The reaction γ p -> $f_2(1270)$ p from double-π^0 data at CLAS

Ken Hicks, Ohio Univ. (for M. Carver and A. Celentano)

Workshop on Two-Meson Photoproduction

Jefferson Lab, Sept. 18, 2019

Background

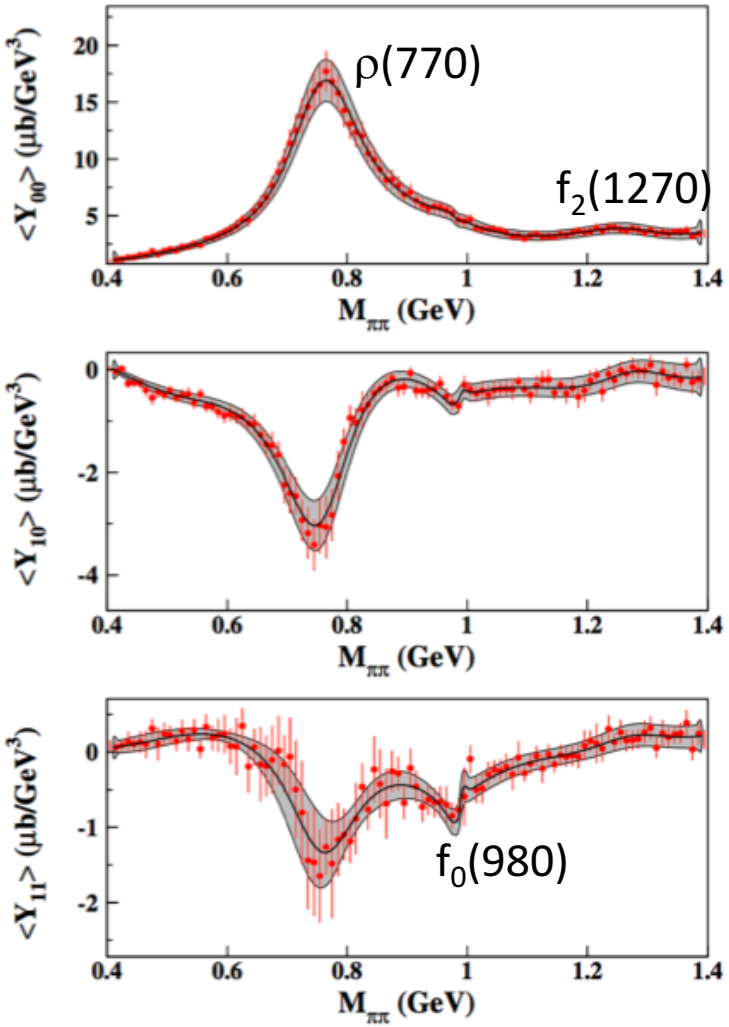
- The $f_2(1270)$ meson is the lowest-mass tensor meson, in the nonet that contains the $a_2(1320)$ and the $K^*_2(1430)$.
  - It is easily excited in photoproduction reactions.
  - The decay $f_2(1270) \rightarrow \pi\pi$ with B.R. = 84.2%.
  - Threshold for $\gamma p \rightarrow f_2\, p$ at W = 2.21 GeV, corresponding to E_γ = 2.13 GeV.
- The g12 data from CLAS contains a large number of $\pi^0\pi^0$ events.
  - These events are from 4γ events, where all hit the EC (at forward angles).
  - The analysis was initiated from the pre-sifted data files of A. Celentano, which were originally made for a different purpose.
  - The $\pi^0\pi^0$ final state was analyzed by M. Carver as a summer research project

Interest in the $f_2(1270)$

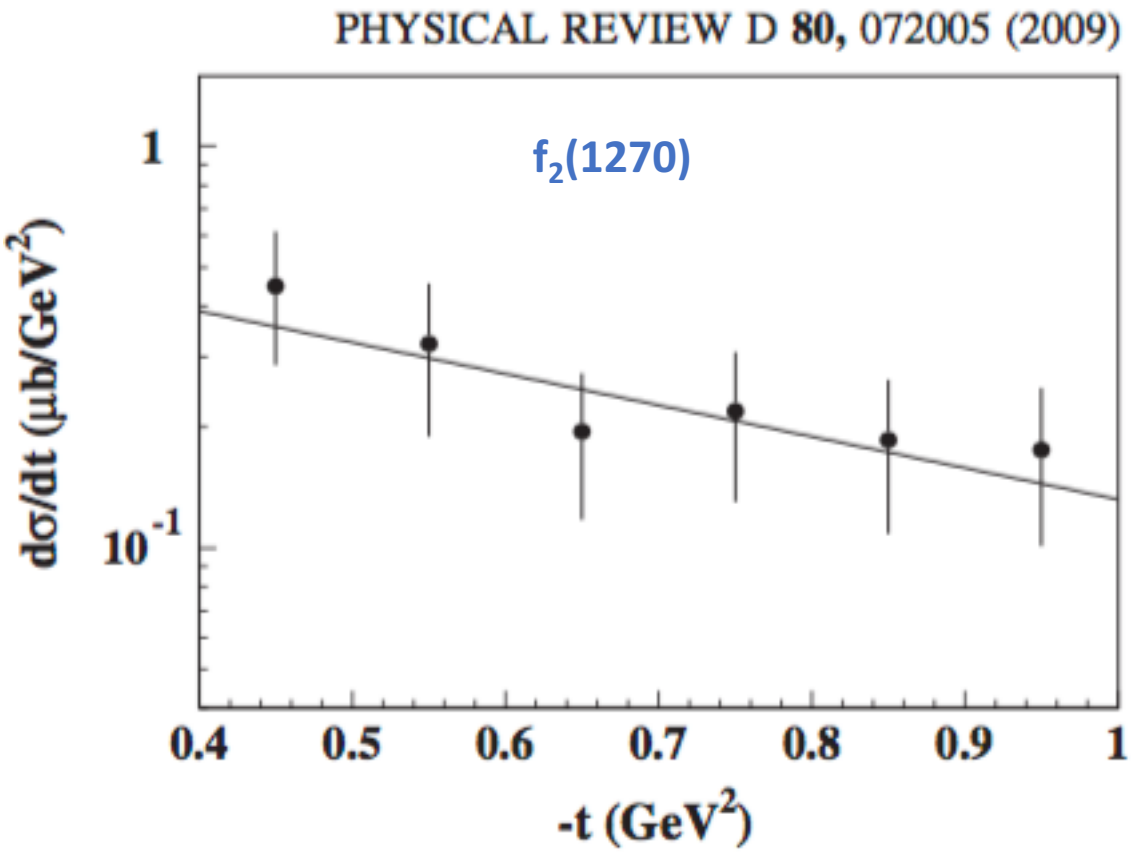
- There is possible mixing of the $J^{PC} = 2^{++}$ mesons with the 2^{++} glueball.
  - If we want to understand the glueball spectrum, we need to first understand the conventional tensor mesons
  - J/ψ decays to $\gamma+f_2(1270)$ requires 2 D-wave components: due to 2^{++} glueball?
    - Ref: Shen and Yu, PRD 40, 1517 (1989): "Glueball components of the meson $f_2(1270)$"
- Another proposal is that the $f_2(1270)$ is a $\rho-\rho$ molecule
  - Ref: Xie and Oset, Eur. Phys. J. A 51, 111 (2015)
  - Based on fits to older CLAS data: Battaglieri et al., PRD 80, 072005 (2009).
  - The CLAS data had large (>20%) error bars, based on $\pi^+\pi^-$ final state from g11.
  - Xie and Oset also predict an E_γ dependence to the total cross section.

CLAS g11 $\pi^+\pi^-$ analysis: Multipole Fits

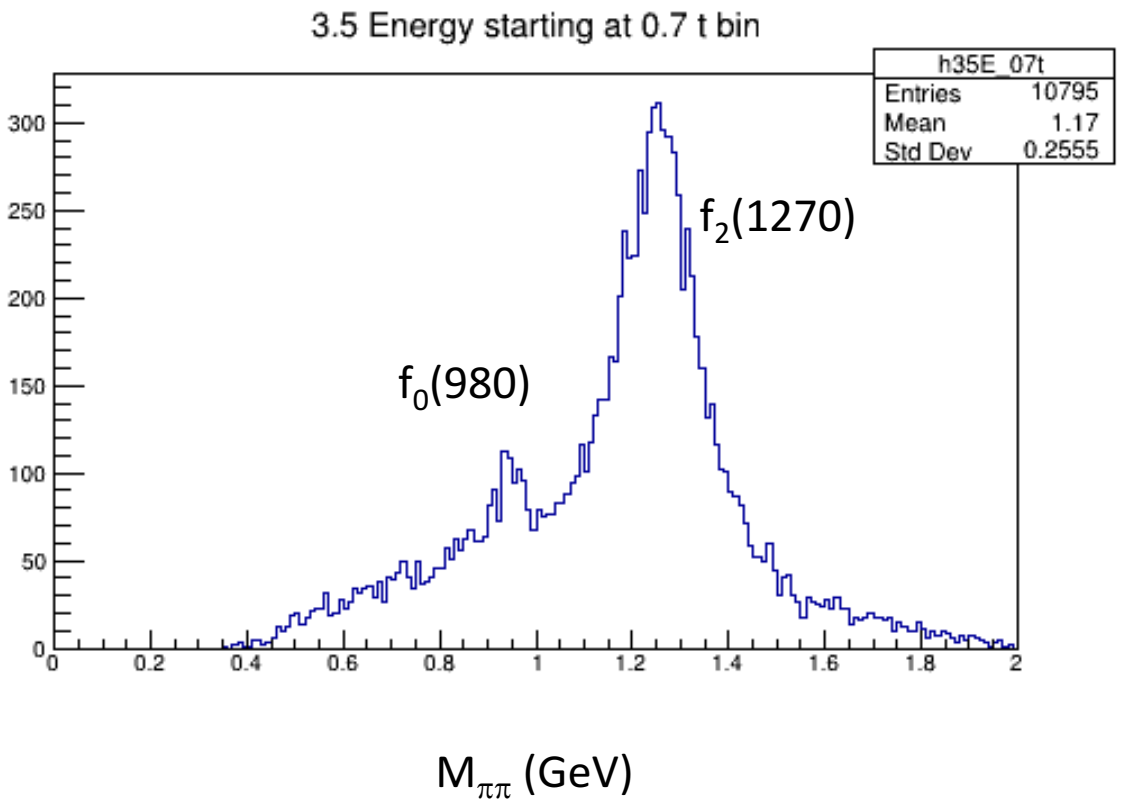
For one bin: E_γ=3.2-3.4 GeV, |t|=0.5-0.6.

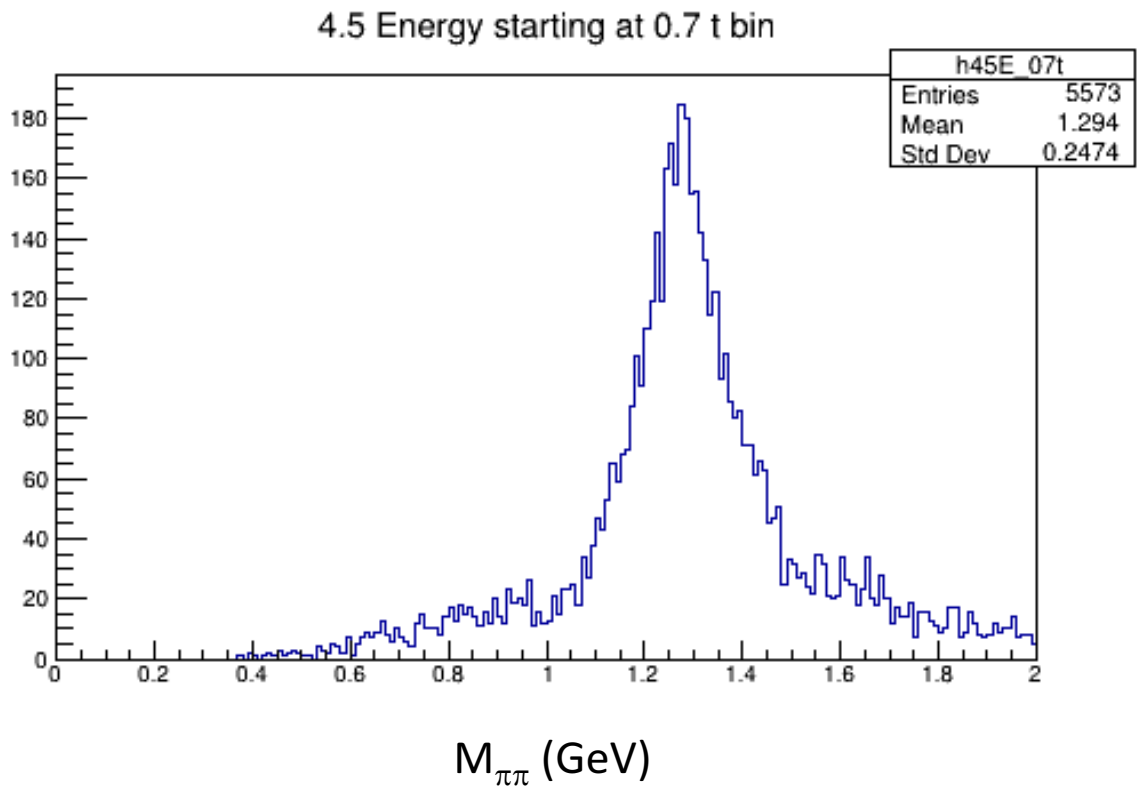


$M_{\pi\pi}$ = 1.19-1.46 GeV, for E_γ = 3.0-3.8 GeV



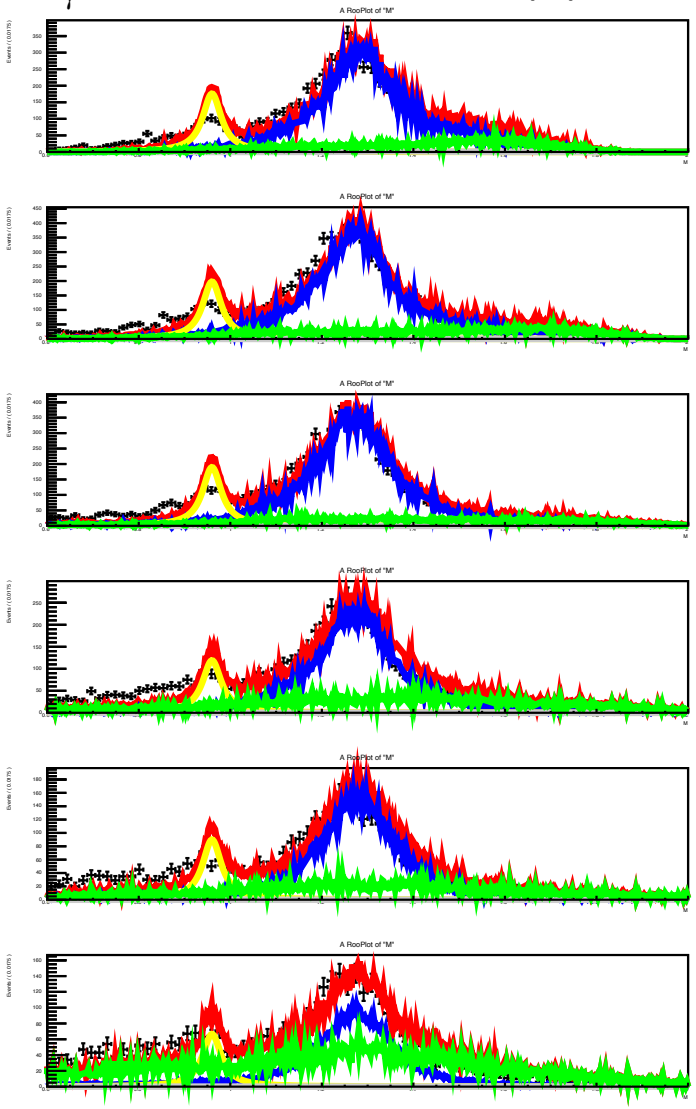
New g12 data using $\pi^0\pi^0$: no ρ background



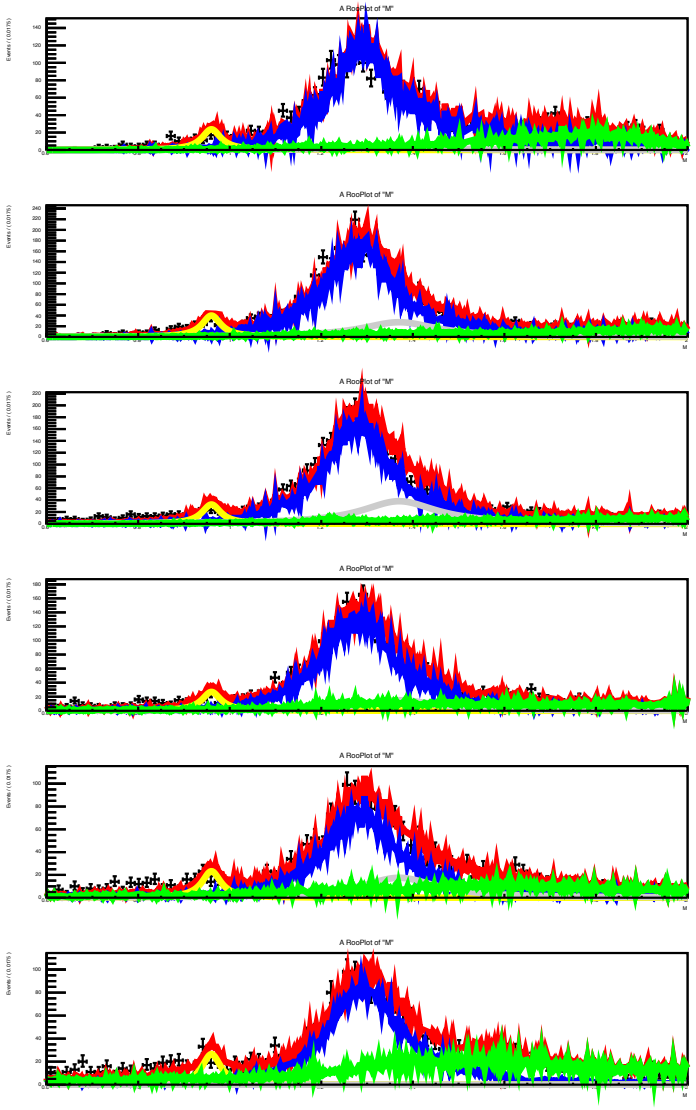


Preliminary fits to the g12 data

E_γ = 3.5-4.5 GeV, various |t| bins

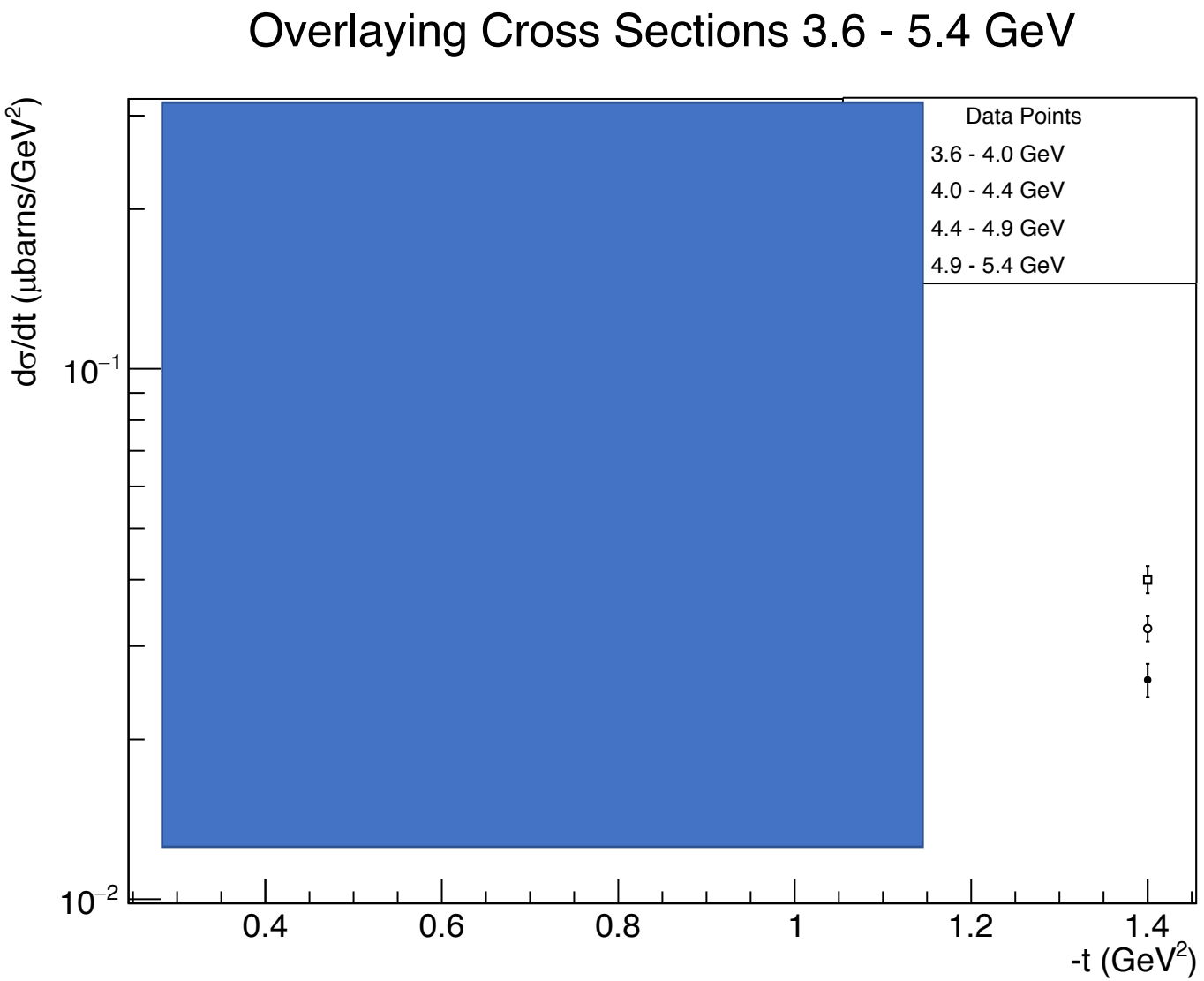


E_γ = 4.5-5.5 GeV, various |t| bins



Red: sum of all parts
Blue: $f_2(1270)$ peak
Green: phase space

VERY preliminary cross sections: DO NOT USE!

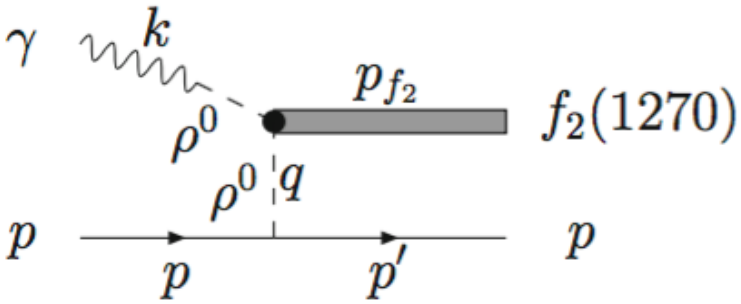


The take-away message is that the statistical error-bars are small.

Theory predictions

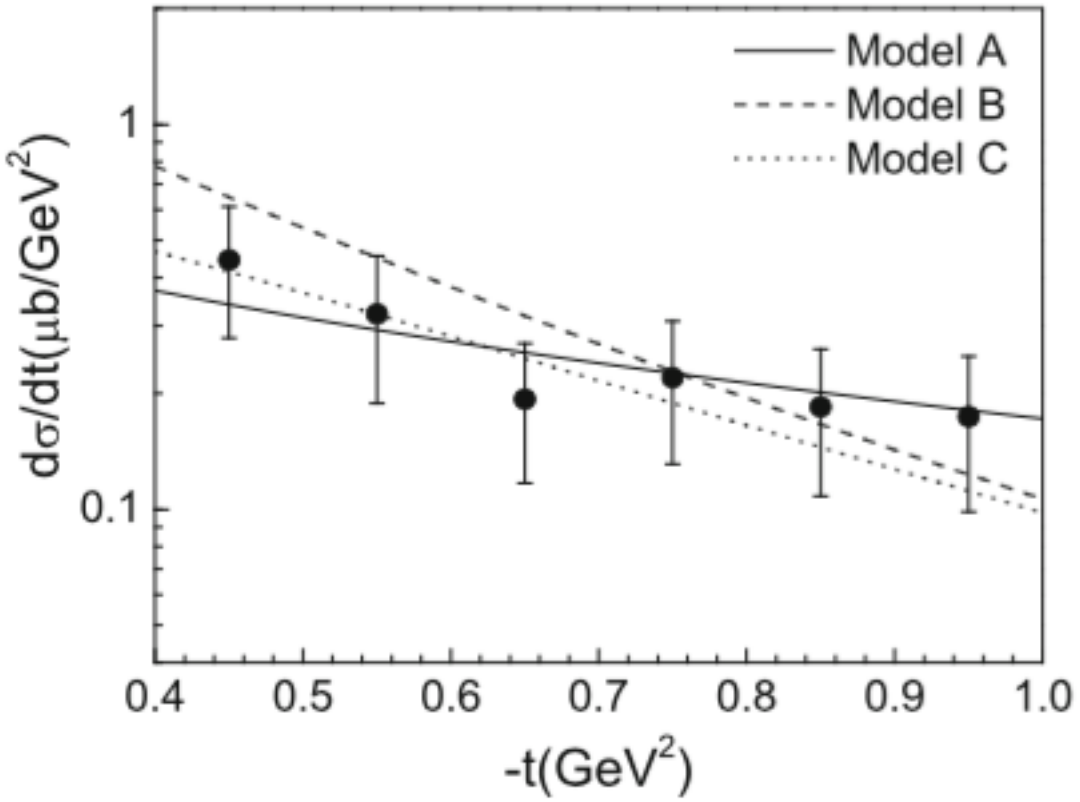
Xie and Oset: EPJ A 51, 111 (2015)

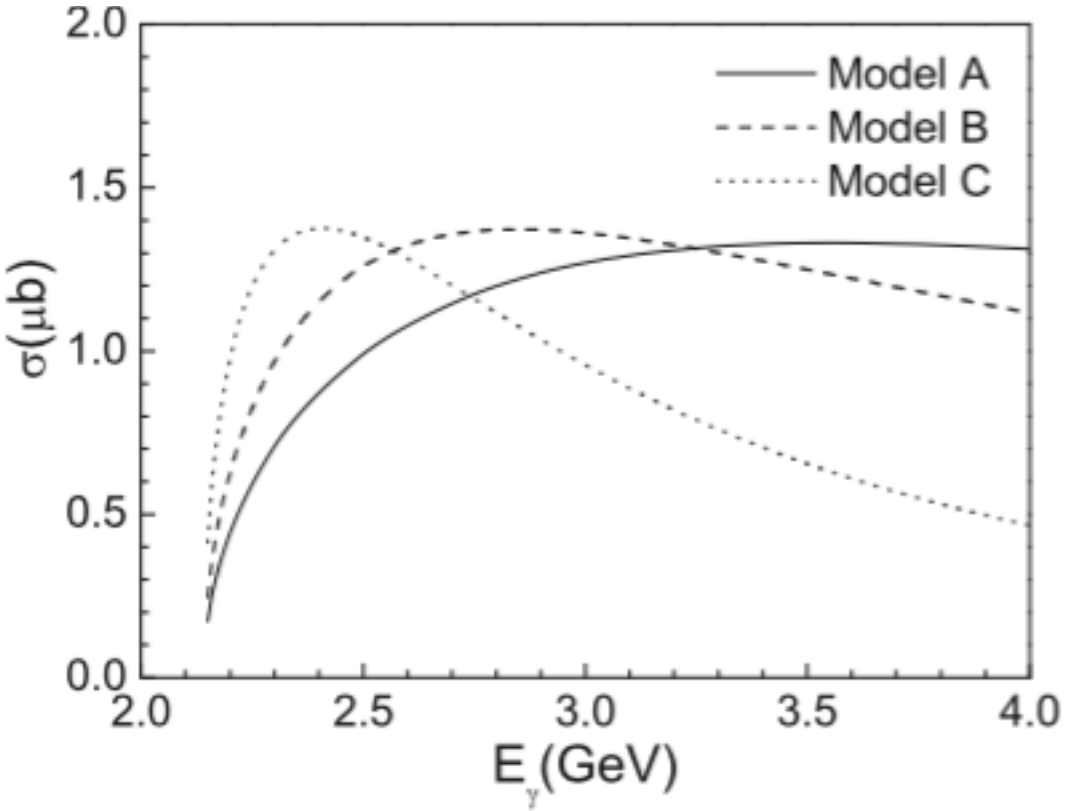
Data from Battaglieri, PRD 80 (2009)



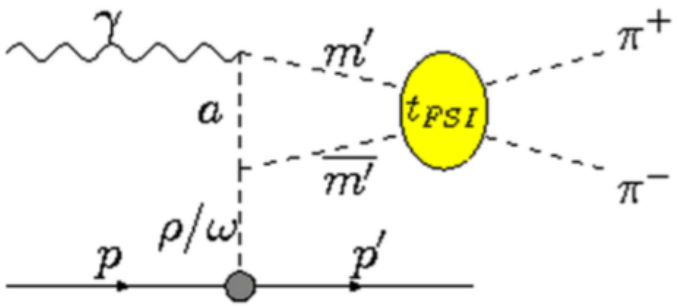
which gives a $\rho^0 pp$ vertex

$$-it_{\rho^0 pp} = ig_{\rho NN}\bar{p}\left(\gamma^\mu + \frac{i\kappa_\rho}{2m_N}\sigma^{\mu\nu}q_\nu\right)p\epsilon_\mu(\rho^0),$$





Question: can we use circ.-pol. γ's of g12?

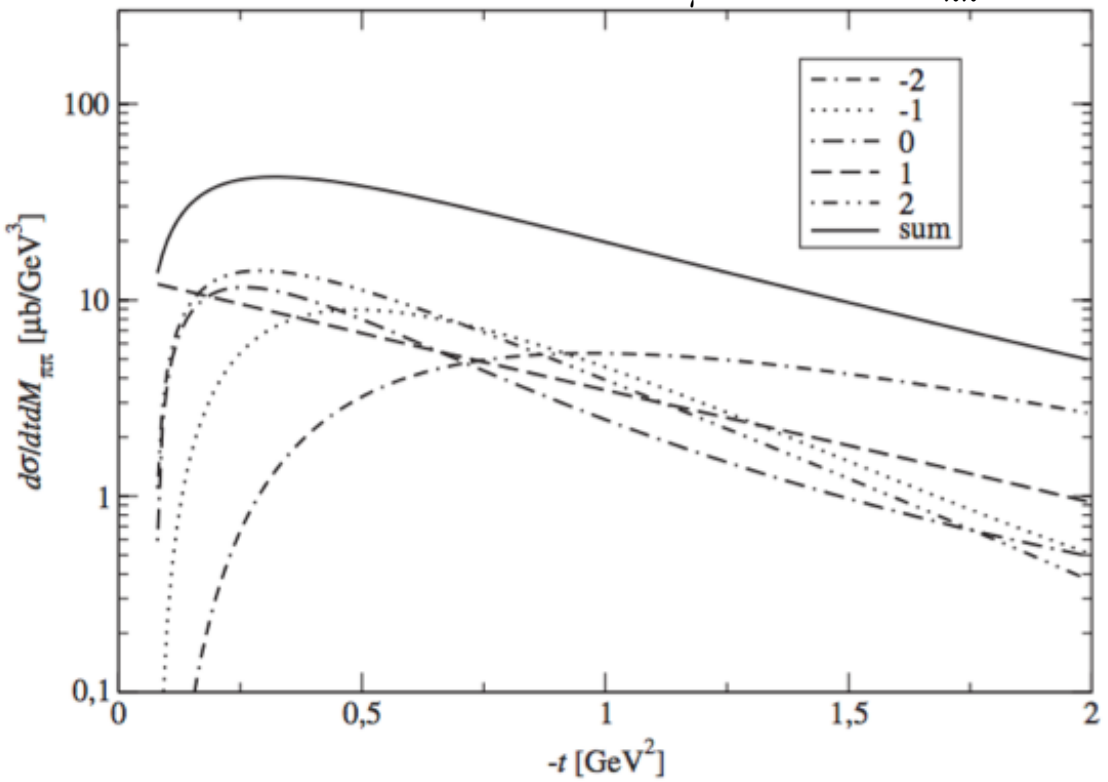


Bibrzycki and Kaminski, PRD 87, 114010 (2013).

parity transformation. So we choose the photon helicity $\lambda_\gamma = +1$ as a reference helicity and refer to amplitudes corresponding to various M as no flip, single flip (either up or down), double flip amplitudes, and so forth. From

The point here is that the t-dependence is very different for each M-substate. Can we use the polarization from g12 to see this?

Born cross sections for $\pi^0\pi^0$ at E_γ = 3.5 and $M_{\pi\pi}$ = 1.27



Summary

- There are good physics reasons for studying the $f_2(1270)$
  - Likely mixing with the tensor glueball
  - Possible ρ–ρ molecular coupling, which could be studied on the lattice.
- The previous photoproduction data from $\pi^+\pi^-$ is limited
  - Statistical errors are limited by huge ρ-meson background
  - Large E_γ range needed to average over is not good for comparison to theory
- New g12 data for $\pi^0\pi^0$ final state has good statistics
  - Smaller error bars, smaller bins in E_γ and $|t|$.
  - Also, the possibility of circular polarization. Is it useful here?