Spin and Parity Assignment of ^{120}Sn Levels via Homologous States

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The $(\vec{\mathrm{p}},\alpha)$ reaction on nuclei around closed or semiclosed shells reveals several properties that make it a useful spectroscopic tool for supplementing level structure information obtained by other charged particle reactions.

In order to complete the spectroscopic study of ^{120}Sn, a high resolution experiment [1] was carried out with a 24 MeV polarized proton beam of the Munich MP Tandem accelerator, using the new Stern-Gerlach source [2], the Q3D magnetic spectrograph and the new focal plane detector [3]. The reaction $^{123}\mathrm{Sb}(\vec{\mathrm{p}},\alpha)^{120}\mathrm{Sn}$ is now compared with $^{122}\mathrm{Sn}(\vec{\mathrm{p}},\alpha)^{119}\mathrm{In}$ [4].

High resolution and very low background allowed to study 61 transitions to final states of ^{120}Sn up to an excitation energy of $\sim$4700 keV with a precision of $\pm$3 keV. This lead to a remarkable increase of the knowledge of the ^{120}Sn nucleus, because for 19 new levels energy, spin, and parity could be determined; to 16 levels spin and parity values have been assigned, while unique parity has been assigned to 11 levels. Multiplets of states of ^{120}Sn homologous to the low lying states of ^{119}In have been identified. In particular we found the octet of states [1^+, 2^+, 3^+, 4^+, 5^+, 6^+ (fragmented in two levels), 7^+, 8^+] homologous to the G.S. ($9/2^+$) of ^{119}In, the doublet of states [3^- (fragmented in three levels), 4^-] homologous to the 0.311 MeV $1/2^-$ level of ^{119}In, the quadruplet of states [2^-, 3^-, 4^-, 5^- (fragmented in four levels)] homologous to the 0.604 MeV $3/2^-$ level of ^{119}In, and the sextet of states [1^-, 2^-, 3^-, 4^-, 5^- 6^- (fragmented in four levels)] homologous to the 1.044 MeV $5/2^-$ level of ^{119}In.

In case of weak coupling the cross section of a homologous state with spin J_i, in a given multiplet can be related to that of the corresponding parent state by the following expression:

$$\sigma_{\mathrm{daughter}}(^{120}\mathrm{Sn}, J_i) = \frac{(2J_i+1)\sigma_{\mathrm{parent}}(^{119}\mathrm{In})}{\Sigma_i(2J_i+1)}.$$

In Fig. 1 the quantities $\frac{\sigma_{\mathrm{daughter}}(^{120}\mathrm{Sn},J_i)}{\sigma_{\mathrm{parent}}(^{119}\mathrm{In})}\Sigma_i(2J_i+1)$ are reported for each member of the multiplet vs. J_i, together with the straight $(2J_i+1)$ line. The satisfactory agreement between experimental data and the prediction of the weak coupling model supports the spin and parity assignment of the ^{120}Sn homologous levels.

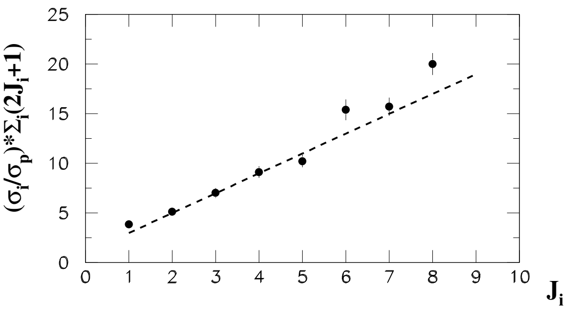

Fig. 1: The experimental quantities $\frac{\sigma_{\mathrm{daughter}}(^{120}\mathrm{Sn},J_i)}{\sigma_{\mathrm{parent}}(^{119}\mathrm{In})}\Sigma_i(2J_i+1)$ (dots) are reported for each member of the multiplet vs. J_i, together with the straight $(2J_i+1)$ line (dashed line).

In Fig. 2 the comparison between the measured $\sigma(\theta)$ and $\mathrm{A}_y(\theta)$ for the transitions to the multiplet of ^{120}Sn states (dots) homologous to the G.S. of ^{119}In and the measured ones for the transition to the G.S. of ^{119}In is shown. In the same figure the cumulative cross section and asymmetry for the octet of levels (dots) homologous to the G.S. of ^{119}In are compared with cross section and asymmetry for the transition to the G.S. of ^{119}In. It is possible to observe the good agreement both in shape and absolute value.

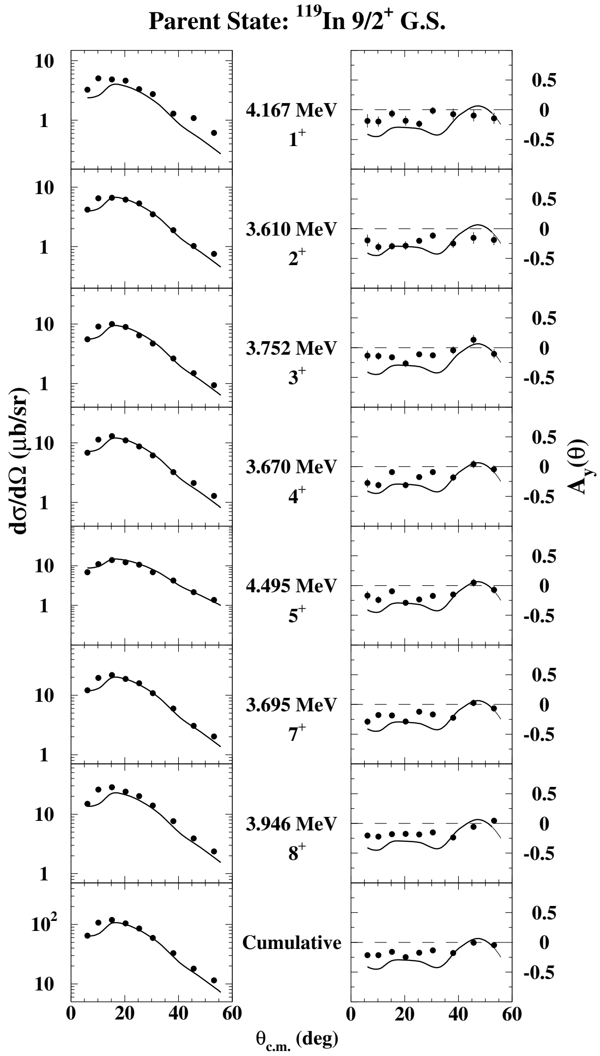

Fig. 2: Comparison between the measured $\sigma(\theta)$ and $\mathrm{A}_y(\theta)$ (dots) for the transitions to the multiplet of ^{120}Sn states (dots) homologous to the G.S. of ^{119}In and the measured ones for the transition to the G.S. of ^{119}In (solid line), together with the experimental cumulative cross section and asymmetry for the octet of levels (dots) homologous to the G.S. of ^{119}In and the experimental cross section and asymmetry for the transition to the G.S. of ^{119}In (solid line).

References

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