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Formation of protons and deutrons from the interaction of deutrons with an energy of 14.5 MeV with Cobalt

Programs to develop a new generation of nuclear power systems with a high level of safety (Accelerator Driven System), consisting of a proton accelerator, a neutron-producing target and a subcritical reactor, have been deployed in many countries. When creating such devices, for correct modeling of the neutron flux, data on the spectral composition and angular distributions of secondary protons and light charged particles produced by the primary proton beam is required [1]. Experimental data on reactions in which light complex particles (deuterons, tritons, ^3He and α particles) are in the input and/or output channels are very limited. It is worth noting that the presence of such experimental data directly affects the quality of existing theoretical models and increasing their predictive power [2].

New experimental data on reactions (d,xd) and (d,xp) on the ^{59}Co nucleus at E_d = 14.5 MeV were obtained at the U-150M isochronous accelerator of the Russian State University of Nuclear Physics. A self-supporting 3.5 μm thick natural cobalt foil was used as a target. The thickness and uniformity of the target used was determined by measuring the energy loss of alpha particles (^{226}Ra preparation). The reaction products were recorded with an ΔE–E telescope. Double-differential and integral cross sections of emitted deuterons were measured in the angle range $30^0 - 135^0$ in the laboratory mass system. Energy calibration was carried out using peaks corresponding to the known states of the final nuclei. The total error of the measured sections usually did not exceed 10% for all angles.

The experimental data were analyzed within the framework of the phenomenological exciton model of pre-equilibrium decay within the framework of the Talys calculation code. The developed fast methods for solving kinetic equations have opened up the possibility of studying multiparticle particle emission. The exciton model simultaneously describes the energy spectra of not only nucleons, but also complex particles. In addition to calculations within the framework of the exciton model, calculations were carried out within the framework of other mechanisms of nuclear reactions: direct processes (transfer - nucleon knockout, inelastic scattering) and equilibrium radiation using the Hauser-Feshbach compound nucleus decay formalism. It has been determined that the cross section under study is predominantly formed by pre-equilibrium decay mechanisms. The contribution of single-stage direct processes is negligible.

The experimental results obtained supplement the nuclear database on reaction cross sections and can be used in the design of safe and waste-free hybrid nuclear power plants.

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Section

Experimental and theoretical studies of nuclear reactions

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