PHOTONEUTRON SPECTRA OF PLATINUM, BISMUTH, LEAD, AND URANIUM

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USING a linear accelerator and the time of flight method, we have measured the photoneutron spectra from platinum, lead, bismuth, and uranium. Targets of natural isotopic composition were bombarded by 16 MeV electrons. The neutrons were counted by a fission chamber placed at a distance of 35 m from the target at an angle of 90° to the electron beam. The resolution of the equipment used for the spectrum measurements was 0.150 μsec. The photoneutron energy distributions are shown in the figure. The solid curves a, b, and c are the evaporation spectra

$$N(E) \sim \frac{E}{T} \exp\left(-\frac{E}{T}\right)$$

with the temperature T = 0.48 ± 0.03 MeV for platinum, 0.84 ± 0.04 MeV for Bi, and 0.98 ± 0.04 MeV for lead.

The temperature for each spectrum was determined by the method of least squares, considering experimental data only in the region 0.2—1.3 MeV for lead and bismuth, and 0.2—2 MeV for platinum. Curves b and c also show the results of subtracting the evaporation spectrum from the experimental data.

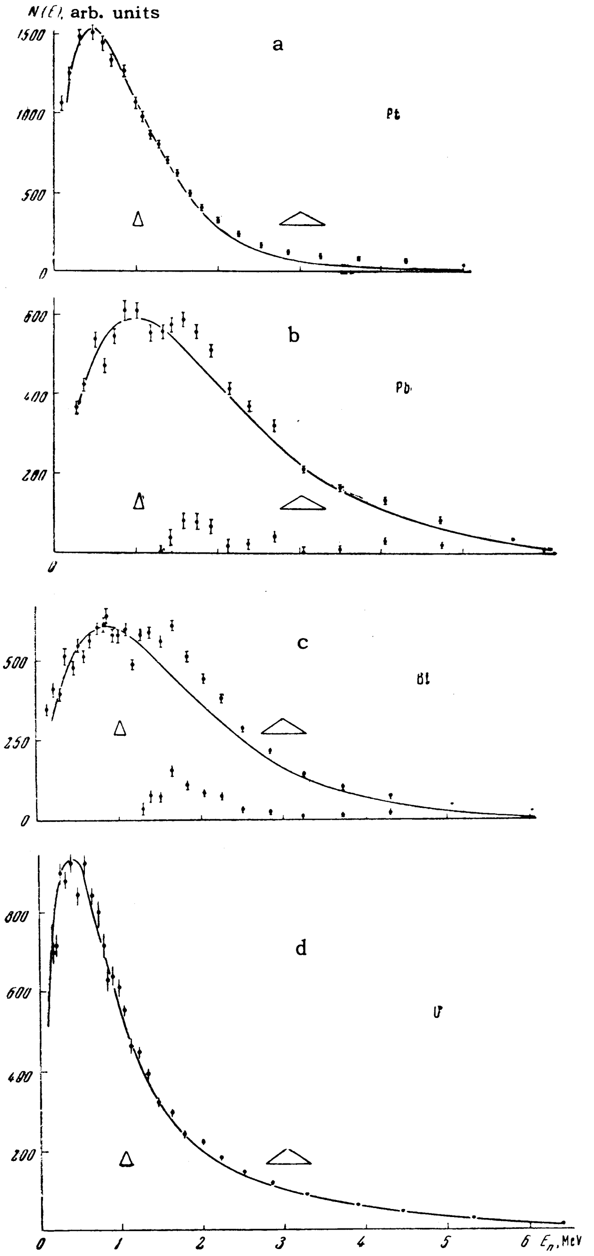
The solid curve d is the sum of the evaporation spectrum and the fission spectrum of uranium:

$$N(E) = \alpha \frac{E}{T} \exp\left(-\frac{E}{T}\right) + (1 - \alpha) \exp\left(-\frac{E}{T}\right) \times \frac{1}{\sqrt{\pi\omega T_f}} \exp\left(-\frac{E}{T_f}\right) \sinh \frac{\sqrt{\omega E}}{T_f}$$

with the parameters: T = 0.33 ± 0.03 MeV, T_f = 1.05 ± 0.04 MeV, ω = 0.5 MeV, α = 0.49 ± 0.01.

In the photoneutron spectra from bismuth and lead, two groups of neutrons show up clearly in addition to the evaporation spectrum: the first in the region 1.3—3 MeV; the second in the region $E_n > 3$ MeV. A deviation from the statistical distribution in the photoneutron energy region above 3 MeV has been observed by many authors[1]; apparently it is due to the contribution of the direct interaction of γ rays with neutrons in the different nuclear shells.

The neutron peak at 1.3—3 MeV, in our opinion, is due to single-particle transitions from excited



Photoneutron energy distributions.

levels of the compound nucleus. From the work of Balashov et al.[2] we can conclude that such transitions are possible in the excitation energy region of ~ 10 MeV.

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INVESTIGATION OF THE COMPOSITION OF PRIMARY COSMIC RADIATION BY OBSERVATION OF CERENKOV RADIATION FLUCTUATIONS IN EXTENSIVE AIR SHOWERS

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THE study of the composition of the primary cosmic radiation in the energy region above 10^{14} eV has previously been carried out either by analysis of the structure of the cores of extensive air showers (EAS)[1] or by comparison of the relative intensities of the electron and μ-meson components of showers[2-4].

In the present work we have analyzed the composition of the primary radiation by study of the burst of Cerenkov radiation accompanying the passage of an extensive shower through the atmosphere, and the total number of particles at the level of observation. We compute the fluctuations in the ratio of the intensity of the Cerenkov radiation burst (Q) to the number of particles in the shower (N). The results of calculations made with different assumptions about the primary composition are compared with the fluctuation in Q/N obtained from experiments[5,6] carried out in the Pamirs (elevation 3860 m above sea level).

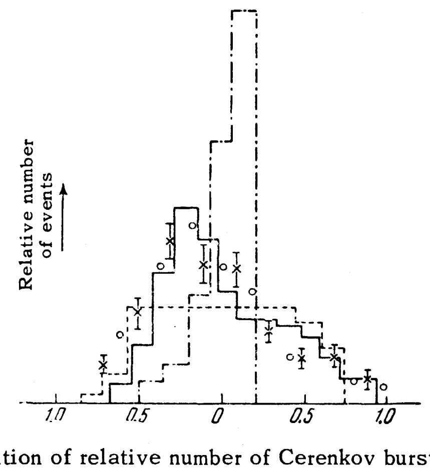
In the calculations the dependence of Q/N on the energy E_0^n of the primary nucleus of mass number A, which produced the shower, was assumed to be

$$Q/N \sim (E_0^n/A)^{\beta-\alpha},$$

where α and β are the exponents in the relations: $N \sim E_0^{\alpha}$ and $Q \sim E_0^{\beta}$. The experimental data of Chudakov et al.[5] on the Cerenkov radiation for showers with a number of particles $N = 10^5 - 10^7$ at the elevation of the Pamirs yield a value $\beta - \alpha = 0.2 \pm 0.05$.

Using the relation $Q/N = f(E_0^n, A)$, we have computed the distributions of Q/N for two different primary compositions, on the basis of the analogous distribution of showers formed by protons (see the figure). The latter distributions were obtained with the assumption that proton showers develop according to the scheme assumed by Nikol'skiĭ and Pomanskiĭ[7].

In the calculations we took into account the fact that the difference in the development of showers produced by protons and by heavier particles causes the charge distribution of the primary particles to differ from the corresponding distribution of showers at the level of observation. We have introduced a correction coefficient $K = A^{\kappa-\gamma}$, where κ and γ are the respective exponents of the shower particle-number spectrum and of the primary energy spectrum. In addition we took into account the increase in



Distribution of relative number of Cerenkov bursts in EAS at an elevation of 3860 m above sea level. The abscissa is the quantity $(Q_i/N_i)/(Q/N) - 1$. Calculated distributions: dash-dot line – for the case when all showers are generated by protons, solid line – Assumption I, dotted line – Assumption II. Experimental data: (circles) 1955 experiments[6], (crosses) 1957 experiments[5].