region the absorption coefficient appeared to change smoothly with energy. Only 1.5 percent of the transmitted photons could be accounted for by bad geometry effects. These photons were at most 0.5 Mev outside the selected energy bin. Room background consisted essentially of x-rays and it was easily shielded. With the coincidence arrangement this background did not amount to more than 1 percent of the true coincidences.

Coincidences between the straggled electrons and neutrons emitted in photonuclear processes seems to be within the possibilities of the monochromator scheme. In this kind of experiment where a counter is not exposed to the total bremsstrahlung spectrum the possibility exists of using the full yield of the betatron before jamming the electron counter.

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Negative π-μ Meson Decays in Photographic Emulsion*

W. F. Fry, *University of Wisconsin, Madison, Wisconsin*

AND

George R. White,† *Iowa State College, Ames, Iowa*

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It is generally believed that a slow negative π meson which stops in an emulsion will be captured into mesonic orbits of an atom and then absorbed by the nucleus. Experimental observations[1-3] have shown that nuclear absorption of slow negative π mesons in photographic emulsion completely predominates over π-μ decay. However, several negative decays in emulsion have been observed recently.

Electron-sensitive G-5 plates were exposed behind absorbers to slow negative π mesons from the various channels of the University of Chicago cyclotron. Among 40 000 meson endings, 18 π-μ meson decays were observed. The μ meson stopped in the emulsion in 11 of these 18 cases. The characteristics of these 11 π-μ decays are given in Table I. A histogram of the μ meson range distribution for these decays is shown in Fig. 1.

In 5 of the 11 cases where the μ meson stopped in the emulsion, the range of the μ meson is outside the limits of the experimental μ meson range distribution from positive π-μ decays;[4,5] thus it is highly improbable that these 5 events are positive decays. Also, 5 of the 11 decays (events 1, 3, 6, 7, and 11) show no decay electron from the μ-meson ending; thus it is very improbable that these 5 are positive π-meson events.[6] In fact, this fraction of μ-e decays is reasonable if it is assumed that the μ mesons are negative.[7] There is no correlation of the μ-meson range with the presence of a decay electron. Of the 6 events where the range of the μ meson is within the distribution from 1000 positive π-meson decays, the decay-electron track is observed in only 3 cases. Therefore, it is improbable that more than 2 events are positive decays; however, it is possible that all are negative. The π and μ mesons in event No. 1 are undoubtedly negative, as shown by the 1-prong star caused by the μ meson.

Table I. Characteristics of negative π-μ decays.

Event	Range of μ meson	μ-e decay?
1[a]	320	(one-prong star)
2	443	yes
3	580	no
4	581	yes
5	598	yes
6	610	no
7	615	no
8	647	yes
9	687	yes
10	720	yes
11	780	no

[a] An electron track is observed at the π-μ junction. The energy of the electron is about 25 kev.

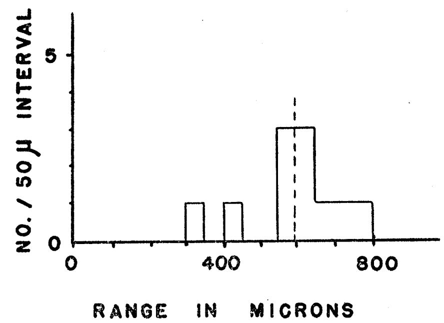

Fig. 1. The μ-meson range distribution from negative π-meson decays is shown in the histogram. The mean range from positive π-meson decays is 597 microns.

The spead of the μ-meson range distribution from negative π decays is significantly greater than the spread from positive π decays. This fact suggests that the negative π mesons did not decay from rest. The μ-meson range distribution implies that the average momentum of the π meson at the time of decay was about 3.3 Mev/c. The stopping time in an emulsion for a π meson of this momentum ($E_\pi=40$ kev) is estimated to be about 10^{-13} sec. The probability of decay in flight is the ratio of the moderation time to the mean lifetime (5×10^{-8}). This probability is too small to account for the number of π-μ decays observed.

The events are interpreted as π-meson decays from negative energy states where the average momentum is about 3.3 Mev/c. The relative scanning efficiency for π-μ decays in comparison to π-meson stars is estimated to be 75 percent. Thus, the probability that a slow negative meson will decay in a photographic emulsion is $(18/40\,000)(4/3)=6\times10^{-4}$. It is not known whether the decays follow the atomic capture in the heavy or the light elements. From a previous study of μ-meson phenomena it was found that 61 percent of the slow μ mesons stop in Ag or Br and that 39 percent stop in the light elements (C,N,O).[7] These same percentages should apply to slow negative π mesons. If the π-meson decays follow the stopping in Ag or Br, the ratio of decay to nuclear absorption is $(18/40\,000\times0.61)(4/3)=1.0\times10^{-3}$. If the decays follow the stopping in the light elements, the ratio of decay to nuclear absorption is $(18/40\,000\times0.39)(4/3)=1.5\times10^{-3}$.

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