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ANGULAR DISTRIBUTION IN $\pi \longrightarrow \mu + \nu$ DECAY

(PART II)

by

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ANG LAR DISTRIBUTION IN $\pi \longrightarrow \mu + \nu$ DECAY *,**

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Summary A study of the angular distribution of 8.669 μ mesons resulting from π decay at rest in nuclear emulsion is made using area scanning, looking for μ ends. Increasing the statistics essentially the same results of a previous paper of ours were obtained. The results give no backward-forward asymmetry, contrasting with other results obtained in the same plates with area scanning, looking for $\pi - \mu$ vertices.

Thus the conclusion of our previous paper that the backward-forward asymmetry found by other authors was due to bias is enforced.

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Introduction

Hulubei et al[1], using area scanning to find the points of π decays, obtained histograms that suggest angular distribution of μ and positrons from π-decays of the form:

$$\frac{dN}{d\theta} = C(1 + a_1 \cos\theta + a_2 \cos 2\theta + a_3 \cos 3\theta) \qquad (1)$$

θ being the angle between the initial direction of the μ-meson or positron, projected on the plane of emulsion, and the direction of π beam.

The values of a_1, a_2, a_3, together with the usual backward-forward asymmetry coefficient $b = \frac{2(F-B)}{F+B}$, calculated from Hulubei's data, are given in Table I.

Table I

Particle	a_1	a_2	a_3	b
μ	-0.107 ± 0.016	-0.210 ± 0.018	-0.050 ± 0.022	-0.115 ± 0.023
e_+	$+0.036 \pm 0.016$	-0.090 ± 0.016	$+0.020 \pm 0.021$	$+0.037 \pm 0.023$

In this paper we used the μ-end scanning described in our paper [2] which leads to a strong reduction of bias against small values of θ.

μ-distribution

The angular distribution of the μ-mesons obtained in the present work is plotted in fig. 1, together with the results of reference [1] with the standard deviations for comparison. The line labelled μ in table II gives the corresponding values of a_1, a_2, a_3 and b to be compared with those of table I.

Table II

Particle	a_1	a_2	a_3	b
μ	-0.017±0.015	-0.045±0.017	+0.011±0.020	-0.026±0.021
e_+	+0.015±0.016	-0.016±0.017	+0.026±0.020	+0.014±0.022
α	+0.017±0.013	-0.013±0.015	-0.002±0.017	+0.023±0.019
$\mu + e_+ + \alpha$	+0.006±0.009	-0.024±0.009	+0.007±0.011	+0.005±0.012

We see that the backward-forward asymmetry coefficients (a_1, a_3 and b) are consistent with zero. Also the value of $|a_2|$ is smaller and not compatible with a_2 from reference [1] (Table I above).

π - μ angles distribution

The distribution of the angles between the cord of the projected last 8.6 μm of the π-meson and the initial direction of the μ-meson (π - μ angle) was also determined. The results are plotted in fig. 2 with standard deviations. They are compatible

with isotropy as it should be in the absence of distortion in emulsion.

As in paper [2] all registered events were relooked by more experienced scanners. The fact that 18 out of 29 π-decays, not identified by the first scanner, had a $\pi - \mu$ angle smaller than 25° might indicate that there is still some bias, in our method, against small values of θ. In fig. 2 however, there is no indication of lack of events for small angles. This result shows that if bias exists it is very small. The possible distortion effects will be analysed below.

Possible distortion effects

Although our results for the angular distribution are compatible with isotropy, the value of a_2 is about 2.6 statistical error. In the other hand the value of a_2 found in reference [1] for positrons was -0.090 ± 0.016 (table I above). This might be an indication that distortion effects exist and are larger in other plates (we used only some of the plates used by Hulubei et al). Thus we looked for eventual distortion effects by examining also the angular distribution of the positrons from μ-decay and 11.636 α-particles from natural radioactive stars which have been determined simultaneously with the μ distribution.

A total of 141 positrons could not be identified in two of the three plates we used. In fig. 3 the distributions are plotted with some of the standard deviations. The values of the

coefficients of eq. (1) are given in table II for positrons, for α, and also for the total distribution of μ, positrons and α together.

No back-forward asymmetry appears. The a_2 values are found to be consistent with that for μ distribution which might indicate the existence of distortion, but they are also consistent with isotropy within three standard deviations.

If such distortion exists, the absolute value of a_2 in π-μ distribution should be smaller than in μ, positron and α distribution as a consequence of the broad π end distribution relative to the incoming beam direction. Also the distortion will decrease the small π-μ angles events and our argument against the bias existence are still correct.

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References

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2. E. Frota-Pessôa and N. Margem: Supl. N. Cim. n.1, vol. 21, série X, pg. 48, (1961).

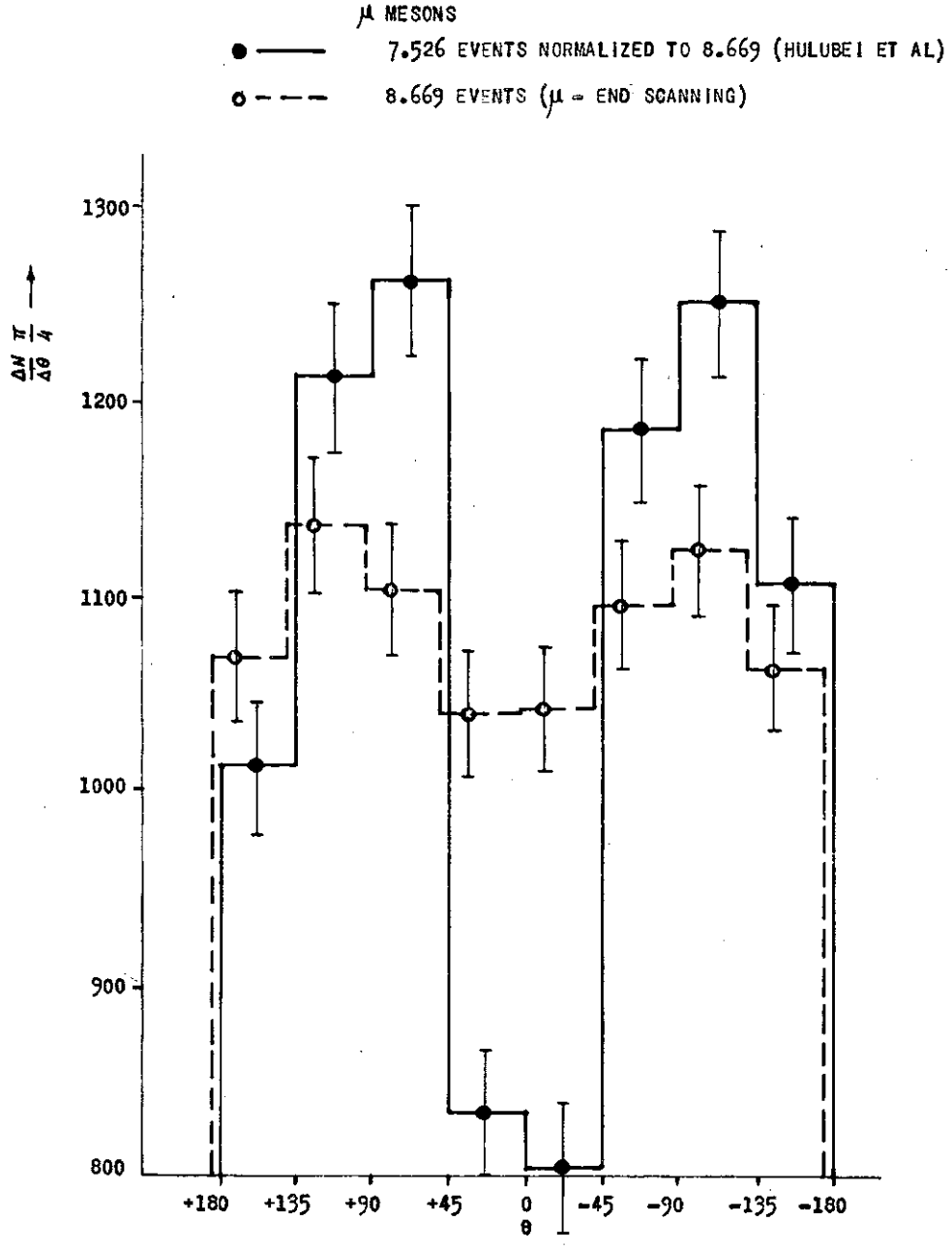
μ MESONS
7.526 EVENTS NORMALIZED TO 8.669 (HULUBEI ET AL)
8.669 EVENTS (μ - END SCANNING)
1300
1200
1100
1000
900
800
+180
+135
+90
+45
0
-45
-90
-135
-180
θ

FIG. 1

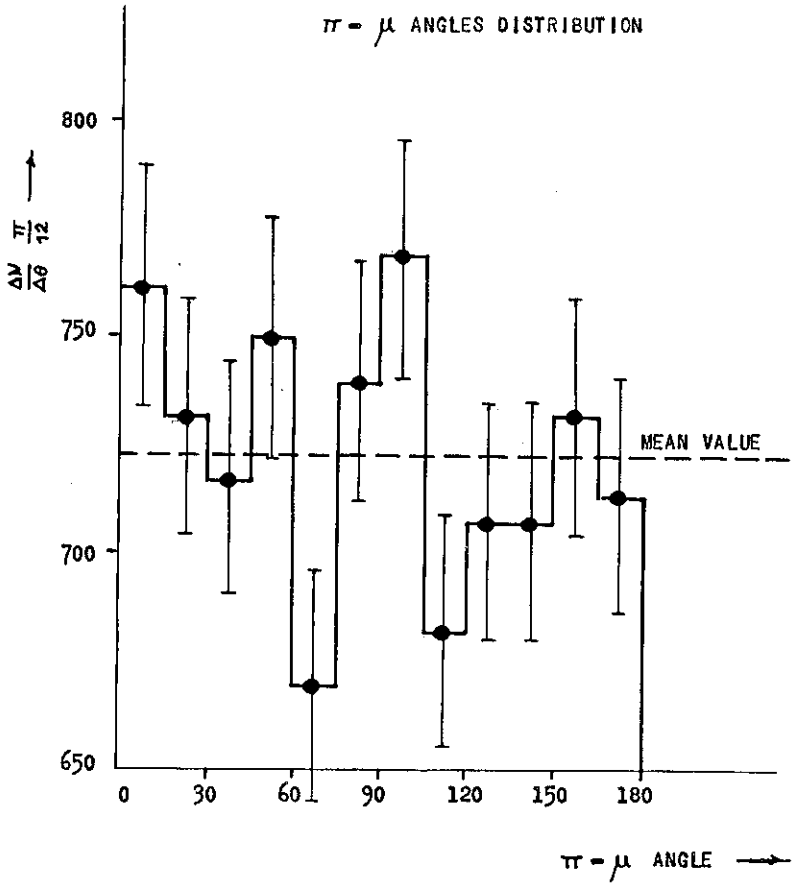
π - μ ANGLES DISTRIBUTION
800
750
700
650
ΔN/Δθ π/12
MEAN VALUE
0
30
60
90
120
150
180
π - μ ANGLE

FIG. 2

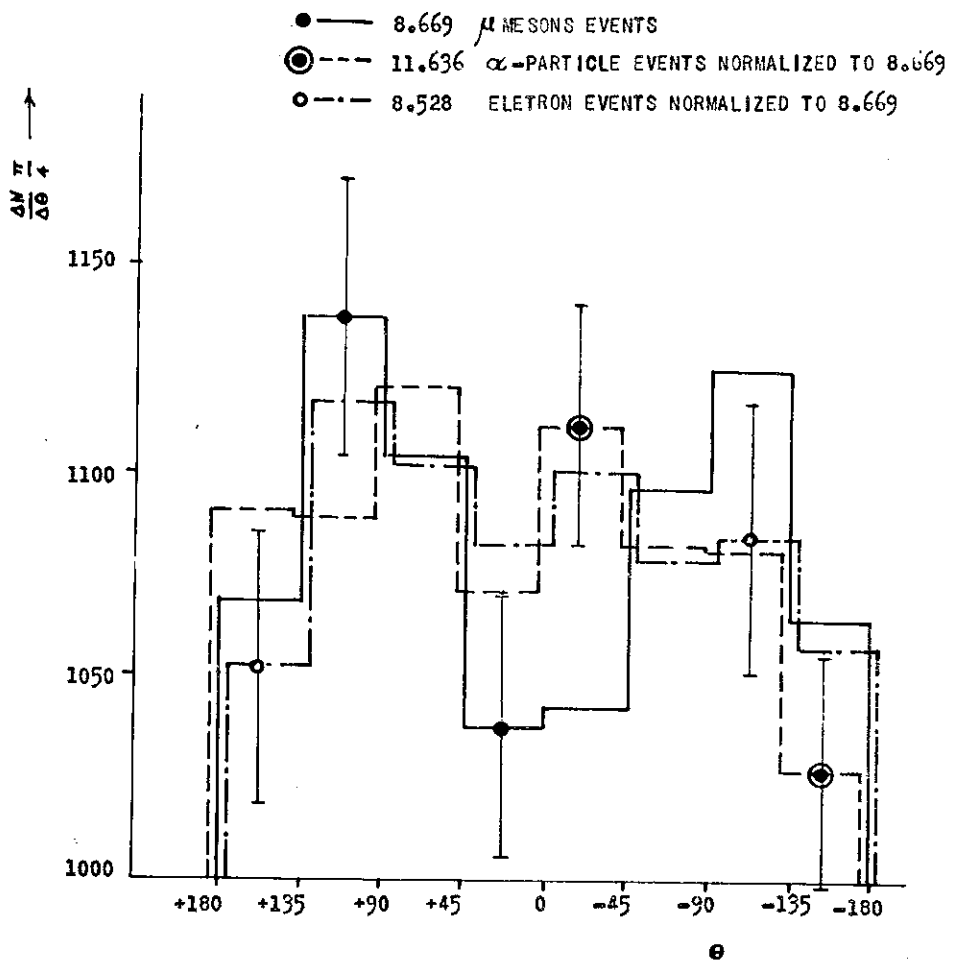
8.669 μ MESONS EVENTS
11.636 α-PARTICLE EVENTS NORMALIZED TO 8.669
8.528 ELETRON EVENTS NORMALIZED TO 8.669
ΔN/Δθ
1150
1100
1050
1000
+180
+135
+90
+45
0
-45
-90
-135
-180
θ

FIG. 3