acta phys. slov. 25 (1975), No. 2—3

CONTRIBUTION OF DIRECT REACTIONS TO THE PRE-EQUILIBRIUM SPECTRUM OF THE NON-ELASTIC SCATTERING OF NUCLEONS[1]

ROLAND REIF,* Dresden

Relative cross sections to higher excited states are calculated in *DWBA* with form-factors constructed with statistical assumptions on the $1p1h$-component of the nuclear wave functions.

In non-elastic nucleon scattering, parts of the high energy tail of the spectrum should originate in processes during which the incident nucleon excites components of the target wave function of more and more complexity by successive scattering events and after-wards is emitted without being captured in the intermediate bound states (see also Ref. [7]). Starting from a multiple scattering expansion of the scattering operator [1] and neglecting interference terms, the cross section may be written as a sum of partial cross sections for the excitation of different n-exciton states. In a microscopic description the single scattering term gives the excitation of the $1p1h$-component $c_{ph}(I, E)$ of the higher excited target states $|IE>$. Assuming random phases of the coefficients c_{ph} and a distribution function [2]

$$|c_{ph}(I, E)|^2 = \frac{1}{\pi \varrho_c(I, E)} \frac{\Delta + \Gamma_{ph}(E)}{(E - \varepsilon_{ph})^2 + \frac{1}{4}(\Gamma_{ph}(E) + 2\Delta)^2} \tag{1}$$

for the squares of $c_{ph}(\varepsilon_{ph}$: undisturbed ph-energies, ϱ_c: density of states coupled to the $1ph$-component, $\Gamma_{ph}(E)$: spreading width of the simple ph-component), the *DWBA*-cross section averaged over an intervall Δ of the excitation energy is an incoherent super-position

$$\left\langle \frac{d\sigma}{d\Omega} \right\rangle_E = \sum_I \left\langle \frac{d\sigma(E, I)}{d\Omega} \right\rangle_E \varrho_c(E, I) \tag{2}$$

$$\left\langle \frac{d\sigma(E, I)}{d\Omega} \right\rangle_E = \sum_{ph} |c_{ph}(I, E)|^2 \sigma_{ph}(I, E, \Theta) \tag{3}$$

of cross sections σ_{ph} for the excitation of ph-pairs (including the angular momentum conservation).

[1] Contribution delivered at the International Symposium on Neutron Induced Reactions, September 2—6, 1974 at SMOLENICE, Czechoslovakia.

* Technical University Dresden, Department of Physics, Mommsenstrasse 13, 8027 DRESDEN, DDR.

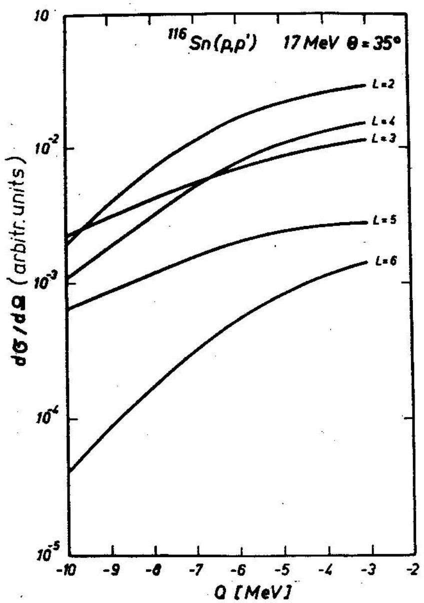

Fig. 1. Mean differential cross section $\sigma_{ph}(I, E)$ at $\Theta_{c.m.} = 35°$ in *DWBA* for different I-transfer in dependence on the excitation energy.

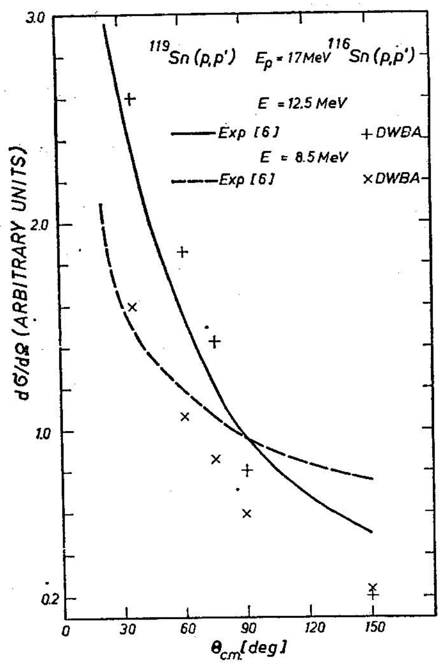

Fig. 3. Experimental and *DWBA* angular distribution for different excitation energies.

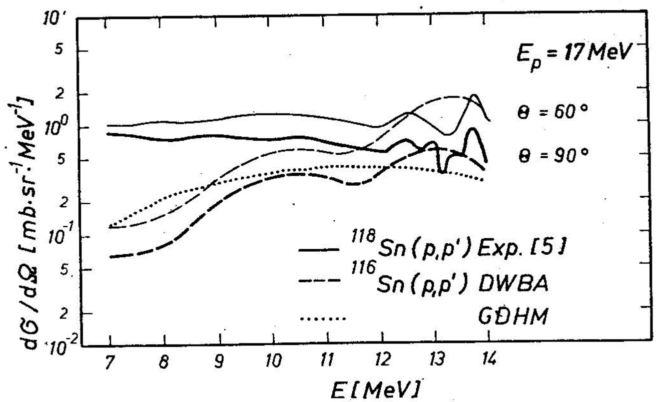

Fig. 2. Relative *DWBA* spectra ($\Delta = 0.5$ MeV, $\Gamma = 0.5$ MeV) compared with the $n = 3$ component of the pre-equilibrium spectrum from the geometry dependent hybrid model and the experimental data. The theoretical curves are normalized independently.

Calculations have been performed for the reaction $^{116}Sn(p, p')$, $E_p = 17$ MeV (for computational details and parameters see Ref. [3]). The dependence of the differential cross section on the Q-value can be seen in Fig. 1 for a different L-transfer. Relative spectra calculated according to Eqs. (1–3) (multipole orders from $I = 2$ up to $I = 6$, level density ϱ_c from Ref. [4]) are compared with experimental data for the reaction $^{118}Sn(p, p')$, $E_p = 17.8$ MeV [5] in Fig. 2. (Normalizing the effective interaction strength contained in σ_{ph} to the cross sections, collective 2^+ and 3^--transition of absolute spectra are obtained, too). The theoretical angular distributions are compared with the experimental results of $^{119}Sn(p, p')$, $E_p = 17$ MeV [6] in Fig. 3.

The calculated relative spectrum for a definite scattering angle resembles in shape the $n_0 = 3$ component of the pre-compound spectrum from the geometry dependent hybrid model with intranuclear transition rates from the optical model. The structure of the *DWBA*-curves is connected with the distribution of the quasiparticle energies. At about a 13 MeV excitation energy the peak comes mainly from the $I = 2$ transfer while in the broad bump at about 10 MeV $I = 3$ dominates. For higher excitation energies the transition strength is missing because of the neglect of higher multiple-scattering terms in the continuum as well as the re-emission from quasibound states. The calculated spectrum changes only slightly with the scattering angle. Compared with the experiment the theoretical angular distributions are too much forwardpeaked for regions of higher txcitation energies.

REFERENCES

[1] Rodberg L., *Intermediate Structure in Nuclear Reactions.* Univ. Kentucky Press, 1968.
[2] Jeukenne J. P., Mahaux C., Nucl. Phys. *A 136* (1969), 49.
[3] Iwe H., Reif R., Riedel C., Nucl. Phys. *A 183* (1972), 105.
[4] Soloviev V. G. et al., Nucl. Phys. *A 224* (1974), 411.
[5] Kalbach-Cline C. et al., Nucl. Phys. *A 222* (1974), 405.
[6] Degnan J. H. et al., Phys. Rev. *C 7* (1973), 316.
[7] Lewis M. B., Phys. Rev. *C 9* (1974), 1878.

Received October 18th, 1974