M1 Quenching Mechanism in ^{28}Si

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Missing strengths, called a quenching problem, in Gamow-Teller (GT) and $M1$ excitations has been one of interesting subjects in nuclear physics. Sophisticated experimental studies on GT resonances have revealed that a coupling with $2p$-$2h$ states is a main source of the quenching phenomenon, while a coupling with Δ-h states plays a minor role [1]. As for the $M1$ strengths, comparison of an amount of the quenching between isoscalar (ΔT=0, IS) and isovector (ΔT=1, IV) strengths is essential for understanding the quenching mechanism owing to the following reason. The $M1$ IS excitation has no contribution from a coupling with Δ-h states due to the isospin selection rule, while both couplings can occur in the IV one. Several (p,p') experiments were performed to study the $M1$ quenching [2] and their results are shown in Fig. 1 (A). It was claimed that $M1$ quenching was not observed since the results were scattered from unity, however, serious problems were still remaining. One was that their results had relatively large ambiguities, and the other was, this was the more important, that the IS quenching factors were smaller than the IV ones. Note that the IS factor is expected to be equal or larger than the IV one owing to the reason already mentioned.

We realized a ^{28}Si(p,p') measurement at E_p=295 MeV at zero-degrees with high resolution [3] in order to deduce reliable conclusions of $M1$ quenching. After several procedures for selecting $M1$ resonances [4], cumulative sums of B(σ) for both IS and IV transitions were compared with shell model calculation using the USD interaction with free g-factor (Fig. 1 (B), (C)). The result was again that the IS factor was smaller than the IV one (see Ref. [4]). Although effective g-factor [5] was used to include higher order configuration mixings, the IS factor was still quenched, while the IV one exceeded the unity. This result indicates that the Δ-hole admixture does not play an important role in the $M1$ excitations of ^{28}Si. Theories, however, cannot fully explain the fact that the IS factor was smaller.

We have a plan to measure all even-even N=Z sd-shell nuclei in order to observe separately spin-flip $M1$ IS and IV strengths. Systematic study is expected to explain the interesting result on $M1$ quenching.

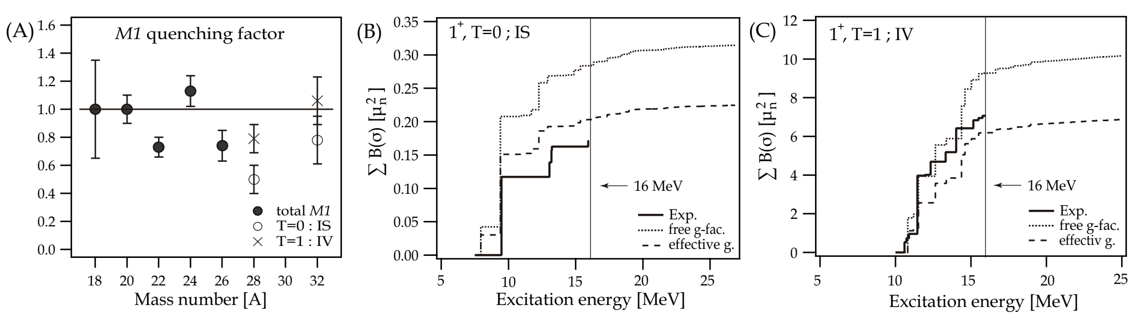

Figure 1: (A): Previous results of $M1$ quenching facotors [2]. (B),(C): Measured cumulative sums of B(σ) up to E_x=16 MeV are compared with shell model calculations with free g-factor (dotted) and effective one (dashed).

References

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