

Shortcomings of the present $\pi^+\pi^-$ photoproduction models (from the $f_0(980)$ search perspective)

Łukasz Bibrzycki

State School of Higher Education, Oświęcim, Poland

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Results obtained with L. Leśniak, INP PAN, Cracow, Poland

Kinematic area of interest:

$$E_\gamma = 3-10 \text{ GeV}$$

$$|t| < 1 \text{ GeV}$$

$M_{\pi\pi} = 2m_\pi - 1.5 \text{ GeV}$. This encompasses the data of:

Ballam *et al.* (1972) - SLAC

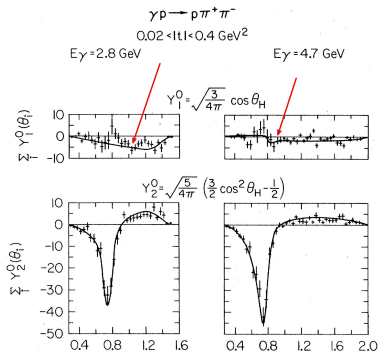
Struczinski *et al.* (1972) - DESY

Battaglieri *et al.* (2001) - CLAS

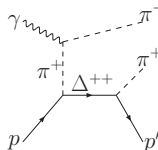
Battaglieri *et al.* (2009) - CLAS

Objective: to describe angular distributions of CLAS (and any forthcoming experiments) in terms of specific reaction mechanisms

Problems of the old and slightly newer models-Ballam analysis

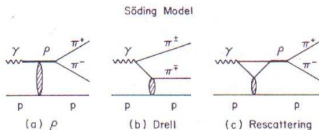


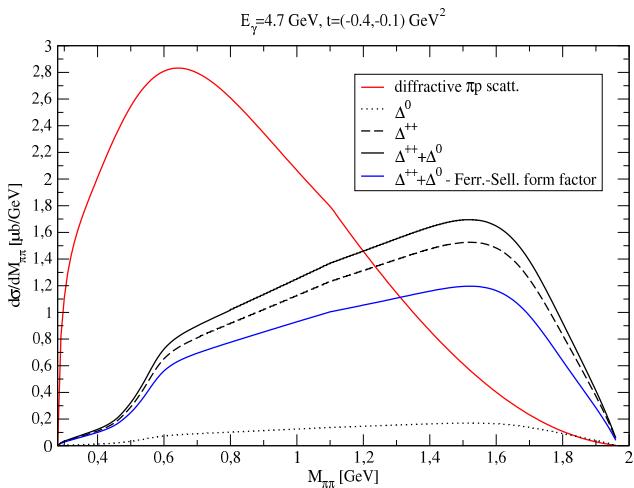
These were supplemented by Drell diagrams with resonant $\pi\pi$ interaction.



These were, however, added incoherently

$$W(\Omega) \sim |A_\rho + A_{Drell}|^2 + |A_\Delta|^2$$



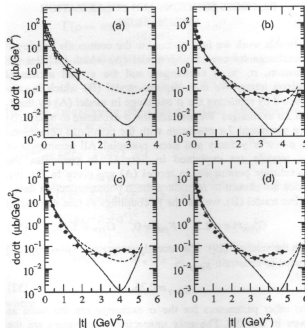
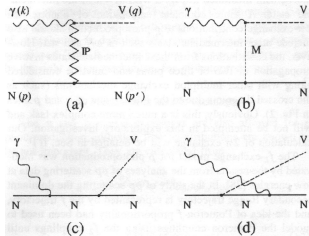


Interference of diffractive ρ photoproduction with “resonant” Drell amplitudes is important !

Contribution of the σ and $f_2(1270)$ exchange

Friman, Soyeur (1996), Laget (2000)

Oh, Lee (2004)



$M=\pi, \sigma, f_2(1270), V=\rho(770)$

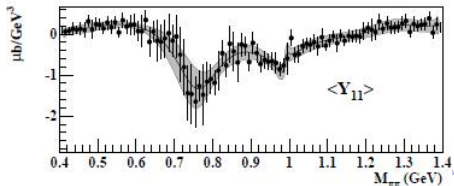
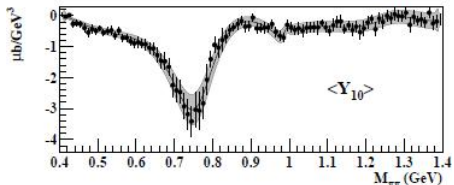
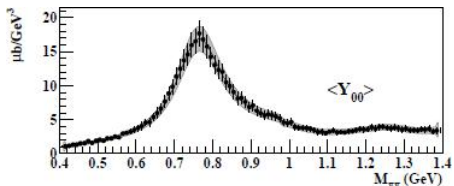
- Good cross section description (especially for small $|t|$)
- Likely problems with mass distributions due to the lack of Drell diagrams
- Large uncertainty as to the value of $g_{\gamma\rho\sigma}=0.25(\rho \rightarrow \sigma\gamma)$ -3.2(QCD sum rules, F&S fit)

This translates to: $2.6 < |g_{\gamma\rho\sigma} g_{NN\sigma}| < 36.0$

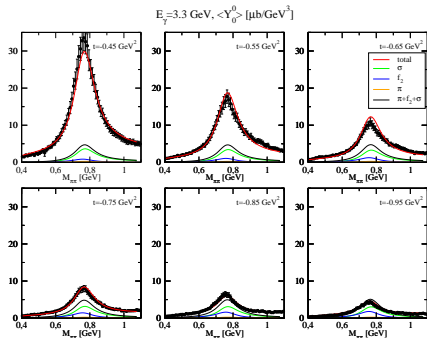
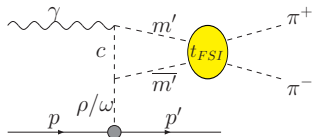
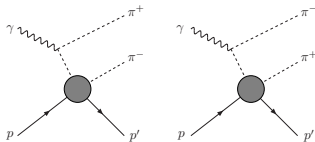
Now we have CLAS data

First measurement of direct $f_0(980)$ photoproduction on the proton

M. Battaglieri,¹ R. De Vita,¹ A. P. Szczepaniak,² K. P. Adhikari,³⁴ M. Aghaevyan,¹⁹ M.J. Amarian,³⁴ P. Ambrozewicz,¹⁴ M. Anghinolfi,¹ G. Asryan,⁴⁷ H. Avakian,⁴¹ H. Bagdasaryan,³⁴ N. Baillie,⁴⁶ J.P. Ball,⁴ N.A. Baltzell,⁴⁰ V. Batourine,^{36,41} I. Bedlinskyi,²¹ M. Bellis,⁷ N. Benmouna,¹⁶ B.L. Berman,¹⁶ L. Bibrzycki,²⁸ A.S. Biselli,¹³ C. Bookwalter,¹⁵ S. Bouchigny,²⁰ S. Boiarinov,⁴¹ R. Bradford,⁷ D. Branford,¹² W.J. Briscoe,¹⁶ W.K. Brooks,^{41,43} S. Bültmann,³⁴ V.D. Burkert,⁴¹ J.R. Calarco,²⁹ S.L. Careccia,³⁴ D.S. Carman,⁴¹ L. Casey,⁸ S. Chen,¹⁵ L. Cheng,⁸ E. Clinton,²⁷ P.L. Cole,¹⁸ P. Collins,⁴ D. Crabb,⁴⁵ H. Crannell,⁸ V. Crede,¹⁵ M. Csanád,³⁵ P. Daloz,¹⁸ A. Datta,³³ M. De Jure,⁴⁷ D. De Maessene,⁹ D. De Santis,¹⁹ M. D'Onofrio,⁴¹



Model supplemented with Drell amplitudes and $f_0(980)$ photoproduction



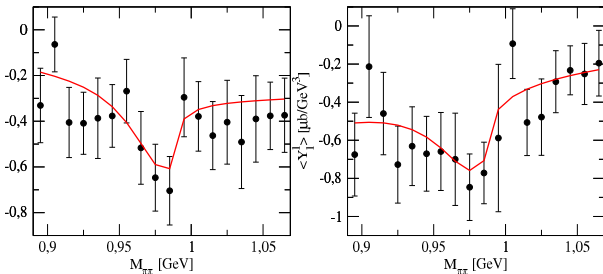
- Good description of mass distributions
- New estimation of the $|\mathcal{G}_{\gamma\rho\sigma}\mathcal{G}_{NN\sigma}| = 15.12 \pm 1.53$

Fit of the moments

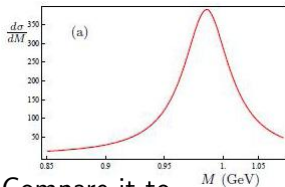
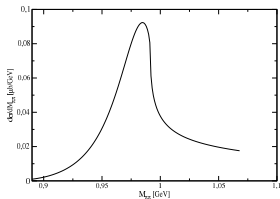
$$\langle Y_M^L(t, M_{\pi\pi}) \rangle = N \int d\Omega Y_M^L(\Omega) |A^P + A^\pi + A^\sigma + A^{f_2} + A^D + A^{f_0}|^2$$

e.g.:

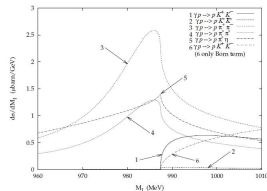
$$\begin{aligned} \langle Y_0^1 \rangle = & \frac{1}{\sqrt{4\pi}} \left[2\text{Re}(S_0^* P_0) + 2\sqrt{\frac{3}{5}} \text{Re}(P_{-1}^* D_{-1}) + \frac{4}{\sqrt{5}} \text{Re}(D_0^* P_0) \right. \\ & + 2\sqrt{\frac{3}{5}} \text{Re}(D_{+1}^* P_{+1}) + 2\sqrt{\frac{3}{7}} \text{Re}(D_{-2}^* F_{-2}) + 4\sqrt{\frac{6}{35}} \text{Re}(D_{-1}^* F_{-1}) \\ & \left. + 6\sqrt{\frac{3}{35}} \text{Re}(D_0^* F_0) + 4\sqrt{\frac{6}{35}} \text{Re}(D_{+1}^* F_{+1}) + 2\sqrt{\frac{3}{7}} \text{Re}(D_{+2}^* F_{+2}) + \dots \right] \\ & t=0.55 \text{ GeV}^2 \end{aligned}$$



S-wave mass distribution

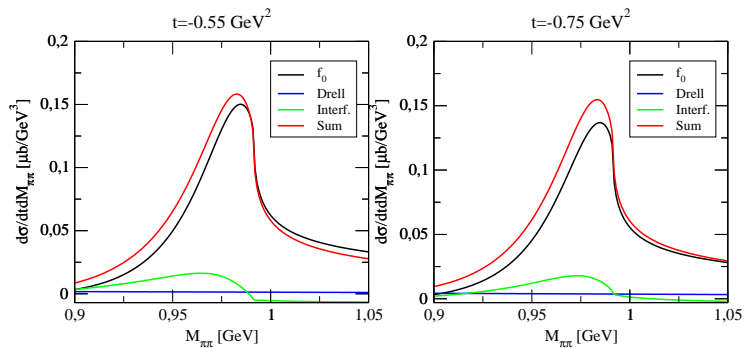


Compare it to...
Donnachie,
Kalashnikova(2008)
[in nb]



Marco, Oset, Toki(1999)

The role of interference



Caveats

- Problems in description of the moments for the masses lower and higher than $f_{(980)}$ region
- Impact of the $f_2(1270)$?
- Impact of other mechanisms (Kroll-Ruderman, baryonic cascades,...) ?

Oset et al. (2001)

