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# Strong Masking of Folded Spin-Orbit Potential by Channel Coupling of Projectile Excited States

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In the coupled-channel (CC) studies (1,2) of the $^{7}Li+^{58}Ni$ scattering at 20 MeV, it was clarified that the folded spin-orbit potential between $^{7}Li$ and $^{58}Ni$ contributes negligibly to the vector analyzing power($iT_{11}$), but the CC effect of the projectile excitation explains the $iT_{11}$ beautifully. In the application (3) of this model to the $^{7}Li+^{12}C$ scattering at 21 MeV, we showed that the same CC effect plays essentialy important role in reproducing the experimental data.

In the case of the $^{12}C$ target, however, we point out here that the folded spin-orbit potential gives rise to rather large $iT_{11}$ as long as the projectile-excited channels are omitted, but the role of the potential is strongly masked when the channel coupling is switched on.

The projectile virtual excitations are taken into account by the CC method where the $1/2^-$ and $7/2^-$ excited states are considered as well as the $3/2^-$ ground state. The CC form factors are given by the cluster folding interactions; namely, wave functions of those $^{7}Li$ states are constructed by the $\alpha$-t cluster model and the $\alpha$-$^{12}C$ and t-$^{12}C$ optical potentials are folded into the transition densities which are made of the wave functions (3).

The folded spin-orbit potential (LS) between $^{7}Li$ and $^{12}C$ is generated by folding the spin-orbit part of the t-$^{12}C$ potential. The central and tensor potentials (C and T, respectively) are produced by the folding of the central part of the $\alpha$-$^{12}C$ and t-$^{12}C$ potentials. T causes the reorientation effect of the $3/2^-$ channel and the coupling among the $3/2^-, 1/2^-$ and $7/2^-$ channels. Roles of C, T and LS are investigated in the following single and CC calculations:

a) Single-channel ($3/2^-$) calculation with C+LS neglecting T (Fig. 1a).
b) Single-channel ($3/2^-$) calculations with C+T+LS and with C+T (Fig. 1b).
c) Two-channel ($3/2^-, 1/2^-$) calculations with C+T+LS and with C+T (Fig. 1c).
d) Three-channel ($3/2^-, 1/2^-, 7/2^-$) calculations with C+T+LS and with C+T (Fig. 1d).

The vector analyzing power calculated by the cases a) to d) are shown in Figs. 1a to 1d, respectively. From Fig. 1a, we understand that the folded spin-orbit potential almost explains the observed magnitude as long as both T of the $3/2^-$ channel and the coupling of the excited channels are switched off. This situation is quite different from the case of $^{7}Li+^{58}Ni$ scattering where the coulomb barrier interupts heavily the shorter ranged LS to work; in the case of $^{7}Li+^{12}C$, the barrier is much lower than the bombarding energy and therefore the effect of LS can be seen evidently in the calculation a).

The difference of the solid line and dashed line in Figs. 1b to 1d represents the role of LS in the presence of the T of the $3/2^-$ channel and the coupling of the $1/2^-$ and $7/2^-$ channels. It is clearly seen that the effect of LS decreases quickly as the number of the coupled channels increases; in the case of the full channels coupled, LS is almost completely masked out. The mechanism of this masking may be understood as follows: Since the range of T is much longer than that of LS, the strong coupling by T interupts the inside LS to work before the incoming wave reaches it. This effect is to be reminded of when the vector analyzing powers of heavy-ion scattering are analyzed within the single-channel folding model with C+LS, even if the experimental data were reproduced well by the model.

From the above considerations, one may expect that, when the bombadring energy of $^{7}Li$ ($^{6}Li$) becomes much higher than 20 MeV, the folded spin-orbit potential becomes

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evidently important in understanding the vector analyzing power even though the channel coupling of the projectile excited states were not switched off. This is actually recognized in two contribution papers of this conference by M. Tanaka et al. on the double scattering of $^{6}Li$ (150 MeV) from $^{12}C$ and by Y. Sakuragi et al. on the analysis of $^{7}Li$ scattering from $^{120}Sn$ (44 MeV).

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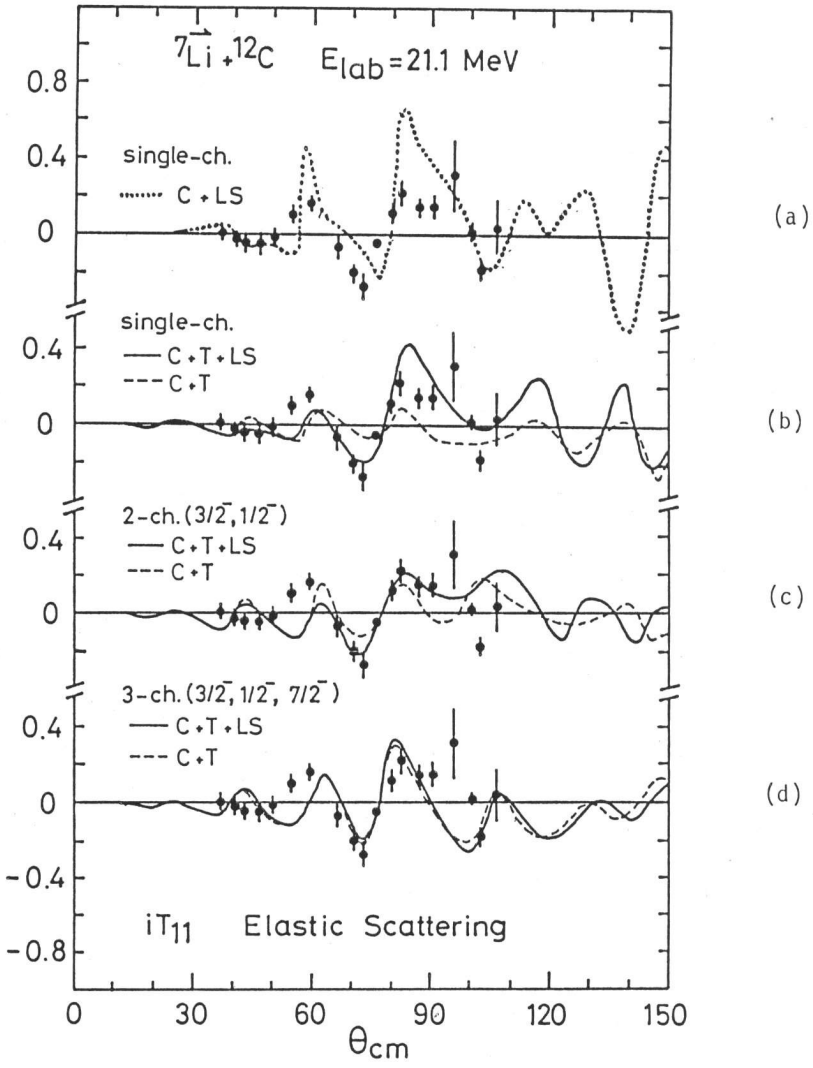


Fig. 1. Observed (4) and calculated vector analyzing powers of the $^{7}Li$+$^{12}C$ scattering at 21.1 MeV. Curves in a) to d) are given respectively by the single- and coupled-channel calculations a) to d) mentioned in the text. Strong masking of the folded spin-orbit potential (LS) by the channel coupling is clearly seen.