K\(^+\)-Deuteron Scattering - I (*)

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1. - Introduction.

The K\(^+\)-nucleon interaction appears in three basic processes: elastic scattering on protons and neutrons, exchange scattering on neutrons: strangeness conservation forbids processes involving hyperons. Since the isotopic spin of K\(^+\) is \(\frac{1}{2}\), the three corresponding scattering amplitudes can be expressed in terms of two scattering amplitudes in the total isotopic spin states \(I = 1\) and \(I = 0\), and of the Coulomb scattering amplitude \(f_c\) (*):

\[
\begin{align*}
(I) & \quad K^+ + p \rightarrow K^+ + p & a_1 + f_c \\
(II) & \quad K^+ + n \rightarrow K^+ + n & (a_1 + a_0)/2, \\
(III) & \quad K^+ + n \rightarrow K^0 + p & (a_1 - a_0)/2.
\end{align*}
\]

(*) Supported in part by the United States Air Force through the European Office, Air Research and Development Command.

(*) It can be easily seen that coulombic phase factors must be neglected.
At the present time, our knowledge of this interaction is based on two
types of experiments:

1) **Scattering of K\(^+\) by hydrogen** which gives information on the \(I = 1\) interaction. The results show a relatively constant total cross-section up to
200 MeV corresponding to a scattering length of the order of \(0.24 \, \hbar/\mu\) e (\(^2\)).
The angular distribution shows the predominance of the \(S\) state in spite of
an unexplained marked minimum in the backward direction. Obviously the
experimental data can be improved and make the situation clearer.

2) **Elastic and inelastic scattering of K\(^+\) in emulsions.** – The description
of elastic scattering by an optical potential shows that the average K\(^+\) nucleon
interaction is repulsive (\(^3\)). The ratio of exchange to non exchange inelastic
(or rather quasi-elastic) scattering of K\(^+\) should directly give the ratio of the
\(I = 0\) and \(I = 1\) scattering amplitude if the nucleons, inside the nucleus, could
be considered as perfectly free. This is not the case and we feel that the cor-
rections to be done before giving the \(I = 0\) amplitude are rather uncertain.
Nevertheless it turns out that the \(I = 0\) amplitude is small and seems to in-
crease with energy.

The need for another, more direct, way of investigation of the \(I = 0\)
interaction seems to be clear. In our opinion, the experimental data which
can be handled by theoreticians are those given by scattering of K\(^+\) on the
simplest substance containing neutrons, i.e. deuteron. The experiment is quite
feasible, since analogous experiments have recently been done by sending
K\(^-\) mesons in a deuterium bubble chamber (\(^4\)).

The object of the present paper is to give a preliminary calculation of K\(^+\)-
deuteron scattering, both elastic and inelastic; this calculation uses impulse
approximation; final state interactions have been provisionally neglected, and,
in the numerical computation, done on IBM 704 digital computer, \(P\)-waves
have been ignored. We have especially investigated the sensitivity of the
results to the \(I = 0\) scattering length. It turns out that the angular distribu-
tions for both elastic and inelastic non exchange scattering are dominated
by form factors and Coulomb scattering; therefore it would be difficult to see
a modification of this angular distribution due to \(P\) waves. The most inter-
esting quantities are the differential and total exchange cross-sections. Their
ratios to the non-exchange cross-sections are very sensitive to the \(I = 0\)

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