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Compound Nucleus Analyzing Power in $^{28}Si(\vec{p},p')$ Inelastic Scattering

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The differential cross section σ and differential analyzing power (AP) A for reactions with the $\overrightarrow{1/2} + J_1 \rightarrow J_2 + J_3$ spin structure may be put down in the following form

$$\sigma = a + b , \quad A = (a - b)/\sigma . \tag{1}$$

Correspondingly the partial cross sections (PCS) a and b are equal to

$$a = \sigma(1+A)/2 , \quad b = \sigma(1-A)/2 . \tag{2}$$

The energy averaged PCS $\langle a \rangle$ and $\langle b \rangle$ have the forms

$$\langle a \rangle = a_d + \langle a_{fl} \rangle , \langle b \rangle = b_d + \langle b_{fl} \rangle , \tag{3}$$

where a_d and b_d are the direct reaction PCS and $\langle a_{fl} \rangle$, $\langle b_{fl} \rangle$ are averaged compound nucleus (CN) ones. In order to determine the CN AP A_{CN} it is necessary to find and to compare $\langle a_{fl} \rangle$ and $\langle b_{fl} \rangle$.

Let us investigate, for example, A_{CN} in the $^{28}Si(\vec{p},p')$ proton inelastic scattering at E_p = 12-18 MeV, ϑ = 140° with excitation of the 4_1^+(4.61 MeV) level of ^{28}Si [1]. To obtain $\langle a_{fl} \rangle$ and $\langle b_{fl} \rangle$ we use the statistical correlation (SC) method [2]. Namely, after trend-reduction of the data by averaging over 650 keV interval [1] we study the correlation dependences of the $\langle r^2(y) \rangle$ variance for PCS a and b versus y. Histograms in Fig.1 have been drawn by taking, in analogy with [2], the number of sets y and r differed by energy shifts $e \leq 1$ MeV. The values of shifts have been choosen from the condition of uncorrelation between a(E) and a(E+e) as well as between b(E) and b(E+e) on the 10% level of the statistical accuracy. From Fig.1 it is seen that the correlation dependence $\langle r^2(y) \rangle$ for PCS a is considerably weaker than for PCS b. Hence, taking into account the equality (within 5% limit) of normalized variances (NV) of a and b (NVa = 0.107, NVb = 0.113) we arrive at the reliable inequality $y_d^a < y_d^b$. Here $y_d^a = a_d/\langle a \rangle$, $y_d^b = b_d/\langle b \rangle$. For averaged PCS the analysis gives (in relative units): $\langle a \rangle$ = 0.773, $\langle b \rangle$ = 0.573. Using the relations

$$\langle a_{fl} \rangle = (1-y_d^a) \langle a \rangle , \quad \langle b_{fl} \rangle = (1-y_d^b) \langle b \rangle , \tag{4}$$

we obtain for A_{CN} the lowest limit which corresponds to the equality $y_d^a = y_d^b$:

$$A_{CN} = (\langle a_{fl} \rangle - \langle b_{fl} \rangle)/(\langle a_{fl} \rangle + \langle b_{fl} \rangle) = 0.15 \tag{5}$$

For $y_d^a < y_d^b$ the value of A_{CN} can only increase. In addition, it is easy to make sure that not only $A_{CN} \neq 0$ but also $N_a \neq N_b$, where N_a and N_b are numbers of the independent channels for a and b PCS.

Thus, even the simplest SC analysis [2] reveals the deviations from Bohr's CN model: $A_{CN} \neq 0$ and $N_a \neq N_b$ [3]. It supports the predictions of the latest CN theories [4] that CN phases in the presence of direct reactions can be correlated. The consideration for $\vartheta = 160°$ as well as for the excitation of 2_1^+(1.78 MeV) level of ^{28}Si is not so obvious and will be published elsewhere.

Hence, the CN phase correlations in $^{28}Si(\vec{p},p')$ scattering were found to be strongly camouflaged. They were not discovered in channel-channel correlation analysis [1] nor in the statistical analysis of the correlation between AP and cross section [3] based completely on the randomness concept .

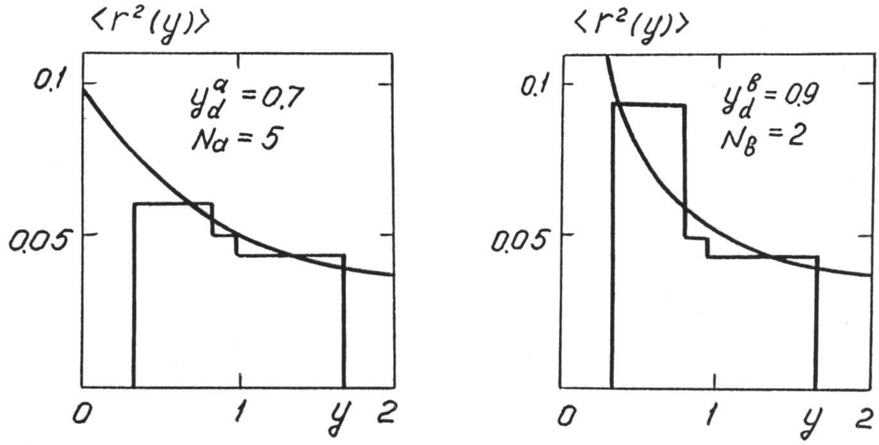

Fig. 1. Experimental (histograms) and calculated correlation dependences of $\langle r^2(y) \rangle$ variance versus y. Values y_d^a, y_d^b, N_a and N_b have been choosen by visual fiting.

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