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2.2 Vector Polarization of ^{6}Li Elastically Scattered by ^{12}C at E = 150 MeV

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Very little has been known about the spin dependence of heavy ion interactions. The experimental information on it is limited to the analysing powers obtained by low energy polarized ^{6,7}Li beam with E $\sim$ 10-20 MeV[1] or to spin flip probabilities of heavy ion inelastic scatterings[2,3]. Through these work, it has been found that observed quantities were far larger than the potential scattering model predictions, in which the folded spin orbit (SO) potentials were used. However, recent theoretical approaches[4,5,6] based on the coupled channel (CC) calculations could elegantly reproduce the experimental data for soft projectile nuclei like ^{6,7}Li at low energies , when effects of projectile excitations were reasonably taken into account.

Contrary to the low energy behaviour, it is expected that the role of the folded SO interaction will win recognition at higher incident energies (>100 MeV) because of the contribution of higher partial waves and the reduction of dynamic polarization resulting from the projectile excitation due to the cancellation between contributing many projectile exitation states. Additionally, this may facilitate the determination of the folded SO interaction in a manner free from the dynamic polarization.

Based on the above aspect, we measured, for the first time, the vector polarization of ^{6}Li elastically scattered by ^{12}C at E = 150 MeV by means of a double scattering method. In order to attain measurements with a low background and large solid angle, the polarization spectrograph, DUMAS[7] was utilized. As shown in Fig. 1-(a), -(b), incident ^{6}Li beam provided by the RCNP isochronous cyclotron was introduced on the ^{12}C target with a thickness of 40 mg/cm^2 and stopped by the graphite Faraday cup. Elastic particles were focussed through the DUMAS on the ^{12}C target ($\sim$40 mg/cm^2) of the polarization analyser, whereas inelastic particles were stopped at the slit near the focal plane of the D1-magnet. The secondary ^{6}Li beam was finally stopped by the plastic scintillator whose signals were recorded for on-line monitoring. Elastic ^{6}Li from the second target was detected by the two sets of SSD counter telescopes mounted on the arms. The axis of the polarization analyser chamber was adjusted to coincide with the secondary beam axis by using additional two sets of position sensitive detectors (PSD). The polarization analyser chamber was rotatable around the secondary beam axis for the measurement of the tensor polarization.

In general, the cross-section is represented[8] for I = 1ℏ by

$$d\sigma/d\Omega = (d\sigma/d\Omega)_0 \; [\, 1 + \langle T_{20}\rangle_1 \langle T_{20}\rangle_2 + 2(\, \langle iT_{11}\rangle_1 \langle iT_{11}\rangle_2 - \langle T_{21}\rangle_1 \langle T_{21}\rangle_2 \,) \cos\phi + 2\langle T_{22}\rangle_1 \langle T_{22}\rangle_2 \cos 2\phi \,], \tag{1}$$

where $(d\sigma/d\Omega)_0$ is the cross-section for unpolarized beam, $\langle iT_{11}\rangle$, $\langle T_{20}\rangle$, etc. are the vector and tensor analysing powers, subscript 1, 2 represents the first and second scattering and ϕ is the azimuthal angle measured with respect to the secondary beam axis. However it is noticed from the CC calculation that the tensor analysing powers are small for forward scattering angles as compared with the vector one and an incident energy dependence of the vector analysing power is not remarkable for the incident energy range of present interest (= 130-150 MeV)[9]. Under these circumstances, the left-right asymmetry is approximated by

$$(L - R)/(L + R) = 2\langle iT_{11}\rangle_1 \langle iT_{11}\rangle_2. \qquad (2)$$

Preliminary experimental results of $|iT_{11}|$ extracted from left-right asymmetries are plotted in Fig. 2 for $\theta_L \sim 8°$ and 13°, where differential cross-sections of elastic scattering are maximum. Error bars indicated are mainly due to undetermined instrumental asymmetries. Though the sign of iT_{11} cannot be determined only from our measurement, it is noted that at least, relative signs are same at both angles.

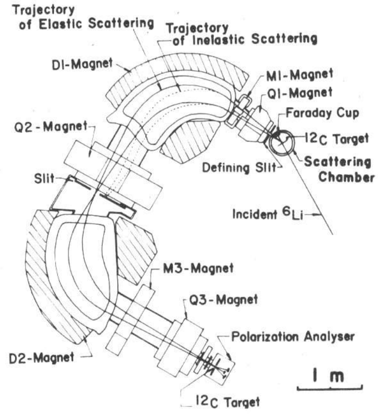

Fig. 1-(a) Schematic view of the DUMAS

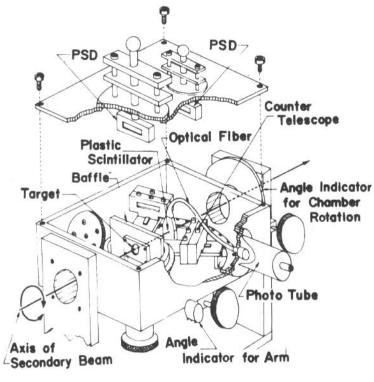

Fig. 1-(b) Stereographic view of the Polarization Analyser

The solid curve in Fig. 2 is the result of the cluster folding CC calculation, in which ^{6}Li is assumed to comprize α and d. Projectile excitations not only to resonant states with L = 2 but also to non-resonant break-up continuum states with L = 0 are taken into above calculation. The optical potentials for $\alpha + {}^{12}$C and d +^{12}C are referred to ref. 10) and 11). They are ones determined from elastic scatterings of α by ^{12}C at 104 MeV and of $\vec{d}$ by ^{12}C at 56 MeV, respectively. The dotted curve is the result without the SO interaction and the dot-dashed one is obtained without couplings to projectile excitations.

From this result, a qualitative agreement between the experiment and the theory is obtained when both the SO interaction and the projectile excitation effect are involved in the calculation,. In other word, this result reminds us that the SO interaction really exists in the heavy ion scatterings.

Further effort to improve the measurement is now attempted paying attention to the reduction of the instrumental asymmetry and to the determination of the upper limit of the tensor polarization.

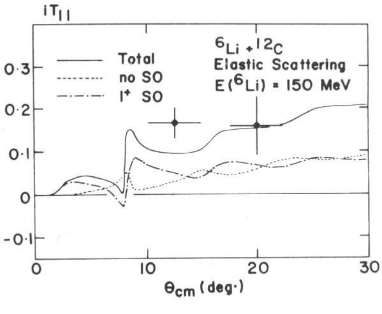

Fig. 2 Observed and calculated iT_{11}. The notations, 1^+ SO, no SO and Total represent the calculations without projectile excitations, without SO potentials and with projectile excitaions and SO potentials, respectively.

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