Lawrence Berkeley National Laboratory

Recent Work

Title
PHOTO-PRODUCTION OF NEUTRAL MESONS FROM DEUTERIUM

Permalink
https://escholarship.org/uc/item/6nz8n0j5

Authors
Heckrotte, W.
Henrich, L.R.
Lepore, J.V.

Publication Date
1951-12-13
TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545
DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.
PHOTO-PRODUCTION OF NEUTRAL MESONS FROM DEUTERIUM

W. Heckrotte, L. R. Henrich, and J. V. Lepore

December 13, 1951

Berkeley, California
PHOTO-PRODUCTION OF NEUTRAL MESONS FROM DEUTERIUM

W. Heckrotte, L. R. Henrich, and J. V. Lepore

Radiation Laboratory, Department of Physics
University of California, Berkeley, California

December 13, 1951

The manner in which neutral mesons are coupled to nuclear matter may be determined by an experimental study of the photo-production of neutral mesons from deuterium. This follows from the fact that the radiated meson waves may differ in phase depending on whether they arise from neutron or proton. The relative phase of this radiation is clearly controlled by the algebraic sign of the coupling. Thus, for meson wave lengths comparable to the separation of the particles in the deuteron large interference effects may be expected.

Near threshold meson production may be expected to lead to deuteron formation. For this case interference effects will be large. At higher energies continuum states will be favored and the interference will be less.

We have calculated the cross section for neutral meson production when a deuteron is formed in the final state. The pseudoscalar meson theory with pseudovector coupling has been assumed, and we have treated the process according to perturbation theory. Although there is no straightforward way to do this we have attempted
to incorporate higher order meson processes by using the anomalous
moments of the nucleons. Specifically, effects due to exchange
currents have been neglected but by using the anomalous moments we
have, in a sense, included those virtual mesic effects not due to the
presence of a second nucleon. The nucleons have been treated non-
relativistically and for simplicity the deuteron wave function has
been taken as a Gaussian. In addition to this we have used plane
waves in the intermediate states. The results are given in Fig. 1.
It is found, as one might expect, that the principal contribution
to the cross section is proportional to \((g_p \mu_p + g_n \mu_n)^2\), the
square of the interaction energy. If \(g_n\) and \(g_p\) are of opposite
sign this term is larger than when they are the same. For \(|g_n| = |g_p|\)
the ratio between the two cases is 30. There is a difference in
angular distribution but it is slight. We can expect our total cross
section to be smaller than the correct value \(^{1,2}\) if the coupling
constant is chosen to be 1/2 (either \(g_p^2/\hbar c\) or \(g_n^2/\hbar c\)). However,
the ratio of the cross sections for the two cases should be correctly
given.

This experiment would have interesting implications regarding
the charge independence of nuclear forces since the symmetrical meson
theory, the most elegant designed to yield this result, requires
\(g_n = -g_p\).

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


FIGURE CAPTION

Figure 1. The differential cross section in the laboratory system for photo-production of neutral mesons in deuterium.
\[ \begin{align*}
E_\gamma &= 150 \text{ MEV} \quad \left\{ \begin{array}{l}
\sigma_p^p - g_n^p \frac{d\sigma}{d\theta} = 3.4 \times 10^{32} \text{ x(ordinate)}, 
\sigma_t = 1.3 \times 10^{30} \text{ cm}^2 \\
\sigma_p^p - g_n^p \frac{d\sigma}{d\theta} = 9.8 \times 10^{31} \text{ x(ordinate)}, 
\sigma_t = 3.8 \times 10^{29} \text{ cm}^2
\end{array} \right.
\]

\[ \begin{align*}
E_\gamma &= 200 \text{ MEV} \quad \left\{ \begin{array}{l}
\sigma_p^p = g_n^p, \frac{d\sigma}{d\theta} = 4.6 \times 10^{31} \text{ x(ordinate)}, 
\sigma_t = 1.1 \times 10^{29} \text{ cm}^2 \\
\sigma_p^p = g_n^p, \frac{d\sigma}{d\theta} = 1.3 \times 10^{29} \text{ x(ordinate)}, 
\sigma_t = 3.1 \times 10^{28} \text{ cm}^2
\end{array} \right.
\]

Fig. 1