# Enhanced $0^+_{g.s.} \rightarrow 2^+_1$ E2 transition strength in $^{112}$Sn

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## Introduction

Numerous experimental and theoretical studies are currently focused on nuclear shell structure far from the line of stability [1 and references contained therein]. In particular, the evolution of nuclear properties, e.g. the reduced transition probabilities across the Z = 50 chain of tin isotopes has been examined in detail. This constitutes the longest shell-to-shell chain of semi-magic nuclei investigated in nuclear structure to date. The B(E2) values calculated from shell model for the even tin isotopes $^{102-130}$Sn show a parabola-like trend as a function of mass number (Fig.1), which resembles the typical behaviour of one body tensor operator across a shell in the seniority scheme.

Existing experimental data show an almost perfect agreement with this plot for the tin isotopes heavier than A= 114 [2, 3], i.e. only if at least half of the major shell N = 50 - 82 is filled. In the case of lighter stable tin isotopes, the reported $^{112}$Sn [4, 5] and $^{114}$Sn [6, 7] B(E2) values have higher yield than expected from the shell model calculations. So far, large experimental errors prohibit further theoretical interpretations. One main reason for these errors is that these experiments either have partially enriched targets, with uncertainities from the impurity of the target, or used the recoil distance Doppler-shift (RDDS) method which adds sizable errors for lifetimes lower than 1ps.

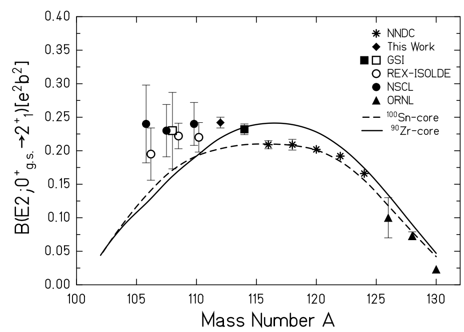


FIG. 1: Experimental $B(E2;\, 0^+_{g.s.} \rightarrow 2^+_1)$ values in even-even Sn isotopes. The present work is also shown.

## Experimental Details

The inaccurate $B(E2\uparrow)$ values in $^{112}$Sn and $^{114}$Sn motivated two Coulomb excitation experiments to improve these crucial data points. In a previous measurement, the $B(E2\uparrow)$ value of $^{114}$Sn was determined at GSI [8]. The result showed an unexpected enhancement relative to the $B(E2\uparrow)$ of $^{116}$Sn. The present experiment was performed at the Inter University Accelerator Centre (IUAC) in New Delhi. Two targets of ~0.53 mg/cm$^2$

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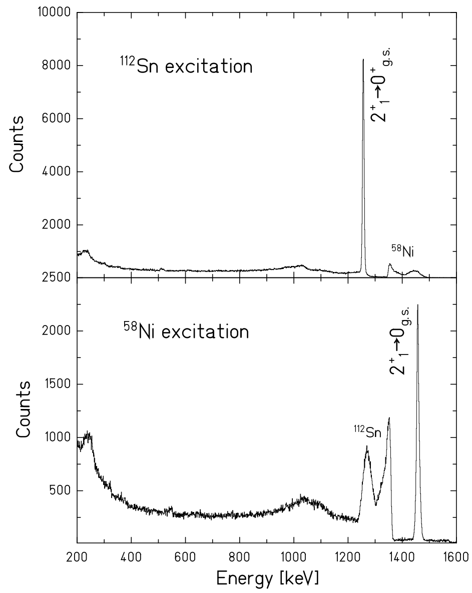


FIG. 2: Doppler corrected $\gamma$-ray spectra emitted from the $^{112}$Sn target nuclei (top) and the $^{58}$Ni projectiles (bottom)

$^{112}$Sn (99.5 % enriched) and $^{116}$Sn (98 % enriched) were bombarded with $^{58}$Ni ions at an incident energy of 175 MeV, which is well below the Coulomb barrier to ensure pure electromagnetic interaction. In two consecutive experiments the relative excitation strengths of the $2^+$ state in $^{112}$Sn and $^{116}$Sn was determined, with the first excited $2^+$ state in $^{58}$Ni used for normalisation.

The scattered beam was detected by a position sensitive annular gas-filled parallel plate avalanche counter (PPAC) detector subtending the angular range $15° \leq \vartheta_{lab} \leq 45°$ in the forward direction and the de-excitation $\gamma$ rays were detected in 4 clover detectors mounted at $\vartheta_\gamma \sim 135°$ with respect to the beam direction.

## Results

A Doppler shift correction were performed for each Clover detector ($\vartheta_\gamma$,$\varphi_\gamma$) event-by-event. Figure 2 shows the Doppler corrected spectra for $^{112}$Sn excitation (top) and $^{58}$Ni excitation (bottom) . From the observation of the Doppler corrected $\gamma$-ray lines corresponding to the $2^+_1 \to 0^+_{g.s.}$ transitions, the target and projectile excitation can be extracted. The Coulomb excitation calculations were performed with the Winther-de Boer COULEX code [9]. The $\gamma$-ray decay was calculated taking into account the particle-$\gamma$ angular correlation, the internal conversion and the finite geometry of the $\gamma$- detector. The $0^+_{g.s.} \to 2^+_1$ matrix element in $^{112}$Sn was adjusted in the COULEX calculations to reproduce the experimental double ratio. The resulting $B(E2\uparrow)$ value in $^{112}$Sn is 0.242(8) e$^2$b$^2$. This is significantly higher than the value [10] obtained from DSAM measurements. The present measurements support the deviation trend of the lighter Sn isotopes [11] from the predictions of large basis shell model calculations. The observed increase in BE2 value for lighter Sn isotopes can be explained in the frame work of relativistic quasiparticle random-phase approximation (RQRPA) calculations [12].

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