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(n,γ) and (n,n'γ) - correlations in reaction of neutron inelastic scattering on 12C

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The knowledge about (n,γ) and (n,n'γ) correlations is very useful for understanding the process of inelastic neutron scattering and for estimation of the influence of the direct and compound nucleus (CN) mechanisms on the nuclear reaction. A detailed review of the CN approach is presented in [1], the direct mechanism is described in [2]. The formalism reported in [1] works quite well for low-energy particle scattering, but it fails to describe 14 MeV neutron scattering [3]. There are not too many experiments measuring (n,n'γ)-correlation with 14 MeV neutrons, and the largest part of them was carried out more than 40 years ago with rather poor accuracy [4,5]. In recent years (n,n'γ)-correlation in the reaction of inelastic neutron scattering on ^{12}C was measured in wide neutron energy range in work [6], but their results don't generally agree with previous experiments. Thus, it is interesting to obtain data on (n,n'γ)-correlation with small errors and higher angular resolution.

In Dubna, at the TANGRA setup, an experiment is being carried out to measure angular correlations (n, n'γ) in the inelastic scattering of neutrons with an energy of 14.1 MeV on ^{12}C using the tagged neutron method. We use 12 long (1 meter) plastic scintillation detectors with two PMTs. Ten of them are placed around the target in the plane of reaction and two detectors are placed perpendicular to the plane of reaction. These detectors have time resolution about 3ns and space resolution about 20cm that helps us to obtain better angular resolution and separate gamma-rays from neutrons by the time-of-flight. The main idea of all experiments with triple-correlations is to fix plane of reaction made by directions of initial neutron and inelastically scattered neutron. One of the advantages of our setup is a possibility to see the correlation out of reaction plane.

Besides experimental part a theoretical approach will be proposed in this report to describe the differential probability of gamma ray emission in the reaction of inelastic neutron scattering depending on the directions of the initial neutron, scattered neutron and gamma quanta for both direct and CN reaction mechanisms. This approach is based on invariant spherical functions of several vectors - see, for example, [7]. Our formula for angular correlations includes elements of the S-matrix, which can be obtained from the TALYS program, which calculates cross sections for nuclear reactions.

In this work we compare our theoretical approach with experimental data. Parameters of the model in TALYS were adjusted to fit data on neutron inelastic scattering and gamma-quanta angular distribution.

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