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New results on the pd→^{3}He η production near threshold

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Measurements on the η meson production in proton-deuteron collisions have been performed using the COSY-11 facility at COSY (Jülich). Here we present preliminary results on total and differential cross sections for the pd→^{3}He η reaction at five excess energies between Q = 5.1 and Q = 40.6 MeV. The obtained angular distributions for the emitted η mesons in the center of mass system expose a transition from an almost isotropic emission to a highly anisotropic distribution. The extracted total cross sections support a strong η-^{3}He final state interaction and will be compared with model predictions.

Keywords: near threshold meson production; final state interaction; quasi-bound states.

1. Introduction

Close to threshold data on the pd→^{3}He η reaction are of great interest to study the strong attractive η-nucleus interaction at low energies, which might be a signal for

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the existence of quasi-bound η-nucleus states. First observed at the SPES-IV and SPES-II spectrometers at SATURNE[1,2], the η-production in the reaction channel pd$\rightarrow^3$He η reveals remarkable features. Additionally to the unexpected high cross section, the shape of the excitation function reveals a maximum very close to the production threshold and a large drop of the production amplitude within only a few MeV above threshold, which clearly deviates from pure phase space expectations. In contrast, the angular distributions of the emitted η mesons in the center of mass system appeared to be consistent with pure phase space expectations and exhibit no contributions from higher partial waves.

In order to describe this unexpected near threshold behaviour, a two-step model based on a double-scattering reaction mechanism has been proposed by Kilian and Nann[3]. Calculations by Fäldt and Wilkin[4], exploiting this approach, succeeded to reproduce the threshold cross section within a factor of 2.4. However, in order to reproduce the observed rapid drop of the production amplitude with increasing energy, the two-step approach had to be refined by a strong η-^{3}He final state interaction (FSI) with a large η-^{3}He scattering length.

Further measurements performed at higher excess energies of ∼50 MeV by the COSY-GEM-Collaboration[5] and between 22 MeV and 120 MeV by the WASA/PROMICE collaboration[6], resulted in non-isotropic angular distributions and total cross sections that are underestimated by the description of the refined two-step model fitted to the SPES data. A different reaction mechanism based on the excitation of the N*(1535) has been suggested[5], however, it fails to reproduce the observed shape of the previously determined excitation function.

Therefore, to clarify the still open question concerning the dominant production process, as well as to investigate the development of the angular distributions with increasing excess energy, additional measurements on the reaction of type pd$\rightarrow^3$He X have been carried out using the COSY-11 installation.

2. Experiment and Results

The reaction channel pd$\rightarrow^3$He η has been studied using the COSY-11 installation[7] at COSY (Jülich)[8] by detection of the emitted ^{3}He nuclei and identification and reconstruction of the produced η mesons using the missing mass technique. Over the range of studied excess energies (Q=5.1, 10.8, 15.2, 20.0 and 40.6 MeV) a transition from a rather flat angular distribution at the two lowest energies to a highly anisotropic behaviour for the highest measured excess energy of 40.6 MeV is observed.

By determining the integrated luminosity via the pd→pd elastic scattering[10,11] it was also possible to derive total cross sections and production amplitude information for each of the measured excess energies. The obtained production amplitudes close the open gap between the SATURNE data at low energies and the higher energy data from WASA/PROMICE and GEM (figure 1). The observed shape of the COSY-11 data strongly supports the predictions of the refined two-step model

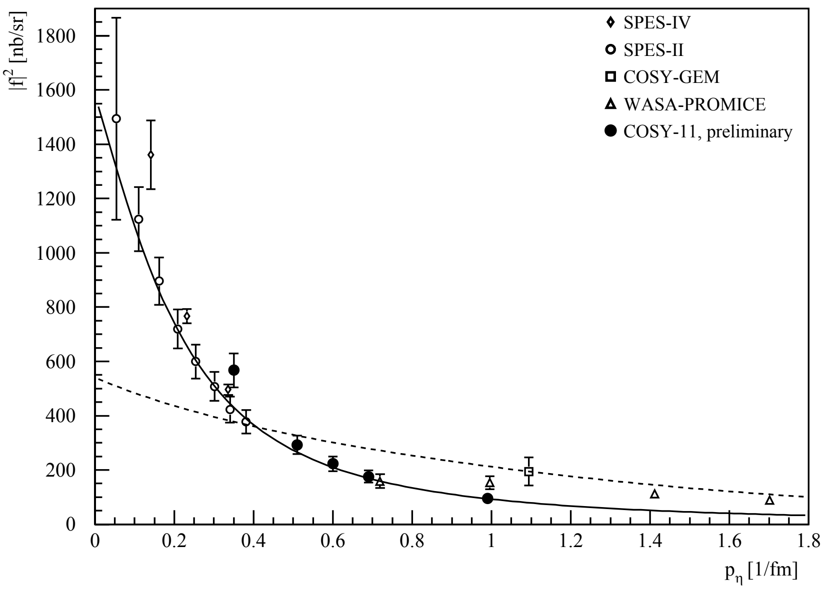

Fig. 1. Average production amplitude squared $|f|^2$ as fuction of the cms momentum of the emitted η mesons for the pd→^{3}He η reaction. The solid and dashed lines represent fits to the data based on a strong η-^{3}He FSI and a resonance model description respectively.

and indicates none or only weak contributions from a production according to the resonance model.

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