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Studies of the η meson production with polarized proton beam at COSY-11

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Abstract

We summarize the COSY-11 measurements of the analyzing power for the $pp \to pp\eta$ reaction and interpret the results in the framework of the meson exchange models. Determined analyzing power is essentially consistent with zero implying dominance of the s-wave in the η meson production process.

1 Introduction

Investigations of the production and decay of hadrons deliver information needed to deepen our knowledge about the strong interaction in the domain of low energy region, where the application of the perturbative approach of quantum chromodynamics is not possible. Here we briefly present the results concerning the hadronic production of the η meson and interpret them in the framework of meson exchange models. More detailed description has been recently reported in the Proceedings of the Symposium on Meson Physics [1].

From the total and differential cross section measurements for the $pp \to pp\eta$ reaction [2] it was concluded [4–6] that the production of the η meson proceeds via a two-step process, with the mesonic excitation of a nucleon to the resonance in first stage, and further deexcitation of this state into the N-η system. In fact, any of the π, η, ω, or ρ meson may contribute to the resonance creation. As an intermediate resonance, the $S_{11}(1535)$ is anticipated to be the dominant one, however the other nuclear resonances may give noticeable contribution as well [7].

Studies of the isospin dependence of the η meson production in NN collisions [3] revealed strong isospin dependence of the production process. The production of the η meson with the total isospin I=0 exceeds the production with the total isospin I=1 by a factor of 12, suggesting that the isovector meson exchange – the π or ρ meson exchange – is the dominant process in the excitation of the $S_{11}(1535)$ resonance. However, the relative contributions of the pseudoscalar π or vector ρ meson still remained to be determined.

Among the available theoretical models Nakayama et al. postulated [6] a dominance of exchange of the pseudoscalar mesons, while Fäldt and Wilkin [5] found a main contribution originating from the vector meson exchange. Both models are in good agreement with unpolarized observables, however, they differ significantly in the predictions for the analyzing power function.

2 Results

COSY-11 group has performed measurements of the vector analyzing power A_y for the $\vec{p}p \to pp\eta$ reaction at the excess energies of Q=10 and 37 MeV [8].

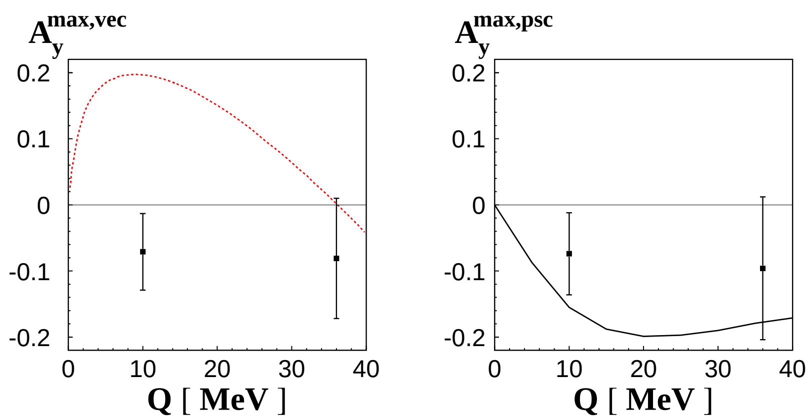

Figure 1: Theoretical predictions for the energy dependence of the amplitude of A_y confronted with the amplitudes determined in the experiments at the excess energies Q=10 and 37 MeV for the vector (left) and pseudoscalar meson exchange dominance model (right).

Results, presented in Fig. 1 in the form of the analyzing power amplitude [8], show that the predictions of the model based on the dominance of the π meson exchange [6] are fairly consistent with data (at the level of 1 σ), whereas the calculations performed within the frame of the vector meson dominance model, based on the photoproduction data and the assumption of the dominance of the ρ meson exchange [5], differ from the experimental points by more than four standard deviations. This confrontation of the theoretical predictions with the experimental data indicates that the excitation of the nucleon to the $S_{11}(1535)$ resonance is predominantly due to the exchange of the π meson.

The analyzing power values for both excess energies are consistent with zero within one standard deviation. This is in line with the results obtained by the DISTO [9] collaboration in the far-from-threshold energy region. Such a result may indicate that the η meson is predominantly produced in the s-wave.

3 Future perspectives

Recently, the proposal for the measurement of the analyzing power function [10] with the WASA-at-COSY aparatus [11] has been presented and awaits recommendation of the COSY Programme Advisory Committee. Measurements are planned with about 50 times better statistics which, assuming the same background-to-signal ratio in the missing mass spectrum, enables the error bars from Fig. 1 to be reduced of circa 7 times.

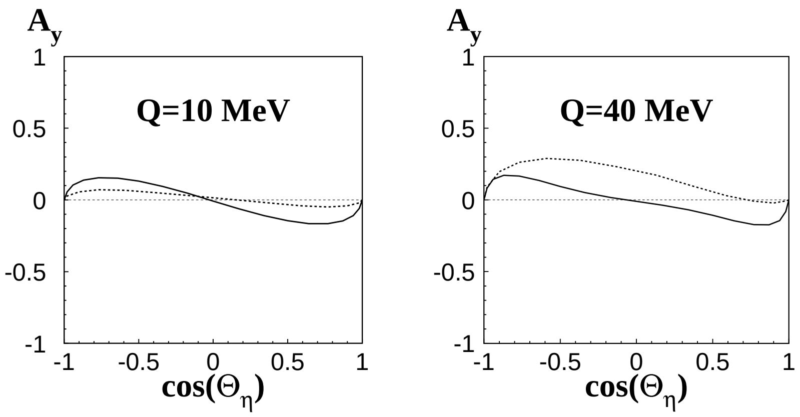

Figure 2: Predictions of the dependence of the analyzing power function on the intermediate resonance type [7].

Fig. 2 presents the dependence of the analyzing power as a function of the cosine of the polar angle of the η meson emission in the center-of-mass system on the intermediate resonance type [7]. Solid line are the calculations of the pseudoscalar meson exchange model performed under assumption that only $S_{11}(1535)$ resonance contributes to the η meson production amplitude, whereas the dotted line represent the predictions of the same model, including $D_{13}(1520)$, $S_{11}(1535)$, $S_{11}(1650)$, and $D_{13}(1700)$ resonances. Therefore, the improvement in the measurement accuracy would enable to investigate the influence of other-than-$S_{11}(1535)$ resonances upon the production amplitude.

4 Acknowledgement

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