$L > 0$ Excitations in $\Delta J^\pi = 1^+$ States at 0° Suggested from ^{37}Cl(^{3}He, t)^{37}Ar Measurements

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A charge-exchange (CE) reaction at an intermediate energy is regarded as a powerful tool to study Gamow-Teller (GT) transitions [1]. At the energy above 100 MeV/nucleon and at 0°, the projectile-target nucleon interaction is dominated by the $V_{\sigma\tau}$ term. Since the cross section caused by this $L = 0$, $\sigma\tau$ interaction is essentially dominant at 0°, the differential cross section is related with the GT transition strength of the β decay, and is proportional to the B(GT) value [2]. Recent systematic studies at RCNP have shown that a (^{3}He, t) reaction has this proportionality like a (p, n) reaction [3, 4]. A combination with the magnetic spectrometer made the (^{3}He, t) reaction a good spectroscopic tool to study individual GT transitions with a high resolution.

The differential cross sections of the $L > 0$ components at 0° are small but they are not zero. Particularly the $L = 2$ component can mix with the GT states of $\Delta J^\pi = 1^+$. Watson *et al.* [5] insisted that the tensor term, which behaves like $L = 2$, influences particularly the GT transition of $(j_<^{+1}, j_<^{-1})$, in which the proportionality is exceptionally broken. Therefore, it is important to study whether the cross section of GT states seen at around 0° is mixed with the $L = 2$ component.

Since the differential cross sections of GT transitions are dominated by the $L = 0$ component, to see the $L = 2$ part is usually difficult. The ^{37}Cl is an interesting target to study the $L = 2$ component mixed with the GT transition, because the transition of $(d_{3/2}^{+1}, s_{1/2}^{-1})$ can contribute to the $\Delta J^\pi = 1^+$ transition at the lower excited energy region in the daughter nucleus ^{37}Ar. The $(d_{3/2}^{+1}, s_{1/2}^{-1})$ transition is sensitive only to $L = 2$ but insensitive to $L = 0$. Therefore, it is expected that the angular distribution is affected from the $L = 2$ component if the GT state include the $(d_{3/2}^{+1}, s_{1/2}^{-1})$ configuration.

In E158 and E208, we performed ^{37}Cl(^{3}He, t)^{37}Ar measurements at 140 MeV/nucleon by using the high resolution spectrometer Grand Raiden. The self-supporting ^{37}Cl target foil developed by Shimbara *et al* [6] was installed in the scattering chamber. Grand Raiden was placed at 0°, 2.5°, 4° and 6°. The highest resolution was 35 keV (FWHM) in the obtained spectra.

The spectra at 0° and 4° are shown in Fig. 1. The ordinates of these spectra are normalized so that the 2.80 MeV state has the same height. This state is expected to have $L = 0$ nature by the shell model and DWBA calculations. The J^π values are given on the basis of Ref. [7]. The state at 4.99 MeV is the IAS. Ten GT states are shown with the excitation energies in Fig. 1. The GT state at 1.41 MeV in the 0° spectrum is completely hidden by the state coming from ^{13}C included in the target.

We found that the peak at 3.60 MeV increases compared to the other GT states at 4°, which suggests that this peak has a strong $L = 2$ component. On the other hand, the IAS

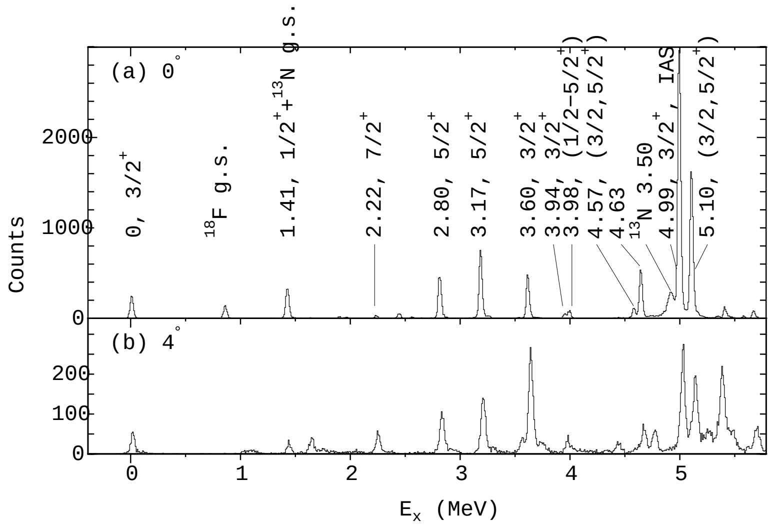

Figure 1: The ^{37}Cl(^{3}He, t)^{37}Ar spectra at (a) $\Theta_{\rm lab} = 0°$ and (b) $4°$.

Table 1: The Z coefficients calculated by code OXBASH for primal configurations.

E_x(MeV)^a	E_x(MeV)^b	$2J^\pi$	$(1d^{+1}_{3/2}, 1d^{-1}_{5/2})$	$(1d^{+1}_{3/2}, 1d^{-1}_{3/2})$	$(1d^{+1}_{3/2}, 2s^{-1}_{1/2})$
0.0	0.0(0)	3^+	−0.04215	−0.24416	0.06266
2.846	2.797(4)	5^+	0.04239	0.40413	−0.10303
3.460	3.600(4)	3^+	−0.09171	−0.03978	−0.47745

^{a}Shell model
^{b}Empirical data

decreases compared to the GT states, suggesting that the $L = 2$ contribution is small.

A shell model calculation was performed using the code OXBASH with W interaction. The calculation reproduced the same J^π values as the present data for the lower five GT states up to 3.60 MeV. In these states the major component is $(d^{+1}_{3/2}, d^{-1}_{3/2})$. The Z coefficients, which corresponding to the transition amplitude, for three representative states are shown in Tab. 1. We see that the state at 3.46 MeV have particularly large amplitude of $(d^{+1}_{3/2}, s^{-1}_{1/2})$. It is consistent with the fact that the angular distribution of 3.60 MeV increases compared to the other GT states at 4°. We suspect for some GT states that the contribution of the $L = 2$ component cannot be neglected in the differential cross section even at 0°.

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