Two Step Mechanism for Meson Production

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The meson production in the proton-deuteron system at proton momenta below the threshold of the free nucleon-nucleon collisions should allow to distinguish different reaction mechanisms. At these beam momenta the energy necessary for production of the corresponding meson can be gained in a single step reaction from the internal motion of nucleons inside the deuteron or by a two step reaction. The simplest example might be: $pd \to {}^3He\,\eta$ divided into step **A**: $pp \to d\pi^+$ and step **B**: $\pi^+ n \to \eta p$.

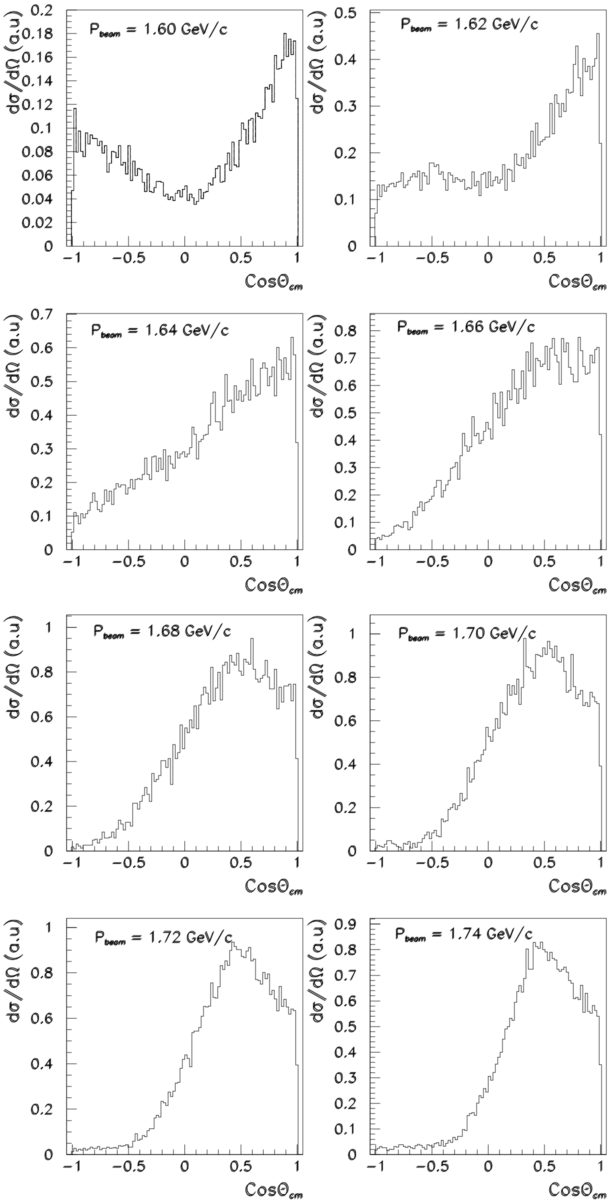

Figure 1: Shape of the angular distribution of ${}^3He$ predicted by the two step model in $pd \to {}^3He\,\eta$.

It was shown by Kilian and Nann [1] that the meson production in the two body proton deuteron interaction ($pd \to {}^3He\,X$ or $pd \to {}^3H\,X^+$) might be enhanced in a narrow beam energy and angular range if it proceeds by a two step mechanism due to a selective fusion of the three outgoing baryons because they are matched in velocity. Experimental proof of such an enhancement in the cross section of $pd \to {}^3He\,\eta$ would proof the importance of the two step reaction. The contribution of the two step mechanism alone to the cross section of the reaction $pd \to {}^3He\,\eta$ is simulated. An approach is used which is relativistically correct. For the first time the folding process includes the angular and energy dependence of the two subsequent steps and the correct off mass shell situation also in the ${}^3He$ fusion and not only as in [1] with the bound reaction partners from the original target deuteron. The angular distribution predicted by the two step process (Fig. 1) shows a forward peak of ${}^3He$ in the center of mass system and it enhances the cross section in a rather narrow energy range (Fig. 2). It has its maximum contribution to the total cross section at approximately 50 MeV excess energy [2]. The forward peak of ${}^3He$ is in contrast to the direct single step reaction which is known to create a rise of ${}^3He$ in the backward direction. An experimental search for this effect is planned at COSY [3].

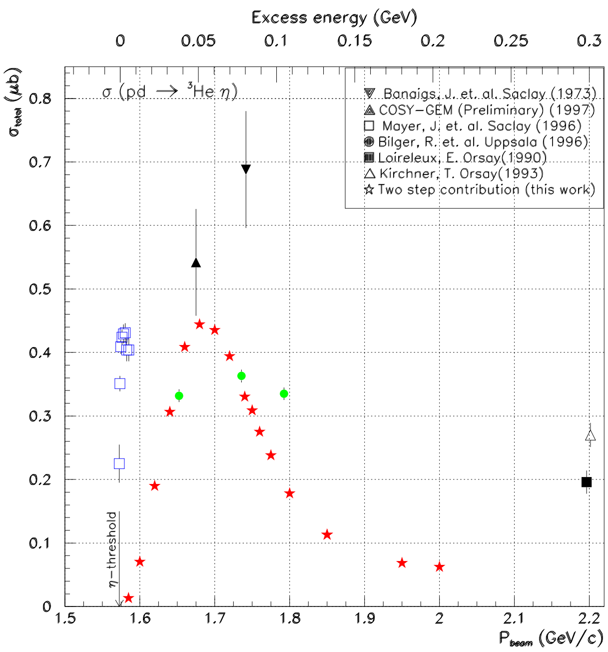

Figure 2: Shape of the cross section contribution of the two step model to the reaction $pd \to {}^3He$ as a function of beam momentum and excess energy. The calibration may not be precise.

References:

[1] K. Kilian and H. Nann, contribution to the workshop on "Particle production near threshold", Nashville, 1990, AIP conference proceedings 22, 185 (1990)

[2] Hassan A., Thesis Zagazige Univ. Cairo, Egypt, 1998

[3] COSY Proposal Nr. 7

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