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Extraction of singlet pp-virtual state energy in $d+^1$H$\to p+p+n$ reaction

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Earlier in [1], it was suggested that the reason of discrepancies in experimental a_{nn} values (from –16 to –22 fm) may be connected to a large effect of $3N$ forces. It can also be assumed that the values of the proton-proton scattering length a_{pp} and the energy of the virtual $^1S_0$ state E_{pp} extracted from the experiment with three particles in the final state will differ from the values obtained in the free pp scattering. We plan to test this idea studying the $d+^1\mathrm{H}\to p+p+n$ reaction.
Simulation of this reaction showed that studying the energy spectrum shape of single proton in coincidence with the neutron will allow us to determine the energy of the virtual state of the pp-pair. Parameters of the experimental setup were also determined by simulation.
The experiment was started at 15 MeV deuteron beam of the SINP. A solid deuterated polyethylene target was used. To determine the spectrum of protons, we used a three-detector ($\Delta E-E_1-E_2$) telescope of silicon surface-barrier detectors. The advantage of such a system is a separation of events with coincidences in two ($\Delta E-E_1$) and three ($\Delta E-E_1-E_2$) telescope detectors, which greatly simplifies the analysis of energy loss diagrams (the absence of inverse loci in $\Delta E-E_1$ and E_1-E_2 diagrams). With this in mind, a technique was developed for reconstructing the energy spectrum of charged particles from energy losses of particles in detectors. The basis of this technique is the kinematical simulation of the passage of charged particles through matter. The neutron energy is determined by the time of flight using liquid-hydrogen scintillation detector. At that, it is possible to separate neutron events from those caused by gamma rays by the pulse shape. Preliminary data on the shape of the spectrum of protons in coincidence with neutrons are obtained.

1. E.S.Konobeevski et al. // Physics of Atomic Nuclei. 2018. V. 81. P. 595.

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