THE INCLUSION OF EXCHANGE EFFECTS IN ELASTIC SCATTERING

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In the usual treatment of elastic scattering for bombarding energy regions where compound effects are not important one assumes that two particles interact via some distorting potential leaving the particles unaffected after the interaction. This in effect amounts to assuming that the two interacting particles are inert. For the case of heavy ion reactions for which the interacting particles are complex one might expect the process to be more complicated. One effect that can be important arises from the more realistic assumption that the complex nuclei contain active nucleons which can be transferred in the elastic process. If one thus imposes antisymmetry for the incident andexit channel wavefunctions it no longer becomes possible to distinguish between a pure elastic process and one that arises from the exchange of nucleons providing the residual and detected particle pairs are equivalent in the two channels. This is true only in a formal sense, however, since the mass transfer (exchange effect) process will exhibit different kinematic features from pure elastic scattering. In addition, if the exchange process is strong enough in relation to the pure elastic one then interference patterns can arise due to coherence effects and would further characterise angular distributions.

The purpose of this study is to investigate the importance of these exchange effects within the context of the distorted wave Born theory by comparing calculations with some representative cases. The method employed is as follows. We assume that in addition to the usual pure elastic channel particle χ is transferred as follows:

$$\begin{aligned} A + B &= (A = B' + \chi) + B \\ &= B' + (A' = B + \chi) \\ &= B' + A' \end{aligned}$$

Now if $A = A'$, $B = B'$ then the above transfer process is indistinguishable from pure elastic scattering. The distorted wave Born transition amplitude for the exchange process is then

$$T^{e\chi} = \langle f | V_{B\chi} + V_{BB} - U_{AB} | i \rangle$$

where V_{xy} designates the sum of interactions between particles in x and y. The cluster structure $B + \chi$ is involved in calculations and if $\ell_{\chi B}$ designates the relative orbital angular momenta between x and B then the total angular momentum transfer for the exchange process is $\vec{P} = \vec{\ell}_{xB} + \vec{\ell}_{\chi B}$. For the case $P = 0$, T^{ex} will add coherently with the pure elastic scattering component but will add incoherently otherwise. The total transition amplitude will thus be

$$T = T^{Pe} + T^{ex}$$

and it is straightforward to add them appropriately in partial wave space