Microscopic DWBA Calculations of the ^{120}Sn Homologous States Populated via $(\vec{p},\alpha)$ Reactions

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Microscopic DWBA calculations of the angular distributions of cross sections and asymmetries for the transitions to the ^{120}Sn 0^+ ground state (not homologous) and to the octet of states homologous to the ^{119}In $9/2^+$ ground state have been previously presented [1] in a study of ^{123}Sb$(\vec{p},\alpha)$

The ^{123}Sb ground state is represented by a $1g_{7/2}$ proton outside the Z=50 major proton shell closure. The 22 neutrons outside the N=50 major neutron shell closure are assumed to move in the $1g_{7/2}$, $2d_{5/2}$, $2d_{3/2}$, $3s_{1/2}$, and $1g_{7/2}$ shells. We have performed a shell-model study of the motion of these neutrons, using a realistic interaction derived from the CD-Bonn nucleon-nucleon potential. The model space has been truncated to states with seniority less than or equal to 4 [2]. Our major assumption is that the $1g_{7/2}$ proton can be regarded as a spectator outside a stable ^{122}Sn ground-state core.

If the $(\vec{p},\alpha)$ reaction removes the $1g_{7/2}$ proton, the resulting ^{120}Sn nucleus is, in this picture, a Z=50 proton closed-shell core, plus 20 neutrons outside the N=50 major neutron shell. We have also done a shell-model study of the 20-neutron system. These states of ^{120}Sn represent the non-homologous states. However, if the $(\vec{p},\alpha)$ reaction removes a proton from the filled $1g_{9/2}$, $2f_{5/2}$, $2p_{3/2}$, $2p_{1/2}$, or $1f_{7/2}$ shells, the residual ^{120}Sn nucleus has a $1g_{7/2}(\mathrm{nlj})^{-1}$ proton configuration. If we assume the neutrons retain their 0^+ ground-state configuration, then the states populated in this way can be regarded as a $1g_{7/2}$ proton coupled to an $(\mathrm{nlj})^{-1}$ proton hole state in ^{119}In. We refer to these states as homologous states. In the case of $1g_{9/2}$ proton pickup, for example, the result is a $1g_{7/2}(1g_{9/2})^{-1}$ proton configuration, which gives rise to even-parity levels with angular momenta J_f=1,2,3,4,5,6,7, and 8. Similarly, if a $2p_{3/2}$ proton is removed, the result is the proton configuration $1g_{7/2}(2p_{3/2})^{-1}$, which give rise to odd-parity levels with angular momenta J_f=2,3,4 and 5.

The calculation of the $(\vec{p},\alpha)$ transfer amplitude requires evaluation of the overlap between the relative motion of the transferred nucleons in their shell model orbitals, and their relative motion in the outgoing α-particle. The theory has been described in [3]. The result of this analysis is that the shape of the transfer form-factor is the same for all the J_f levels associated with a given $1g_{7/2}(\mathrm{nlj})^{-1}$ proton configuration, but the amplitude of the J_f level is proportional to $(2J_f+1)^{-1/2}$. Thus, apart from Q-value effects, the angular distributions for these levels should be the same, and their cross-sections should be proportional to $(2J_f+1)$. For the families of levels based on the $1g_{7/2}(1g_{9/2})^{-1}$, $1g_{7/2}(2p_{1/2})^{-1}$, $1g_{7/2}(1f_{5/2})^{-1}$, and $1g_{7/2}(2p_{3/2})^{-1}$ proton configurations, cumulative cross section and asymmetry angular distribution are shown in fig. 1. The overall multiplicative factor, used to give a reasonable fit to the experimental data, is the same for all the cumulative cross sections, i.e. the same used also to fit the ^{120}Sn G.S. cross section and the cumulative cross section of the multiplet of ^{120}Sn states homologous to the ^{119}In G.S. [1].

References

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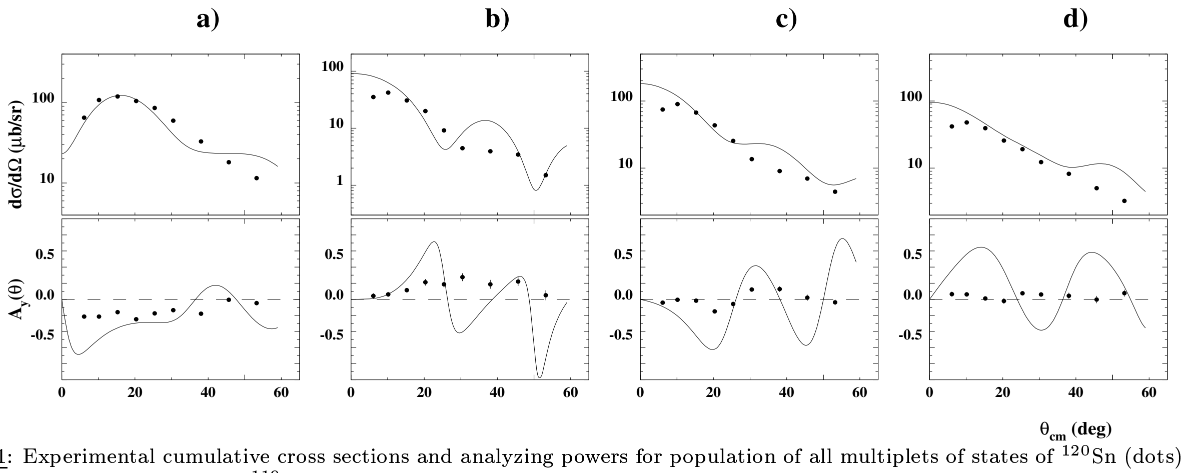

Fig. 1: Experimental cumulative cross sections and analyzing powers for population of all multiplets of states of ^{120}Sn (dots) homologous to the low-lying parent states of ^{119}In, including the fragmented level contributions, are compared with the results of microscoic calculations (solid lines): a) for the multiplet homologous to the ^{119}In G.S., $1g_{7/2}(1g_{9/2})^{-1}$; b) for the multiplet homologous to the ^{119}In 0.311 MeV level, $1g_{7/2}(2p_{1/2})^{-1}$; c) for the multiplet homologous to the ^{119}In 0.604 MeV level, $1g_{7/2}(2p_{3/2})^{-1}$; d) for the multiplet homologous to the ^{119}In 1.044 MeV level, $1g_{7/2}(1f_{5/2})^{-1}$.