Contribution ID: **28** Type: **not specified**

Characterization of an EJ-200 Plastic Scintillator Array for Experiments with 14-MeV Tagged Neutrons Using Carbon and Polyethylene Samples

Tuesday, 27 May 2025 16:05 (20 minutes)

The main goal of the TANGRA (TAgged Neutrons and Gamma RAys) project at the Frank Laboratory of Neutron Physics (JINR, Dubna) is to study the interaction of 14.1 MeV neutrons with various nuclei. One of the experimental setups developed within the project consists of an array of 20 EJ-200 plastic scintillators and is designed to study the angular distributions of neutrons and γ-rays resulting from the elastic and inelastic scattering of 14.1 MeV neutrons. The motivation for this work is the problem of computational and experimental determination of the detection efficiency of organic scintillation detectors for neutron energies above 8 MeV. In particular, the issue of simulating the efficiency of EJ-200 scintillators arises from contradictory and insufficient data regarding the light output functions for secondary charged particles emitted during neutron interactions with this scintillator material. Another pressing issue is the development of novel methods for the experimental verification of the detection efficiency of neutron detectors used in tagged neutron beam experiments.
To resolve these issues the energy dependence of the light output for secondary charged particles (protons and α-particles) was measured in the neutron energy range of 1.5 to 14.0 MeV for an array of EJ-200 scintillation detectors. The scattering of a tagged neutron beam with an energy of 14.1 MeV on graphite and polyethylene samples was used to obtain neutrons with known energies at various angles. Based on the obtained data, both the response function and the intrinsic efficiency of the detectors used were simulated in GEANT4. To verify the simulated efficiency, a method based on the measurement of elastically scattered neutrons from the 1H(n,n0)1H reaction was implemented.

Acknowledgment

The present study was supported by the Russian Science Foundation (grant no. 23-12-00239).

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Session Classification: Parallel Session 2: Nuclear data for applied and scientific purposes/Neutron detection & Methodical aspects

Track Classification: Parallel session: Parallel session 2