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THE DENSITY SPECTRUM OF THE PENETRATING COMPONENT OF THE EXTENSIVE AIR SHOWERS

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BUDAPEST

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ABSTRACT

The exponent of the muon-density spectrum of the EAS has been determined at the altitude 2925 m a.s.l. on the basis of 16 926 registered showers by means of an apparatus consisting of four hodoscoped GM counter sets located on the corners of a 8mx8m square under 30 cm lead. The corresponding mean number of muons in the showers was $N_{\mu} \geqslant 1.2 \cdot 10^{6}$. The method used to analyse the data made it possible to eliminate the falsifying effect of the multiplication in the lead. $\gamma = 2.35 \pm 0.05$ has been got for the exponent of the spectrum.

INTRODUCTION

The differencial muon-density spectrum of the extensive air showers is usually supposed [1-6] to be

$$D(x) = a\, x^{-\gamma-1}\, dx \quad ,$$

where a is a constant, x is the density of muons in the EAS. The exponent γ has to be determined experimentally. There is, however, a great contradiction between the results of the earlier measurements of γ [1-6] . The main reason is, probably, that the authors have not taken into consideration the effect of the multiplication in the absorber depending on the type of the detecting apparatus. The multiplication in the absorber takes place because of the nuclear interactions of the nuclear active component and the generation of δ -electrons and δ -showers by the muons. The number of the secondary particles increases with increasing energy, so the multiplication diminishes the measured value of γ . In the present work the authors sought to eliminate this falsifying effect.

APPARATUS

The measurements were made on mount Musala, Bulgaria, 2925 m a.s.l. The apparatus consisted of four hodoscoped GM-counter sets placed on the corners of a 8mx8m square. Each set consisted of ten identical counters having a sensitive area of 320.04 cm^2 per counter. Each set was covered by lead 30 cm thick on the top and sides, and 7.5 cm thick on the bottom. The master pulse for the hodoscope was given by the fourfold coincidence of at least one counter from every set. The frequency of the registered extensive air showers was about $1\ h^{-1}$, the resolving time of the hodoscope system was 15 μs, the probability of random discharge of a counter during this 15 μs was about 0.01. Altogether 16 926 events were registered.

METHOD OF DATA TREATMENT

The probability of registering locally generated secondary particles as independent ones decreases with increasing distance between the counters. So the registered showers were grouped into five statistically independent classes. Class V contains events when between two working counters there were at least four counters giving no signal in each set. Class IV contains events that do not belong to class V and in which between two working counters there were at least three counters giving no signal in each set. Class III contains events that do not belong to classes IV and V and in which between two working counters there were at least two counters giving no signal in each set. Class II contains events that do not belong to classes III, IV and V and in which between two working counters there was at least one counter giving no signal in each set. Class I contains events that do not belong to the higher classes. So the probability of registering locally generated secondary particles as independent ones decreases with increasing class number.

The exponent γ was determined for each class independently by the method of maximum likelihood. The results are given in Table 1.

Table 1

Class	I*	II	III	IV	V	Weighted mean of the classes II-V
γ	1.40 ± 0.016	2.42 ± 0.08	2.37 ± 0.14	2.69 ± 0.21	2.26 ± 0.07	2.35 ± 0.05

* from 7109 events only

DISCUSSION

The results for calsses II-V are in good agreement with each other and they are significantly higher then the result for class I. So the conclusion may be drawn that the influence of the multiplication is limited to class I, and the weighted mean of the γ values for classes II-V

$$\gamma = 2.35 \pm 0,05$$

may be considered as the exponent of the muon-density spectrum. It belongs definitely to the density of muons and not to the density of the all penetrating particles, because the nuclear active particles have a large probability of interacting in the 30 cm lead absorber, so they cause the events containing them to belong to the class I with very great probability.

The mean density of muons was about 3.6, 3.2, 2.0 and 1.9 muon/m^2 respectively for the classes II, III, IV and V. It means that the total number of the muons in the registered extensive air showers was

$$N_\mu \geqslant 1.2 \cdot 10^6 \quad .$$

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