Title
THE GAMMA-RAY SPECTRUM FROM THE ABSORPTION OF Pi- -MESONS IN DEUTERIUM

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Publication Date
1950-08-15

UNIVERSITY OF CALIFORNIA — BERKELEY

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August 15, 1950

Berkeley, California

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The Gamma-Ray Spectrum from the Absorption of π^--Mesons in Deuterium

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August 15, 1950

The gamma-ray spectrum resulting from the absorption of π^--mesons in deuterium has been analyzed with a pair spectrometer having 30 channels covering a range of 3 to 1 in energy. The experimental arrangement is similar to that discussed in previous letters by the same authors.[1][2] The deuterium is contained in the pressure vessel at 2700 p.s.i. at the temperature of liquid nitrogen. Its density[3] is 0.096 as compared with a hydrogen density of 0.046 under the same conditions.

Ten runs were made over a 72 hour period without changing the physical set-up. The regions centering on 130 Mev and 70 Mev were examined with full sensitivity. Comparisons were obtained between hydrogen, deuterium, helium and vacuum background in the upper energy region. In the lower energy region deuterium, helium and background were examined so that a limit might be set to the null effect observed there in deuterium.

The spectrum from π^- capture in hydrogen has been attributed to the reactions

(a) $\pi^- + p \longrightarrow n + \gamma$ (E_γ = 131 Mev)

(b) $\pi^- + p \longrightarrow n + \pi^o \quad n + 2\gamma$ (E_γ = 70 Mev)

In deuterium one or more of the following reactions are probable:

(c) $\pi^- + d \longrightarrow 2n + \gamma$ (E_γ = 0--135 Mev)

(d) $\pi^- + d \longrightarrow 2n + \pi^o \quad 2n + 2\gamma$ (E_γ = 70 Mev)

(e) $\pi^- + d \longrightarrow 2n$

By combining the channels in which a positive counting rate is observed

we find the following total counting rates for the various processes:

(a) 0.470 ± 0.046 c/m — For a total of 0.925 ± 0.1 c/m in hydrogen.

(b) 0.455 ± 0.09 c/m

(c) 0.275 ± 0.034 c/m — For a total of 0.275 ± 0.04 c/m in deuterium.

(d) -0.008 ± 0.010 c/m

The ratio of the yield in deuterium to that in hydrogen is 0.30 ± 0.04.

(e) Attempts are being made to detect the fast neutrons from this process, but without conclusive results at this time. This process probably accounts for the remainder of the π^- captures in deuterium.

The runs with helium were made to see if the background was increased by π^0 production from fast protons scattered into the deuterium, since it is known[4] that the cross section for production of π^0 mesons by protons on neutrons is much greater than for protons on protons. No counts above vacuum background were observed from the helium, although the total number of counts was small ($\sim$120).

The observed spectrum from process (c) differs markedly from that calculated on phase space considerations alone, possibly because of the interaction of the outgoing neutrons. Process (d) is energetically possible; however, the yield is expected to be small since energy available for the π^0 is small and selection rules require that the π^0 come off in the P state with respect to the two neutron system (assuming parity of π^0 same as π^- and capture from the S state).

This work was performed under the auspices of the Atomic Energy Commission.

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References

(1) Panofsky, Aamodt and York, Phys. Rev. 78, 825 (1950)

(2) Panofsky, Aamodt, Hadley and Phillips, Phys. Rev., in press.

(3) Johnston, Bozman, Rubin, Swanson, Corak, Rifkin, MDDC-850

(4) Crandall, Moyer and York (Private communication)

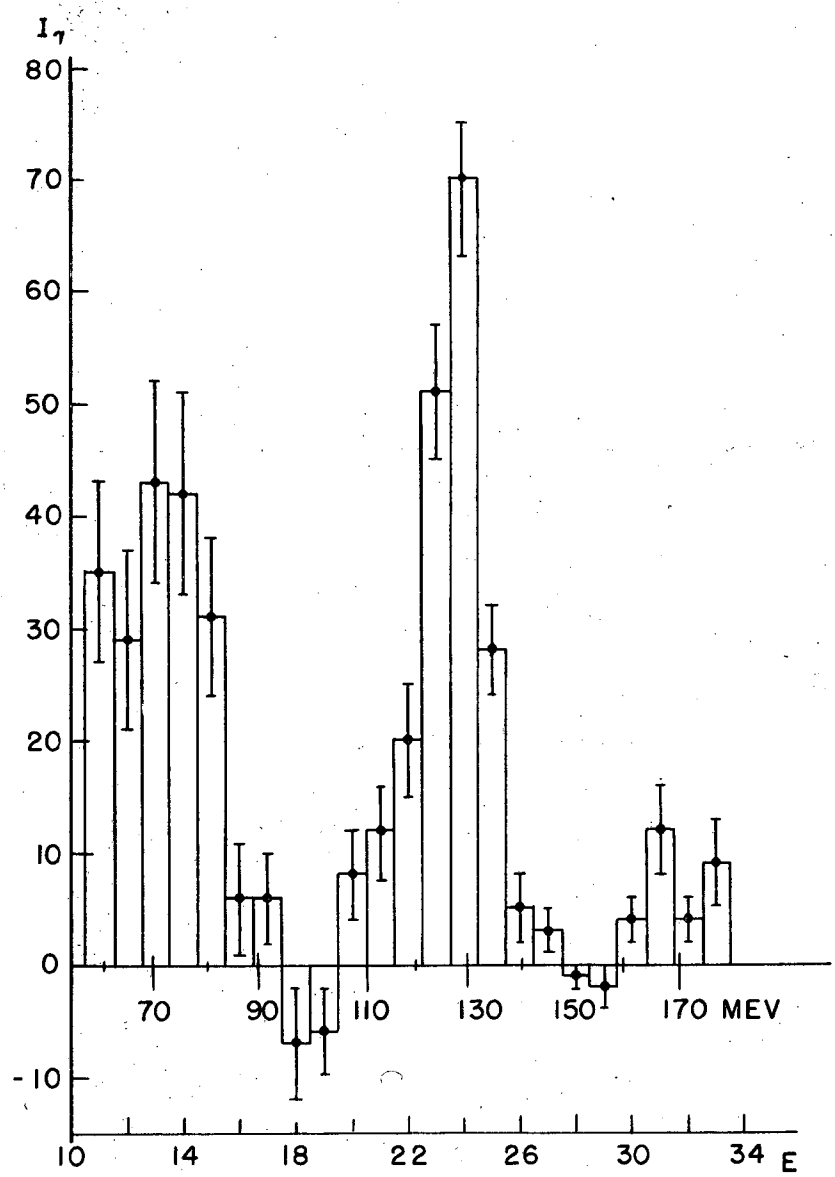

FIG. 1 MU 688 165291

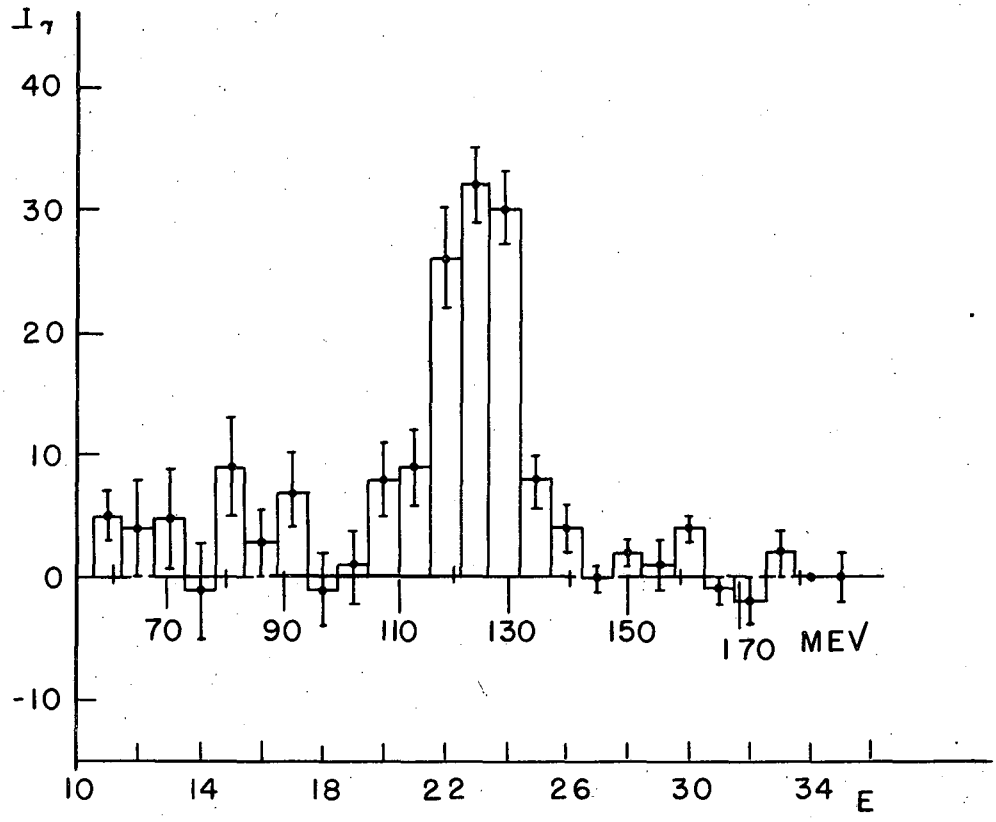
I_γ
40
30
20
10
0
-10
70
90
110
130
150
170 MEV
10
14
18
22
26
30
34
E

FIG. 2 MU 6 87