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On the possibility of f_0 observation in low energy pp collisions*

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Abstract. Within the meson-exchange model we calculate f_0-meson production cross section in πN and NN reactions and investigate the possibility for f_0 observation via the $K\bar{K}$ decay mode in pp collisions. Our studies indicate that an extraction of the f_0 signal is unlikely due to the large background from other reaction channels.

PACS. 13.75.Cs Nucleon-nucleon interactions – 13.75.Gx Pion-baryon interactions

1 Introduction

The status of the scalar f_0-meson is still an open problem in particle physics. In the 1996 Review of Particle Physics [1] the f_0 decay modes were announced as $78.1 \pm 2.4\%$ for the $\pi\pi$ and $21.9 \pm 2.4\%$ for the $K\bar{K}$-channel. In the 1998 Review [2], however, the $f_0 \to \pi\pi$ mode is established as *dominant*, while the $f_0 \to K\bar{K}$ mode is stated as *seen*.

A recent theoretical status of the problem has been presented by Oller and Oset [3] and Krehl, Rapp and Speth [4]. Here we do not attempt to add a further summary on the problem, but discuss the possibility for a direct observation of f_0-mesons in low energy proton-proton collisions. Our study is relevant to the measurement of K^+K^- spectra from pp interactions performed recently by the DISTO Collaboration at SATURNE [5] as well as to the current experimental program at COSY [6].

It is well known that the resonance spectral function is distorted if one of the resonance decay channels has a threshold within the resonance width [7]. A classical example is the scalar f_0-meson with a pole mass slightly below the $K\bar{K}$ threshold, but due to the finite f_0 width this decay channel is kinematically allowed. This leads to an enhanced $K\bar{K}$ production close to the two kaon mass and was observed experimentally in πN reactions [8–14]. Moreover, as was proposed by Bashinskii and Kerbikov [15], similar phenomena can be directly observed in the $pd \to ^3 HeX$ reaction close to the $K\bar{K}$ threshold.

Here we focus on the $K\bar{K}$ production in pp reactions. We start with the paradigm proposed by Morgan and Pennington [16,17] and use the Breit-Wigner resonance prescription for the f_0-meson, though keeping in mind the simplicity of the BW approximation as e.g. pointed out by Janssen et al. [18].

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2 The reaction $\pi N \to f_0 N$

In order to test the validity of the approach [16,17] we start with the $\pi N \to f_0 N \to K\bar{K}N$ reaction. The relevant one-pion exchange diagram is shown in Fig. 1; the corresponding differential cross section can be calculated as

$$\frac{d\sigma}{dM} = \int_{t_{min}}^{t_{max}} dt \; \frac{1}{2^8 \pi^3 \; s} \; \frac{|\mathbf{k}|}{|\mathbf{q}|^2} |M_{if}|^2, \tag{1}$$

where M is the invariant $K\bar{K}$-mass, s is the total energy of the pion-nucleon system squared, $\mathbf{q}$ is the pion three-momentum in the πN center-of-mass frame, while $\mathbf{k}$ is the kaon three-momentum in the f_0 rest frame and $|\mathbf{k}| = \sqrt{M^2 - 4m_K^2}/2$. In (1) t stands for the transfered four-momentum squared $t = (p_2' - p_2)^2$, where p_2, p_2' are the four-momenta of the nucleons in the initial and final states.

The matrix element in Eq. (1) is given by

$$M_{if} = g_{\pi NN} \; \bar{u}(p_2') \; i \; \gamma_5 u(p_2) \; \frac{A_{\pi\pi \to KK}(M)}{t - m_\pi^2} \times F_{\pi NN}(t) \; F_{f_0 \pi\pi}(t). \tag{2}$$

In principle, the $\pi\pi \to K\bar{K}$ amplitude can be taken as a K-matrix solution from the coupled channel analysis of the experimental data on πp and $\bar{p}p$ reactions (cf. Anisovich et al. [14]). Another way is to adopt the Breit-Wigner approach and to define the $\pi\pi \to K\bar{K}$ amplitude as

$$A_{\pi\pi \to KK}(M) = \frac{g_{f_0 \pi\pi} \; g_{f_0 KK}}{M^2 - m_{f_0}^2 + i \, m_{f_0} \Gamma_{tot}(M)}, \tag{3}$$

where $g_{f_0\pi\pi}$ and $g_{f_0 KK}$ denote the coupling constants, while m_{f_0} and Γ_{tot} are the mass and width of the f_0-meson, respectively. Finally, the squared matrix element –

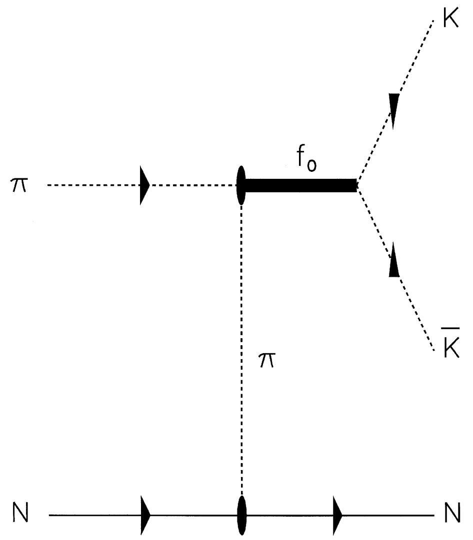

Fig. 1. Diagram for the $\pi N \to f_0 N \to K\bar{K}N$ reaction

averaged over the initial and summed over the final states – is given as

$$|M_{if}|^2 = \frac{g^2_{\pi NN}\ g^2_{f_0\pi\pi}\ g^2_{f_0KK}}{(M^2 - m^2_{f_0})^2 + m^2_{f_0}\Gamma^2_{tot}(M)} \times \frac{-t}{(t - m^2_\pi)^2}\ F^2_{\pi NN}(t)\ F^2_{f_0\pi\pi}(t), \qquad (4)$$

where $F_{\pi NN}$ is the form factor at the πNN vertex taken in the monopole form

$$F(t) = \frac{\Lambda^2 - m^2_\pi}{\Lambda^2 - t} \qquad (5)$$

with a cut-off parameter $\Lambda = 1.05$ GeV [20]. The πNN coupling constant is $g^2_{\pi NN}/4\pi = 14.4$ [19]. $F_{f_0\pi\pi}$ is the form factor at the $f_0\pi\pi$ vertex taken as in (5) with $\Lambda = 1.05$ GeV again. Note that (4) is valid only for low pion energies, since at high energies one needs to Reggeize the reaction amplitude similar to [14,21]. Since the $\pi N \to f_0 N \to K\bar{K}N$ cross section depends upon the product $g^2_{f_0\pi\pi}\cdot\ g^2_{f_0KK}$ of the squared couplings and not their values itself, one can fit only the product of the coupling constants by experimental data.

The dominant f_0-meson decay channels are the pion and kaon modes [2]. Neglecting other possible modes with extremely small decay branching ratios Br, one has to saturate the unitarity condition:

$$Br(f_0 \to \pi\pi) + Br(f_0 \to K\bar{K}) = 1. \qquad (6)$$

The branching ratios $Br(f_0 \to \pi\pi)$ and $Br(f_0 \to K\bar{K})$ are given by integrals of the Breit-Wigner distribution over the invariant mass of the final particles [22]:

$$Br(f_0 \to \pi\pi) = \int_{2m_\pi}^{\infty} \frac{2dM}{\pi} \frac{M\ m_{f_0}\ \Gamma_{f_0\pi\pi}(M)}{(M^2 - m^2_{f_0})^2 + m^2_{f_0}\Gamma^2_{tot}(M)} \qquad (7)$$

$$Br(f_0 \to K\bar{K}) = \int_{2m_K}^{\infty} \frac{2dM}{\pi} \frac{M\ m_{f_0}\ \Gamma_{f_0KK}(M)}{(M^2 - m^2_{f_0})^2 + m^2_{f_0}\Gamma^2_{tot}(M)},$$

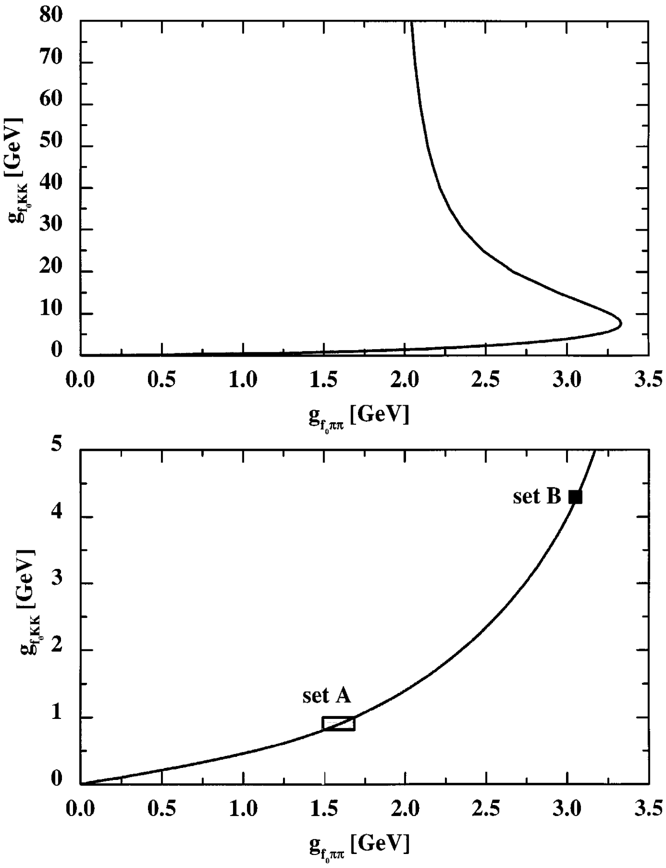

Fig. 2. Dependence of the coupling constants $g_{f_0K\bar{K}}$ on $g_{f_0\pi\pi}$ according to the unitarity condition (6). *Set B* denotes the constants evaluated with the f_0 properties from the 1996 Review of Particle Physics [1]. *Set A* is our present estimation (see text)

where the total width of the f_0-meson is defined as

$$\Gamma_{tot}(M) = \begin{cases} \Gamma_{f_0\pi\pi}(M), \\ \text{if } M \le 2m_K\,, \\ \Gamma_{f_0\pi\pi}(M) + \Gamma_{f_0KK}(M), \\ \text{if } M \ge 2m_K, \end{cases} \qquad (8)$$

and the partial decay widths $f_0 \to \pi\pi$ and $f_0 \to K\bar{K}$ are related to the relevant coupling constants as

$$\Gamma_{f_0\pi\pi}(M) = \frac{g^2_{f_0\pi\pi}}{16\pi} \frac{\sqrt{M^2 - 4m^2_\pi}}{M^2}, \qquad (9)$$
$$\Gamma_{f_0KK}(M) = \frac{g^2_{f_0KK}}{16\pi} \frac{\sqrt{M^2 - 4m^2_K}}{M^2}.$$

Substituting (7), (8) and (9) into (6) one finds that formula (6) provides a unique relation between the coupling constants $g_{f_0\pi\pi}$ and $g_{f_0K\bar{K}}$. Figure 2 shows the result of our numerical solution of (6). The upper part of Fig. 2 displays g_{f_0KK} as a function of $g_{f_0\pi\pi}$ in a wide range. The maximum value of $g_{f_0\pi\pi}$ is found to be $\simeq$3.33 and it approaches an asymptotic value of 1.93, whereas g_{f_0KK} always increases with $g_{f_0\pi\pi}$ for values below 3.33. The lower part of Fig. 2 shows the latter range for $g_{f_0\pi\pi}$ and g_{f_0KK} on a larger scale.

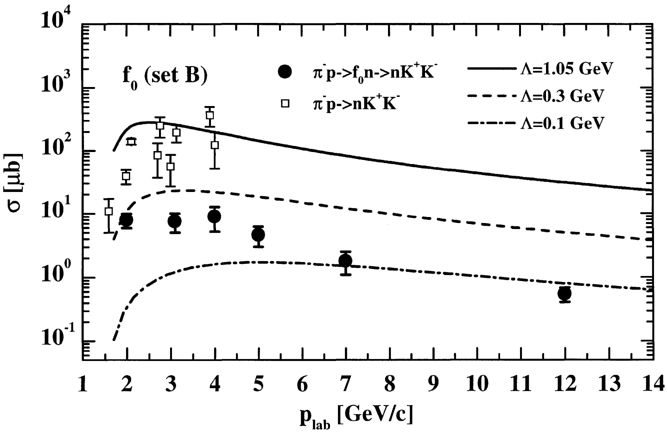

Fig. 3. The $\pi^-p \to f_0 n \to K^+K^-n$ and $\pi^-p \to K^+K^-n$ cross sections. The lines show calculations with the coupling constants from *set B* for different cut-off parameters at the $f_0\pi\pi$ vertex. The experimental data are from Refs. [8,9,23]

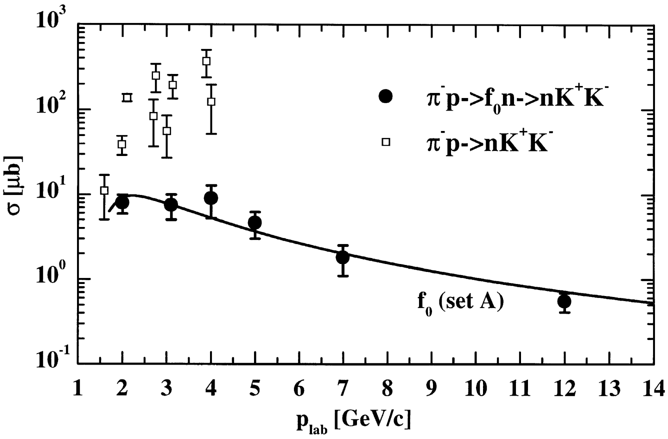

Fig. 4. The $\pi^-p \to f_0 n \to K^+K^-n$ (full dots) and $\pi^-p \to nK^+K^-$ (open squares) cross sections from Refs. [8,9,23]. The solid line shows the calculation with the coupling constants from *set A*.

In order to fix the $f_0\pi\pi$ and $f_0K\bar{K}$ coupling constants individually one needs the explicit knowledge of one of the branching ratios. For instance, taking $Br(f_0 \to \pi\pi)$ =78.1% [1] we obtain $g_{f_0\pi\pi}$=3.05 GeV and g_{f_0KK}=4.3 GeV; according to (9) and (8) the total f_0 width then amounts to 233 MeV. Figure 2 shows this solution as *set B*.

The $\pi^-p \to f_0 n \to K^+K^-n$ total cross section calculated with *set B* is shown by the solid line in Fig. 3 and overestimate the experimental data collected in Refs. [8,9]. Figure 3 also shows the data [23] for the $\pi^-p \to K^+K^-n$ cross section, which is substantially above the $\pi^-p \to f_0 n$ data since it includes other production mechanisms as e.g. proposed in Ref. [24].

In principle, to fit the $\pi^-p \to f_0 n \to K^+K^-n$ data with the coupling constants from *set B* one might adjust the cut-off Λ in (5) at the $f_0\pi\pi$ vertex as a free parameter. Figure 3 shows the calculations with Λ=0.3 GeV and Λ=0.1 GeV, which are roughly in line with the absolute magnitude for the $\pi^-p \to f_0 n$ cross section but contradict its energy dependence.

We conclude that it is not possible to describe the experimental data on the $\pi^-p \to f_0 n \to K^+K^-n$ reaction adopting the $f_0\pi\pi$ and $f_0K\bar{K}$ coupling constants from *set B*. Moreover, as was shown above, *set B* yields a large total width for the f_0-meson (233 MeV) that is out of the range Γ_{f_0}=40-100 MeV quoted in the 1996-estimation from the Particle Data Group [1].

We now fit the data [8,9] on the $\pi^-p \to f_0 n \to K^+K^-n$ cross section by taking the product of the $g_{f_0\pi\pi}$ and g_{f_0KK} coupling constants as a free parameter. The result is shown in Fig. 4. Our solution for the product of the coupling constants is shown in Fig. 2 as *set A* ($g_{f_0\pi\pi}$=1.49 GeV, g_{f_0KK}=0.82 GeV) that leads to the following f_0-meson properties:

$$\begin{aligned} Br(f_0 \to \pi\pi) &= 98\% \\ Br(f_0 \to K\bar{K}) &= 2\% \\ \Gamma_{tot} &= 44.3 \text{ MeV}, \end{aligned} \tag{10}$$

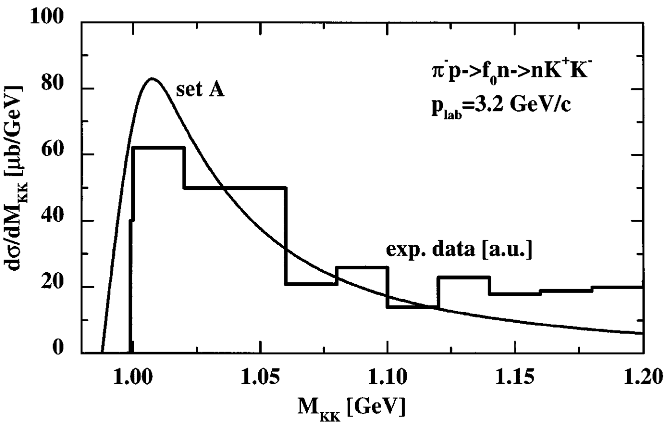

Fig. 5. The $K\bar{K}$ invariant mass distribution from π^-p reactions at 3.2 GeV/c. The histogram shows the experimental data from Ref. [8] while the solid line is our calculation with *set A*.

which are in a nice agreement with the numbers from the recent Review of Particle Physics [2].

Figure 5 displays the $K\bar{K}$ invariant mass spectrum from π^-p collisions at a beam momentum of 3.2 GeV/c in comparison to the experimental data from [8]. The solid line in Fig. 5 indicates our calculation with the parameters from *set A* which reasonably describes the experimental spectrum.

3 The reaction $NN \to f_0 NN$

The relevant diagrams for the $NN \to f_0 NN \to K\bar{K}NN$ reaction are shown in Fig. 6; the corresponding differential cross section is given as

$$\frac{d\sigma}{dM} = \int dE_1' dq_0 d\cos\theta_q \, d\varphi_q \, \frac{1}{2^{11}\pi^6\sqrt{s}} \, \frac{|\mathbf{k}|}{|\mathbf{p}_1|} \, |M_{if}|^2, \tag{11}$$

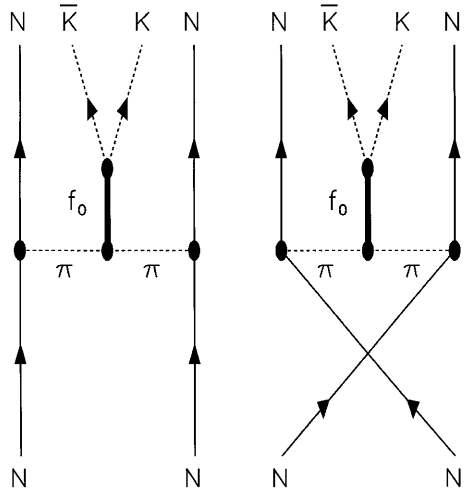

Fig. 6. The diagrams for the $NN \to f_0 NN \to K\bar{K}NN$ reaction.

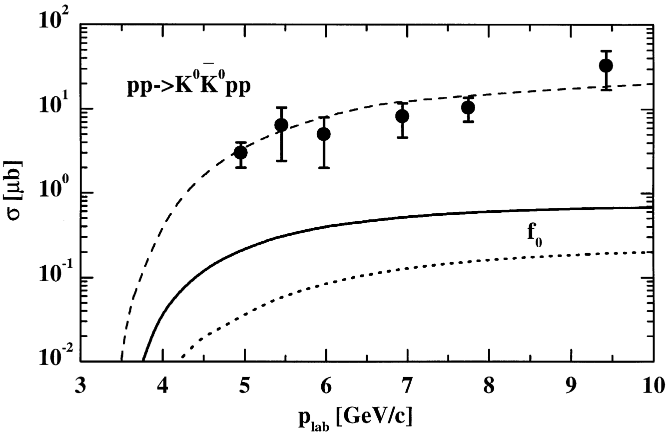

Fig. 7. The $pp \to f_0 pp \to K^0\bar{K}^0 pp$ cross section calculated with coupling constants from *set A* and with (dotted line) and without form factor (solid line) at the $f_0\pi\pi$ vertex. The experimental data for the $pp \to K^0\bar{K}^0 pp$ reaction are taken from Ref. [23], while the dashed line shows the corresponding calculation within the one-boson exchange model from Ref. [24].

with the matrix element taken as the sum of the direct and exchange terms in Fig. 6,

$$\begin{aligned} M_{if} &= g^2_{\pi NN}\ \bar{u}(p'_1)\ i\ \gamma_5\ u(p_1)\ \frac{A_{\pi\pi\to KK}(M)}{(q_1^2 - m_\pi^2)(q_2^2 - m_\pi^2)} \\ &\times \bar{u}(p'_2)\ i\ \gamma_5\ u(p_2)\ F_{\pi NN}(q_1^2)\ F_{\pi NN}(q_2^2) \\ &- g^2_{\pi NN}\ \bar{u}(p'_1)\ i\ \gamma_5\ u(p_2)\ \frac{A_{\pi\pi\to KK}(M)}{(\tilde{q}_1^2 - m_\pi^2)(\tilde{q}_2^2 - m_\pi^2)} \\ &\times \bar{u}(p'_2)\ i\ \gamma_5\ u(p_1)\ F_{\pi NN}(\tilde{q}_1^2)\ F_{\pi NN}(\tilde{q}_2^2), \end{aligned} \quad (12)$$

where $\mathbf{k}$ is the kaon three-momentum in the f_0-rest frame, p_1 and p_2 are the four-momenta of the initial nucleons, while p'_1 and p'_2 are the four-momenta of the final nucleons. Moreover, $\mathbf{p_1}$ is the three-momentum of the initial nucleon in their center-of-mass frame (cms), E'_1 is the energy of the final nucleon in the cms, q_0 and $\mathbf{q}$ are the energy and three-momentum of the kaon pair in the cms, respectively. In (12) θ_q is the polar angle of the vector $\mathbf{q}$ in the cms defined as $\theta_q = \widehat{\mathbf{q}, \mathbf{p_1}}$, while φ_q is the azimuthal angle of $\mathbf{q}$ in the cms. The transfered 4-momenta are defined as: $q_1 = p'_1 - p_1$, $q_2 = p_2 - p'_2$, $\tilde{q}_1 = p'_1 - p_2$ and $\tilde{q}_2 = p_1 - p'_2$, while M denotes the invariant mass of the $K\bar{K}$-system.

The square of the matrix element (12) – averaged over the initial and summed over the final states – is given by

$$\begin{aligned} |M_{if}|^2 = &\frac{g^4_{\pi NN}\ g^2_{f_0\pi\pi}\ g^2_{f_0 KK}}{(M^2 - m^2_{f_0})^2 + m^2_{f_0}\Gamma^2_{tot}(M)} \\ &\times F^2_{\pi NN}(q_1^2)\ F^2_{\pi NN}(q_2^2) \frac{q_1^2\ q_2^2}{(q_1^2 - m_\pi^2)^2(q_2^2 - m_\pi^2)^2} \\ &+ \frac{g^4_{\pi NN}\ g^2_{f_0\pi\pi}\ g^2_{f_0 KK}}{(M^2 - m^2_{f_0})^2 + m^2_{f_0}\Gamma^2_{tot}(M)} \\ &\times F^2_{\pi NN}(\tilde{q}_1^2)\ F^2_{\pi NN}(\tilde{q}_2^2) \frac{\tilde{q}_1^2\ \tilde{q}_2^2}{(\tilde{q}_1^2 - m_\pi^2)^2(\tilde{q}_2^2 - m_\pi^2)^2} \\ &+\ interference\ term \end{aligned} \quad (13)$$

Actually one has to introduce a form factor at the $f_0\pi\pi$ vertex since both pions are off their mass-shell. Following the assumption from Refs. [25,26] we use the form

$$F_{f_0\pi\pi}(q_1^2, q_2^2) = F_{\pi NN}(q_1^2) F_{\pi NN}(q_2^2), \quad (14)$$

where the πNN form factor was taken as in (5) with a cut-off parameter Λ=1.05 GeV. The form factor (14) is normalized to unity at $q_1^2 = m_\pi^2$ and $q_2^2 = m_\pi^2$, which is consistent with the kinematical conditions for the determination of the $f_0\pi\pi$ coupling constant.

The dotted line in Fig. 7 shows the $pp \to f_0 pp \to K^0\bar{K}^0 pp$ cross section calculated with the coupling constants from *set A* and with the form factor (14) in comparison to the experimental data [23] for the $pp \to K^0\bar{K}^0 pp$ reaction. The dashed line shows the calculations within the pion and kaon exchange model from Ref. [24] for $K\bar{K}$ production. To estimate the maximal f_0 production cross section we neglect the form factor at the $f_0\pi\pi$ vertex and show the result in terms of the solid line in Fig. 7. Actually, the contribution from f_0 production to the total $pp \to K^0\bar{K}^0 pp$ cross section is almost negligible at high energies. However, a possible way for f_0 observation is due to the low energy part of the $K\bar{K}$ invariant mass spectrum.

We thus calculate the K^+K^- invariant mass spectrum from the $pp \to K^+K^- pp$ reaction at a beam energy of 2.85 GeV, which corresponds to the kinematical conditions for the DISTO experiment at SATURNE [5]. Since at this energy the ϕ-meson production becomes possible we include its contribution to the K^+K^- spectrum. The $pp \to \phi pp$ total cross section was taken from Ref. [27] and the K^+K^- invariant mass was distributed according to the Breit-Wigner resonance prescription with a full ϕ-meson width Γ_ϕ = 4.43 MeV and the branching ratio $Br(\phi \to K^+K^-) = 49.1\%$ [2].

The dotted line in Fig. 8 shows the K^+K^- invariant mass spectrum for the $pp \to \phi pp$ reaction while the dash-dotted line indicates the spectrum from the $pp \to K^+K^- pp$ reaction, which was calculated as in Ref. [24] on the basis

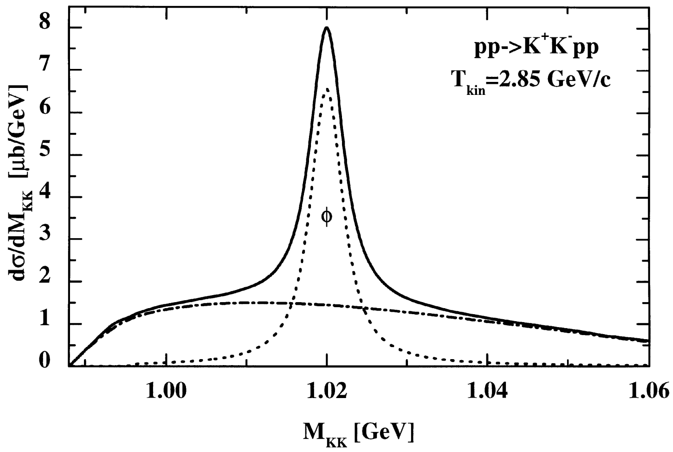

Fig. 8. The K^+K^- invariant mass distribution from pp collisions at 2.85 GeV. The dash-dotted line shows the contribution from K^+K^--pair production according to the OBE model from Ref. [24]; the dotted line is the spectrum from the $pp\to\phi pp$ reaction while the solid line illustrates their sum.

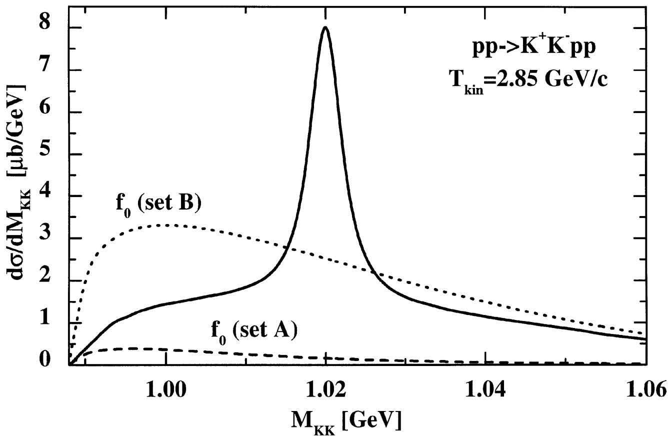

Fig. 9. The K^+K^- invariant mass distribution from pp collisions at 2.85 GeV. The solid line is the same as in Fig. 8. The dashed line shows the contribution from the $pp\to f_0pp\to K^+K^-pp$ reaction calculated with constants from *set A*, while the dotted line shows the result obtained with *set B*.

of pion and kaon exchange diagrams. The solid line in Fig. 8 shows the total K^+K^- spectrum.

To test the possibility for a direct f_0 observation via the K^+K^- spectrum from pp collisions one should compare the total K^+K^- production cross section from meson-exchange diagrams and ϕ-decay (denoted as background) with the explicit contribution from the $pp \to f_0pp \to K^+K^-pp$ reaction. The solid line in Fig. 9 shows the background while the dashed line indicates the K^+K^- spectrum calculated with the coupling constants from *set A* and without form factor at the $f_0\pi\pi$ vertex. If the $f_0\pi\pi$ and $f_0K\bar{K}$ coupling constants are determined by the *set A*, than it is quite obvious that the f_0-meson cannot be directly detected in pp collisions by using the K^+K^--mode. Note, that when introducing a form factor (14) at the $f_0\pi\pi$ vertex the contribution from $pp\to f_0pp\to K^+K^-pp$ becomes even smaller.

To test the sensitivity of the model upon the f_0 parameters we also perform the calculation with *set B* and show the result in terms of the dotted line in Fig. 9. Indeed, in that case the f_0 contribution is very strong at low K^+K^- invariant mass. Thus experimental data from DISTO might be crucial for the examination of the f_0 properties.

We also test the possibility for f_0 detection by use of the K^+K^- spectrum from pp collisions at energies very close to the $pp\to K^+K^-pp$ reaction threshold, i.e. for the kinematical conditions available at the COSY accelerator. Figure 10 shows our calculations for the excess energies $\sqrt{s} - 2m_N - 2m_K$ of 5 and 50 MeV. The dashed lines in Fig. 10 show the K^+K^- production calculated again in accordance with [24]. The solid lines correspond to our results obtained with the $f_0\pi\pi$ and $f_0K\bar{K}$ coupling constants from *set A*, while the dotted lines are calculations with *set B*. Note that the results shown in Fig. 10 are obtained without a form factor at the $f_0\pi\pi$ vertex, thus they should be considered as upper limits for the f_0-meson

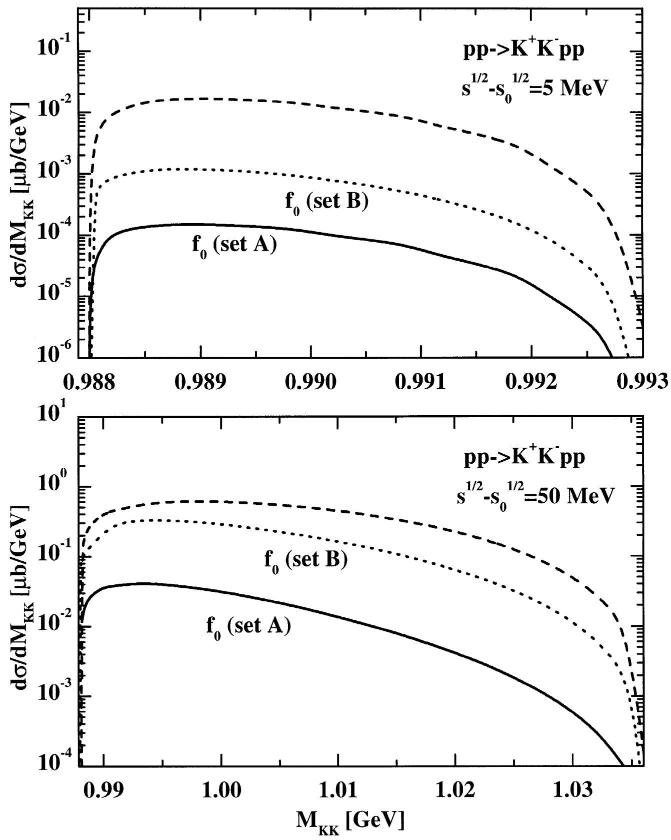

Fig. 10. The K^+K^- invariant mass distribution from pp collisions at excess energies of 5 (upper part) and 50 MeV (lower part). The dashed lines indicate the contribution from the $pp\to K^+K^-pp$ reaction according to Ref. [24]. The solid lines show the K^+K^- spectrum from the $pp\to f_0pp\to K^+K^-pp$ reaction calculated with the coupling constants from *set A*, while the dotted lines are the calculations with *set B*.

contribution. Furthermore, at an excess energy of 5 MeV strong final state interactions between the two protons should enhance the yield substantially. However, these final state interactions are of similar strength in both reaction channels and may be disregarded in their ratio, which is the relevant quantity here.

We conclude that at an excess energy of 5 MeV, i.e. very close to the $pp \to K^+K^-pp$ reaction threshold, the contribution from f_0-meson production is almost negligible and cannot be separated from the background processes. At $\sqrt{s} - 2m_N - 2m_K$=50 MeV the contribution from the $pp \to f_0 pp \to K^+K^-pp$ reaction, as a maximal estimation, is a few times less than the contribution from K^+K^--pair production due to pion and kaon exchange diagrams.

4 Conclusions

We have investigated the production of f_0-mesons in pp interactions and the possibility for its observation via the $f_0 \to K\bar{K}$ mode. Our calculations have been based upon the one-pion exchange model and a Breit-Wigner prescription for the f_0 resonance which allows for a quantitative estimate. The coupling constants at the $f_0\pi\pi$ and $f_0K\bar{K}$ verticies have been constraint by experimental data on the $\pi N \to f_0 N$ reaction; this approach gives a full f_0-meson width of 44.3 MeV and the branching ratios $Br(f_0 \to \pi\pi)$ = 98%, $Br(f_0 \to K\bar{K})$ = 2%. Our estimation is in line with the f_0 properties from the recent 1998 Review of Particle Physics [2], but substantially contradicts the numbers from the 1996-Review [1].

It is found that the K^+K^- invariant mass distribution from the $pp \to K^+K^-pp$ reaction at a beam energy of 2.85 GeV, which corresponds to the experimental condition for the DISTO experiment at SATURNE, might be sensitive to the f_0-meson properties. With the f_0 properties given by the 1996 Review of Particle Physics [1] the f_0 signal should be seen as an enhancement in the low energy part of the K^+K^--mass spectum. However, following our estimation, we do not expect such an enhancement and predict a K^+K^- invariant mass spectrum as shown in Fig. 9 (*set A*).

The possibility for the f_0-meson observation in $pp \to K\bar{K}pp$ reactions at near-threshold energies available at the COSY accelerator was studied, too. Our calculations indicate that no f_0 signal might be extracted from the K^+K^- invariant mass spectrum due to the large background contribution from other reaction channels [24] as arising from pion and kaon exchanges.

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References

1. Particle Data Group, Phys. Rev. D **54**, 1 (1996)
2. Particle Data Group, Eur. Phys. J. C **3**, 1 (1998)
3. J.A. Oller, E. Oset, hep-ph/9809337
4. O. Krehl, R. Rapp, J. Speth, Phys. Lett. B **390**, 23 (1997)
5. F. Balestra et al., Phys. Rev. Lett. **81**, 4572 (1998)
6. J. Smirsky, T. Lister, et al., COSY Proposal No. 46.1 (1997)
7. S.V. Bashinskii, R.L. Jaffe, Nucl. Phys. A **625**, 167 (1997)
8. O.I. Dahl, et al., Phys. Rev. **163**, 1377 (1967)
9. W. Beusch, et al., Phys. Lett. B **25**, 357 (1967)
10. A.J. Pawlicki, et al., Phys. Rev. D **12**, 631 (1975)
11. N.M. Cason, et al., Phys. Rev. Lett. **41**, 271 (1978)
12. D. Cohen, et al., Phys. Rev. D **22**, 2595 (1980)
13. A. Etkin, et al., Phys. Rev. D **25**, 1786 (1982)
14. V.V. Anisovich, et al., Phys. Lett. B **355**, 363 (1995)
15. S.V. Bashinskii, B. Kerbikov, Phys. Atom. Nucl. **59**, 1979 (1996)
16. D. Morgan, M.R. Pennington, Phys. Rev. D **48**, 1185 (1993)
17. D. Morgan, M.R. Pennington, Phys. Rev. D **48**, 5422 (1993)
18. G. Janssen, B.C. Pearce, K. Holinde, J. Speth, Phys. Rev. D **52**, 2690 (1995)
19. R. Machleid, K. Holinde, Ch. Elster, Phys. Rep. **149**, 1 (1987)
20. A. Sibirtsev, K. Tsushima, A.W. Thomas, Phys. Lett. B **421**, 59 (1998)
21. N.N. Achasov, G.N. Shestakov, Phys. At. Nucl. **60**, 1522 (1997)
22. N.N. Achasov, V.V. Gubin, Phys. Lett. B **363**, 106 (1995)
23. Landolt-Börnstein, *New Series*, ed. H. Schopper, I/12 (1988).
24. A.A. Sibirtsev, W. Cassing, C.M. Ko, Z. Phys. A **358**, 101 (1997)
25. W.S. Chung, G.Q. Li, C.M. Ko, Nucl. Phys. A **625**, 371 (1997)
26. K. Nakayama, A. Szczurek, C. Hanhart, J. Haidenbauer, J. Speth, Phys. Rev. C **57**, 1580 (1998)
27. A.A. Sibirtsev, Nucl. Phys. A **604**, 455 (1996)