BACKGROUND SUPPRESSION IN THE MEASUREMENT OF REACTIONS USING THE NEUTRON TAGGING TECHNIQUE ON THE NG-150 NEUTRON GENERATOR

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Precision experimental data on the differential cross sections for the interaction of fast neutrons with nuclei are in demand in both applied and fundamental research.

In 70-90 years these reactions were intensively studied, especially in the range of neutron energies $\mathrm{En}=13-15\mathrm{MeV}$, obtained by the reaction $\mathrm{T}+\mathrm{d}\rightarrow\mathrm{n}+\alpha$. However, the errors in determining the cross sections using the $\Delta\mathrm{E}-\mathrm{E}$ method were $\sim 15-20\%$, which are largely due to the significant value of background events in such experiments 1. The main sources of background events are the reactions $^{28}\ \mathrm{S(n,p)}^{28}\mathrm{Al}$, $^{28}\mathrm{Si(n,d)}^{27}\mathrm{Al}$ and detector into the telescope and the use of triple coincidences significantly reduces the probability of random coincidences from reactions occurring in each of the detectors. However, the registration of the reaction products that occurred in the first detector $\Delta\mathrm{E}$ (with a flight forward) or in the final E-detector of the telescope (with a flight backward) leads to real triple coincidences that form the background. To suppress it, we used the tagged neutron technique [2]. The principle of background suppression is illustrated in Fig. 1. Alpha particles arising from the interaction of a deuteron beam with a tritium-containing target are recorded at a backward angle by a semiconductor detector E_a in a certain solid angle Ω_a. In this case, a beam of neutrons labeled by registration of alpha particles flies forward in a corresponding solid angle Ω_n. The target under study is installed in an evacuated chamber on the axis of this beam. A telescope consisting of Si detectors $\Delta\mathrm{E}_1, \Delta\mathrm{E}_2$ and E can be installed at the required angles θ relative to the tagged neutron beam. In this case, the camera with the target and the telescope is obviously in the flux of fast (including untagged) neutrons generated in the tritium target of the neutron generator, so that background reactions occur in the target, and in all detectors and constructive elements (see neutron trajectories 1 and 2 in the figure).

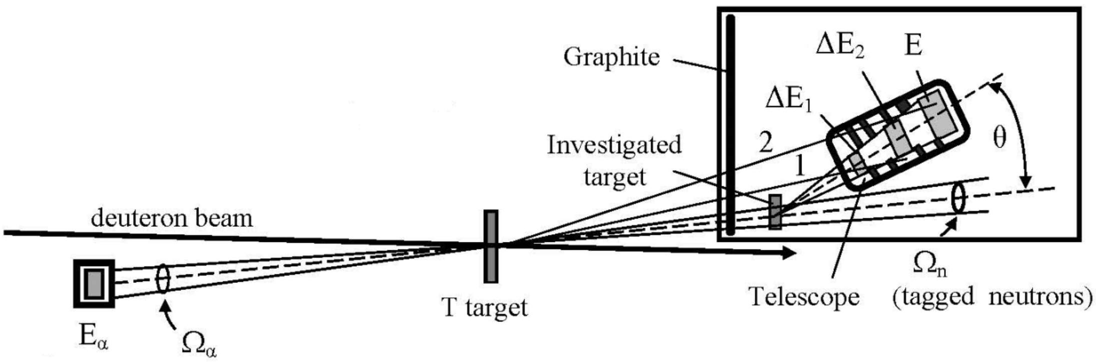

Figure 1: Measurement scheme with background suppression.

The degree of background suppression was experimentally estimated by measuring the background twodimensional $\Delta\mathrm{E2}-\mathrm{E}-$ spectra (in the absence of the target under study) on the NG-150 neutron generator of the INP AS RUz. The acquisition of events was controlled by a pulse coincidence signal from all four detectors (neutron tagging mode), and a pulse coincidence signal from only three telescope detectors. The telescope consisted of detectors with thicknesses $\mathrm{W}_{\Delta\mathrm{E1}}=60\mu\mathrm{m}, \mathrm{W}_{\Delta\mathrm{E2}}=75\mu\mathrm{m}$ and $\mathrm{W_E}=1200\mu\mathrm{m}$. According to preliminary estimates,
seeding by background events in the kinematically allowed registration region decreased several times when the tagged neutron mode was switched on.

If the registration of coinciding events in the telescope is allowed by the signal from the detector Eα, then all the reaction products arising outside the region of intersection of the tagged neutron beam with the target under study will not be registered. Of course, the reaction of background events will not be realized for small values of the angle θ, when the telescope aperture overlaps with the tagged neutron beam.

It is planned to use such a measurement mode to study reactions (n, d) on a number of light nuclei in order to obtain spectroscopic information necessary for nuclear astrophysical calculations.

References:

1. G. Paić, I. Slaus and P. Tomas, Nucl. Instr. & Meth. **34**, 40 (I965)
2. https://neutrontech.ru/index.php?id=about&content=method

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