the existence of such region at that time were observations by means of charged particle traps aboard Soviet Luniks. Now the properties of this region in different directions with respect to the Earth-Sun line became known considerably better. For instance, the presence of soft electron fluxes beyond the region of trapped radiation in the direction of the Sun, in the comparative proximity from the geomagnetic equator is connected apparently with the thermolisation of solar plasma beyond the front of the shock wave appearing during the interaction of solar plasma fluxes with the Earth's magnetosphere (which in principle coincides with the explanation of the origin of this zone given at first in [9]).

The existence of the "night" portion of the outermost belt of charged particles is connected apparently with the existence of the "neutral layer" in the "magnetic tail" on the magnetosphere night side, discovered by N.F.Ness in 1964 from the satellite IMP-I [10]. The experiments on the Mars-1 probe [2] and Electron-2 [11,12] have shown that soft electron fluxes on the night side exist also at high geomagnetic latitudes. It should be stressed that at present there is not a single case when a space vehicle carrying instrumentation capable of recording low-energy electron fluxes, while crossing the outer radiation belt boundery in any direction, did not record these fluxes. Therefore one can think that since the region of the existence of low-energy electron fluxes everywhere rest upon the trapped radiation zone outer boundary (sometimes penetrating inside the outer radiation belt) the part of this region situated from the side of the Sun is connected with its "night" part. Both parts (perhaps not identical by physical properties and the origin) form a single zone of a complicated configuration. Let us note that the character of the connection between these two parts of the outermost belt of charged particles (the "day" side and the "night" side) essentially depends on the fact whether the magnetosphere is open or closed in the antisolar direction. Assuming the open model of the magnetosphere and noting the correlation between low-energy electron fluxes with the formation of auroras A.Dessler and R.Juday suggested that these fluxes should be called "auroral radiation"

[13]. In our opinion, the zone of the existence of soft electron fluxes on the solar side and in the opposite direction may be properly called the <u>outermost belt of charged particles</u> (or the <u>outermost zone of charged particles</u> if one consideres the term "belt" inseparably connected with the conception of trapped radiation).

3. <u>Observations of the Solar Wind</u>

By means of the modulation and integral traps of charged particles described in section 1, during some communication sessions with the Zond-2 station, the fluxes of the solar wind protons and their energy spectra were measured. The main position of the modulation trap is a position when its axis is oriented on the Sun. When the trap axis deviates from this direction corrections were introduced into the measured values based on the study of trap angular characteristics in the laboratory.

Fig.4 and 5 give, as examples of the obtained data, some solar wind spectra measured on December 5, 1964. The diagrams show Greenwich time (hours and minutes). During these measurements the station was at a distance of $\sim 1,7 \cdot 10^6$ km from the Earth.

The values of the fluxes measured on December 5, 1964, are comparatively small ($\lesssim 10^8 cm^{-2} sec^{-1}$). It should be noted that the day December 5, 1964, was exceptionally quiet magnetically (the sum of three-hour K-indexes for 24 hours from the data of the observatory in Caimbra $\sum K=2$). As in the previous experiments on the Venus-1 probe in 1961 [14] and on Mars-1 probe in 1962, the measurements have shown that the increase of geomagnetic disturbances is connected with the growth of solar plasma fluxes. For instance on December 7, 1965, when from the data of the same observatory $\sum K = 18$ at 21 h GMT a flux of $\sim 1{,}5 \cdot 10^{9} cm^{-2} sec^{-1}$ was recorded. On this day (December 7, 1965) a single December magnetic storm with sudden commencement was observed.

Let us note that during strong geomagnetic disturbances, on the Mars-1 station there were observed solar plasma fluxes of $\sim 10^{9} cm^{-2} sec^{-1}$, for instance on November 22, 1964 at 9 h.10 min. and on November 30, 1964 at 10 h.GMT.

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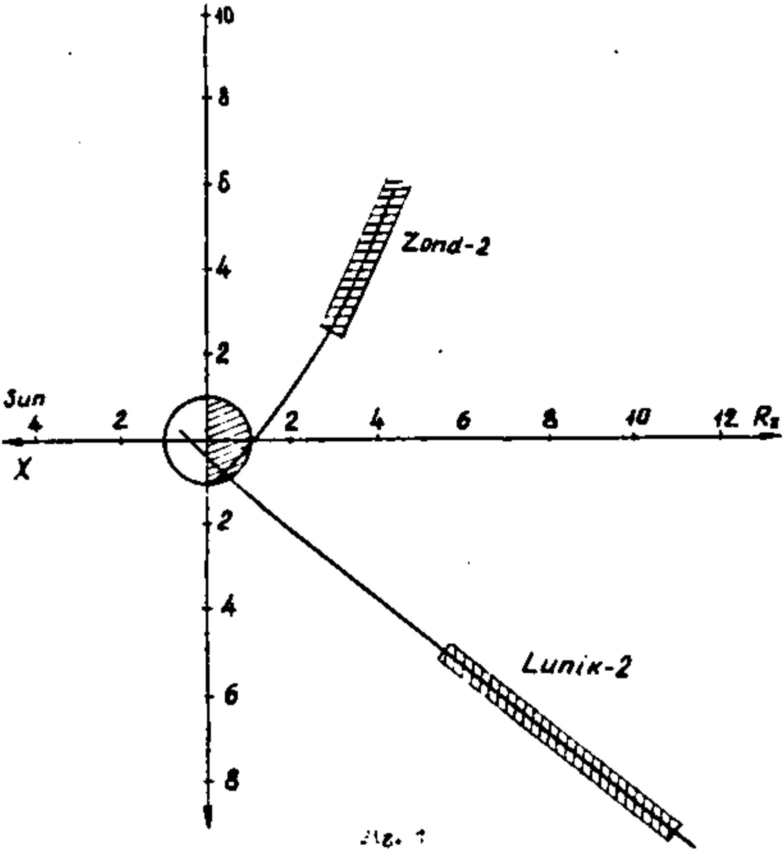
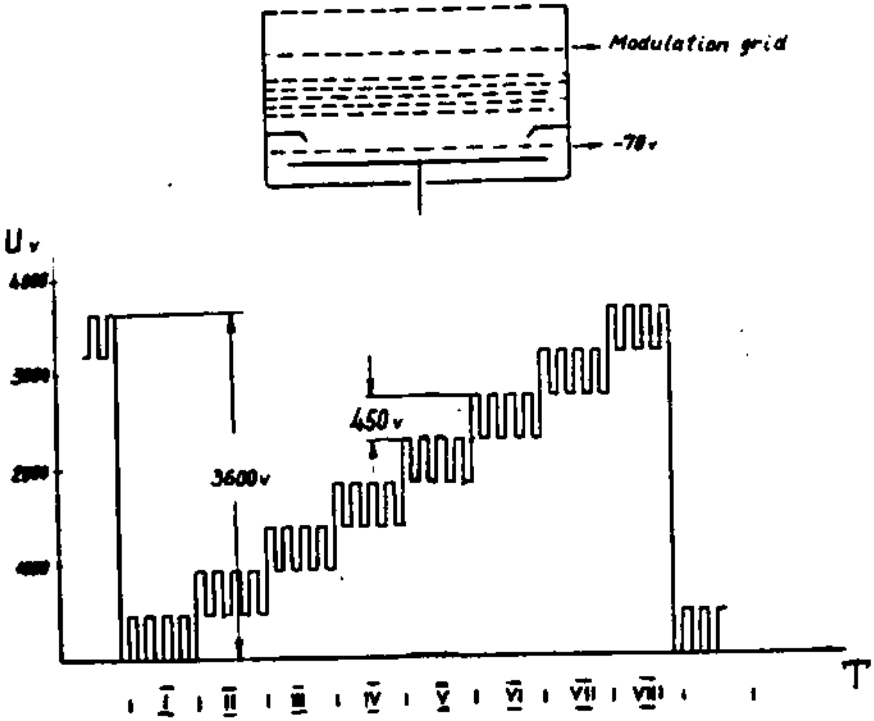


Fig. 1


Modulation grid
-70 v
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4000
3000
2000
1000
3600 v
450 v
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I
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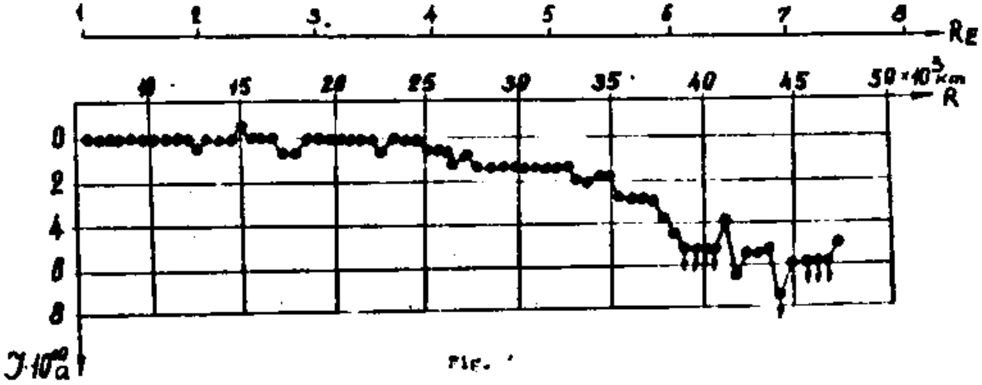
VI
VII
VIII

Fig. 2


1
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RE
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15
20
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35
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50×10^5 km
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0
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8
$J \cdot 10^{10}_a$

FIG. 1

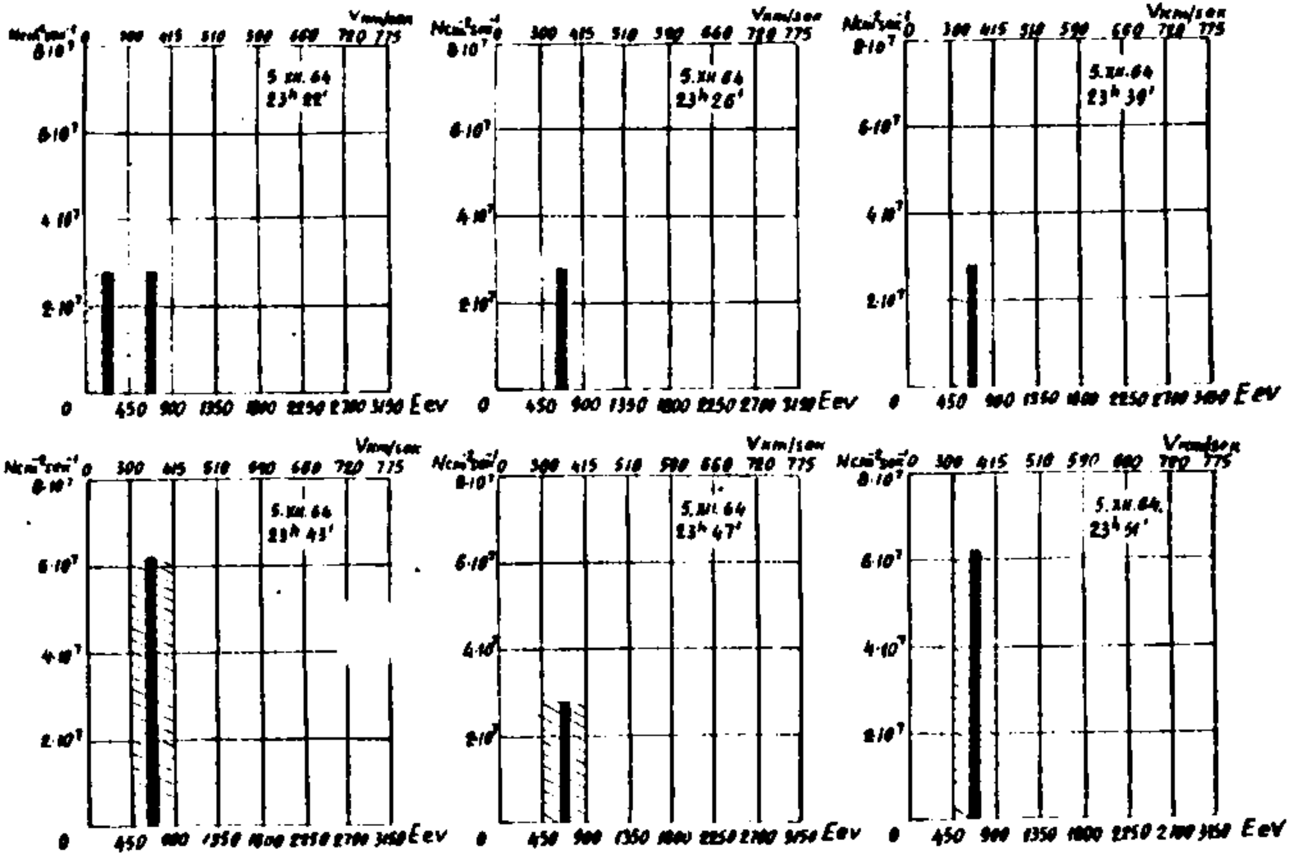
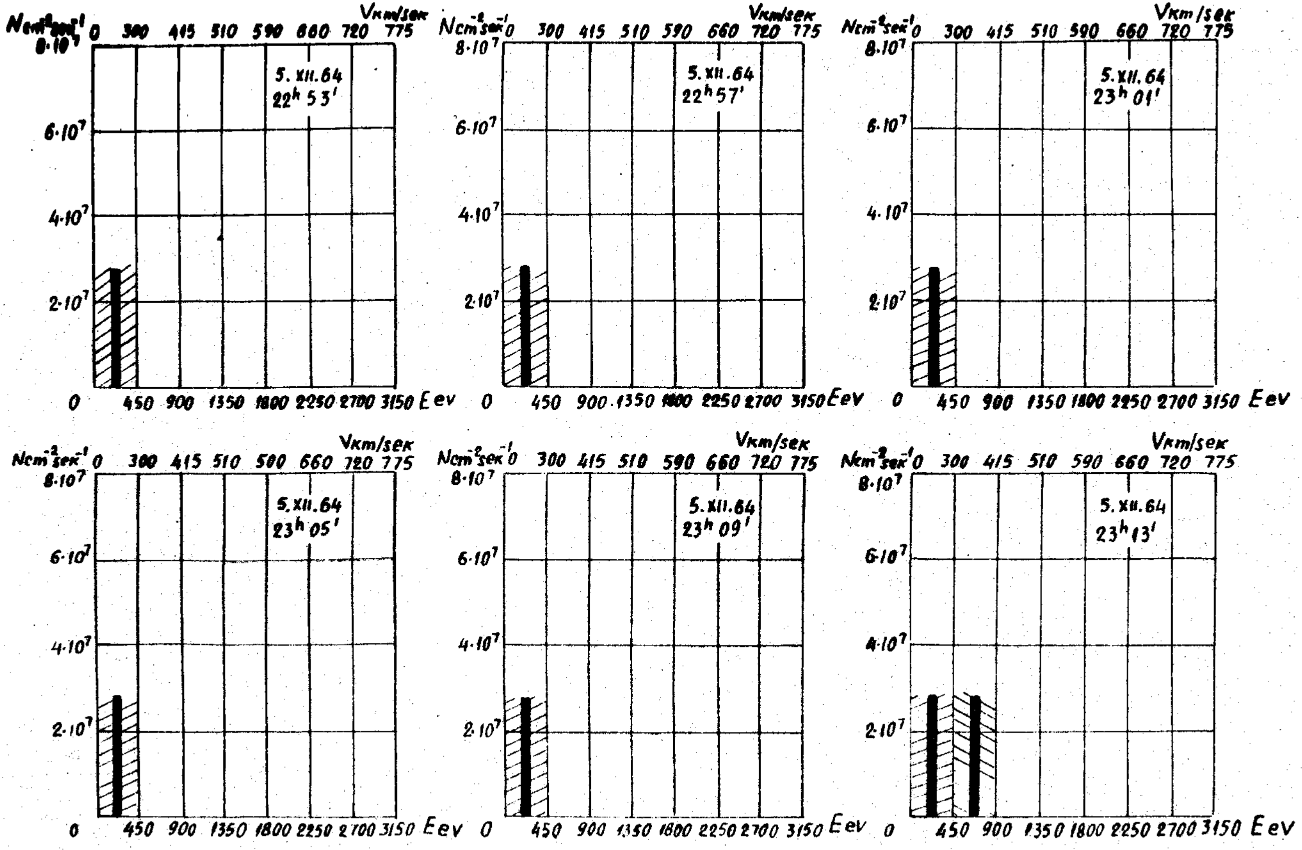

N cm^{-2} sec^{-1}
V km/sec
0 300 415 510 590 660 720 775
8·10^7
6·10^7
4·10^7
2·10^7
0 450 900 1350 1800 2250 2700 3150 E ev
5.XII.64 23^h 22'
5.XII.64 23^h 26'
5.XII.64 23^h 30'
5.XII.64 23^h 43'
5.XII.64 23^h 47'
5.XII.64 23^h 51'

Fig. 5

Ncm⁻²sek⁻¹
8·10⁷
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Vkm/sek
0 300 415 510 590 660 720 775
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23ʰ 05′
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23ʰ 09′
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23ʰ 13′

Fig. 4