

A STUDY OF PROTON FLUXES IN THE RANGE 1.5–50 MeV
ON THE ZOND-4 AND ZOND-5 SPACE PROBESB. P. KONSTANTINOV, M. M. BREDOV, A. A. KOLCHIN,
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A study of 1.5–50 MeV proton fluxes was carried out on Zond-4 and Zond-5 space probes. Numerical values of proton flux intensities in the ranges 1.5–10, 10–21, 30–35 and 45–50 MeV obtained are presented.

As well-known, the study of low-energy cosmic rays has already yielded valuable information on the structure of the interplanetary magnetic field and the mechanism of solar modulation. However a clear understanding of the processes occurring in the interplanetary space can be gained only through an investigation of the change of its physical characteristics in time, i.e. of the dynamics of the phenomena involved. This should permit, in particular, an unambiguous relation between the characteristics observed and solar activity to be revealed. The major part of the work in this region has been carried out at the minimum of the solar activity cycle [1, 2, 3] although later publications are also available [4].

A study of proton fluxes in the range 1.5–50 MeV was carried out on Zond-4 and Zond-5 space probes launched to the Moon on March 2 and September 15, 1968, respectively. A short description of the equipment used and of the results obtained is presented below.

The proton measuring equipment consisted of two instruments. The first instrument represented a sandwich of two silicon lithium drifted detectors, the second of them (D2) being connected in anticoincidence with the first one (D1). The area of D1 was 1.5 cm², the area of D2 was 2.5 cm². The detectors were screened from light with aluminium foil 10 μ thick. The geometric factor of the instrument was 3.9 cm² ster. The instrument detected protons in the energy ranges 1.5–10 MeV and 10–21 MeV.

The second instrument represented a telescope of two identical silicon lithium drifted detectors 2.5 cm² in area each. The cone angle was 100°; the separation between the detectors being 14 mm. By properly choosing the thickness and shape of absorbers and the discriminator threshold, the instrument was set to detect protons in the energy ranges 30–35 MeV and 45–50 MeV. No particles other than protons could trigger the telescope.

The proton measuring equipment was oriented in such a way that as the space probes rotated, the instruments scanned mainly in the plane perpendicular to the ecliptic plane. However sometimes they changed orientation on command. In what follows we shall mainly discuss the results obtained on Zond-5.

Fig. 1 shows the outgoing and incoming parts of Zond-5's trajectory as projected on the ecliptic plane in a coordinate system with a fixed sun-earth line.

First data were telemetered from a distance of about $3.5 R_e$. At that time the space probe traversed the outer radiation zone. A high counting rate (apparently due to electrons) was registered in PS-1 channel (the 1.5–10 MeV range) which revealed fluctuations with increasing distance from the earth, and eventually dropped to a steady level measured outside the magnetosphere. No increased counting rate was revealed in the telescope channels while in the outer radiation zone. Short "bursts" lasting sometimes less than a minute could be seen in the PS-1 channel up to a geocentric distance of about $16 R_e$.

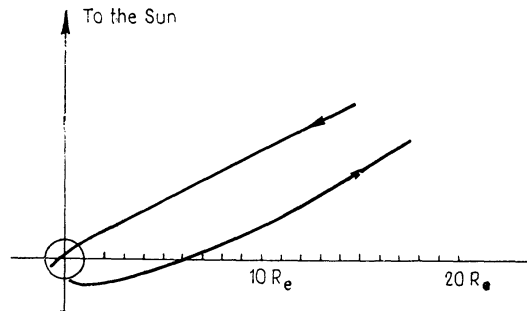


Fig. 1. Outgoing and incoming parts of Zond-5's trajectory as projected on the ecliptic plane in a coordinate system with a fixed sun-earth line

We shall describe here measurements carried out starting from this moment on and till the switching off of the equipment which was been effected on the way back to the earth, at about $13 R_e$. The corresponding data are apparently characteristic for free-space conditions in the vicinity of the earth during the period 15 to 21 September, 1968.

Fig. 2 presents the variation of the counting rates in the three channels during the period $11^{\text{h}} 16^{\text{m}}$, 15 September to $13^{\text{h}} 30^{\text{m}}$ 21 September 1968. Points in the graph were obtained by averaging out over intervals ranging from 45 to 140 min.

A day-to-day averaging makes some increase of the counting rate in the PS-1 channel more pronounced during this period from 0.39 to 0.46 sec^{-1} , the standard deviation being less than 0.01 sec^{-1} . The counting rates in the PT-1 and PT-2 channels similarly show some increase. However, on the whole one can say that neither of our instruments detected any sharp change in the counting rate that could have been attributed to a marked change of conditions in space near the earth in the period from September 15 to September 21.

The comparatively low duration of our experiment does not permit an unambiguous conclusion to be drawn as to whether our instruments measured a "quiet" background between solar flares or whether the data presented correspond to some plateau lying well above the background, Zond-5 being flown in the year of maximum solar activity, makes the latter alternative seems to be more probable. The question can obviously be answered by comparing our data with the data obtained on other spacecraft which were outside the magnetosphere at the time.

As mentioned above, Zond-5 sometimes changed its orientation on command from the earth. The fact that the average counting rate in all channels remained approximately the same all the time gives us the right to use here the average proton flux intensity, which characteristic is related in a straight-forward way (via the geometric factor) to the average counting rate. This is essentially equivalent to an assumption of an isotropic proton flux during the averaged intervals.

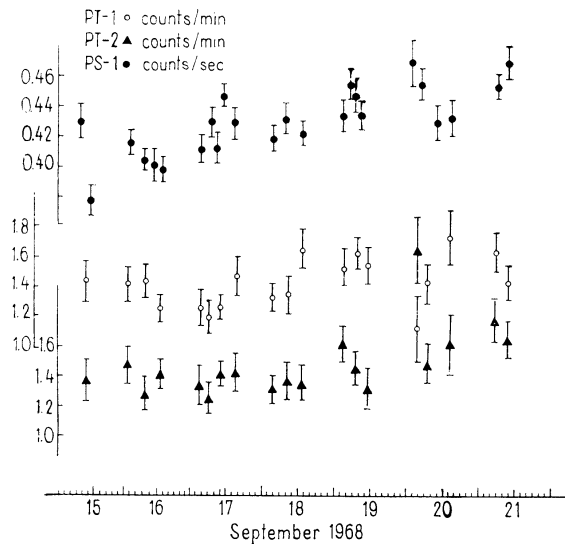


Fig. 2. Variation of the counting rates from September 15 to September 21, 1968

Bearing this in mind, we present below the values of the average proton flux intensities obtained in our experiment:

1.5 – 10 MeV:	$I = 0.9 \times 10^3 \text{ m}^{-2} \text{ ster}^{-1} \text{ sec}^{-1}$
10 – 21 MeV:	$I = 40 \text{ m}^{-2} \text{ ster}^{-1} \text{ sec}^{-1}$
30 – 35 MeV:	$dI/dE = 35 \text{ m}^{-2} \text{ ster}^{-1} \text{ sec}^{-1} \text{ MeV}^{-1}$
45 – 50 MeV:	$dI/dE = 50 \text{ m}^{-2} \text{ ster}^{-1} \text{ sec}^{-1} \text{ MeV}^{-1}$

The values obtained on Zond-4 in March 1968 are somewhat lower.

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