III-5-4. The Polarization of Cosmic Ray Muons of Different Energies*

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1. By measuring the polarization of cosmic ray muons we get information on their generation in atmosphere. Detailed data on the change of the degree of the muon polarization with their energy give a possibility to study more closely the generation spectrum of π-mesons, the probable contribution of K-particles in the muon generation and also in principle contribution of after thinkable generation mechanisms.

The knowledge of the polarization of the cosmic ray muons beam may prove to be of use in a member of experiments. It is naturally, that of greatest interest is the high energy region, unfortunately, most difficult to measure.

2. So far the best studied is the polarization of low energy muons (<500 Mev[1,2]). The present work deals with the measurement of polarization in the energy region 0.2–1.55 Bev (the preliminary data were reported at the cosmic ray conference in Moscow 1959).

3. The degree of polarization is determined by the asymmetry of μ-e decay, when muon is stopped in the copper absorber. The copper absorber in which the muon is stopped is surrounded by several trays of Geiger counters, operating in the regime of high voltage pulse supply. Each counter is connected with a hodoscope cell. The photo for every case of μ-e decay has separate muons and electron traces, what allows very good identification of decay events and practically excludes background.

The measurements were made by two geometrically different modifications of the arrangement, one-rectangular (a) and the other cylindrical (b). To maintain the symmetry of the arrangement, the system of counters (a) was turned by 180° and system (b) was used rotated around the absorber. In addition to the space distribution of the $\mu \rightarrow e$ decay events in the arrangement (a) the time distribution of decay positrons also was measured. It gives additional check and also allows the presence[2] or absence of depolarization of the muon to be detected, after it is stopped in the absorber. Fig. (1) presents the dependence of the polarization upon the time after the stop. From the curve in Fig. (1) it is seen that the depolarization of muon in the copper absorber appears to be absent. (The black points are the data of 2)). The lower curve represents measurements, where as the absorber was used iron, which completely depolarizes the muon.

The summarized data of this run of measurements (with iron) confirm the symmetry of the arrangement (a): the ratio up/down for decay positrons is 1.02–0.023.

4. The measurements of the degree of polarization were made at the following

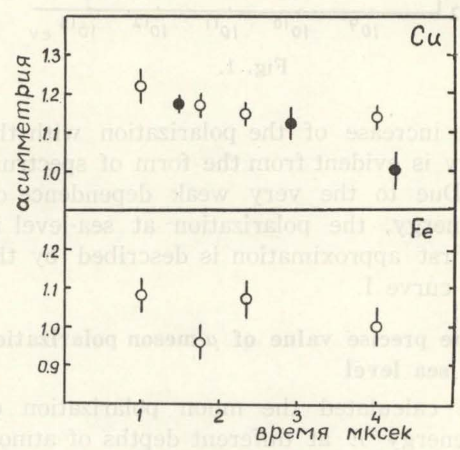

Fig. 1.

Table I.

Muon energ (E) in Bev	Type of arrangement	Polariza-tion	Theoretical value
0.2	a	0.25±0.045	0.21
0.3	b	0.29±0.08	0.24
0.55	a	0.26±0.035	0.28
1.05	b	0.40±0.08	0.330
1.4	a	0.35±0.05	0.335
1.55	b	0.40±0.05	0.335

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values of muon energies at sea level, 0.2, 0.3, 0.55, 1.05, 1.4, 1.55 Bev. The total number of pictures of the $\mu \rightarrow e$ decay for these measurements is over $4 \cdot 10^4$. The results are cited in the table.

The degree of polarization was calculated from the experimental data by numerical integration and also with the help of the computer "Ural" at the Lebedev Institute of Physics, USSR Ac. of Science. In the right column of the table the expected theoretical values of the muon polarization as calculated by Berezinsky are given[3]). They were received on the assumption of the muon generation by π-mesons with a mov. detailed consideration, then in works by Hayakawa and Goldman[4,5]) of the π-meson generation spectrum at energies up to 10 Bev.

5. From the experimental data the increase in the degree of polarization with the change of muon energy from (0.2–0.5) Bev to (1.4–1.55) Bev is characterized by the factor 1.5–0.18. The authors are thankful to Prof. Alikanian for his attention to this work.

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III-5-5. The Spectrum of Cosmic Ray Muons and Protons Near Sea Level*

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Introduction

The momentum spectra of the fast particles at sea level are fundamental constants of cosmic rays. By comparing them with other spectra, such as the primary spectrum, information can be gained on nuclear processes at high energy.

Experimental Arrangement

The experiments have been carried out using the Durham Cosmic Ray Spectrograph. This instrument comprises four detecting arrays, two above and two below a large electromagnet (Fig. 1). Each array consists of a tray of geiger counters and eight layers of neon flash tubes. When operated at maximum current the maximum detectable momentum is ~700 Gev/c. Measurements were made on the momentum spectrum of muons using this arrangement. Two experiments were performed to measure the proton flux; in the first, covering the momentum range 0.8–29 Gev/c, a layer of lead was placed above array D and protons were recognised by their absorption. In the second experiment an IGY neutron pile was operated above D and the proton flux was found from the numbers of neutrons produced by proton interactions.

Results

The muon and proton spectra are shown in Fig. 2. The pion production spectrum has been derived from the muon spectrum; representing it by a power law, $N_\pi(p) \propto p^{-\gamma}$, γ is sensibly constant and equal to 2.64 ± 0.05 between 4 and 100 Gev/c. Below 4 Gev/c

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