Investigation of the ^{3}Heη-final state in dp-collisions*

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Previous investigations on the reaction dp→ η^3He at low excess energies have shown unexpected results in the total and differential cross section as seen by measurements accomplished at ANKE [1]. The total cross section shows a steep rise at threshold followed by a plateau for a wide energy range. The differential cross sections show a strongly increasing asymmetry with rising excess energies.

For the interpretation of these results the possibility of an η^3He quasi-bound state was discussed [2]. As a theoretical approach for the interpretation of the data a final state interaction model is used. In detail a description with two poles in the production amplitude f is chosen [1]. One of the poles is determined near the reaction threshold which is a necessary prerequisite for a bound or quasi-bound state.

Another criterion for a quasi-bound state is a fast change of the magnitude and the phase of the s-wave. This value is attainable by the interference of the s- and p-wave contribution to the scattering process. This interference changes the angular distribution and can be obtained by the asymmetry factor α defined as the slope of the angular distribution at $\cos\theta = 0$ [2]:

$$\alpha = \frac{\mathrm{d}}{\mathrm{d}(\cos\theta)} \ln\left(\frac{\mathrm{d}\sigma}{\mathrm{d}\Omega}\right)_{\cos\theta=0} \qquad (1)$$

The results presented in [1] were achieved using a continuous linear ramp in beam momentum provided by the COSY accelerator. This allows a precise determination of the total cross section in small steps which in turn limits the angular resolution for statistical reasons.

New data were taken in a beam time for the determination of the η mass at ANKE which are also used to determine total and differential cross sections of the reaction dp→ η^3He. For this measurement COSY was operated at fixed beam momenta which were dermined with highest precision by spin resonance measurements [3]. Thereby the excess energy for the 15 different settings above threshold is known with high accuracy (i.e. 0.05 MeV). Due to the large statistics collected in this experiment, angular distributions of high quality will be accessible. The reaction itself is identified by using the missing mass technique. The background can be described by using data taken below the reaction threshold. This is demonstrated exemplarily for one angular bin at $Q = 8.1$ MeV excess energy in Fig. 1.

Using this background correction and counting the missing mass peak content for all angular bins allows to determine angular distributions. Very preliminary examples are shown in Fig 2. Although detector efficiency corrections are not yet included the relevance of higher partial waves already at excess energies above 4 MeV ist clearly visible. In the final analysis the angular distributions will allow for the precise determination of the asymmetry factor α. This provides the possibility to investigate the η^3He final state and might provide further important hints for a quasi-bound state.

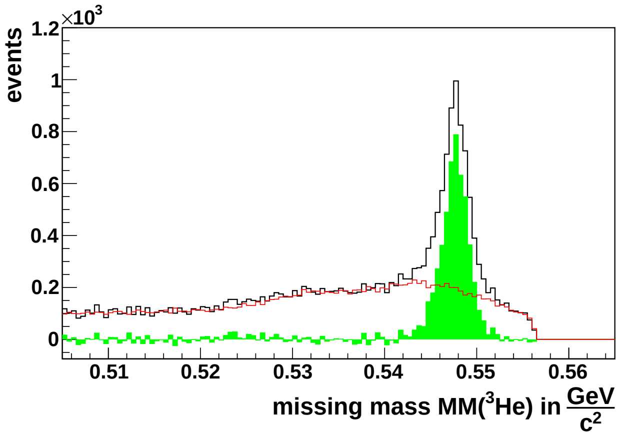

Fig. 1: ^{3}He missing mass distribution (black) at an excess energy of $Q = 8.1$ MeV and $\cos\theta_{^3\mathrm{He}} = [-0.6, -0.5]$. The background can be well discribed by subthreshold data (red) to extract the η^3He signal (green).

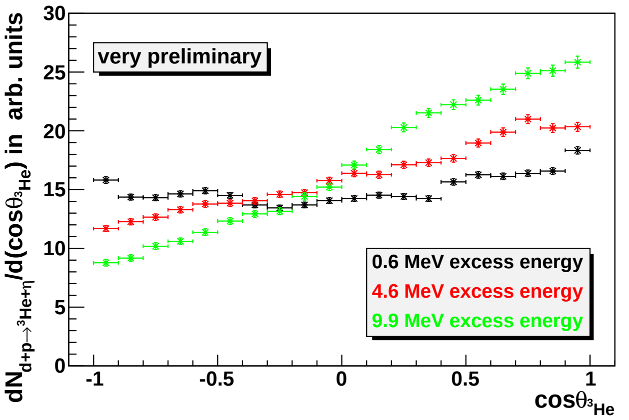

Fig. 2: Preliminary angular distributions of emitted ^{3}He-nuclei for three different excess energies.

The preliminary results demonstrate that the data set allows for the determination of total and differential cross sections with high statistics and unattained angular resolution. Although still preliminary the presented results indicate that new high quality data will be available in future.

References:

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