Measurements of Polarization in the 13C+12C Scattering

著者	Satoh O., Yamaya T., Oh-ami S., Kotajima K., Seki H., Shinozuka T., Fujioka M.
journal or publication title	CYRIC annual report
volume	1987
page range	32-34
year	1987
URL	http://hdl.handle.net/10097/49397

I. 6 Measurements of Polarization in the $^{13}C+^{12}C$ Scattering

Satoh O., Yamaya T., Oh-ami S., Kotajima K.*, Seki H.*, Shinozuka T.** and Fujioka M.**
Department of Physics, Faculty of Science, Tohoku University
Department of Nuclear Engineering, Faculty of Engineering, Tohoku University*
Cyclotron and Radioisotope Center, Tohoku University**

Several experiments have been performed in order to get information on the spin-dependent interactions between composit nuclei (A>6). According to these experimental results, the spin-orbit potentials as a spin-dependent term of the optical potential are much stronger than those obtained from theoretical calculations, that is, folding model calculations. However, we have not been any experimental informations investigated by direct measurements of the polarization observables in heavy ion scattering experiments except for $^{6,7}Li$ ions.

In the present work, the polarizations of ^{13}C elastically scattered from ^{12}C were measured at bombarding energies of 52, 56, and 60 MeV using a double scattering method. The experiments were carried out by use of the Tohoku University Model-680 Cyclotron with $^{13}C^{4+}$ beam. Doubly scattered ion were detected with the left and right counter systems. The first scattering angle of $\theta_{lab} = 8°$ and the second scattering angles of $\theta_{lab} = 8°$, $9.6°$, and $11.3°$ were determined to an accuracy of an order of 0.01°. The polarizations deduced from the measured left-right asymmetries in $^{13}C+^{12}C$ double scattering are plotted in Fig. 1 together with theoretical curves.

The phenomenological optical model and the microscopic double folding model analyses have been performed for the measured cross section and the polarizations in $^{13}C+^{12}C$ elastic scattering. The results of these calculations are indicated by the solid and the dashed curves, respectively, in Fig. 1. In this case, the Thomas-shape spin-orbit potential was used as an "effective spin-orbit potential". As shown in Fig. 1, the calculated curves are well reproduced the data, and the potential depth of $V_0 = 0.2$ MeV for the spin-orbit term was deduced from the data. This value is much larger than the theoretical value of $V_{so} = 0.03$ MeV which deduced from the folding model.[1)]

In order to investigate an origin of the polarization of ^{13}C at small angles, the measured polarization at 60 MeV was compared with the results of the coupled channel calculations including inelastic transition channels.[2)] The results are indicated in Fig. 2(a) by the solid-dashed (projectile excitation channels only) and the dashed (projectile and target excitation channels) curves. Furthermore, the coupling between the two mutual excitation channels of ^{13}C and ^{12}C was added in the calculation (see solid curve). As shown in the Fig. 2(a), the effect of the inelastic transition channels coupling with the elastic channels is very small for polarization at the small angles. One-nucleon transfer channel is considered as another origin of the polarization in the $^{13}C+^{12}C$ elastic scattering. Two-step process calculations were performed using the finite-range DWBA code. The one-nucleon transfer processes to the single-particle states of the $1/2^{+}$, 3.086 and the $5/2^{+}$, 3.854 MeV of ^{13}C were considered in the calculations as the intermediate states. The calculated two-step amplitudes were summed coherently with the elastic amplitude. The results are shown in Fig. 2(b). The solid-dashed and the dashed curves indicate the two-step process through the neutron transfer channel to the $1d_{5/2}$ and $2s_{1/2}$ states, respectively. The solid curve indicates the results of the coherent sum of these amplitudes. As the results of these analyses, it was found that the polarization of ^{13}C at small angles originates from the one-neutron transfer channels.

References

1) Amakawa H. and Kubo K. -I., Nucl. Phys. A226 (1976) 521.

2) Sakuragi Y., private communication.

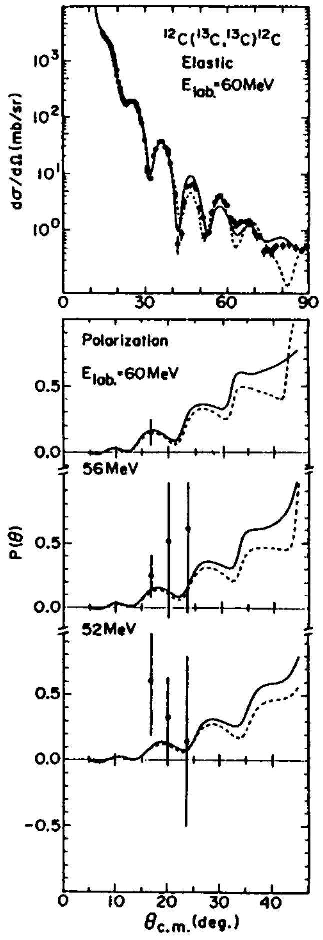

Fig. 1.

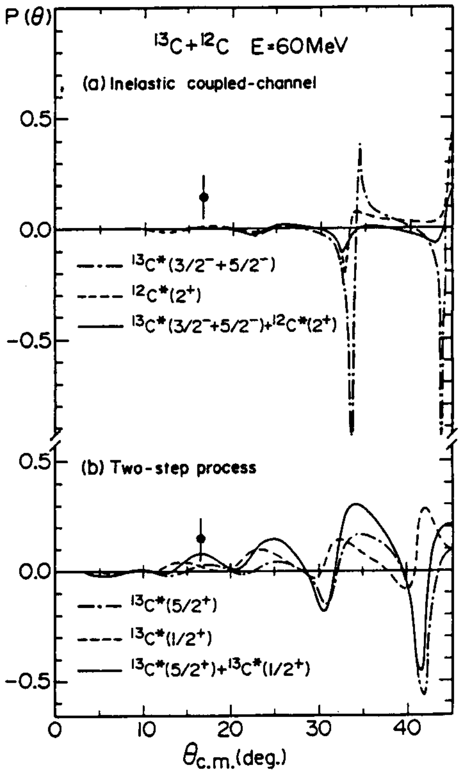
P (θ)
13C+12C E=60MeV
(a) Inelastic coupled-channel
13C*(3/2⁻+5/2⁻)
12C*(2⁺)
13C*(3/2⁻+5/2⁻)+12C*(2⁺)
(b) Two-step process
13C*(5/2⁺)
13C*(1/2⁺)
13C*(5/2⁺)+13C*(1/2⁺)
0.5
0.0
-0.5
0
10
20
30
40
θc.m.(deg.)

Fig. 2.