NEAR THRESHOLD EXCITATION FUNCTION FOR THE $dp \to dp\eta$ REACTION*

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on behalf of the COSY-11 collaboration

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Results of the near threshold measurements of the η meson production in the $dp \to dp\eta$ reaction are presented. The experiment was performed at the COSY-Jülich accelerator with the use of the COSY-11 apparatus [1]. Data were taken for three values of deuteron beam momenta corresponding to excess energies of 3.1, 6.0 and 9.1 MeV for $dp\eta$ reaction channel. Preliminary results were reported at the MESON-06 conference. Here we presented cross section values re-examined taking into account the newest value of the η-meson mass [2–5]. The energy dependence of the total cross section confirms a strong effect of the final state interaction.

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1. Introduction

The studies of the multi-nucleon interaction are nowadays specially interesting due to the research of the quark-gluon plasma conducted in heavy ion collisions and in connection with dynamically developing multi-body interaction theory. The simplest system suitable for the examination of the multi-nucleon interaction is the three nucleon system. From experimental point of view, the most appropriate for these studies are the pd or dp collisions due to the high quality of proton and deuteron beams available at particle accelerators. Recently the $d-\eta$ and $^3\mathrm{He}-\eta$ interaction was intensively studied on the theoretical ground. This interaction is of special interest due to the possible existence of the η-nucleus bound or quasi-bound states. First experimental indication of such states coming from the MAMI collaboration [6] has been vigorously discussed during the present

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meeting [7–9]. For the η meson production near threshold in the three nucleon system much less measurements were done as compared to the two nucleon system [10–12]. The data collection for the ^{3}Heη production in pd [13–18] and dp [19, 20] collision has improved recently, however, for the reaction $pd \to dp\eta$ there exist only two data points close-to-threshold from SATURNE [21] and data for Q>14 MeV from PROMICE/WASA collaboration [22, 23]. The aim of the present experiment was determination of the $dp \to dp\eta$ cross sections near threshold in order to study the interaction between the particles in the final state. The energy dependence of the total cross section is expected to be very sensitive to the $d - \eta$ interaction. Even much weaker $p - \eta$ interaction significantly modifies this shape as observed in the $pp \to pp\eta$ reaction [24, 25].

2. Experiment

The experiment was carried out using the stochastically cooled deuteron beam of the COoler SYnchrotron (COSY) in Jülich [26] scattered on internal proton target of the cluster jet type [27]. Choice of the deuteron beam is caused by the fact that the COSY-11 detection acceptance for dp reaction is about ten times larger than in the case of proton beam scattered on deuteron target. During the experimental run two reaction channels were registered simultaneously: $dp\eta$ and ^{3}Heη. The details of the measurement are already presented in the reference [28], therefore, here we discuss in detail only a new detector installed for the purpose of the detection of deuterons in this measurement. The outgoing deuterons from the near threshold $dp \to dp\eta$ reaction have about two times larger momentum than the outgoing protons and, consequently, their deflection in the magnetic field of the COSY-11 dipole magnet is two times smaller. They leave the COSY-11 vacuum chamber through 10 cm wide and 5.6 cm high forward window. For the deuterons registration small drift chamber D4 supplemented by two thin scintillators dE1, dE2 and Cerenkov threshold counter were installed. The drift chamber was specially build for the purpose of this experiment in the Institute of Physics of the Jagiellonian University. The chamber has a box shape with dimensions of 13 cm x 18 cm x 18 cm. It consists of seven detection planes: four planes with 10.4 cm long vertical wires separated by three planes with 12.70 cm horizontal wires. Each detection plane contains hexagonal cells [29] with the width of 1.1 cm. The distance between adjacent planes is 1.65 cm. As chamber gas the P10 mixture (90% argon, 10% methane) at atmospheric pressure is used. The sense wire potential is +1800 V and the field wires are grounded. Shape of applied cells and a scheme of the drift chamber are shown in Fig. 1. The chamber allows for the three dimensional particle tracks reconstruction. The particles mo-

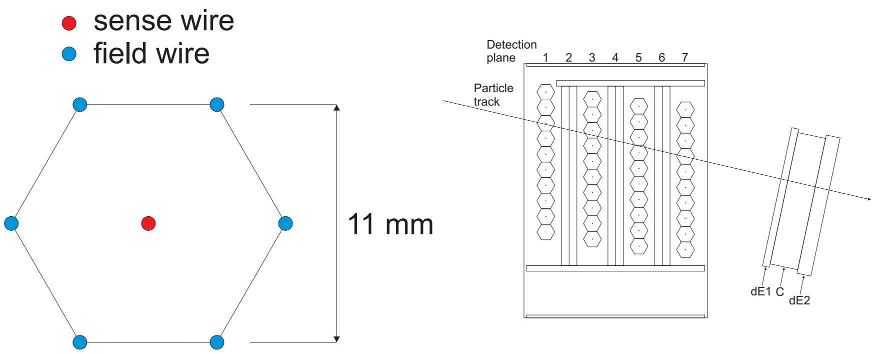

Fig. 1. (left) Drift cell with marked sense– and six field–wires. (right) Top view of the drift chamber showing four identical detection planes: 1, 3, 5, 7, containing 10 cells with vertical wires and three planes: 2, 4, 6, containing 8 cells with horizontal wires, each. Behind the drift chamber two scintillation detectors dE1, dE2 and Cerenkov threshold counter are placed.

menta are determined by tracing their trajectories in the magnetic field of the dipole magnet back to the target position. Behind the drift chamber two 5 mm and 10 mm thick scintillators dE1 and dE2 are placed. Their signals (if in coincidence) are used as a trigger for the drift chamber read-out and as a stop signal for the Time Of Flight (TOF) measurement on the 2.3 m path from the target. The time of the reaction at the target is derived from measurement of velocity of the associated particle registered in the scintillator hodoscopes S1 and S3 and from the time measured by the S1 detector. The TOF combined with the information about the particle momentum is used for the particle identification. In order to reduce a huge spectator proton background originating from the break-up of the deuteron beam a threshold Cerenkov detector consisting of 2 cm Plexiglas plate is used. Further improvement of the particle identification is done by taking into account the energy losses in the scintillation detectors.

The η-mesons produced in the $dp \to dp\eta$ reaction were identified using the missing mass method.

The integral luminosity for each beam momentum setting was determined from acceptance corrected number of $^3\mathrm{He}\eta$ events measured simultaneously with $dp\eta$ channel. The $dp \to {}^3\mathrm{He}\eta$ total cross section was taken from Ref. [19, 20].

3. Preliminary results

The measurement was performed for three deuteron beam momenta above the $dp \to dp\eta$ threshold namely: 3177.4, 3189.4 and 3202.4 MeV/c and one momentum below the threshold equal to 3163.4 MeV/c. The precise determination of the beam momentum is described in article [28]. The measurement below the threshold was used for the background subtraction under the η peak in the missing mass spectra. The determined $dp \rightarrow dp\eta$

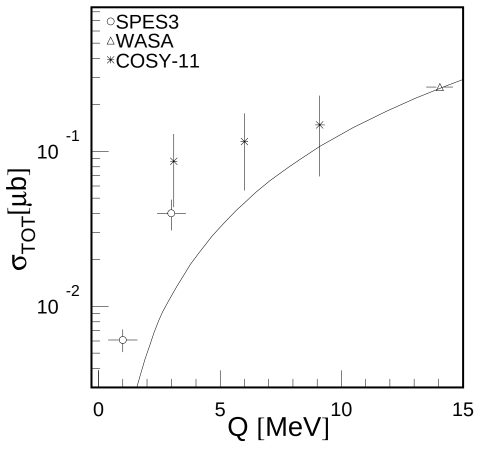

Fig. 2. Dependence of total cross section on the excess energy. The line indicates three body phase-space volume normalised to the PROMICE/WASA point [23]. Open circles show data from reference [21], and stars denote preliminary results determined by the COSY-11 group.

total cross sections are shown in Fig. 2 together with the data measured at SATURNE and at WASA. The enhancement of the near-threshold cross sections with respect to the phase-space behaviour indicates for an effect of a strong interaction between the final state particles. We expect that further elaboration of the background systematics will allow to reduce the relatively large uncertainties of our preliminary data points.

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