OMEGA PRODUCTION WITH THE REACTION $p + d \to {}^3He + \omega$*

The SATURNE Exp.222 Collaboration[1]
presented by

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Differential cross sections for ω production at 180° in the c.m. system were measured from threshold up to a c.m. momentum of 625 MeV/c. The cross sections observed at low c.m. momenta are not yet understood theoretically. Data are compared to the prediction of an empirical model by C. Wilkin [1], which provides a first step towards understanding near threshold ω production.

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1. Introduction

Meson production in proton induced reactions has been of great interest for many years, especially in the case of two-body final states. The measurement of a missing mass spectrum by detecting the ^{3}He resulting from

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target-projectile fusion in a magnetic spectrometer is a convenient and powerful tool for studying neutral meson production. The cross sections of π^0 and η production in the reactions $p + d \rightarrow {}^3\text{He} + (\pi^0, \eta)$ behave very differently close to their respective thresholds [2]. Therefore, the behavior of the cross sections for heavier mesons, like the ω, is an interesting subject to study.

2. Experiment

The experiment was carried out with the proton beam of the SATURNE II synchroton, impinging on a 38mm liquid-deuterium target. The beam intensity ($\simeq 10^{11}$ p/s) was monitored by a secondary electron detector and three scintillator telescopes. The SPES4 spectrometer and its standard detection system were used for the momentum analysis of the ^{3}He fusion products at 0° with respect to the proton beam. The detection system consists of scintillator hodoscopes measuring the time-of-flight, and of two drift chamber arrangements measuring the particles trajectories. The long flight distance of about 16.2 m caused a good background suppression. The momentum acceptance of SPES4 was ±3.2%.

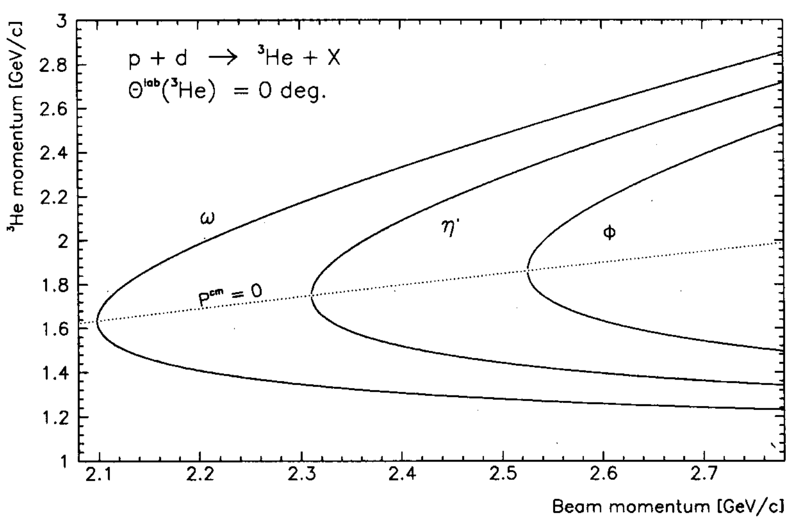

Fig. 1. ^{3}He kinematics

The ^{3}He kinematics for the production of ω, η', Φ mesons is shown in Fig. 1. The dotted line shows the 0° lab. momentum of the ^{3}He resulting from p+d fusion and produced at rest in the c.m. system (see R. Jahn's talk "Near Threshold Meson Production"). The full curves show the ^{3}He momenta observed at a 0° lab angle, if ω, η', Φ meson production accompanies

$p + d$ fusion. The upper branches show the ^{3}He momentum for the meson production under 180° and the lower ones under 0° in the c.m. system.

3. Results

The Fig. 2 shows the focal plane spectrum of 1.728 GeV beam energy and a spectrometer momentum p/z of 1246 MeV/c. One can see a Breit–Wigner fit for the omega and a linear multipion background. Integration of this Breit–Wigner curve yields the differential cross section for ω production under 180° in the c.m. system.

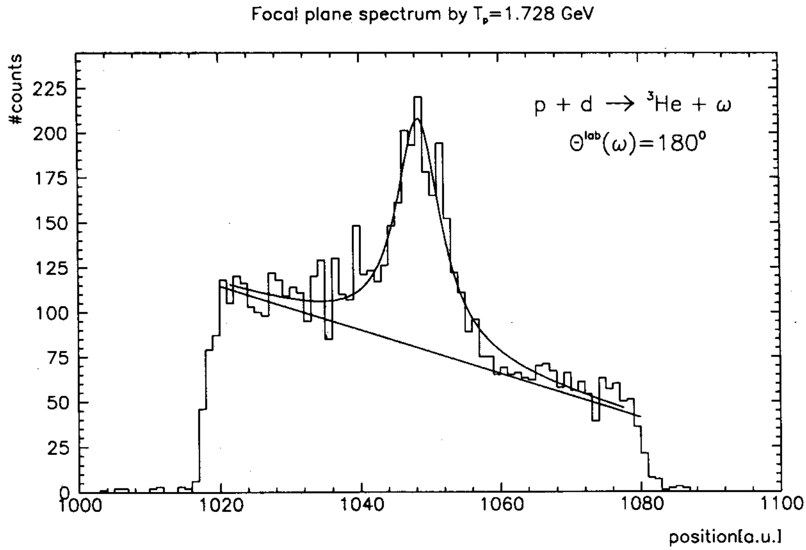

Fig. 2. Focal plane spectrum of the ω

In the last two years, we have measured the differential cross section for the ω production in backward direction for 18 different beam energies from threshold up to 625 MeV/c c.m. momentum above threshold. The results are shown in Fig. 3. The circles and triangles are data from different runs, where the triangles were normalized to the circles, because no absolute normalisation measurements were made in June 1992. The transformation from the lab. system into the c.m. system was done for the circle points by a monte carlo simulation [3], which included losses due to target effects. In the case of the triangle points only the jacobian determinant was used for this transformation. The drawn curve is a theoretical analysis of C. Wilkin [1], which fits the data well for lower c.m. momenta. The empirical "3-nucleon" model of Wilkin assumes participation of all three nucleons involved and he divides the reaction $p + d \rightarrow {}^3\text{He} + \omega$ into two steps:

$$\begin{aligned} &\text{1. step:} \quad p + p \rightarrow \pi^+ + d \\ &\text{2. step:} \quad \pi^+ + n \rightarrow \omega + p . \end{aligned}$$

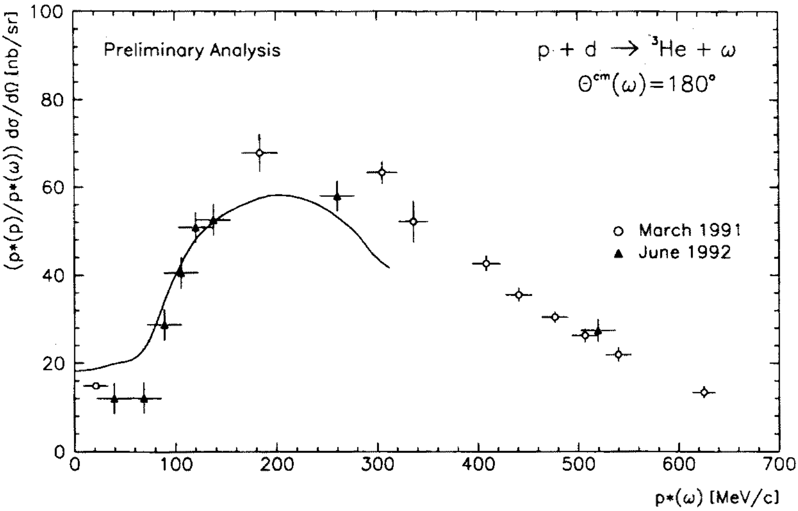

Fig. 3. Differential cross section of the ω production

The behavior of the theoretical curve is dominated by the amplitude of the elementary $\pi^- + p \rightarrow \omega + n$ reaction, which is substituted for $\pi^+ + n \rightarrow \omega + p$. The formfactor and the energy dependence of the $\pi^+ + d \rightarrow p + p$ reaction is less important for ω production in backward direction. The deviation of the c.m. momenta from 180 to 300 MeV/c between the curve and the data is systematically about 20%. For higher c.m. momenta there are no more precise data of the $\pi^- + p \rightarrow \omega + n$ reaction, which Wilkin uses for his calculations.

4. Conclusion

The differential cross section of the backward angle ω production rises from threshold to $d\sigma/d\Omega^{\text{cm}} = 15$ nb/sr at about 180 MeV/c c.m. momentum of the ω and decreases from there on up to 625 MeV/c above threshold. The empirical 3-nucleon model of Colin Wilkin can describe the suppression in the differential cross section near threshold very well. This agreement and the necessity of 3-nucleon contributions in the η production [4] suggest that all three nucleons involved participate in the ω production mechanism in the reaction $p + d \rightarrow {}^3\text{He} + \omega$.

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