STUDY OF ULTRAHIGH-ENERGY MUONS IN A STRATIFIED MEDIUM

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(Presented by F.R.ARUTYUNYAN)

The present work gives experimental results of the study of interference radiation produced by the passage of fast charged particles at constant speed through a periodic stratified medium. The properties of such radiation were discovered by Ter-Mikaelyan [1, 2] and analyzed for the purpose of its application in high-energy physics in [3]. Preliminary results were communicated at the All-Union Conference on Cosmic Rays [4].

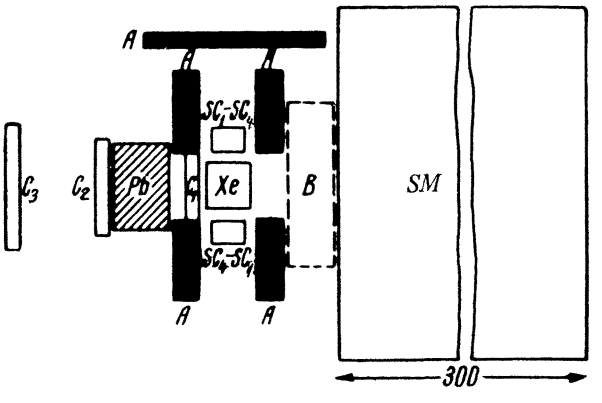

Fig. 1. Experimental lay-out.

The experimental layout is shown in Fig. 1. The stratified medium *SM* consists of 300 paper layers, each 0.02 cm thick and spaced 1 cm apart. Ultrahigh-energy muons of cosmic radiation travelling at an angle from 73 to 90° to the vertical produce upon passing through such a medium γ quanta with the spectrum given in [1 – 3]. These γ quanta are absorbed by xenon atoms enclosed in a thin-walled container (Xe) with dimensions $10 \times 10 \times 40$ cm^3, which then emit characteristic γ quanta with an energy of ~ 35 keV. The latter are recorded in directions differing from the direction of motion of the muons by a scintillation hodoscope consisting of eight NaI crystals (Tl) ($SC_1 - SC_8$) with a diameter of 8 cm and a thickness of 5 cm, which detect γ quanta with energies of 20 – – 100 keV. The muons are recorded by the telescope A, C_1, C_2, C_3 together with at least two γ quanta of the characteristic radiation. The electronic component of the cosmic radiation is excluded by means of a lead fil-

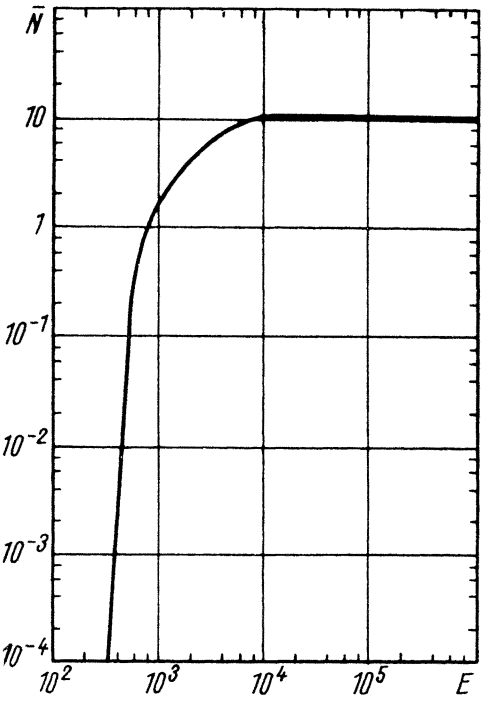

Fig. 2. Mean number N of γ quanta versus the muon energy E, GeV

ter (Pb) (thickness 67 radiation lengths), placed between C_1 and C_2 and the material (50 radiation lengths). Cosmic ray showers are excluded by banks of anticoincidence counters A and the above-indicated discrimination of the energies recorded by the scintillators SC_1 – SC_8. The solid angle of the equipment is 0.29 steradian.

The dependence of the mean number of γ quanta ($\bar{n}$) formed in a stratified medium on the muon energy E (GeV) is given in Fig. 2. The portion of γ quanta which is absorbed in the layered medium and does not cause a photoelectric effect in the xenon amounts to ~ 66% of the number of quanta produced. The calculated recording efficiency (η) of the μ mesons as a function of energy E(GeV), allowing for emission and absorption fluctuations, is given in Fig. 3.

In 5465 measurement hours 77 events were recorded. The distribution of the number of recorded γ quanta is given in Fig. 4. The basic measurements were periodically alternated with control measurements, during which an absorber (B) of 11.5 g/cm^2 thick transparent plastic was placed between the stratified medium and the xenon container. The

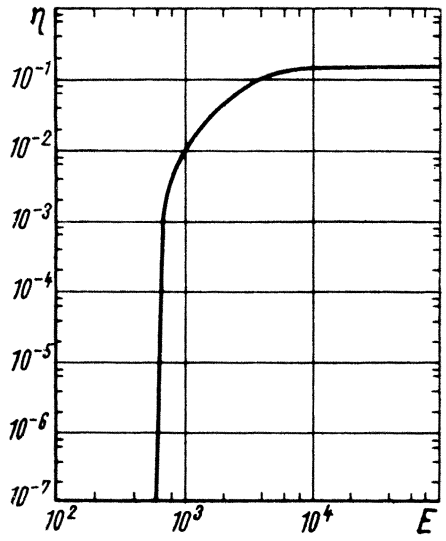

Fig. 3. Recording efficiency (η) of μ mesons as a function of energy.

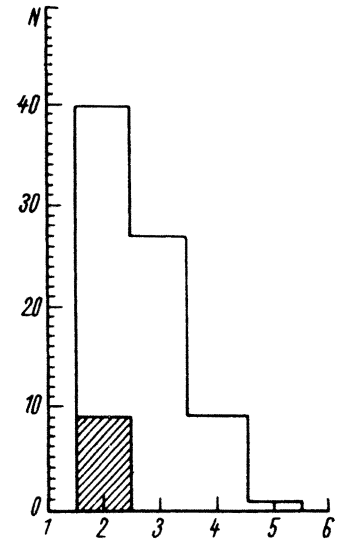

Fig. 4. Distribution of the number of recorded γ quanta.

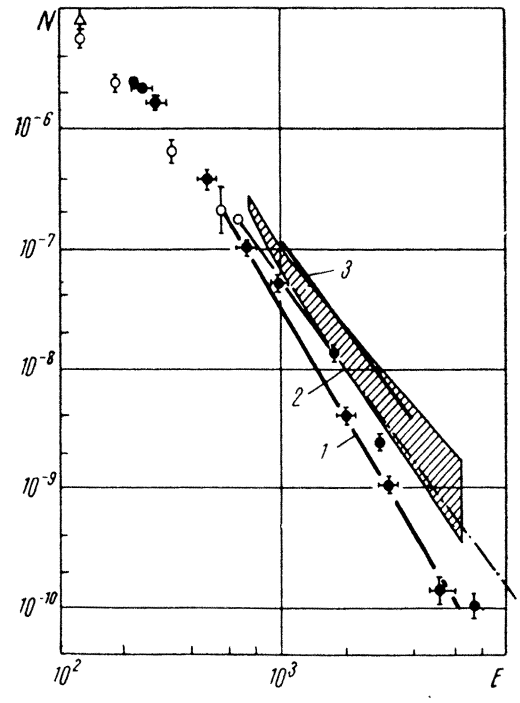

Fig. 5. Integral μ spectrum in the vertical direction at sea level:

$N(>E)$, cm^{-2}·sec^{-1}·steradian^{-1}; E, GeV; *1* and • – – spectrum according to data of [6]; *2* – spectrum representing the best continuation of the experimental data at low energies; *3* – spectrum according to data of [7], ⊕ – data of [8]; ○ – data of [5], △ – data of [9]. The shaded area gives the results of the present experiment.

radiation produced in the stratified medium is almost completely absorbed in such an absorber, whereas any background radiation remains the same as in the basic measurements. During 1800 hr of control measurements 3 events, each of which was recorded by only two scintillators, were recorded. Such a number of events in the control measurements does not contradict the expected number due to the characteristic (background) radiation directly produced by charged particles passing through the xenon. The number of background events is given in Fig. 4 (shaded area) and amounts to 11.7% of the total number of events.

The experimental results thus show that interference radiation of μ mesons in the stratified medium was observed. Fig. 5 gives the integral μ-spectra in the vertical direction at sea level, obtained in [5 – 9]. If these spectra are considered as expected and converted to a height of 1,000 m above sea level, where the present experiment was performed, for zenith angles from 73 to 90°, then our equipment records μ mesons with energies from 700 to ~ 6,000 GeV, and their expected numbers according to curves 1, 2, and 3 are respectively 27, 41, and 82.5, whereas the number of events recorded by us is 68. Fig. 5 the vertical direction at sea level which corresponds to our experimental data with allowance for the errors. On the basis of the obtained data it is very difficult to draw definite conclusions on the ratio of K and π mesons (K/π), produced in primary nucleon-nucleon interaction events.

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