^{112}Sn(p,t)^{110}Sn: Microscopic DWBA Calculations

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In connection with the experimental work [1], we have performed preliminary shell-model calculations of cross section angular distributions for the ground state and first 2^+ excited state of ^{110}Sn.

The microscopic calculation of the (p,t) transfer has been done with the reaction code TWOFNR [2].

The shell-model description of the pair of transferred neutrons is

$$\sum_{n_1,\ell_1,j_1;n_2,\ell_2,j_2} S^J_{n_1,\ell_1,j_1;n_2,\ell_2,j_2} \left\{ \begin{array}{l} \frac{\left[\psi^{n_1,\ell_1,j_1}(\mathbf{r}_1,\sigma_1)\psi^{n_2,\ell_2,j_2}(\mathbf{r}_2,\sigma_2)\right]^J_M}{2(1+\delta_{n_1,n_2}\delta_{\ell_1,\ell_2}\delta_{j_1,j_2})} \\ -\ \frac{\left[\psi^{n_1,\ell_1,j_1}(\mathbf{r}_2,\sigma_2)\psi^{n_2,\ell_2,j_2}(\mathbf{r}_1,\sigma_1)\right]^J_M}{2(1+\delta_{n_1,n_2}\delta_{\ell_1,\ell_2}\delta_{j_1,j_2})} \end{array} \right\} \qquad (1)$$

The spectroscopic amplitudes, $S^J_{n_1,\ell_1,j_1;n_2,\ell_2,j_2}$, are calculated from the target and residual nucleus wave-functions. To calculate the form-factor for the reaction, it is necessary to extract that part of the above two-neutron wave-function in which the neutrons have the same relative and spin wave function that they have in the outgoing triton. The (p,t) transfer calculation yields angular distributions, and relative cross section for different final states, but it is unable to predict absolute cross sections.

The ground states of ^{112}Sn and ^{110}Sn are described in term of 50 protons and 50 neutrons in filled shells, plus (N-50) active neutrons moving in the five single-particle (SP) orbits in the 50-82 shell. The SP energies are (in MeV) $\epsilon_{d_{5/2}} = 0.0$, $\epsilon_{g_{7/2}} = 0.05$, $\epsilon_{s_{1/2}} = 2.30$, $\epsilon_{d_{3/2}} = 2.45$, and $\epsilon_{h_{11/2}} = 3.25$. These active neutrons experience the shell model potential, and are assumed to interact via a pairing force. The Schrödinger equation is solved in the BCS approximation, and the spectroscopic amplitudes, calculated from the ^{112}Sn and ^{110}Sn zero quasi-particle states, are given in the following: $0g_{7/2}$ $0g_{7/2}$ 1.216; $1d_{5/2}$ $1d_{5/2}$ 1.070; $2s_{1/2}$ $2s_{1/2}$ 0.478; $1d_{3/2}$ $1d_{3/2}$ 0.642; $0h_{11/2}$ $0h_{11/2}$ -0.849.

The ^{110}Sn first excited 2^+ state is described as a mixture of the two-quasiparticle states that is favored by a quadrupole-quadrupole interaction. A random-phase-approximation calculation is performed, with the strength of the interaction taken to bring the predicted one-quadrupole-phonon state to its observed distance above the ground state (1.212 MeV).

The (p,t) spectroscopic amplitudes calculated from the ^{112}Sn zero-quasiparticle state and the one-quadrupole-phonon 2^+ state are the following: $0g_{7/2}$ $0g_{7/2}$ 0.505; $1d_{5/2}$ $0g_{7/2}$ -0.153; $1d_{5/2}$ $1d_{5/2}$ 0.365; $2s_{1/2}$ $1d_{5/2}$ 0.180; $1d_{3/2}$ $0g_{7/2}$ 0.155; $1d_{3/2}$ $1d_{5/2}$ 0.096; $1d_{3/2}$ $2s_{1/2}$ -0.196; $1d_{3/2}$ $1d_{3/2}$ -0.137; $0h_{11/2}$ $0h_{11/2}$ 0.167. These spectroscopic amplitudes are used in connection with a two-neutron-transfer code to calculate differential cross sections for the (p,t) population of the two lowest states of ^{110}Sn.

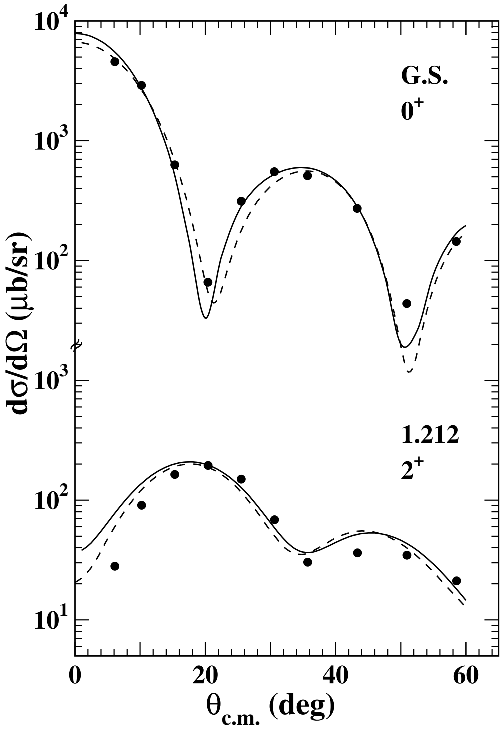

Fig. 1: Microscopic DWBA calculations (dashed lines) are compared with experimental (dots) and cluster (solid lines) DWBA results for 0^+ ground state and 2^+ 1.212 MeV level.

A fairly good agreement with the observed angular distributions is obtained in these very preliminary calculations, as shown in Fig.1. However the calculated cross section for this assumed quadrupole oscillation is too small relative to the ground state cross section, by a factor 4.7. This suggest that the 2^+ level exhibits a collectivity that is not well described by the simple quadrupole oscillation model.

References

[1] P. Guazzoni *et al.*, this report, p.13
[2] M. Igarashi, computer code TWOFNR (1977), unpublished