π^-/π^+ RATIO FROM DEUTERIUM IN PHOTOPRODUCTION AT 500-1000 Mev*

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The ratio of charged pions photoproduced from deuterium has been studied using the bremsstrahlung photon beam from the electron synchrotron at the California Institute of Technology. The ratio of yields of negative and positive pions gives directly the ratio of the cross sections of the two processes, $\gamma+p=n+\pi^+$, and $\gamma+n=p+\pi^-$, assuming deuteron structure effects to be negligible.

The pions were detected by the wedge-shaped magnet and associated counter system described earlier by Dixon and Walker.[1] Pions were observed at laboratory angles and momenta corresponding to photoproduction from free nucleons by photons of 500, 600, 700, 800, 900, and 1000 Mev and center-of-momentum angles of 20°, 40°, 60°, 90°, 120°, 150°, and 163°.

The fact that the target nucleons in deuterium are not free, but have a Fermi motion, means that pions of a given momentum and angle are not produced by photons at a unique energy. Preliminary kinematic calculations, including the bremsstrahlung spectrum, have been made to find the average photon energy in the rest system of the target nucleon. This corresponds to the laboratory energy for photoproduction from free nucleons, and is plotted as the "effective photon energy" in the figure. These calculations also give preliminary photon resolution functions which indicate that the spread from the Fermi motion is comparable to that from the momentum resolution of the magnet, $\Delta p/p=0.10$. The spread in c.m. angles due to the Fermi motion is small.

The solid circles in the figure are results of experiments done earlier at this laboratory by Sands, Teasdale, Walker, and Bloch, part of which have been published.[2]

The pion yields have been corrected for the background from the target assembly. The positive pion yields have been corrected for a small proton contamination. We have assumed that scattering and absorption in passing through the apparatus eliminate an equal fraction of positive and negative pions.

Measurements were, in general, made with the bremsstrahlung end point of the photon beam 100 Mev above the nominal photon energy being studied. This was usually low enough to exclude significant contamination from multiply-produced pions. Measurements made with different end-

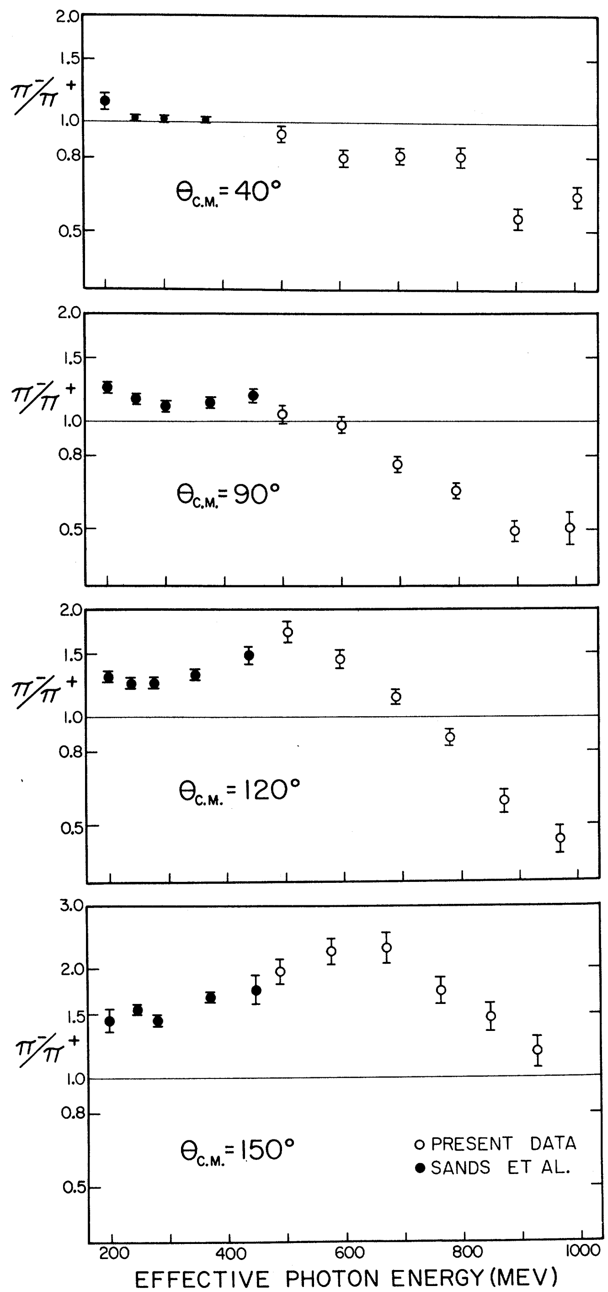

FIG. 1. Preliminary ratio of negative to positive pions photoproduced from deuterium at various c.m. angles as a function of the average photon energy in the rest system of the target nucleon.

point energies at a few points where some contamination was unavoidable indicate that the ratio at these points would be unchanged (within present errors) if corrections for multiply-produced pions were made.

A complete report of this experiment will be made when a final analysis of the data has been completed.

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[1]F. P. Dixon and R. L. Walker, Phys. Rev. Lett. 1, 142 (1958).

[2]Sands, Teasdale, and Walker, Phys. Rev. 95, 592 (1954).

REDETERMINATION OF THE μ^+ MEAN LIFE*

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The decay of the muon involves, except for electromagnetic corrections, only leptons. The rate of this process achieves, therefore, particular importance as a true measure of the strength of this weak interaction. It now appears probable that all weak interactions are of the same type, i.e., the chiral V-A type.[1] Hence this rate would provide, in particular if the conserved V-current hypothesis revived by Feynman and Gell-Mann[2] were correct, information of universal validity for weak interactions. According to this hypothesis, the coupling strength as observed in muon decay would be specified by a single constant G, unaffected (in this particular process) by renormalization effects. This same number G would also be the observable coupling constant of the V part of, say, nuclear beta decay. Thus G could be extracted from the observed decay rates of either the muon or of a pure nuclear V transition, such as $O^{14} \rightarrow N^{14}$. Hence these two decay rates could be computed from each other (correcting for radiative effects), and numerical agreement would provide verification of the hypothesis.

The best available experimental value[3] for the μ^+ mean life, $\tau(\mu^+) = (2.22 \pm 0.02)$ μsec, was indeed found to agree within 2 % with that predicted from the ft value of O^{14}—as long as radiative corrections to either decay process were neglected.[2] Berman[4] estimated these corrections (ignoring nucleon and nuclear structure effects) and concludes that their inclusion leads to $\tau(\mu^+) = 2.33$ μsec. A more recent calculation by Kinoshita and Sirlin[5] reduces this number to 2.31 μsec. This number disagrees with the above experimental value even when some allowance (± 0.05 μsec) for theoretical uncertainties in these corrections and in the O^{14} ft value is made.

Stimulated by these considerations, we have now redetermined $\tau(\mu^+)$. In attempting to reduce the error in $\tau(\mu^+)$ below the uncertainty quoted in reference 3, statistical limitations are secondary with artificial mesons. The following sources of systematic errors are, however, important: (a) the absolute accuracy and linearity of the time measurement, (b) the magnitude and time dependence of the "background," and (c) the possible precession of muons at rest.

In our experimental arrangement, shown in Fig. 1, sources (b) and (c) were minimized by letting the entire chain $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ occur in the target T, a 2.5-g/cm^2 thick scintillator[6] in which the range curve of the incident 150-Mev/c "pion" beam was centered. The stopping particles were detected by the "start" telescope $123T\bar{4}$, the outgoing positrons by the "stop" telescope $\bar{2}\bar{3}T45$. The "start" and "stop" signals were fed—rather than to the conventional time-converter used previously in this laboratory—to an electronic system especially designed[7] to suppress errors from source (a). This system uses a known principle[8]: the pulses of an rf wave train (9.1 Mc/sec) initiated by a "start" signal are counted by a fast scaler (Hewlett Packard 520 A) through a gate triggered by a "stop" signal. The digital output of the scaler, proportional to the interval

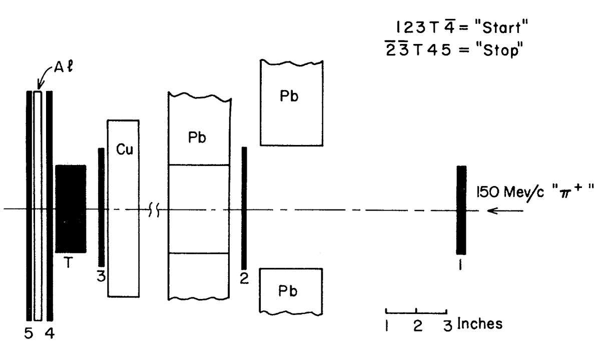

FIG. 1. Experimental arrangement. 1, 2, 3, T, 4, and 5: plastic scintillators, about square; Cu: 17.7-g/cm^2 Cu absorber; Al: 1.71-g/cm^2 Al absorber; Pb = lead collimators; $123T\bar{4}$: "start" telescope; $\bar{2}\bar{3}T45$: "stop" telescope.