SOME DATA ON THE NATURE OF THE RADIATION BACKGROUND AT ALTITUDES 250 - 500 KM

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The satellite "Kosmos-225" was provided with apparatus [1] (Fig. 1) capable of separating electrons (on the basis of the intensity of the shower developing in lead radiators). The events corresponding to operation of the coincidence circuits CC-1 ($\tau_1 \lesssim 0.5$ μsec).

The radio-telemetry channel (RTC) was used to transmit the following information: a) the magnitude of the signal in each of the three measuring scintillators (S), b) the presence in S I of a pulse larger than that produced by two charged particles (α-marker), c) the presence of a signal in the solid Cerenkov counter (SCC) ("direct" events, i.e., particle motion from S I to S II), and d) total number of charged particles (SC channel) triggering the circuit CC-2.

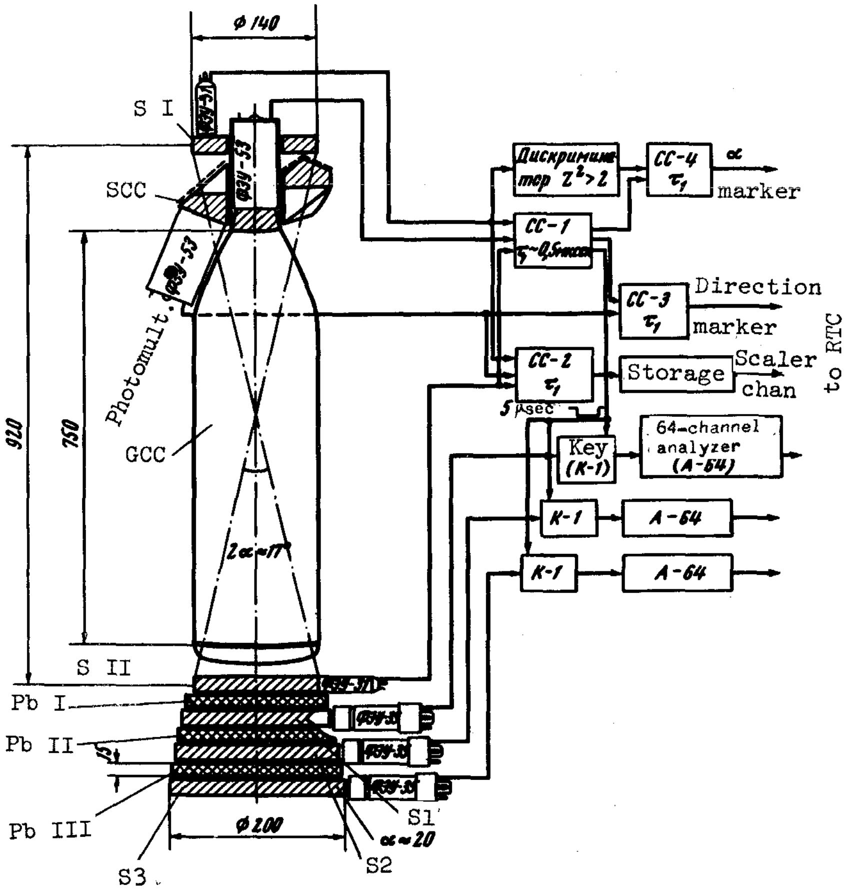

Fig. 1. Diagram of the detecting part of the setup (geometric factor Γ = 1.8 cm²sr) and simplified block diagram of the electronic part: S I, S II - scintillation counters of the control system, GCC - gas Cerenkov counter (nondirectional, β_{thr} = 0.997), SCC - solid Cerenkov counter (directional). S1, S2, S3 - measuring scintillators of the shower part.

The CC-1 circuit operated following passage of electrons with $E_e > 40$ MeV (range $L > 20$ g/cm²) and protons with $E_p > 10$ GeV (threshold energies of the gas Cerenkov counters

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[1] More detailed information on the apparatus is contained in [1]. The initial parameters of the "Kosmos-225" orbit are: apogee 531 km, perigee 275 km, period of revolution 92 min, inclination 38°5', launched 13 June 1968).

(GCC)). The CC-2 circuit was triggered by electrons with $E_e > 40$ MeV (range $L \gtrsim 20$ g/cm^2) and protons with $E_p > 0.6$ GeV (threshold of SCC).

Prior to the flight, the apparatus was calibrated 2) with electrons having $E_e \sim 600$ and 1000 MeV. The calibration curves and the theoretical cascade curves are shown in Fig. 2.

Counting rate (counts/min) in the equatorial region* at altitudes 250 - 500 km

Type of event	In the shower part			Total	In SC channel
	"Shower"		Single		
	Total number	With α-marker			
"Direct" (signal in SCC)	5.24 ± 0.31	2.90 ± 0.22	2.26 ± 0.20	7.5 ± 0.4	-
"Inverse" (no signal in SCC)	3.80 ± 0.26	1.76 ± 0.18	1.30 ± 0.15	5.1 ± 0.3	-
All Events	9.04 ± 0.40	4.66 ± 0.29	3.56 ± 0.25	12.6 ± 0.5	9.7 ± 0.3

Expected from the protons (at $j = 200$ m^{-2}sec^{-1}sr^{-1}) - 2.16.

*Reduction of individual sections of the trajectory, passing through higher latitudes, revealed only a slight latitude effect.

The table lists the main results of the reduction of the data pertaining to the equatorial region, for a total time of 103 minutes. It is seen from the table that the counting rate in the SC channel is about four times larger than the expected counting rate for the cosmic-ray protons (this confirms the existence of a radiation flux, or a radiation background at altitudes 200 - 5000 km) 3). The counting rate of the "shower" events was also several times larger than the proton counting rate.

Figure 2 shows the experimental data on the energy release $\mathcal{E}_i$ under each layer of lead for several groups of events. Events with a definite summary energy release $\sum\mathcal{E}_i$ in the three measuring scintillators were unified into groups. A comparison with the cascade curves corresponding to the same $\sum\mathcal{E}_i$ shows that at low energies (300 - 600 MeV) there is satisfactory agreement, but there is a sharp discrepancy at higher energies.

If all the curves are normalized with respect to the summary energy release against the curve for $E_e \sim 600$ MeV, then all the experimental curves lie close to each other, while the theoretical ones deviate appreciably. We can thus point to two principal results of our experiment: 1) a relatively high counting rate of the events, and 2) a disparity between the form of the observed curves and the theoretical cascade curves, and a similarity of the observed curves to each other.

An analysis of the contribution made to the registered events by the products of proton interaction in the body of the satellite and in the material of the shower part shows that

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2) The calibration was carried out with the accelerators of the Physics Institute of the USSR Academy of Sciences and of the Khar'kov Physico-technical Institute of the Ukrainian Academy of Sciences, and the authors are deeply grateful to their crews.

3) The presence of an increased intensity at these altitudes was pointed out in [2-5].

neither the number of events nor their character can be attributed to processes of this kind.

By way of one of the possible explanations of the observed effect, let us consider the hypothesis that the excess radiation has a structure character [4] at altitudes 200 - 500 km; the charged particles (electrons with $E_e \sim 300 - 600$ MeV, and possibly with smaller E_e) move in the form of a certain particle assembly, which we shall call a "bunch."

The bunch hypothesis makes it possible to explain the results in the following manner. One of the bunch particles, after passing through S I, GCC, and S II, triggers the CC-1 circuit and opens the measuring circuit of the shower part for a time $\tau_{meas} \approx 5$ μsec >> τ_1. The n_1 bunch electrons that fall during the time τ_{meas} on the shower part produce n_1 showers, which produce in the three scintillators a summary signal corresponding to one electron of <u>high</u> energy. But the ratio of the signals under each of the lead layers will be the same as in the case of an electron of <u>moderate</u> energy. Since the resolution time for the formation of the α marker is $\tau_1 \leq 0.5$ μsec, even a large bunch will not always be accompanied by an α marker, especially if it is recognized that the particle density in the "initial" part of the bunch may be lower than the average over the bunch. The estimated bunch dimensions are: length 1500 m, transverse radius 10 - 60 km (determined by the curvature of the electron trajectories in the earth's magnetic field). The particle density in the bunch is $n \approx 3\ 10^{-7}$ cm^{-3}.

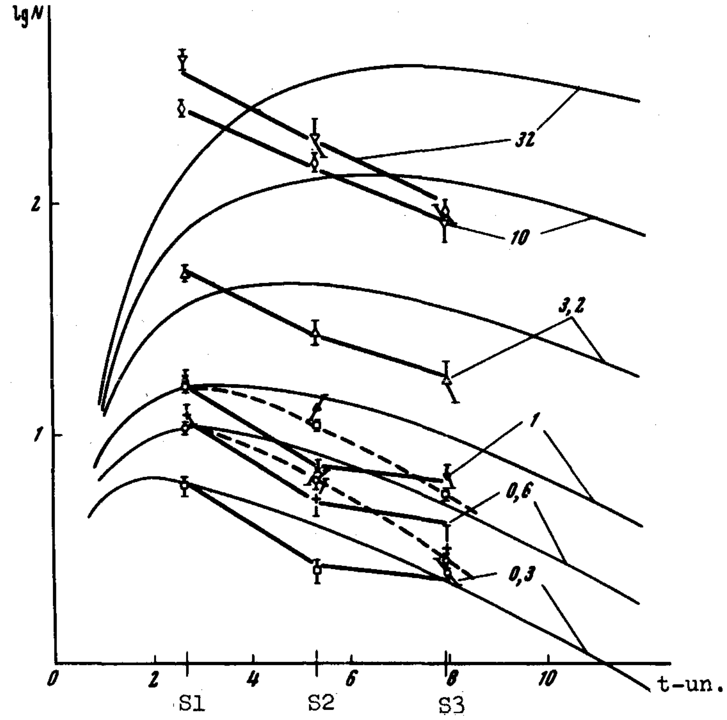

Fig. 2. Comparison of experimental results with the theoretical cascade curves: 1 - cascade curves (numbers - energies of primary electron E_e, GeV); 2 - calibration data, 3 - experimental data (numbers - electron energies corresponding to the registered summary energy release $\Sigma \varepsilon_i$, GeV).

It seems to us that such bunches of quasi-monoenergetic electrons can arise if the accelerating mechanisms present near the earth have a pulsed character, namely only that part of the electrons having the proper direction and velocity at the start of the acceleration "cycle" become involved in the acceleration process and are accelerated to approximately the same energy.

[1] V. A. Bolyshev, I. N. Kapustin, L. V. Kurnosova, et al., Preprint, Phys. Inst. Acad. Sci., 1966.

[2] L. V. Kurnosova, T. N. Kolobyanina, Z. I. Logachev, et al., in: Iskusstv. sputniki Zemli (Artificial Earth Satellites), No. 8, p. 90, 1961.

[3] I. A. Savenko, N. F. Pisarenko, and P. I. Shavrin, ibid. No. 9, p. 71, 1961.

[4] O. I. Savun, Geomagnetizm i aeronomiya 9, 145 (1969).

[5] N. L. Grigorov, Yu. S. Klintsov, V. E. Nesterov, et al., AN SSSR, ser. fiz. <u>30</u>, 1773 (1968).

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[4] An alternate hypothesis, namely that the particles (of high energy or neutral) reaching the earth have a very small interaction range and produce a large number of particles in one act (electrons with $E_e \sim 300 - 600$ MeV), calls for far-reaching assumptions, for which there are patently not enough facts.