# Gamow-Teller strengths in $A = 34$ isobars (II)
## - shell-model and DWBA calculations -

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As mentioned in the previous article, the $B$(GT) values were deduced for GT states by using the $^{34}$Ar $\beta$-decay $B$(GT) value of the strongly excited 3.129 MeV state as a normalization standard. For the strongly excited states at 2.580 and 3.129 MeV, a good proportionality was observed between the $^{34}$S($^3$He,$t$)$^{34}$Cl values and the $^{34}$Ar$\rightarrow^{34}$Cl $\beta$-decay $B$(GT) values. On the other hand, the $B$(GT) value of 0.091 obtained in the ($^3$He,$t$) reaction for the 0.666 MeV state was 40% larger than that of the $\beta$-decay (see Table 1). We try to understand this enhancement by means of shell-model and DWBA calculations.

A shell-model calculation was performed using the WBP interaction [1] and the code OXBASH [2]. The calculated $B$(GT) values listed in column ten of Table 1 include the average renormalization factor of $(0.76)^2$ [3]. A one-to-one correspondence of GT states is observed. The calculated excitation energies and $B$(GT) values generally agree with the experimental values; even small $B$(GT) values of the 0.461 state is well reproduced.

In weak transitions, like the transitions to the 0.461, 0.666, and 4.212 MeV states, the two (or three) "normal $\Delta L = 0$" GT configurations that can be activated by the $\sigma\tau$ interaction interfere destructively and the strengths are almost cancelled. There is then a possibility that "$\Delta L = 2$" configurations, like $(s_{1/2} \rightarrow d_{3/2})$, activated by the T$\tau$ (and/or the IV $L = 2$ spin) interaction become relatively important. The DWBA calculations, which included both the $\sigma\tau$ and T$\tau$ interactions ($V_{\sigma\tau} = -2.1$ MeV and $V_{\mathrm{T}\tau} = -2.0$ MeV [4]), were performed using the one-body transition densities (OBTD) obtained in the SM calculation. The calculated cross sections at 0° are normalized by the SM $B$(GT) value of the 3.250 MeV state and given in the last column of Table 1. Most of the derived values were modified by less than 10%, but that of the 0.660 MeV state increased by about 80%, suggesting a constructive interference of the $\sigma\tau$ and T$\tau$ contributions.

Table 1: States in $^{34}$Cl and GT transition strengths, $B$(GT), from $^{34}$Ar $\rightarrow^{34}$ Cl $\beta$ decay, and the present $^{34}$S($^3$He,$t$)$^{32}$Cl reaction. The results are further compared with the results of shell-model calculations. The configuration having the largest contribution to each GT transition is indicated by "Primary", while those with less contributions are indicated by "Secondary", where $d3$, $d5$, and $s1$ shows $1d_{3/2}$, $1d_{5/2}$, and $2s_{1/2}$ shells, respectively. A destructive interference is shown by the $-$ sign, while a constructive one by the $+$ sign. Excitation energies are in units of MeV.

| Evaluated values[a] | | | Present experiment | | | Shell-Model calculation | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $\beta$ decay | | | ($^3$He,$t$) | | Configuration | | | DWBA |
| $E_x$ | $J^\pi$ | $B$(GT) | $E_x$ | $L$ | $B$(GT) | $E_x$ | Primary | Secondary | $B$(GT) | $\sigma(0°)$[b] |
| 0.0 | $0^+$ | | 0.0 | 0 | | | | | | |
| 0.461 | $1^+$ | 0.019(2) | 0.458 | $0+\geq 1$ | 0.025(3) | 0.317 | $(d3 \rightarrow d3)$ | $-(d5 \rightarrow d3)$ | 0.009 | 0.011 |
| 0.666 | $1^+$ | 0.064(3) | 0.666 | 0 | 0.091(7) | 0.660 | $(d3 \rightarrow d3)$ | $-(d5 \rightarrow d3)$ | 0.090 | 0.164 |
| | | | | | | | | $-(d3 \rightarrow d5)$ | | |
| 2.580 | $1^+$ | 0.299(28) | 2.579 | 0 | 0.285(21) | 2.522 | $(s1 \rightarrow s1)$ | | 0.366 | 0.329 |
| 2.721 | $2^-$ | | 2.718 | $\geq 1$ | | | | | | |
| 3.129 | $1^+$ | 1.369(95)[c] | 3.129 | 0 | 1.369(95)[c] | 3.250 | $(d5 \rightarrow d3)$ | $+(d3 \rightarrow d3)$ | 1.356 | 1.356 |

[a]From Ref. [5].
[b]Values are normalized by the $B$(GT) value (= 1.356) of the 3.250 MeV shell-model state.
[c]$B$(GT) value used for the calibration of the ($^3$He,$t$) values.

## References

[1] E.K. Warburton and B.A. Brown, Phys. Rev. C **46**, 923 (1992).
[2] B.A. Brown *et al.*, NSCL rep. No. 524, and B.A. Brown, private communication.
[3] B.A. Brown and B.H. Wildenthal, At. Data Nucl. Data Tables **33**, 347 (1985).
[4] R.G.T. Zegers *et al.*, Phys. Rev. Lett. **90**, 202501 (2003).
[5] P.M. Endt and R.B. Firestone, Nucl. Phys. **A633**, 1 (1998).