Spectra processing in asymmetry experiments with *(n,p)* reactions

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Abstract. The experimental evaluation of the asymmetry effects in the *(n,p)* reactions are difficult because in the energy region where the effects have high values the cross section are small and in the region where the cross section is high the effects are very small. In both region the measurements are affected by a large background due in principal to the *(n,γ)* reaction. One of the first thing what is obtained from the experiment is the proton spectra (number of events per channel) and for this spectra is necessary to separate the measured effect from the background. As the protons are passing through a target with a finite thickness this separation becomes more complicated.

This work is an attempt to realize the separation of the effect from the background.

INTRODUCTION.

In our analysis we'll start with the case of the forward – backward (FB) asymmetry coefficient measurement in the $^{35}Cl(n,p)^{35}S$ with energy of the incident neutrons up to *1 keV* [1, 2]. The measurement of the FB effect is important because this coefficient together with left – right and parity non conservation coefficient (LR, PNC) allows us to extract the weak matrix element just from experimental data of the mentioned coefficients. The FB coefficient measurement was realized at the IBR30 reactor using the time of flight neutron spectroscopy and a double grid ionization chamber (IC) [3].

With the IC were obtained the spectra of protons exiting from a target with a finite thickness in some energetic interval for incident neutrons [1, 2, 4]. The cross section in the $^{35}Cl(n,p)^{35}S$ reaction has a value of a half of barn for thermal neutrons and is of order of *mb* or lower for *260 eV*. In the thermal region the asymmetry effects are of order of $10^{-3} – 10^{-4}$ and for neutron energy about *260 eV – 300 eV* the FB and LR effects are of order of tens of percents. In both case the measurements are difficult and affected by a gamma background. If in the case of the measurement of effects of order of tens percents, the separation between effect and background can be realized with certain errors when we deal with small effects the separation procedure must be accurate. By Monte Carlo the shape of proton spectra without background was simulated in the case of a target with finite thickness [4] but an analytical expression of the shape it wasn't found.

PROTONS SPECTRA.

For the experimental evaluation of the FB effect in the mentioned reaction were obtained experimental protons spectra for the following incident neutrons energy: *0.5-10 eV*, *10-60 eV*, *100-200 eV*, *150-260 eV* and the *P* resonance energy region (E_P*=398 eV*). We will not present all protons spectra because it is not necessary and we will stop to the spectra in the Figure 1 where we have the protons spectra for neutron energy interval *0.5-10 eV*. In this energy interval the searched effect is of order of 10^{-3}-10^{-3}, the cross section is quit high, of order of hundred of mb but exists a high background. In the Figure 1 we have two spectra, one for all forward direction and one for backward direction. From these spectra it is possible to observe that they are asymmetric and also the background is asymmetric for these two spectra. This will suggest us to introduce some new calculations for the extraction of the FB effect or for other types of asymmetry coefficients.

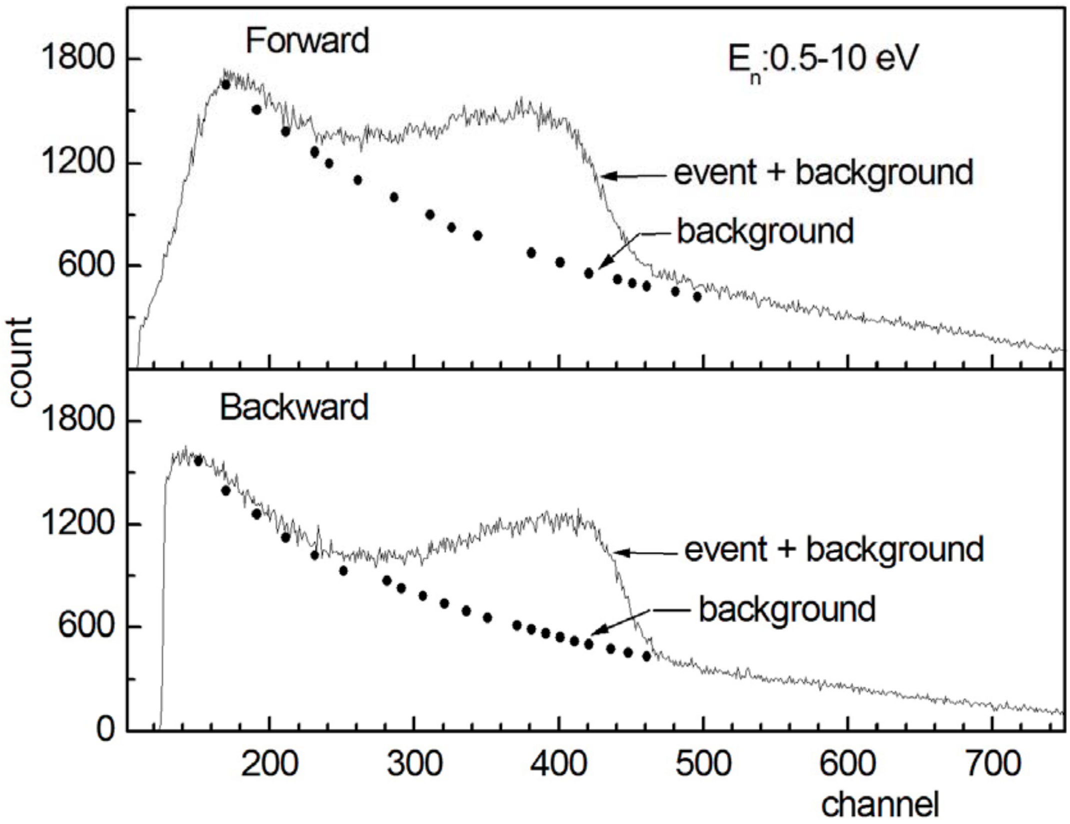

Fig. 1. The proton spectra for FB effects in the neutrons energy interval *0.5-10 eV*

In the Figure 1 the background it is extracted supposing that it has an exponential or polynomial form but not based on definite extraction procedure. In the following paragraph we will propose a way for the extraction of the FB or other effects measured with the experimental setup used by us [1,2].

FORMULAS.

The Figure 1 suggests that in the experiment of the FB measurements we measure the coefficient α containing the searched effect and the background.

$$\alpha = \frac{N_F^{e+b} - N_B^{e+b}}{N_F^{e+b} + N_B^{e+b}} \tag{1}$$

$$N_{F,B}^{e+b} = N_{F,b}^{e} + N_{F,B}^{b} \tag{2}$$

$N^{e+b}_{F,B}$ = the number of forward respectively backward events including the searched effect and the background.

$N^{e}_{F,B}$ = the number of the searched effect in the forward respectively backward direction.

$N^{b}_{F,B}$ = the number of the background in the forward respectively backward direction.

With these definitions lets transform expression (1) in a convenient way using the experimental FB effect.

$$\alpha^{\exp}_{FB} = \frac{N^e_F - N^e_B}{N^e_F + N^e_B} \qquad (3)$$

$\alpha^{\exp}_{FB}$ = the experimental FB asymmetry coefficient (the searched effect).

With these notations expression (1) becomes:

$$\alpha = \frac{\alpha^{\exp}_{FB} - \dfrac{N^b_F - N^b_B}{k\sigma_{np}}}{1 + \dfrac{N^b_F + N^b_B}{k\sigma_{np}}} \qquad (4)$$

$k\sigma_{np} = N^e_F + N^e_B$, k = constant

Relation (4) is very simple but gives us in principle a new possibility for the evaluation of the FB effect and analogous asymmetry coefficients.

DISCUSSIONS.

In expression (4) we are interested in $\alpha^{\exp}_{FB}$ and other terms of this expression in principal are known. The α coefficient is known by direct measurement. The background measurements can furnishes the number of background events in the forward and backward directions and the sum of the forward and backward events of the searched effect (e) is proportional with the cross section. The k coefficient it is a constant depending on the experimental setup. In conclusion, in spite of the fact that expression (4) is very simple some good measurements of the cross section and of the background allow to avoid the complicate procedure of the separation between background and useful effect.

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