

Comparative studies of the Fermi momentum distribution in ${}^3\text{He}$ nucleus for the search of the η -mesic helium

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The COSY-11 group had measured an excitation functions for $dp \rightarrow {}^3\text{He}\eta$ and $dp \rightarrow ppp\pi^-$ reactions and analysed the data in view of possibility of the bound states existence. The measurements were carried out using the deuteron beam of COSY which was circulating through the stream of the internal hydrogen target of the cluster-jet type [?]. Data were taken during a slow acceleration of the beam from 3.095 GeV/c to 3.180 GeV/c, crossing the kinematical threshold for the η production in the $dp \rightarrow {}^3\text{He}\eta$ reaction at 3.141 GeV/c. The determined excitation function for the $dp \rightarrow {}^3\text{He}\pi^0$ process does not show any structure which could originate from a decay of η - He bound state. The estimated upper limit for the cross section of the $dp \rightarrow (\eta^3\text{He})_{\text{bound}} \rightarrow {}^3\text{He}\pi^0$ reaction chain is equal to 70 nb [?]. Similarly, the analysis of the $dp \rightarrow ppp\pi^-$ reaction resulted only in an upper limit of 270 nb for the total cross section of the $dp \rightarrow (\eta^3\text{He})_{\text{bound}} \rightarrow ppp\pi^-$ dp reaction [?].

In this report we present investigation which allows to find out how excitation curve changes for different models of nucleon momentum distribution inside ${}^3\text{He}$ nucleus. Based on reference [?] we use Fermi momentum distribution given by analytic formula (??) which is fitted to the experimental data on $p({}^3\text{He}, 2p)d$ and $p({}^3\text{H}, pn)d$ reactions. It is shown in the Figure 1 and Figure 2 (a).

$$f(p) = p^2[\exp(-263p^2) + 0.177\exp(-69.2p^2)] \quad (1)$$

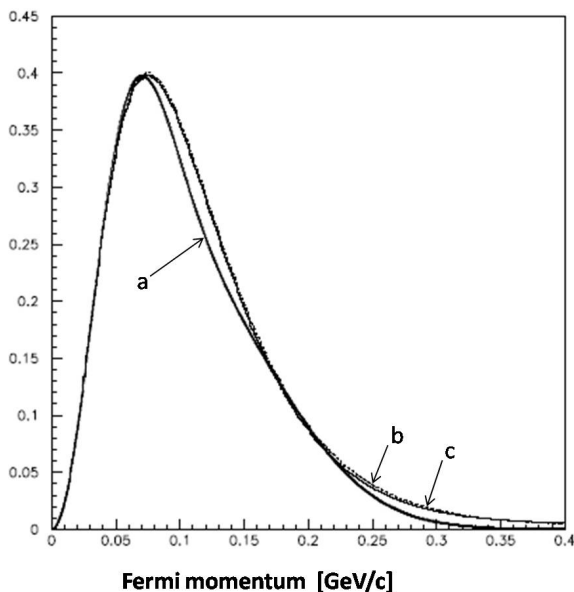


Fig. 1: Fermi momentum distribution for protons inside ${}^3\text{He}$ given by analytic formula (a) and estimated for the AV18 NN (b) and the CDB-2000 NN (c) interaction model.

The distributions of protons and neutrons momentum inside ${}^3\text{He}$ were also estimated by A. Nogga [?] based

on the AV18 NN and the CDB-2000 NN interaction. They are presented in Figure 1 and Figure 2 and ticked by (b) and (c).

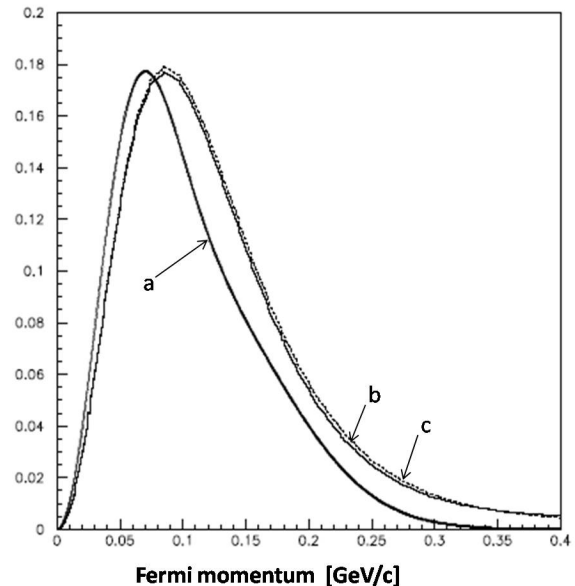


Fig. 2: Fermi momentum distribution for neutrons inside ${}^3\text{He}$ given by analytic formula (a) and estimated for the AV18 NN (b) and the CDB-2000 NN (c) interaction model.

Estimation based upon the fitted formula consistent with the AV18 NN and CDB-2000 NN model for protons with an accuracy better than 4%. In case of neutron momentum distribution difference between first and two other models is noted and equals about 10%.

Currently at WASA-at-COSY the project for search of η - helium bound states is setting out. Two weeks of COSY beamtime were already recommended by the COSY Program Advisory Committee.

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