Near-threshold Production of $a_0(980)$ Mesons in the Reaction $NN \to dK\bar{K}$ (*

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In a recent paper [1] we have performed a detailed study of the a_0^+ production in the reaction $NN \to dK^+\bar{K}^0$ near threshold and at medium energies. Using a two-step model (TSM) based on the Effective Lagrangian approach we have analyzed different contributions to the cross section of the reaction $NN \to da_0$ and found that the dominant contribution is from a u-channel mechanism. Normalizing this u-channel contribution to data from LBL [2] on the forward differential cross section of the reaction $pp \to da_0^+$ at 3.8 GeV/c we are able to reproduce the total cross section of the reaction $pp \to dK^+\bar{K}^0$ at 3.46 GeV/c ($Q = 46$ MeV) measured at COSY [3]. However, the TSM fails to reproduce the experimental distribution on the deuteron scattering angle.

As an alternative and more general approach, we consider the Quark-Gluon Strings Model, that recently has successfully been applied to the description of deuteron photo-disintegration data [4]. The calculated angular and invariant mass distributions for the $pp \to dK^+\bar{K}^0$ reaction at $Q = 46$ MeV in comparison to the experimental data [3] are shown in Fig. 1, where θ_d and θ_{12} are the angles between the initial proton momentum and c.m. momentum of deuteron and the relative momentum of the kaons, respectively. The dashed lines correspond to S-wave $K^+\bar{K}^0$ production through the a_0^+ resonance and have been calculated within the QGSM with new set of parameters (Set $(a_0 d)$). The dashed-dotted lines describe the $K\bar{K}$ P-wave background calculated within a $\pi - K^\star - \pi$-exchange model. The solid lines indicate the sum of the a_0^+-resonance and background contributions. The thin dashed and solid lines in the left figure show the distribution on θ_d calculated using the QGSM with parameters taken from Ref. [4] (Set (γd)). The distribution on θ_d for the a_0^+ contribution calculated within the Reggeized Nucleon Born Term Approach (RNBTA) is presented by the dotted curve. The RNBTA predicts a sharp forward peak similarly to the nonrelativistic two-step model. Therefore, both models — TSM and RNBTA — are not able to reproduce the experimental distribution on θ_d [3]. The best agreement with the data (bold solid line) is obtained when the a_0^+ production is described by the QGSM with parameters of the Set $(a_0 d)$.

Therefore, the QGSM gives a rather good description of the ANKE data on the reaction $pp \to dK^+\bar{K}^0$ at Q=46 MeV [3] simultaneously with the forward differential cross section of the reaction $pp \to da_0^+$ measured at LBL at 3.8, 4.5 and 6.3 GeV/c [2].

In Fig. 2 we present the predictions for the angular and mass distributions at $Q = 110$ MeV where corresponding data from ANKE are expected soon. It is important to note that our model for the $pp \to d\bar{K}^0 K^+$ reaction predicts that the ratio of the P-wave background to the a_0^+ contribution increases by a factor of 3. Therefore, the background contribution is expected to be about 40% at $Q = 110$ MeV. As seen from Fig. 2 most of the events related to the a_0^+ resonance are concentrated in the lower part of the $K^+\bar{K}^0$ mass spectrum, whereas the main contribution of the $K^+\bar{K}^0$ P-wave background occurs at higher invariant masses. Therefore the a_0^+ resonance contribution can be separated from the background.

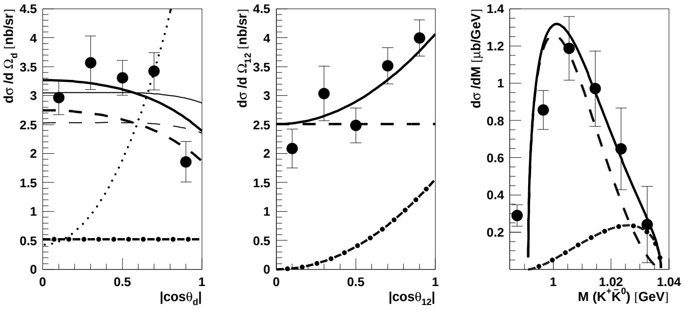

Fig. 1: Angular and invariant mass distributions for the $pp \to dK^+\bar{K}^0$ reaction at $Q = 46$ MeV in comparison with the data [3].

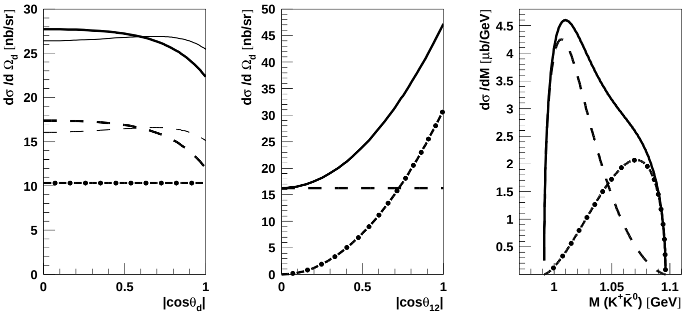

Fig. 2: Angular and invariant mass distributions for the $pp \to dK^+\bar{K}^0$ reaction at $Q = 110$ MeV.

We conclude that the experimental program on the study of near-threshold a_0 and f_0 production in pp, pn, pd and dd interactions at COSY-Jülich [5] seems promising because the a_0 signal in $K\bar{K}$ decay channel can reliably be separated from the non-resonant $K\bar{K}$ background.

References:

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