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POINTS OF MAXIMUM ANALYZING POWER IN THE $^3\text{He}(d,p)^4\text{He}$ REACTION

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The $^3\text{He}(d,p)^4\text{He}$ reaction has been the first process, other than elastic scattering, in which a point $(E_0, \Theta_0)$ of maximum possible tensor analyzing power $A_{yy} = 1$ has been proposed. An inspection of the complete deuteron polarization data of Gruebler et al. at 11.5 MeV and of the $T_{11}$ measurements of Roy et al. at 15 MeV indicates the possibility of large positive values of both $A_y$ and $A_{yy}$ near $\Theta_{cm} = 120^\circ$ and thus of a point $A_y = A_{yy} = 1$ between these energies. The necessary but not sufficient conditions $A_{xx} = A_{zz} = -1/2$ and $A_{xz} = 0$ are nearly fulfilled at 11.5 MeV. Unfortunately these tensor observables are not available at higher energies. For the investigation and possible identification of such a point, the relevant conditions on the M-matrix have to be verified. Using the presentation they are $A = B = 0$ for an extreme value $A_{yy} = 1$; for $A = \pm 1$ they are $A = B = 0$, $C = \mp iE$ and $D = \mp iF$. Imposing these conditions on the formulae for the observables gives the following

\begin{align*}
A_y &= \pm 1, \\
A_{yy} &= -K_{0,y} = 1, \\
A_{xx} &= A_{zz} = -1/2, \\
A_{xz} &= K'_{xz} = C_{xz,y} = 0 \\
k_x' &= K_x' = k_{x,y} = k_{x,z} = 0 \\
k_z' &= K_z' = k_{z,y} = k_{z,z} = 0 \\
C_{x,x} &= C_{z,x} = C_{x,y,x} = C_{y,z,x} = 0, \\
C_{x,z} &= C_{z,z} = C_{x,y,z} = C_{y,z,z} = 0, \\
F_y' &= -K_{0,y} = K_{yy} = -C_{yy,y} = t, \\
K_y' &= -C_{y,y} = \pm t, \\
C_{xx,y} &= -K_{xx}' = C_{zz,y} = -K_{zz}' = 1/2 t, \\
k_x' &= -K_x' = 0, \\
k_{0,x} &= 0, \\
k_{0,z} &= k_{0,z} = v.
\end{align*}
Here $O_0$, $A$, $P$, $K$ and $C$ denote the unpolarized cross-section, analyzing power, particle polarizations, polarization transfer coefficients and efficiency correlation coefficients, respectively. The first subscripted index stands for the beam, the second for the target polarization. Thus 24 polarization observables involving two or less particle polarizations are numerically determined, while the other 14 are given by the 3 parameters $t$, $u$ and $v$. With the cross-section for unpolarized particles there are thus 4 parameters that can be determined experimentally. By a careful selection of the experiments, through an inspection of the general formulae\(^5\),\(^6\), a verification of an extreme point of the components $A_y$ and $A_{yy}$ should be feasible. The establishment of such a point would be very important in an analysis of the process, due to the restrictions imposed on some elements of the M-matrix.

References

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+ On leave of absence from the University of Basel, Switzerland.
Ì Research Council of Canada, Post-doctoral fellow
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