POLARIZATION OF COSMIC RAY μ^+ MESONS

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A multi-plate cloud chamber is employed to measure the degree of polarization of 0.3 and 1.45 BeV cosmic ray muons. Values of 0.23 ± 0.09 and 0.34 ± 0.09 respectively are obtained.

RECENTLY many investigations have been made of polarization of cosmic muons [1-13]. A study of the degree of polarization of cosmic muons at different energies could yield information on the character of spectrum of the pions, as well as a possible contribution of $K_{\mu 2}$ decays to the generation of these muons. Most of the investigations employed counter detectors and the delayed-coincidence method.

We present here the results of a cloud-chamber investigation of polarization of cosmic muons with energies 0.3 and 1.45 BeV. The measurements were carried out in 1960—1961, and the preliminary results of the first series of measurements, involving 0.3 BeV muons, have already been published [4]. The polarization was determined by measuring the angular distribution of the positrons from the muon decay, stopped in the brass plates of the cloud chamber. Compared with the delayed-coincidence procedure, the cloud chamber has several advantages such as greater reliability and clarity of each decay case, possibility of registering all the events independently of the decay time, and the absence of patent instrument asymmetry. In addition, the use of relatively thin plates as absorbers decreases the influence of multiple scattering on the positron emission angles.

The experimental set-up is illustrated in Fig. 1. Here C_1—C_4 are arrays of Geiger-Muller counters, K—cloud chamber with seven thin brass plates each 4 mm thick, and A and B—lead absorbers 100 and 900 g/cm^2 thick, respectively.

The chamber was triggered by the anticoincidences $C_1 + C_2 + C_3 - C_4$, connected with the stopping muon. The momentum of the muon entering the set-up was determined by a light structural cover 40 g/cm^2 thick over the set-up and by absorbers A and B. Absorber B was not used in the first series of measurements. For greater reliability, only cases in which the decays occurred in plates 2—6 were selected from the photographs obtained. To eliminate the possible asymmetry due to the entry of decay positrons into array C_4, an absorber D was installed under the chamber. The necessary condition in the identification of the decay cases was ionization stoppage of the muon, and the presence of an ionization gradient between the stopped muon and the positron. All the selected photographs were scanned on a stereo comparator. The 'joining' of the muon and positron tracks in the plate was checked, and the location of the decay in the chamber was determined. Typical cases of decay with emission of a positron in the upper and lower hemispheres are shown in Figs. 2a and b. The results of both series of measurements are given in the table, where $N_\uparrow$ and $N_\downarrow$ are the numbers of positrons emitted in the upper and lower hemispheres and P is the polarization, determined as in [6,11] from the expression

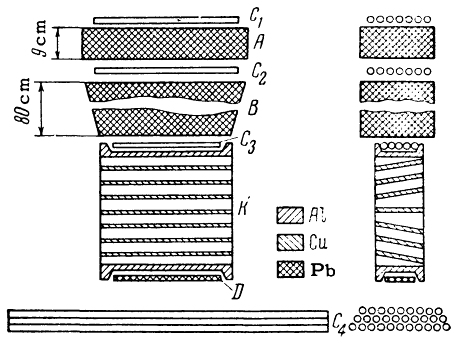

FIG. 1

$$P = K(R-1)/(R+1). \quad (1)$$

The coefficient K takes into account the geometry of the experimental set-up, the energy spectrum, the angular distribution, the range-energy ratio, and also the range scatter for the positrons in

E, BeV	$N_\uparrow + N_\downarrow$	$N_\uparrow$	$N_\downarrow$	$R = N_\uparrow/N_\downarrow$	P_{exp}	P_{theor}
0.3	735	389	346	1.12±0.05*	0.23±0.09	0.25
1.45	888	480	408	1.18±0.05*	0.30±0.09	0.33

*Statistical error

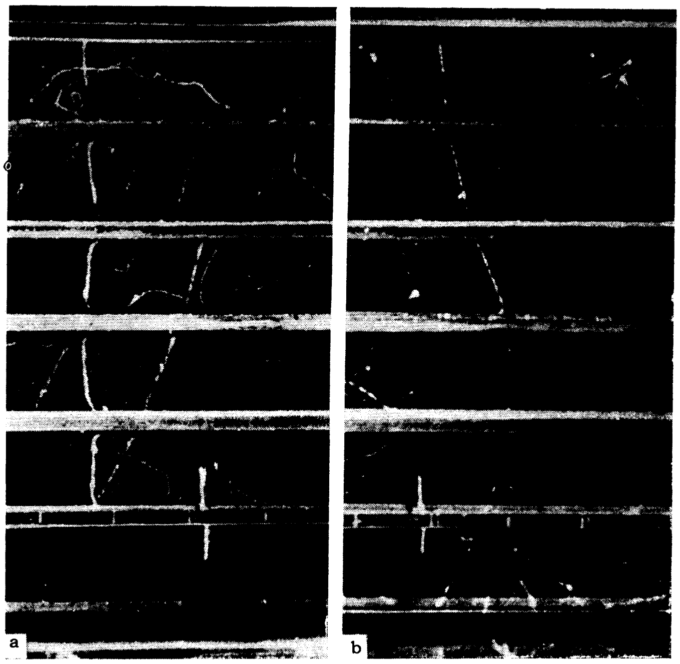

FIG. 2

accordance with the work of Wilson [14]. The value K = 3.68 was obtained for the coefficient with a computer. The table lists the values of the polarization P_{exp} taking into account corrections for the muon de-polarization prior to entering the chamber, and the angular distribution obtained in the given experiment. It also lists the theoretical values of the polarization, calculated by Berezinskiĭ and Dologshein [9] with allowance for muon generation by pions only. As can be seen from the table, the experimental values of the polarization agree well with the theoretical ones. However, it is impossible to draw any unambiguous conclusion either about the mechanism of the muon generation or about the contribution of the $K_{\mu 2}$ decays to this process, owing to the large statistical error. It is difficult to obtain high statistical accuracy with a cloud chamber, and this is the principal shortcoming of the method.

In a recently published work by Sen-Gupta and Sinha [13], who used a set-up similar to ours, the degree of polarization quoted is somewhat higher than that in our paper, although they do not contradict each other within the limits of statistical error.

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