Gamow-Teller strengths in $A = 34$ isobars (I)
- comparison of $T_z = \pm 1 \rightarrow 0$ mirror transitions -

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Charge-exchange (CE) reactions, in particular, those performed at angles around 0° and intermediate beam energies ($E_p > 100$ MeV) were shown to be good probes of GT transition strengths, owing to the relatively simple proportionality between the cross sections at 0° and the B(GT) values [1],

$$\frac{d\sigma_{\rm CE}}{d\Omega}(0^\circ) \simeq K N_{\sigma\tau} |J_{\sigma\tau}(0)|^2 B({\rm GT}) = \hat{\sigma}^{\rm GT}(0^\circ) B({\rm GT}), \quad (1)$$

where $J_{\sigma\tau}(0)$ is the volume integral of the effective interaction $V_{\sigma\tau}$ at momentum transfer $q = 0$, K is a kinematic factor, $N_{\sigma\tau}$ is a distortion factor, and $\hat{\sigma}^{\rm GT}(0^\circ)$ is a unit cross section for the GT transition at 0°.

Under the assumption that isospin T is a good quantum number, an analogous structure is expected for nuclei with the same mass A but with different T_z, i.e., isobars, where T_z is the z component of isospin T defined by $T_z = (N - Z)/2$. The corresponding states in isobars are called analog states and are expected to have the same nuclear structure. Various transitions connecting corresponding analog states are called analogous transitions and have corresponding strengths. The validity of the approximate proportionality of Eq. (1) can be examined when multiple analogous transitions are studied in both the CE reaction and the β decay [2, 3, 4].

In the β^--type CE reaction $(^3{\rm He}, t)$ at intermediate beam energies, precise beam matching techniques were applied [5]. In the $^{34}{\rm S}(^3{\rm He}, t)^{34}{\rm Cl}$ experiment, a resolution of 21 keV has been achieved (see Fig. 1). This high energy-resolution allows to study the transition strengths to individual GT states. These transition strengths can be compared directly with those of isospin analogous transitions that are studied in the mirror ^{34}Ar β^+ decay as shown in Fig. 2.

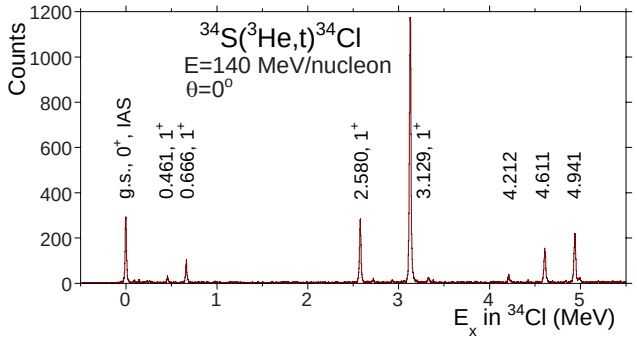

Figure 1: The $^{34}{\rm S}(^3{\rm He}, t)^{34}{\rm Cl}$ spectrum for events with scattering angles $\Theta \leq 0.5°$. GT states are indicated by their excitation energies in MeV.

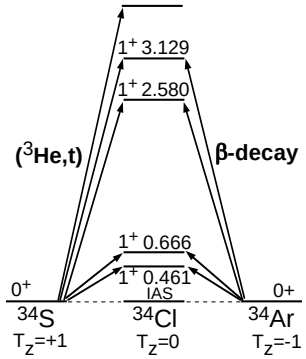

Figure 2: Schematic view of the isospin analogous transitions from the $T_z = \pm 1$ nuclei to the $T_z = 0$ nucleus in the $A = 34$ isobar system. The Coulomb displacement energies have been subtracted.

The B(GT) values were deduced for these GT states by using the β-decay B(GT) value of the strongly excited 3.129 MeV state as a normalization standard. A good proportionality was observed for the strongly excited states at 2.580 and 3.129 MeV. The 0.666 MeV state showed a normal $L = 0$ angular distribution. However, the B(GT) value of 0.091 obtained in the $(^3{\rm He}, t)$ reaction was 40% larger than that of the β-decay (see Table 1 of the following article). As is discussed in the following contribution, the Tτ interaction is suggested to be the source of such enhancement.

References

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