Intermediate-energy Coulomb excitation of $^{104}$Sn: Moderate $E2$ strength decrease approaching $^{100}$Sn†

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In recent years, several experimental findings generated a large interest regarding the $E2$ strength pattern in the tin isotopes. While the neutron-rich isotopes with $A = 126, 128, 130$ follow the anticipated trend of smoothly decreasing $B(E2)$ values towards the major shell closure well described by large-scale shell-model (LSSM) calculations1,2, the proton-rich nuclei take a different path. Commencing with the stable $A = 114$ isotope a steadily growing deviation from the shell-model expectation was observed with almost constant $B(E2)$ values for the $A = 106 - 112$ isotopes1,3,4,5. A first attempt for $^{104}$Sn with limited statistics has recently been made5. The result of 0.10(4) $e^2b^2$ indicates a steep decrease of excitation strength in agreement with LSSM calculations. In a second measurement, a considerably larger value of 0.180(37) $e^2b^2$ was obtained5. Here, we report on the first $B(E2)$ extraction of $^{104}$Sn from absolute Coulomb excitation cross-sections at intermediate energies.

A $^{124}$Xe primary beam was accelerated up to an energy of 345 MeV/nucleon and impinged on a 3 mm thick Be production target at the F0 focus of the BigRIPS fragment separator9. The $B(\rho - \Delta E - B\rho$) method was applied to select and purify secondary beams of $^{104}$Sn and $^{112}$Sn in two subsequent measurements. The secondary beams were transported to the focal point F8, where a 557 mg/cm² thick Pb target was inserted to induce Coulomb excitation reactions. To detect $\gamma$-rays from the $^{2}_{1}^{+} \rightarrow ^{0}_{2}^{+}$ transitions, the reaction target was surrounded by the DALI2 array7. Reaction products were identified behind the reaction target by the ZeroDegree spectrometer1.

A $B(E2)$ value of 0.173(28) $e^2b^2$ was deduced for $^{104}$Sn. The run with $^{112}$Sn, which has a known $B(E2)$† value, was used for feeding estimations. Our result is in agreement with the 0.180(37) $e^2b^2$ obtained in Ref.5 with largely overlapping error bars, but deviates significantly from the value of 0.10(4) $e^2b^2$ obtained in Ref.5. The drop in excitation strength is much smoother than suggested in Ref.5 and cannot be reproduced by present LSSM calculations using standard effective charges as well as proton and neutron excitation across the $N = Z = 50$ shell.

Fig. 1. Doppler corrected $\gamma$-ray spectra of $^{112}$Sn (top panel a) and $^{104}$Sn (bottom panel b). The observed $2_{1}^{+} \rightarrow 0_{2}^{+}$ transitions are compared to simulations.

References