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4.3 Analyzing Powers for $^{12,13,14}C(\vec{p},\pi^-)^{13,14,15}O_{g.s.}$ Reactions Near Threshold

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The proton-induced exclusive pion-production reaction involves large momentum transfer to the nucleus. In the negative pion production reactions,

$$p + (A,Z) \longrightarrow (A+1,Z+2) + \pi^-$$

only a single process $p+n \longrightarrow p+p+\pi^-$ contributes if we assume the two-nucleon processes. Therefore, the (p,π^-) reaction is expected to be simpler than (p,π^+) where $p+p \longrightarrow p+n+\pi^+$ and $p+n \longrightarrow n+n+\pi^+$ contribute coherently[1,2]. In fact, the measured analyzing powers in near-threshold (p,π^-) ground-state transitions for carbon isotopes are strongly dependent on the single-particle orbits of the valence neutrons[1], see Fig. 2, which suggests the dominance of the two-nucleon processes in (p,π^-) reactions. In order to study the reaction mechanisms, we have investigated the j-dependences of the analyzing powers for $\vec{p} + {}^{12,13,14}C \longrightarrow {}^{13,14,15}O_{g.s.} + \pi^-$ reactions at T_p=200 MeV, within the framework of the two-nucleon production model.

We considered the s- and the p-wave pion rescattering diagrams which are shown in Fig. 1. As in ref. 3), we used the factorization approximation for the intermediate delta propagation, and the fourth component of the exchanged pion momentum is approximately fixed by assuming the infinitely heavy nucleus. The incident proton distorted waves are described by the phenemenological optical potential including the spin-orbit part[4]. The pion distorted waves are generated by the Kisslinger-type pion-nucleus optical potential with off-shell cut off. If we adopt the extreme single-particle model for target and residual nucleus, a single matrix element $\langle (p_{1/2}^2)^{J=0} | U | p_{3/2}\Psi_p \rangle$ contributes for ^{12}C, and $\langle (p_{1/2}^2)^{J=0} | U | p_{1/2}\Psi_p \rangle$ for $^{13,14}C$. Here, U denotes the effective two-body operator and Ψ_p being the proton distorted wave. In Fig. 2(A), the solid line corresponds to the result for ^{12}C and the dotted line for $^{13,14}C$. The present result shows that the analyzing power strongly depends on the valence neutron orbits and, hence, the admixture of the other components in the transition amplitude will affect these result considerably. In order to see the effect of the configuration mixings, we used the Cohen-Kurath wave functions[5]. Then, the transition amplitude for ^{12}C becomes to be as;

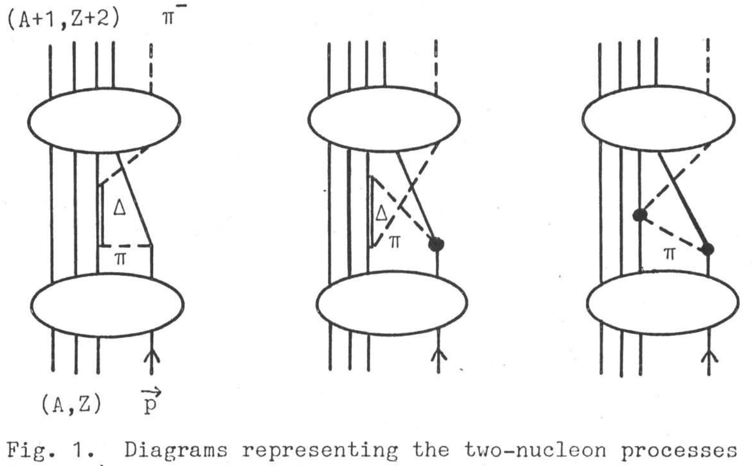

Fig. 1. Diagrams representing the two-nucleon processes included in the present calculations.

$$1.8\langle (p_{1/2}^2)^{J=0}|U|p_{3/2}\Psi_p\rangle + 1.1\langle (p_{3/2}^2)^{J=0}|U|p_{3/2}\Psi_p\rangle + \dots ,$$

while for ^{13}C;

$$1.1\langle (p_{1/2}^2)^{J=0}|U|p_{1/2}\Psi_p\rangle + 0.5\langle (p_{3/2}^2)^{J=0}|U|p_{1/2}\Psi_p\rangle + \dots ,$$

and for ^{14}C;

$$1.9\langle (p_{1/2}^2)^{J=0}|U|p_{1/2}\Psi_p\rangle + 0.8\langle (p_{3/2}^2)^{J=0}|U|p_{1/2}\Psi_p\rangle .$$

The additional matrix elements of the type $\langle (p_{3/2}^2)^{J=0}|U|j\Psi_p\rangle$ come from the processes in which the final proton pair fills the $(p_{3/2}^2)^{J=0}$ holes present in the target nucleus and these components are fairly large. It is interesting to note that the similarity of the transition amplitudes for ^{13}C and ^{14}C still holds except for the overall normalizations. In Fig. 2(B), the results are shown for ^{12}C and ^{13}C by using the above amplitudes (the results for ^{14}C is quite similar to that of ^{13}C and is suppressed). The effect of the configuration mixing is appreciably large and the qualitative trend of the analyzing power can be expressed but not the detailed angular dependences. The present calculations neglected the so-called 'target-emission' diagrams and also the effects of the heavy meson exchange. The study of these effects are under way.

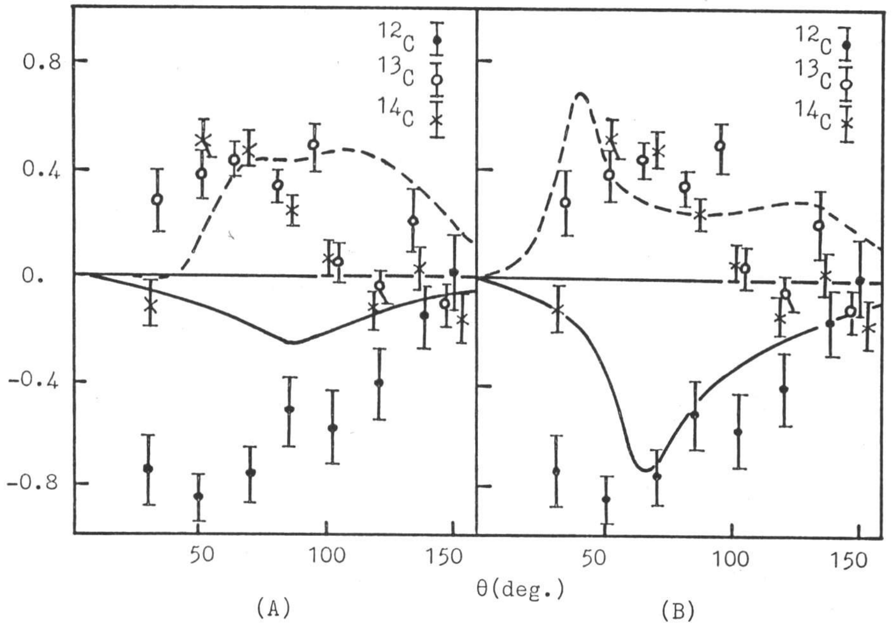

Fig. 2. The analyzing powers for $^{12,13,14}C(\vec{p},\pi^-)^{13,14,15}O_{g.s.}$ transitions at incident energy T_p=200 MeV. For the nuclear wave functions, we have used (A) single particle model and (B) Cohen-Kurath model, respectively. Experimental data are taken from ref. 1).

References

1) W. Jacobs et al.: Phys. Rev. Lett. 49 (1982) 855.
2) S. Vigdor et al.: Nucl. Phys. A396 (1983) 61c.
3) B. Keister and L. Kisslinger: Nucl. Phys. A412 (1984) 301.
4) A. Ingemarsson et al.: Nucl. Phys. A319 (1979) 377.
5) S. Cohen and D. Kurath: Nucl. Phys. 73 (1965) 1.