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STUDY OF ${}^6\text{He} - {}^4\text{He}$ SCATTERING AT THE ACCULINNA-2 FRAGMENT SEPARATOR

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This work presents the results of an experiment performed at the ACCULINNA-2 fragment separator (FLNR JINR) aimed at studying the elastic and inelastic scattering of ${}^6\text{He} + {}^4\text{He}$ over a wide angular range. A secondary ${}^6\text{He}$ beam with an energy of 151 (168) MeV irradiated a 5.5-mm thick cryogenic gaseous ${}^4\text{He}$ target maintained at a temperature of 12 K and a pressure of 1 (2) atm. The reaction products were registered in a two-arm geometry using the detector system described in [1]. The primary objective of the investigation was to determine the differential cross sections for the ${}^6\text{He} + {}^4\text{He} \rightarrow {}^4\text{He} + {}^6\text{He}(\text{g.s.})$ and ${}^6\text{He} + {}^4\text{He} \rightarrow {}^4\text{He} + {}^6\text{He}(2^+)$ channels. For the channel populating the ground state of ${}^6\text{He}$, the angular distribution in the center-of-mass system (c.m.s.) was obtained across a wider angular range and with better resolution than in previous measurements [2]. In particular, new data were obtained for $\Theta_{\text{c.m.s.}} \sim 15^\circ - 60^\circ$ and, most notably, for the $\Theta_{\text{c.m.s.}} \sim 130^\circ - 165^\circ$ range, which corresponds to the two-neutron transfer reaction mechanism. The angular distribution for the channel involving the excitation of the ${}^6\text{He}(2^+)$ state was extracted by selecting events with the simultaneous detection of two alpha particles. Consequently, the angular dependence of the cross section in the $130^\circ - 165^\circ$ region was obtained for the first time. The optical model was applied to describe the data at forward angles, whereas the FRESCO and DWUCK5 codes were utilized for the backward angles. In addition, the spectrum of highly excited states of ${}^6\text{He}$, obtained via the missing mass method in the ${}^6\text{He} + {}^4\text{He} \rightarrow {}^4\text{He} + {}^6\text{He}^* ({}^4\text{He} + n + n)$ reaction, was analyzed separately. It is demonstrated that this spectrum is formed by the contribution of a peak corresponding to the 2^+ state at $E_{\text{ex}} = 1.8$ MeV, alongside a long “tail” most likely attributed to negative parity states. In the ${}^4\text{He}$ -t coincidences, a peak presumably associated with the dipole mode was observed at $E_{\text{ex}} = 26 - 27$ MeV, which is induced by the breakup of the alpha cluster in ${}^6\text{He}$. The mechanism underlying the emergence of potential background events at excitation energies of 15 MeV and above, as well as methods for their elimination, are discussed. References 1. A. A. Bezbakh, S. G. Belogurov, V. Chudoba et al., Detector Array for the 7H Nucleus Multi-Neutron Decay Study, Phys. Part. Nuclei Lett. 20, 629–636 (2023). 2. G. M. Ter-Akopian, A. M. Rodin, A. S. Fomichev et al., Two-neutron exchange observed in the ${}^6\text{He} + {}^4\text{He}$ reaction. Search for the “di-neutron” configuration of ${}^6\text{He}$, Phys. Lett. B 426, 251–256 (1998).

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