^{123}Sb($\vec{\mathrm{p}}$,α)^{120}Sn: Microscopic DWBA Calculations

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For the (p,α) reactions on target nuclei having only one proton outside a completely filled magic shell it is possible to recognize in the energy spectra two different regions, shown in Fig. 1. For the α-spectrum of the ^{123}Sb($\vec{\mathrm{p}}$,α)^{120}Sn reaction measured at $\theta_{\mathrm{lab}} = 10°$ the homologous region ($E_{\mathrm{exc}} > 3.6$ MeV) is intensively populated, while the low excitation energy region is poorly populated by the pickup of the $1g_{7/2}$ spectator proton together with a neutron pair. The configuration of the homologous states results from the coupling of the spectator proton (not involved in the process) with the one-proton-hole–two-neutron-hole states of the ^{119}In core.

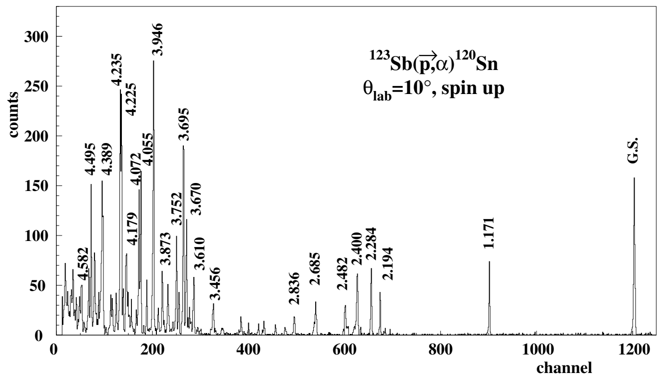

Fig. 1: α-spectrum of the ^{123}Sb($\vec{\mathrm{p}}$,α)^{120}Sn reaction. Numbers: ^{120}Sn excitation energies in MeV.

To carry out microscopic DWBA calculations of the angular distributions of cross sections and asymmetries for the transitions to the ^{120}Sn 0^+ G.S. (not homologous state) and to the octet of states homologous to the ^{119}In $9/2^+$ G.S., the ^{123}Sb G.S. is taken to be a $1g_{7/2}$ proton outside filled proton shells, whereas the 22 valence neutrons move in the $1g_{7/2}$, $2d_{5/2}$, $2d_{3/2}$ and $1h_{11/2}$ shells. These neutrons interact via a neutron-neutron pairing force, which spreads the neutrons over the valence shells, with a total neutron angular momentum of zero. In this same picture, the ^{120}Sn G.S. consists of filled proton shells, with 20 valence neutrons. Thus the pickup reaction involves the transfer of a $1g_{7/2}$ proton, and $1g_{7/2}$, $2d_{5/2}$, $2d_{3/2}$ and $1h_{11/2}$ neutron pairs. Since the assumed interaction is between the incident proton and the mass-center of the three transferred nucleons, it cannot change the relative motion of the three transferred nucleons. Thus we project from shell-model states such as [$1g_{7/2}$($2d_{5/2}$,$2d_{5/2}$)], the part in which the three nucleons have the same relative motion as they will have in the outgoing alpha particle. This is done for each of the possible triples of shell-model states that can connect the initial and final states, and then a coherent sum must be taken to obtain the total transfer form factor.

For the population of the homologous states, one removes a $1g_{7/2}$ proton, as well as a neutron pair. In this way one can reach states with total angular momenta $J = 1, 2, ..., 8$, which consist of a $1g_{7/2}$ proton coupled to a $1g_{9/2}$ proton hole. The form factor is the same for each value of J, except for a factor of $(2J+1)^{1/2}$. Thus apart from Q-value effects, the calculated angular distributions for each of the $J = 1, 2, ..., 8$ final states will be the same, with a $2J+1$ factor of proportionality.

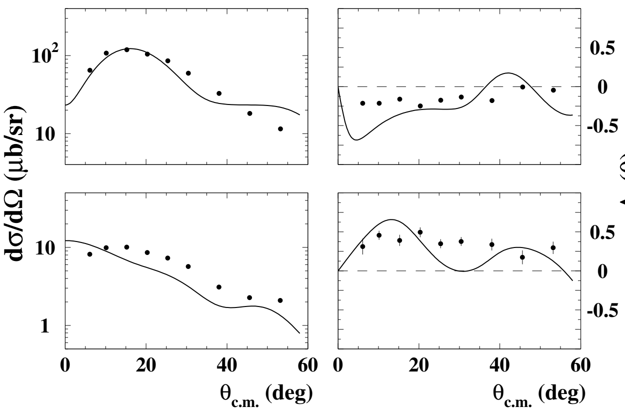

Fig. 2: Comparison between experimental and microscopically calculated angular distributions of $\sigma(\theta)$ and A_y (θ) for the transition to the ^{120}Sn 0^+ G.S. (top) and for the cumulative angular distributions of the ^{119}In G.S. homologous multiplet (bottom).

Fig. 2 shows the comparison between experimental and microscopically calculated angular distributions of cross section and asymmetry for the transition to the ^{120}Sn 0^+ G.S. (top) together with the cumulative angular distributions for the ^{119}In G.S. homologous multiplet (bottom). The calculations were done in finite range approximation with the previously described microscopic configurations. The optical model parameters for the proton entrance channel and for the alpha exit channel are reported in Ref. [1]. The overall multiplicative factor, used to give a reasonable fit to the experimental data, is the same for the cumulative and the G.S. cross sections.

References

[1] P. Guazzoni *et al.*, Annual report 2001, p. 11