Determination of the Gamow-Teller Quenching Factor via the ^{90}Zr(*n, p*) Reaction at 293 MeV

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Gamow-Teller (GT) resonances have been extensively studied since its discovery in 1975. The GT transition is characterized as spin-flip (ΔS = 1), isospin-flip (ΔT = 1) and no transfer of orbital angular momentum (ΔL = 0). There exists a model-independent sum rule, $s_{\beta^-} - s_{\beta^+} = 3(N - Z)$, where S_{β^-} and s_{β^+} are the GT strength of β^- and β^+ types, respectively [1]. Surprisingly, however, only a half of the GT sum rule value was identified from the (*p, n*) measurement on targets throughout the periodic table [2]. This problem, so-called the quenching of the GT strengths, has been one of the most interesting phenomena in nuclear physics because it is related to non-nucleonic (A-isobar) degrees of freedom in nuclei; the quenching factor sets a strong constraint on the Landau-Migdal parameters, g'_{NN} and $g'_{N\Delta}$, in the $\pi + p + g'$ model [3].

Recently, Wakasa et al. have measured the angular distribution of the double differential cross sections for the ^{90}Zr (*p, n*) reaction at 295 MeV. By performing rnultipole decomposition (MD) analysis, the GT strengths of $s_{\beta^-} = 28.0 \pm 1.6$ has been obtained in the continuum up to 50 MeV excitation in ^{90}Nb [4]. Determination of the Δ-isobar contribution to the GT sum rule, however, requires precise (*n, p*) cross-section data at the same energy. For this purpose we have constructed in an (*n, p*) facility at RCNP and measured the double differential cross sections for the ^{90}Zr (*n,p*) ^{90}Y reaction at 293 MeV.

We have obtained the differential cross sections up to 70 MeV excitation energy over an angular range of 0°-12° with a statistical accuracy of 1.7%/2 MeV.1° at l°-2°. Figure 1 shows the result of the MD analysis. After subtracting the contribution from the isovector spin monopole (IVSM) resonance observed at $E_x \approx$ 20 MeV with a width of ~ 10 MeV, we have obtained a total GT strength of $s_{\beta^+} = 3.0 \pm 0.3 \pm 0.8 \pm 0.5$ up to 31.4 MeV excitation where the errors are uncertainties of the MD analysis, the IVSM contribution, and the GT unit cross section.

By using the S_{β^-} value by Wakasa et al., the quenching factor Q, which is defined by $Q \equiv \frac{S_{\beta^-} - S_{\beta^+}}{3(N-Z}$, has been deduced to be $Q = 0.83 \pm 0.06$ in regard to Ikeda's sum rule value of 3(N - Z) = 30. Therefore, the quenching of the GT strength due to the ΔN^{-1} admixture into the l*p*l*h* GT state is significantly smaller than the quenching of ~50%, observed in the previous studies [2] where the GT strengths in the continuum are not taken into account. Then the Landau-Migdal parameters, $g'_{N\Delta}$ and g'_{NN}, have been determined from the quenching factor. The deduction by Suzuki and Sakai [31 in Chew-Low model leads to $g'_{NN} \simeq 0.6$ and $0.16 < g'_{N\Delta} < 0.35$ for $g'_{\Delta\Delta} = 0.6$

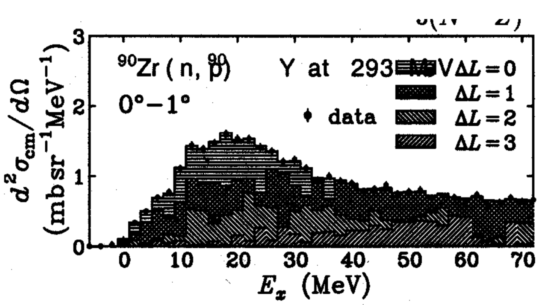

Figure 1: The result of MD analysis on the double differential cross sections for the ^{90}Zr$(n,p)^{90}$Y reaction at 293 MeV.

References

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