Studies on η meson production in dp collisions at the ANKE spectrometer[1]

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The magnetic spectrometer **ANKE** ("**A**pparatus for Studies of **N**ucleon and **K**aon **E**jectiles") is an internal fixed target experiment at the accelerator and storage ring **COSY** ("**CO**oler **SY**nchrotron"), located at the Forschungszentrum Jülich in Germany, to study the properties and interaction of hadrons in a medium energy regime. For this purpose, COSY provides (un)polarized deuteron and proton beams with momenta between 0.3 $^{\mathrm{GeV}}/_{c}$ and 3.7 $^{\mathrm{GeV}}/_{c}$. Furthermore, the design of the ANKE detector setup with its three dipole magnets is very well suited for the detection and reconstruction of charged particles generated even at small scattering angles in reactions close to threshold.
Studies on the total cross sections of the reaction $d + p \rightarrow {}^{3}\mathrm{He} + \eta$ are of special interest since they differ strongly from a pure phase space behaviour near threshold (cf. figure 1) [1, 2, 3, 4, 5]. This can be explained by an unexpected strong final state interaction (FSI) between η mesons and He nuclei which could lead to a quasi bound state of the $\eta{}^{3}$He-system [6]. New high precision data from the ANKE spectrometer allow the extraction of precise total and differential cross sections for the η production up to an excess energy of $Q = 15$ MeV and will be discussed. Assuming the FSI ansatz to be correct, the non pure phase space behaviour of the total cross section near threshold should be seen also in other production channels. This has been tested by different facilities [7, 8, 9]. Nevertheless, none of these measurements could clearly prove whether the η-nucleus system is in a bound or virtual state. In order to further investigate this, a beam time was realized in March 2013 to study the properties of η-mesic nuclei with the reaction $p + d \rightarrow d + \eta + p_{\mathrm{spec}}$, where the initial deuteron serves as an effective neutron target. The combination of two beam momenta $p_1 = 2.09$ $^{\mathrm{GeV}}/_{c}$ and $p_2 = 2.25$ $^{\mathrm{GeV}}/_{c}$ and the Fermi motion inside the deuteron allows to extract differential and total cross sections in a wide excess energy range between

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$0 - 100$ MeV. The behaviour of the total cross sections near threshold will allow to determine the scattering length $a_{d\eta}$ to shed new light on the formation of η-mesic nuclei. The differential cross sections will enable to prove the validity and range of the s-waves assumption of the final state system. Recent preliminary results on both reaction channels will be presented and discussed.

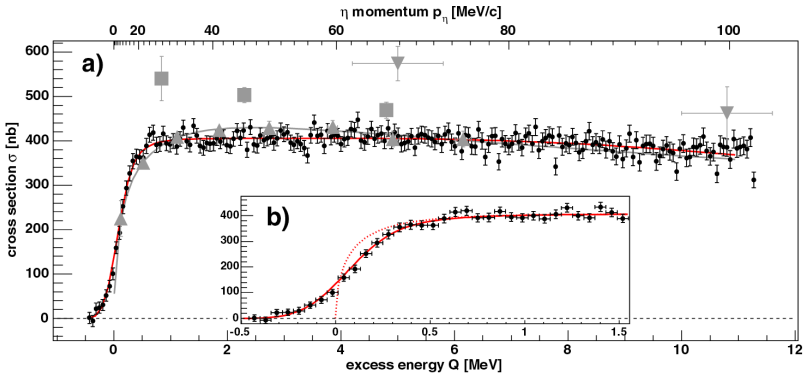

Figure 1: **a)** Comparison of the total cross section of the reaction $d + p \rightarrow {}^3\mathrm{He} + \eta$. The black circles represent an ANKE data set from threshold up to an excess energy of $Q = 11$ MeV [1]. **b)** Enlargement of the near threshold region. The red dotted line shows the FSI ansatz corrected for the beam momentum spread.

References

[1] T. Mersmann *et al.*, Phys. Rev. Lett. **98**, 242301 (2007).

[2] J. Smyrski *et al.*, Phys. Lett. B **649**, 258 (2007).

[3] J. Berger *et al.*, Phys. Rev. Lett. **61**, 919 (1988).

[4] B. Mayer *et al.*, Phys. Rev. C **53**, 2068 (1996).

[5] H.-H. Adam *et al.*, Phys. Rev. C **75**, 014004 (2007).

[6] C. Wilkin *et al.*, Phys. Lett. B **654**, 92 (2007).

[7] F. Pheron *et al.*, Phys. Lett. B **709**, 21 (2012).

[8] A. Budzanowski *et al.*, Nucl. Phys. A **821**, 193 (2009).

[9] A. Budzanowski *et al.*, Phys. Rev. C **82**, 041001(R) (2010).