Analogous Gamow-Teller Transitions Observed in ^{26}Mg(^{3}He, t)^{26}Al Reaction and ^{26}Si $\rightarrow^{26}$Al β-decay

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The $T_z = 1 \rightarrow 0$ GT transitions up to $E_x = 9$ MeV were studied using ^{26}Mg(^{3}He, t)^{26}Al reaction at 0°. The obtained B(GT) values are compared with those of the isospin symmetric $T_z = -1 \rightarrow 0$ GT transitions from ^{26}Si β decay, and a shell-model calculation.

The ^{26}Mg(^{3}He, t) experiment was performed at RCNP, Osaka by using a 140 MeV/nucleon ^{3}He beam from the $K = 400$ RCNP Ring Cyclotron and the Grand Raiden spectrometer placed at 0°. The target was a 0.87 mg/cm^2 foil of ^{26}Mg. A resolution far better than the momentum spread of the beam was realized by applying the *dispersion-matching technique* [1]. Using the high-resolution "WS" course [2] for the beam transportation and the "faint beam method" to diagnose the matching conditions [3, 4], an energy resolution of 45 keV (FWHM) was achieved. With the improvement of resolution, states of ^{26}Al were clearly resolved as shown in Fig. 1. Good angular resolutions in x and y directions were achieved, respectively, by applying the *angular dispersion-matching technique* and by realizing the "over-focus mode" in the spectrometer [5]. The "0° spectrum" in Fig. 1 shows events within the scattering angle $\leq 0.8°$.

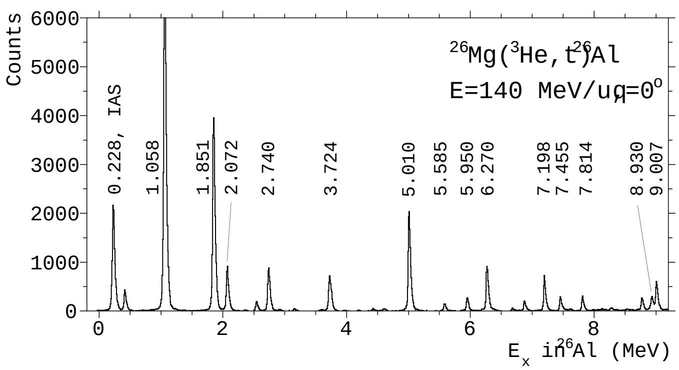

Figure 1: The low-excitation region of the 0°, ^{26}Mg(^{3}He, t). The major GT states are indicated by their excitation energies.

It is known that in CE reactions at 0° the cross sections for GT transitions are approximately proportional to B(GT) values [6]:

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

where $J_{\sigma\tau}(0)$ is the volume integral of the effective interaction $V_{\sigma\tau}$ at momentum transfer $q = 0$, K is the kinematic factor, and $N_{\sigma\tau}$ is a distortion factor. For (^{3}He, t) reactions, it was shown that the proportionality was valid for transitions with $B(\rm GT) \geq 0.04$ from the study of analogous transitions in the $A = 27$, $T = 1/2$ mirror nuclei ^{27}Al and ^{27}Si [7].

In order to obtain B(GT) values by using Eq. (1), a standard B(GT) value is needed. Isospin-symmetric partners of the GT transitions observed in the ^{26}Mg(^{3}He, t)^{26}Al can be studied from the ^{26}Si β decay (see Ref. [8]). The B(GT) values were obtained by using the relationship [9],

$$\left(\frac{g_A}{g_V}\right)^2 B(\mathrm{GT}) = \frac{6145 \pm 4}{f(1+\delta_R)t}. \qquad (2)$$

The f values including the radiative correction $(1+\delta_R)$ were calculated using the tables of Wilkinson and Macefield [10]. The B(GT) values for these four states, calculated by using the ratio $(g_A/g_V) = 1.266 \pm 0.004$ [9], are shown in Fig. 2(a).

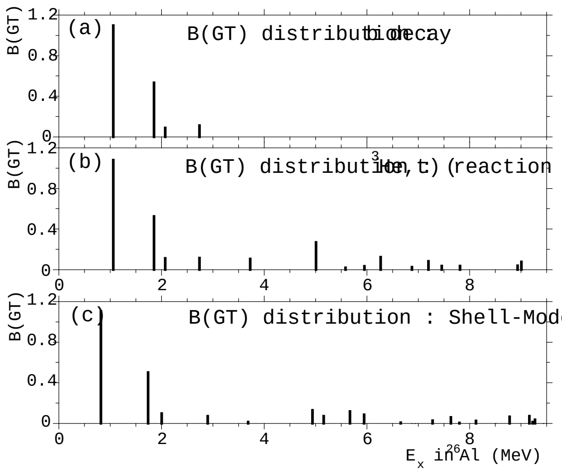

Figure 2: Experimental and shell-model B(GT) distributions. (a) B(GT) distribution from the β decay measurements of ^{26}Si. (b) B(GT) distribution from the present ^{26}Mg(^{3}He,t)^{26}Al reaction. (c) B(GT) distribution from a shell-model calculation.

Four available B(GT) values from the β decay of ^{26}Si were used in order to determine the "unit intensity" of the analogous transitions in the ^{26}Mg(^{3}He, t) reaction. By using one "unit intensity" a good agreement has been achieved for the corresponding B(GT) values in the β decay and the present (^{3}He, t) measurements, as is seen from the comparison of Figs. 2(a) and (b). It also shows that the analogous transitions are isospin symmetric and at the same time the proportionality given by Eq. (1) is valid. The B(GT) values for other excited states were calculated by using the same "unit intensity" from their peak intensities after making excitation-energy corrections.

The results of shell-model calculation using the USD interaction [11] are shown in Fig. 2(c). The calculated B(GT) distribution is generally in agreement with the experimental results.

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