Recent Results on Light Meson Physics

Cesare Bini

Universita' "La Sapienza" and INFN Roma

Outline

1. New results on Scalar Mesons
2. A resonance close to $2M_p$?
3. Search for $J^{PC}=1^{-+}$ exotic states
4. Gluonium content of η'
5. Conclusions

1. New Results on Scalar Mesons

"Too many light scalars below 2 GeV"

I=0	I=1/2	I=1
f_0(400-1200) [σ]	κ(700)	a_0(980)
f_0(980)	K^*_0(1430)	a_0(1450)
f_0(1370)		
f_0(1500)		
f_0(1710)		

Particle Data Group "choice"

$N\ ^{2S+1}L_J$	J^{PC}	$u\bar{d}$, $u\bar{u}$, $d\bar{d}$ $I=1$	$u\bar{u}$, $d\bar{d}$, $s\bar{s}$ $I=0$	$c\bar{c}$ $I=0$	$b\bar{b}$ $I=0$	$\bar{s}u$, $\bar{s}d$ $I=1/2$	$c\bar{u}$, $c\bar{d}$ $I=1/2$	$c\bar{s}$ $I=0$	$\bar{b}u$, $\bar{b}d$ $I=1/2$	$\bar{b}s$ $I=0$	$\bar{b}c$ $I=0$
$1\ ^1S_0$	0^{-+}	π	η, η'	$\eta_c(1S)$	$\eta_b(1S)$	K	D	D_s	B	B_s	B_c
$1\ ^3S_1$	1^{--}	ρ	ω, ϕ	$J/\psi(1S)$	$\Upsilon(1S)$	$K^*(892)$	$D^*(2010)$	D_s^*	B^*	B_s^*	
$1\ ^1P_1$	1^{+-}	$b_1(1235)$	$h_1(1170)$, $h_1(1380)$	$h_c(1P)$		$K_{1B}{}^\dagger$	$D_1(2420)$	$D_{s1}(2536)$			
$1\ ^3P_0$	0^{++}	$a_0(1450)^*$	$f_0(1370)^*$, $f_0(1710)^*$	$\chi_{c0}(1P)$	$\chi_{b0}(1P)$	$K_0^*(1430)$					
$1\ ^3P_1$	1^{++}	$a_1(1260)$	$f_1(1285)$, $f_1(1420)$	$\chi_{c1}(1P)$	$\chi_{b1}(1P)$	$K_{1A}{}^\dagger$					

➔ Last years: new experimental results and phenomenological fits

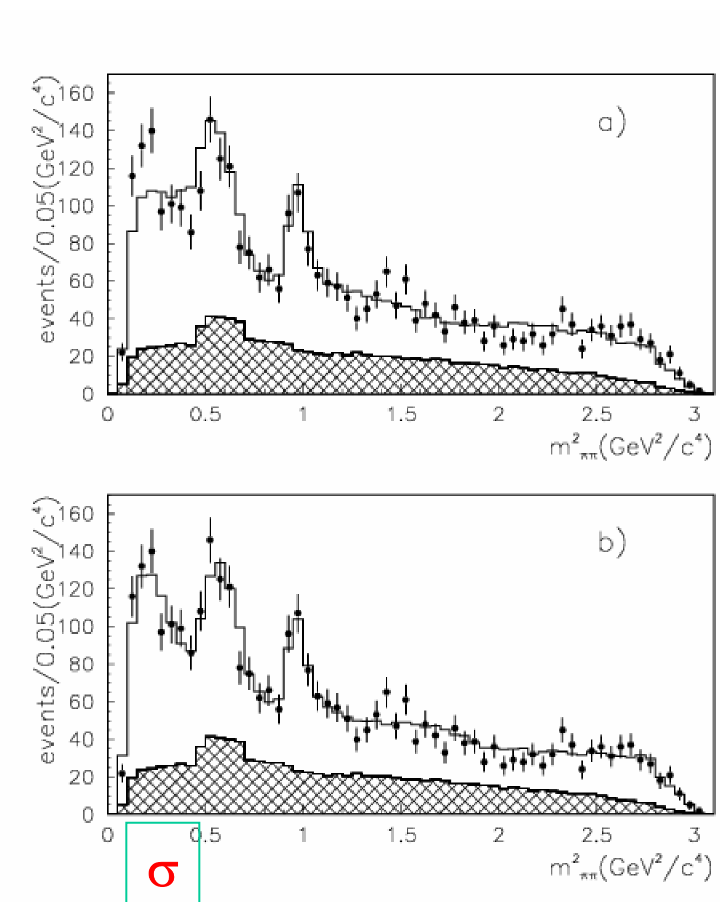
1.1 New evidence of low mass Scalar states:

1. Hadroproduction of Charmed Mesons: ➔ $D^+ \to \pi^+\pi^+\pi^-$ / $D^+ \to K^+\pi^+\pi^-$
   E791 at Fermilab
2. Photoproduction of Charmed Mesons: ➔ $D_{(s)}^+ \to \pi^+\pi^+\pi^-$ / $D^+ \to K^+\pi^+\pi^-$
   FOCUS at Fermilab
3. e^+e^- collisions: ➔ $J/\psi \to K^{*0} K^+ \pi^-$ / $D^0 \to K^- \pi^+ \pi^0$ / $D^0 \to K_S \pi^+ \pi^-$
   BES at Beijing, CLEO at Cornell,

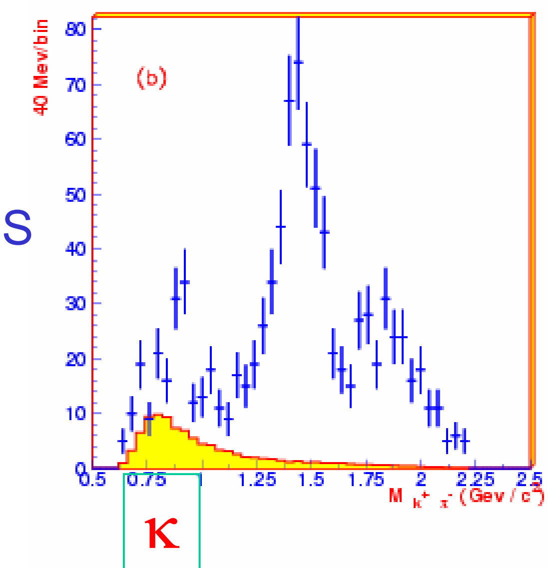
To fit their Dalitz plots they need

2 *"broad" low mass states*: **σ and κ**

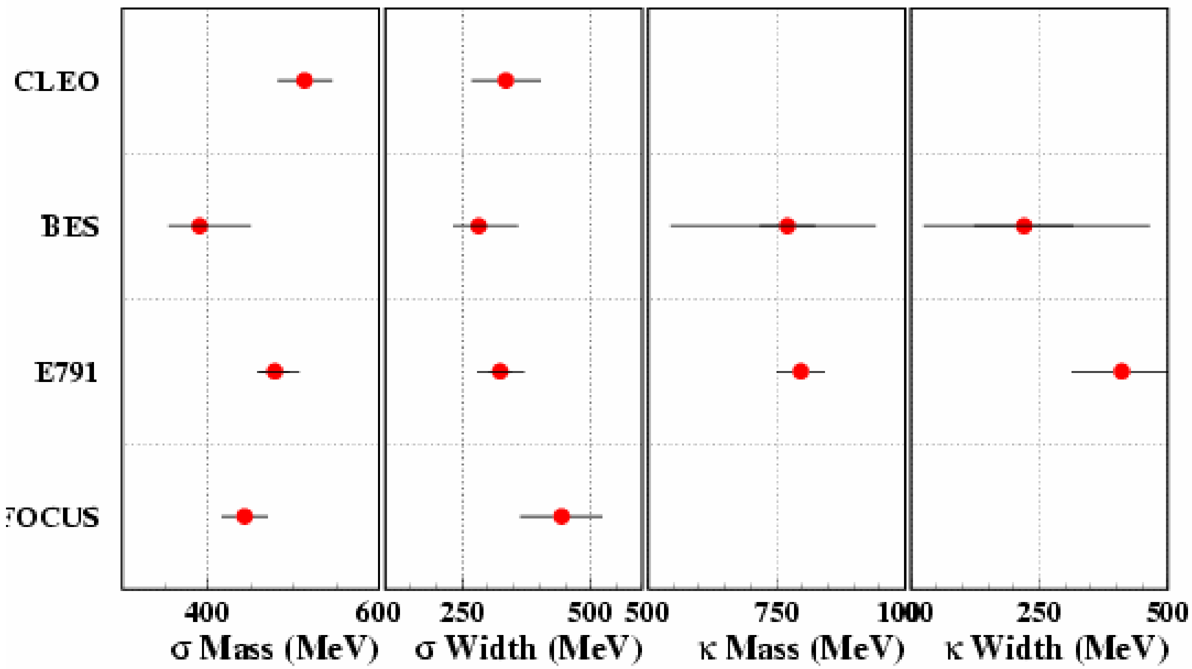
Signal of the σ according to E791:
in $D^+ \to \pi^-\pi^+\pi^+$ Dalitz plot fit



Signal of the κ
according to BES



Summary of σ and κ results



469 ± 15   336 ± 30   800 ± 40   410 ± 90   MeV

CLEO: *Phys.Rev.Lett. 89:251802, 2002 Erratum-ibid 90:059901, 2003*

BES: *hep-ex/0104050 (Talk at Moriond 2001)*
hep-ex/0304001

E791: *Phys.Rev.Lett. 86, 770, 2001*
Phys.Rev.Lett. 89:121801, 2002

FOCUS: *(Talk by S.Malvezzi at Photon03 see http://www.lnf.infn.it)*

Criticism to this approach:

If resonances are strongly overlapping ➔ simple BW sum does't work
unitarity not respected

Alternative approach:

write the propagator using the K-matrix formalism:

$$\boxed{\hat{A} = (\hat{I} - i\hat{\rho}\hat{K})^{-1}}$$

ρ is the diagonal phase space matrix;
K is the scattering matrix

Anisovich-Sarantsev review of scattering data ➔K matrix for $IJ^{PC} = 00^{++}$:

	$f_0(980)$	$f_0(1300)$	$f_0(1500)$	$f_0(1750)$	$f_0(1200 \div 1600)$
Mass (MeV)	**1020 ÷ 1031**	**1306 ÷ 1325**	**1485 ÷ 1490**	**1732 ÷ 1785**	**1450 ÷ 1530**
Width (MeV)	**32 ÷ 35**	**147 ÷ 170**	**51 ÷ 60**	**72 ÷ 160**	**800 ÷ 1000**

No need of σ

4 states of q-bar origin and f_0(1200-1600) possible gluonium origin

V.V.Anisovich, A.V.Sarantsev, Eur.Phys.J,A16, 229, 2003

Preliminary FOCUS fit with K-matrix approach:

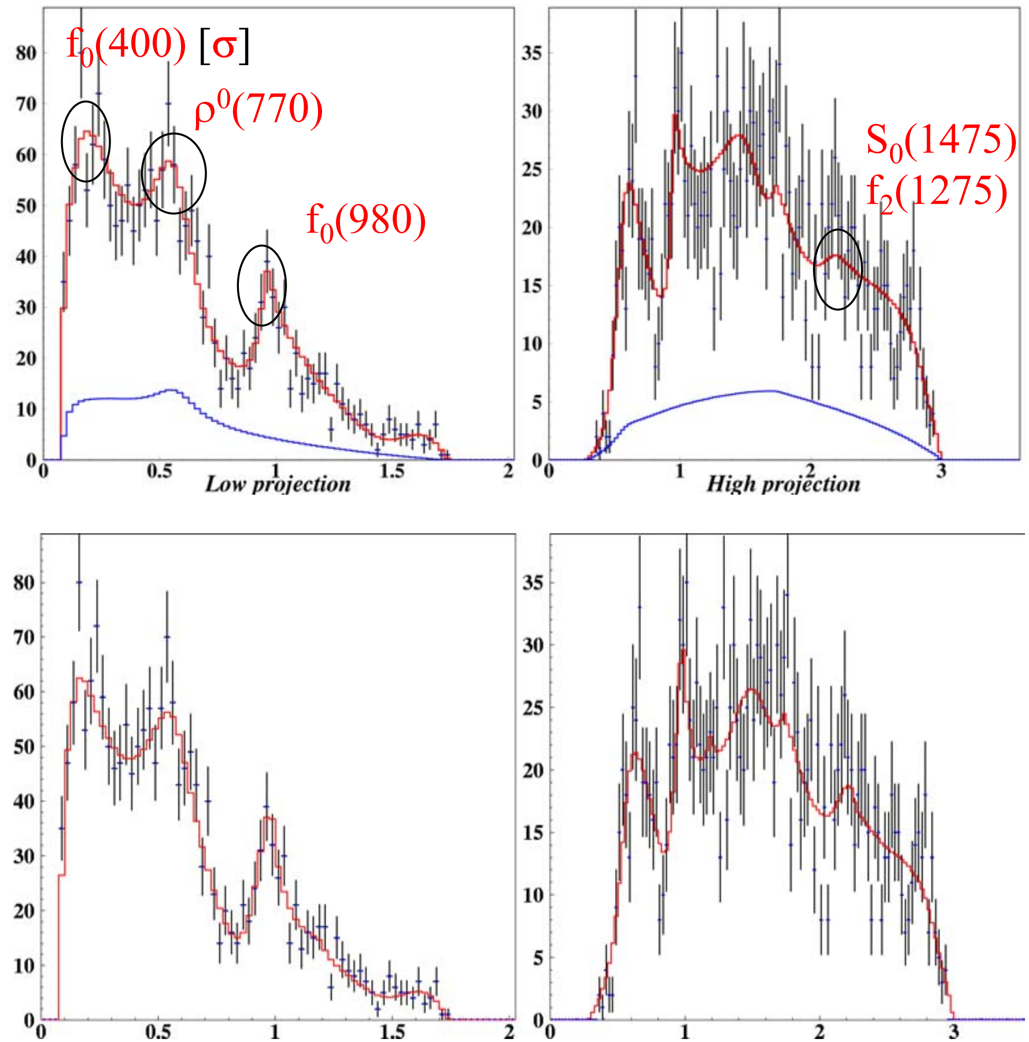
Dalitz plot fit of
$D^+ \rightarrow \pi^+\pi^+\pi^-$

1) Isobar approach:
Sum of BWs for:

$\rho^0(770)$	33%
$f_0(400)$ [σ]	19%
$f_0(980)$	7%
$f_2(1275)$	13%
$S_0(1475)$	2%
Non resonant	10%

2) K-Matrix approach
use AS K-matrix poles

Good fit is obtained:
1. Unitarity is respected
2. AS resonances only
describe well the data



low projection high projection

1.2 Low mass scalar mesons in ϕ radiative decays

$\phi \rightarrow S\gamma \Rightarrow S = f_0(980)\ ,\ a_0(980)^0\ ,\ \sigma$

$\phi \rightarrow \pi\pi\gamma$ (I=0,J=0^{++}) ➔ search for f_0 and σ

$\phi \rightarrow \eta\pi\gamma$ (I=1,J=0^{++}) ➔ search for a_0

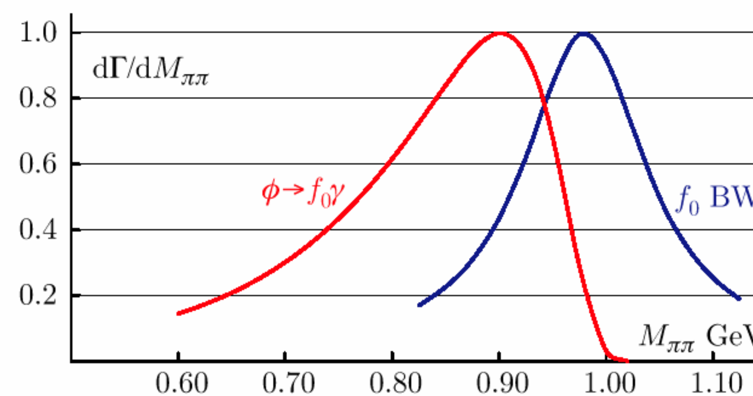
ϕ = pure ss state (KK state)

qq(1)	$f_0 = (uu+dd)/\sqrt{2}$ $a_0 = (uu-dd)/\sqrt{2}$	➔Mass degeneracy ok ➔Small BR($\phi \rightarrow S\gamma$)
qq(2)	f_0= ss $a_0 = (uu-dd)/\sqrt{2}$	➔Mass degeneracy“crisis” ➔BR($\phi \rightarrow f_0\gamma$)>>BR($\phi \rightarrow a_0\gamma$)
qqqq [*Jaffe 1977*]	$f_0 = (uu+dd)ss/\sqrt{2}$ a_0= duss , $(uu-dd)ss/\sqrt{2}$, udss	➔Mass degeneracy ok ➔ $\phi \rightarrow S\gamma$ “superallowed”
KK molecule [*Weinstein, Isgur 1984*]		➔Mass degeneracy ok ➔Small BR($\phi \rightarrow S\gamma$) $F(r^2)$ <<1

Signal shape

Notice:

1. M(ϕ)-M(f_0,a_0)=1020-980=40 MeV
2. M(f_0,a_0) close to 2M(K)
   BW “Flatte’-like”
   ➔ f_0, a_0 line shapes are distorted



$d\Gamma/dM_{\pi\pi} \propto BW \times k^3 \times \text{Overlap}$

Results from KLOE at DAFNE (16 pb^{-1}):

Phys.Lett. B536,209, 2002
Phys.Lett. B537,21,2002

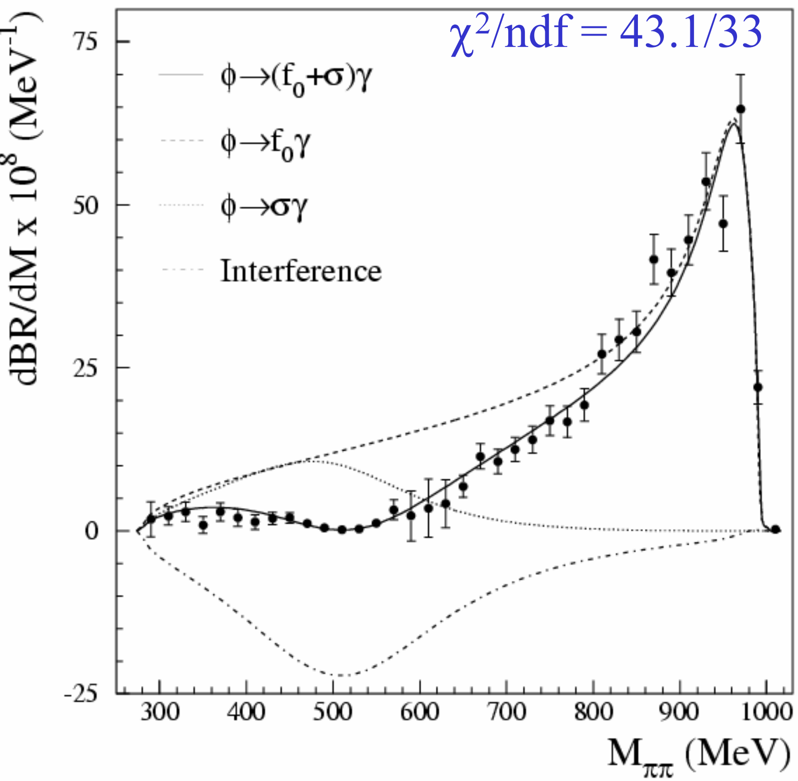
$\pi^0\pi^0\gamma$ final states: 2438 evts

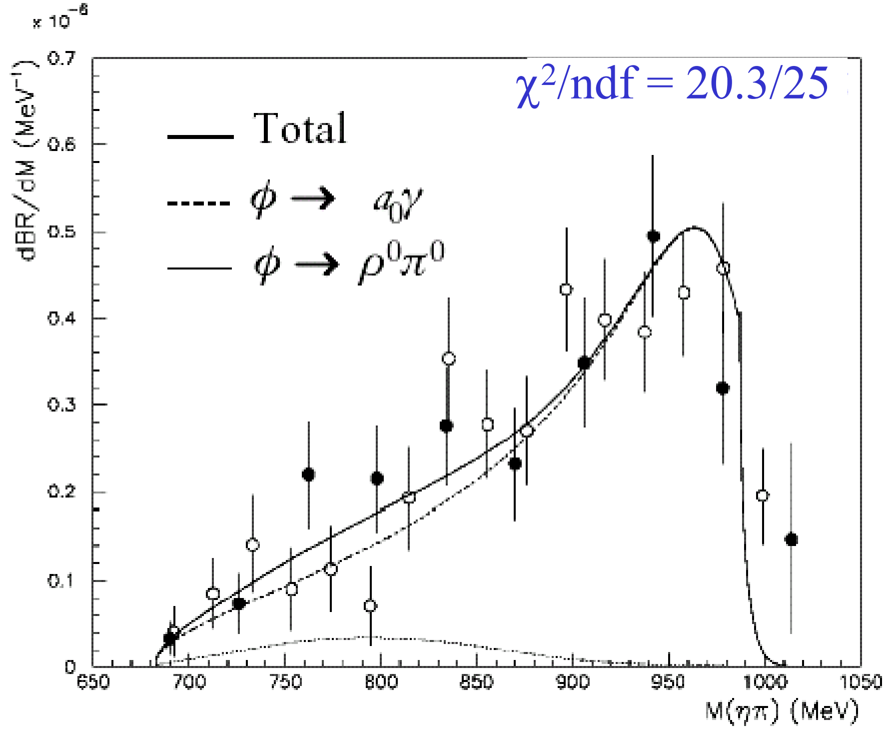
BR($\phi \rightarrow \pi^0\pi^0\gamma$)=$(1.08 \pm 0.03 \pm 0.05)x10^{-4}$

$\eta\pi^0\gamma$ final states: 605 evts $\eta \rightarrow \gamma\gamma$

197 evts $\eta \rightarrow \pi^+\pi^-\pi^0$

BR($\phi \rightarrow \eta\pi^0\gamma$) = $(0.85 \pm 0.05 \pm 0.06)$x10^{-4}
$(0.80 \pm 0.06 \pm 0.04)$x10^{-4}





Fit using kaon-loop model *N.N.Achasov, V.N.Ivanchencko Nucl.Phys.B315, 465 (1989)*

➔Spectra are dominated by f_0 and a_0 production

➔σ needed to account low mass region of $\pi^0\pi^0\gamma$ spectrum (neg. interf.)

Interpretation of KLOE results on scalars (within the context of kaon-loop frame):

parameter	KLOE result	4q model	qq(1) model $f_0, a_0 = (uu \pm dd)/\sqrt{2}$	qq(2) model $f_0 = ss$
$BR(\phi \to f_0\gamma)$	$(4.47 \pm 0.21)\times10^{-4}$	$\sim10^{-4}$	$\sim10^{-6}$	$\sim10^{-5}$
$BR(\phi \to a_0\gamma)$	$(0.74 \pm 0.07)\times10^{-4}$	$\sim10^{-4}$	$\sim10^{-6}$	$\sim10^{-6}$
$g^2(f_0KK)/4\pi$ (GeV^2)	2.79 ± 0.12	"super-allowed"	"forbidden"	"allowed"
$g(f_0\pi\pi)/g(f_0KK)$	0.50 ± 0.01	0.3-0.5	2	0.5
$g^2(a_0KK)/4\pi$ (GeV^2)	0.40 ± 0.04	"super-allowed"	"forbidden"	"forbidden"
$g(a_0\eta\pi)/g(a_0KK)$	1.35 ± 0.09	0.91	1.53	1.53

Large coupling of $\mathbf{f_0}$ with KK ➔ large BRs ➔ 4q model more favorite
BUT *the results are model-dependent.*

KLOE has now 20 x this statistics ➔ results soon also on $f_0 \to \pi^+\pi^-$

Criticism to this approach: → alternative fit to $\pi^0\pi^0\gamma$ KLOE + SND data

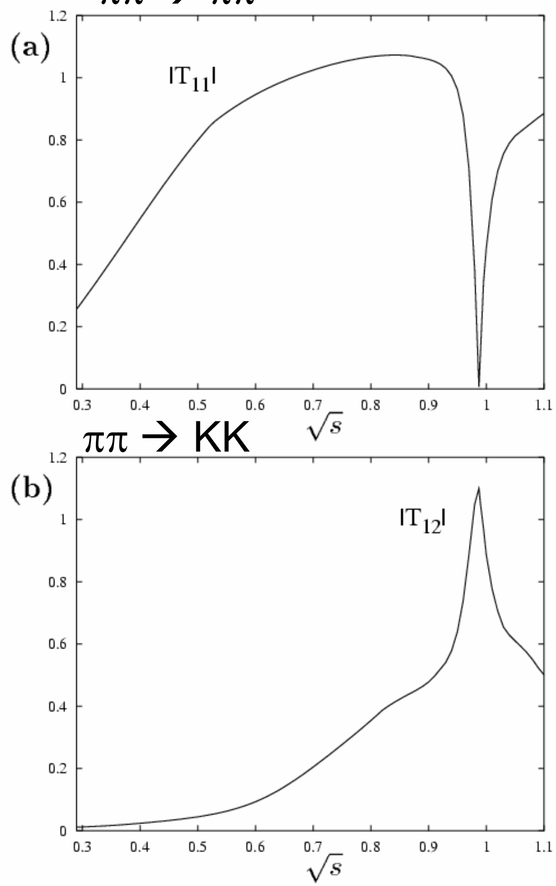
"Towards a model independent determination of the $\phi \to f_0\gamma$ coupling"

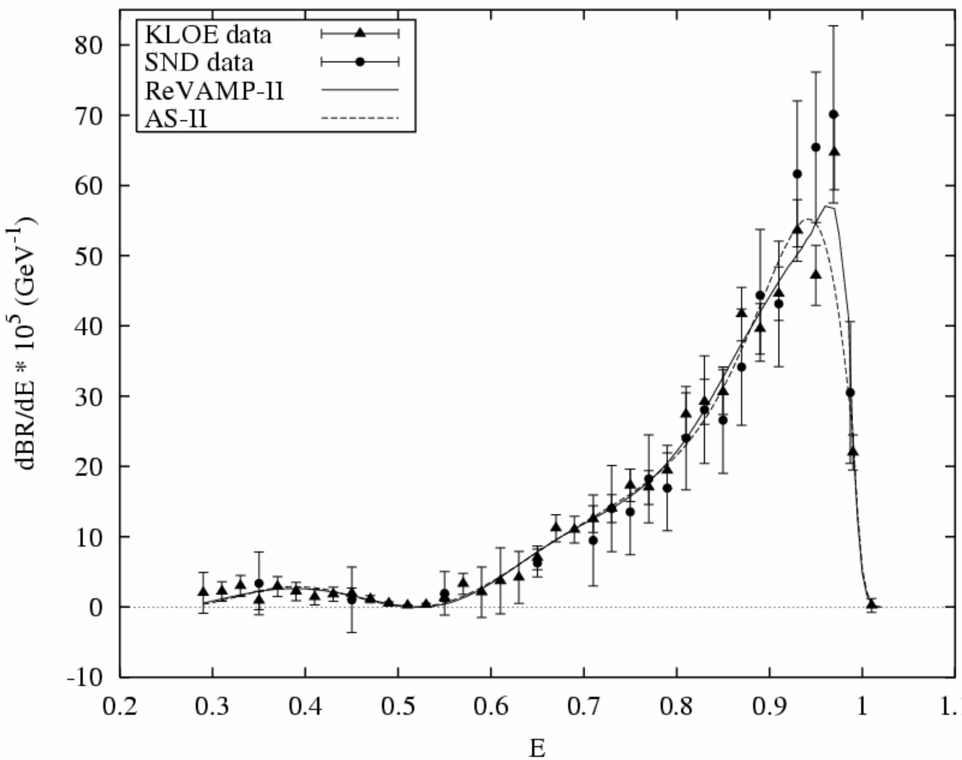
(M.E.Boglione, M.R.Pennington hep-ph/0303200)

$$\frac{d\Gamma(\phi \to \gamma f_0)}{dM_{\pi\pi}} = \rho(s)\left|\alpha_1(s)T_{11}(s) + \alpha_2(s)T_{12}(s)\right|^2$$

$\pi\pi \to \pi\pi$

$\pi\pi \to KK$





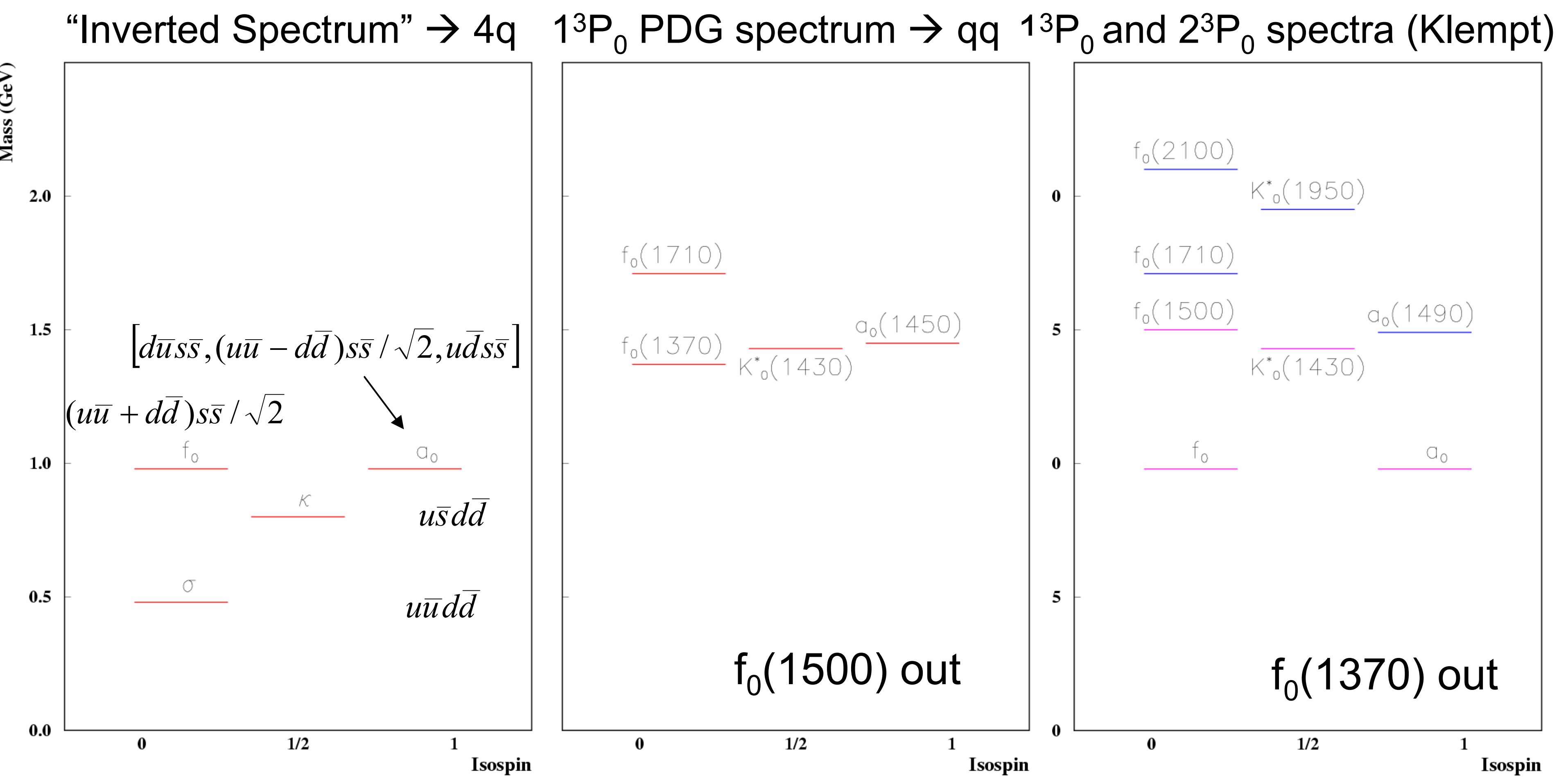
Good fit → f_0 accounts for 10-50% of the spectrum

→ BR much lower → *different interpretation*

BUT: -- result depends on T_{11} and T_{12}

-- what about the remaining 90-50% ?

1.3 Possible scenarios



So it is crucial to understand:

→ σ and κ are real states or are "ghosts" ?

→ What is the s-quark content of **$a_0(980)$** and **f_0 (980)** ? (compare $\phi\eta - \phi$**$f_0(980)$**)

→ Where is the *scalar glueball* ? 50-50 mixing between **$f_0(1370)$** and **$f_0(1500)$** ?

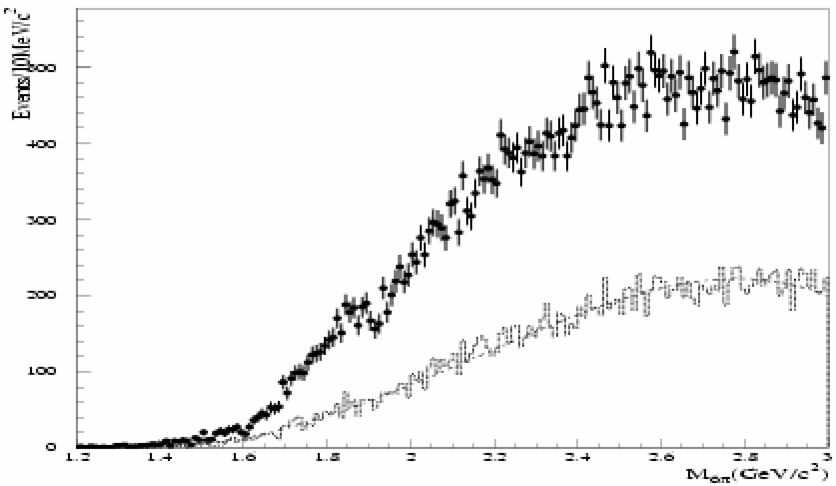
F.Close and A.Kirk Eur.Phys.J C21 , 531 (2001)

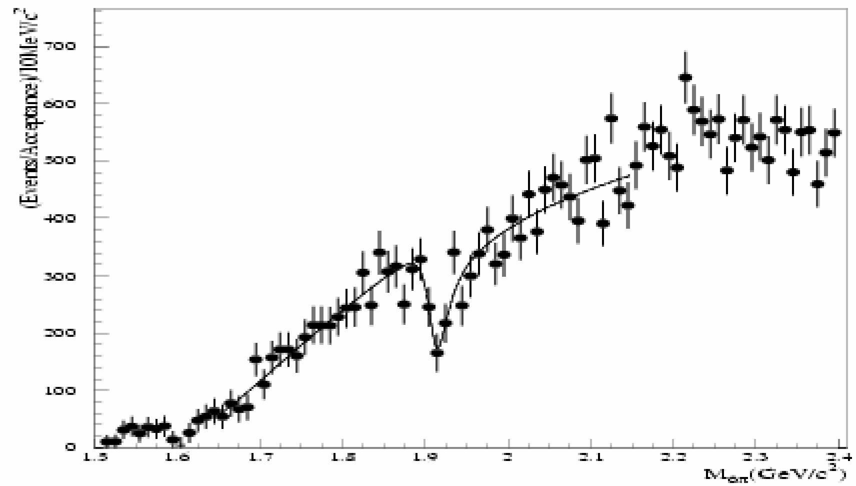
2. A resonance close to $2M_p$

2.1 E687 at Fermilab: diffractive photoproduction of 6 π

$\gamma p \rightarrow 3\pi^+ 3\pi^- p$

E687: *Phys.Lett.B514,240,2001*





Fit results:

M = 1911 $\pm$ 4 $\pm$ 1 MeV/c^2

Γ = 29 $\pm$ 11 $\pm$ 4 MeV/c^2

Quantum numbers:

$J^{CP} = 1^{--}$ (photon q.n.)

G = + , I = 1 (due to pion multiplicity)

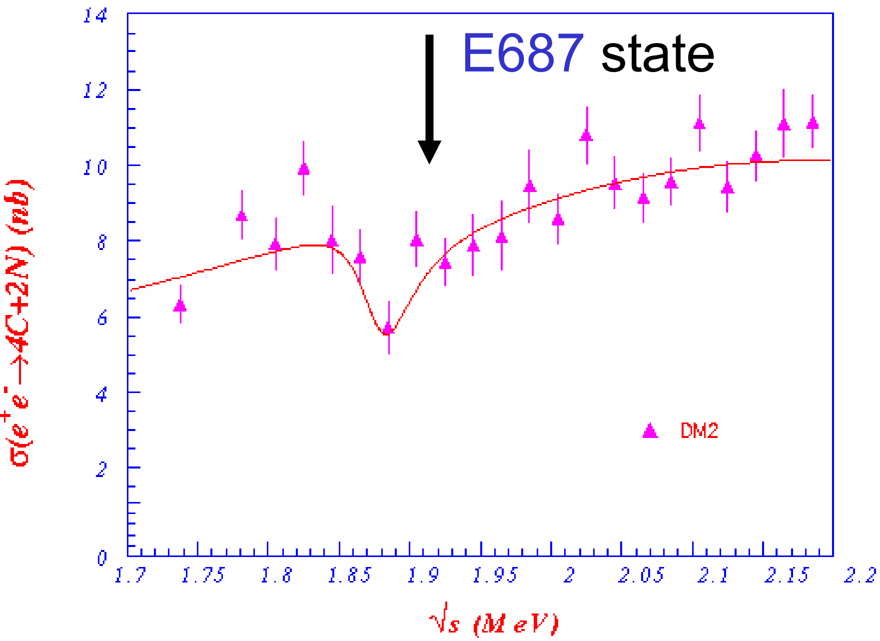
Dip can be due to interference between a narrow and a broad vector (*P.J.Franzini and F.J.Gilman, Phys.Rev.D32,237,1985*)

FOCUS data → x 20 statistics on the same final state, results soon.

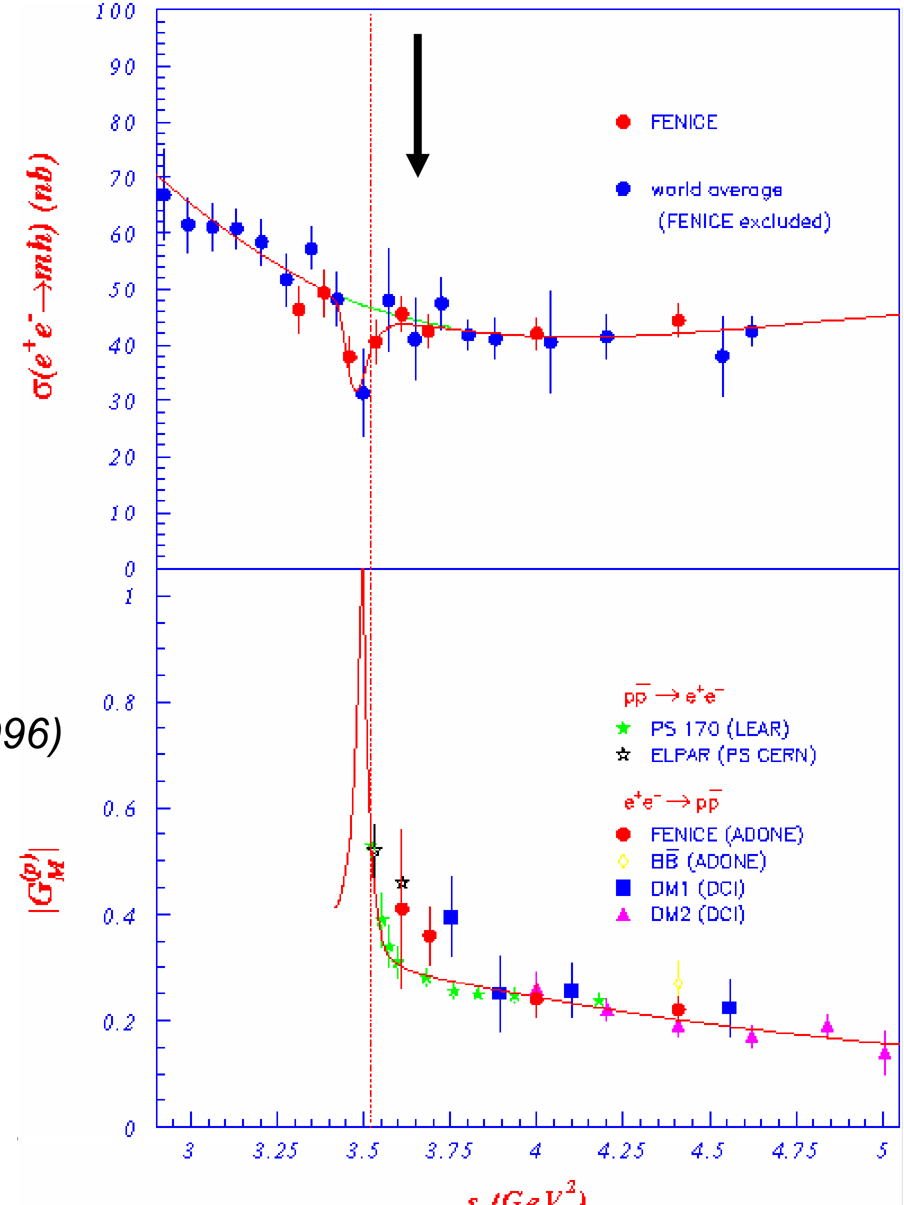
Similar hints from “old” e^+e^- experiments

Old DM-2 (never published data) *(from R.Baldini):*

$e^+e^- \rightarrow$ 6 pions



E687 state



FENICE analysis *Phys.Lett.B365, 427 (1996)*

Simultaneous fit of :

e^+e^- multihadronic data

proton time-like FF

Results:

$M = 1870 \pm 10$ MeV

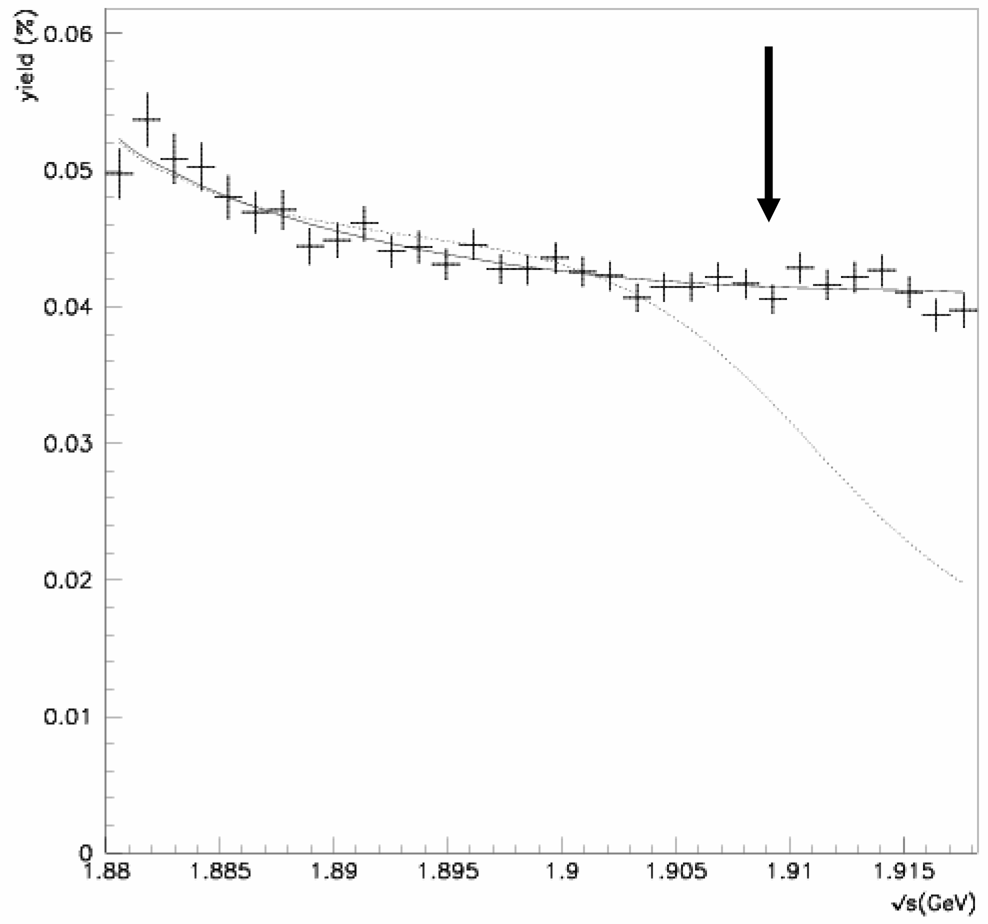
$\Gamma = 10 \pm 5$ MeV

$J^{PC} = 1^{--}$

OBELIX has looked for 6 pions invariant mass distributions in $\bar{n}p$:

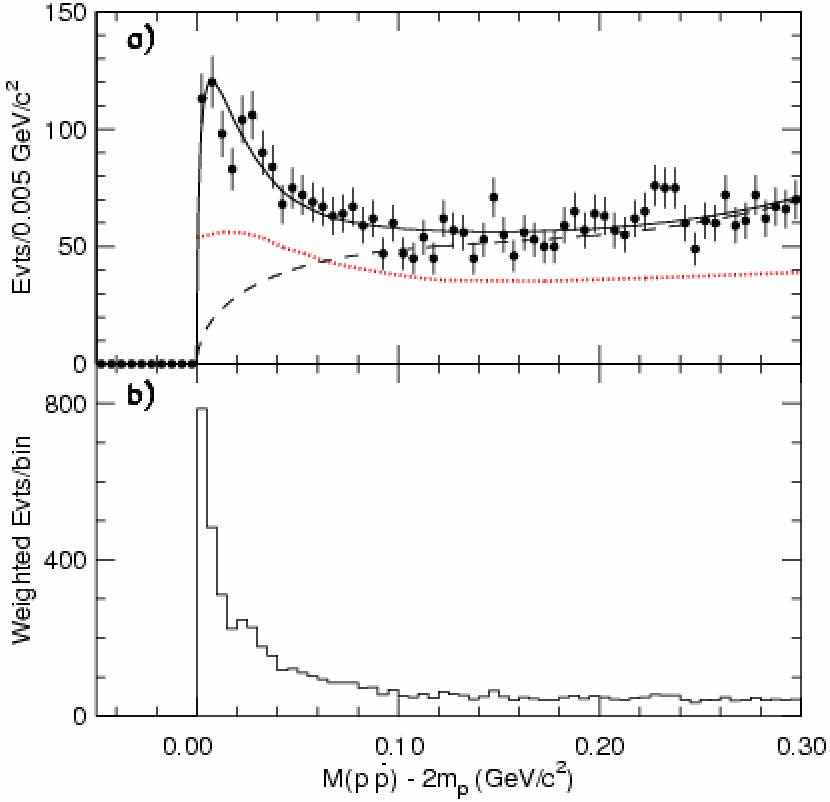
$\bar{n}p \rightarrow 3\pi^+2\pi^-\pi^0$ *(Phys.Lett.B527, 39 (2002))*

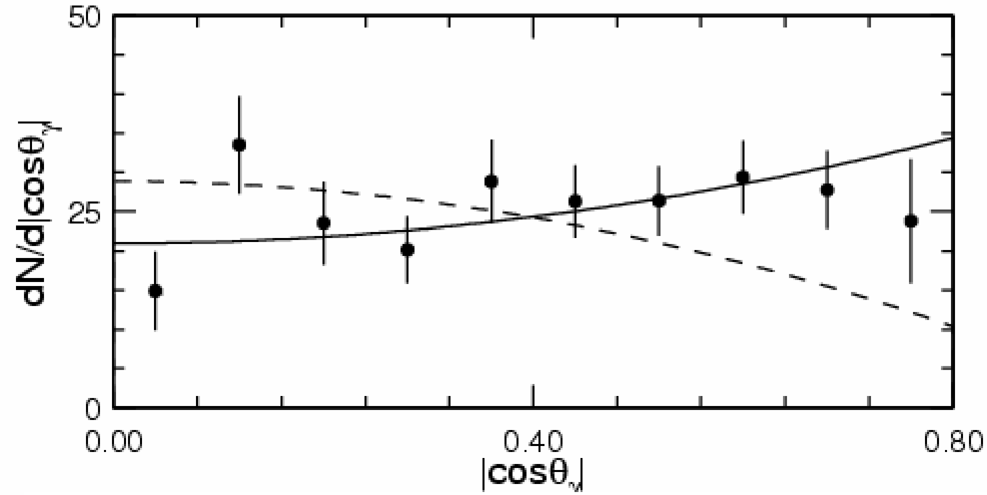
No structure observed ➔ *baryonium* interpretation ruled out



2.2 BES at Bejing: $p\bar{p}$ mass spectrum from radiative $J/\psi \to \gamma p\bar{p}$ decay

BES: *hep-ex/0303006*





$\cos\theta_\gamma$ distribution for events in the "peak"

➔ $(1 + \cos^2\theta_\gamma)$ ➔ Spin 0 (either 0^{++} or 0^{-+})

➔ it is not a "radiative return"

a) Distribution of $M(pp)-2M_p$

———— fit

------- background

········ acceptance profile

b) Distribution weighted by phase space (the effect of the threshold is removed)

Fit results (in MeV):

1) S-wave BW (0^{-+}) + background

$M = 1859\,^{+3}_{-10}$ $\quad\Gamma = 0 \pm 21$

$\chi^2 = 56.3 / 56$

2) P-wave BW (0^{++}) + background

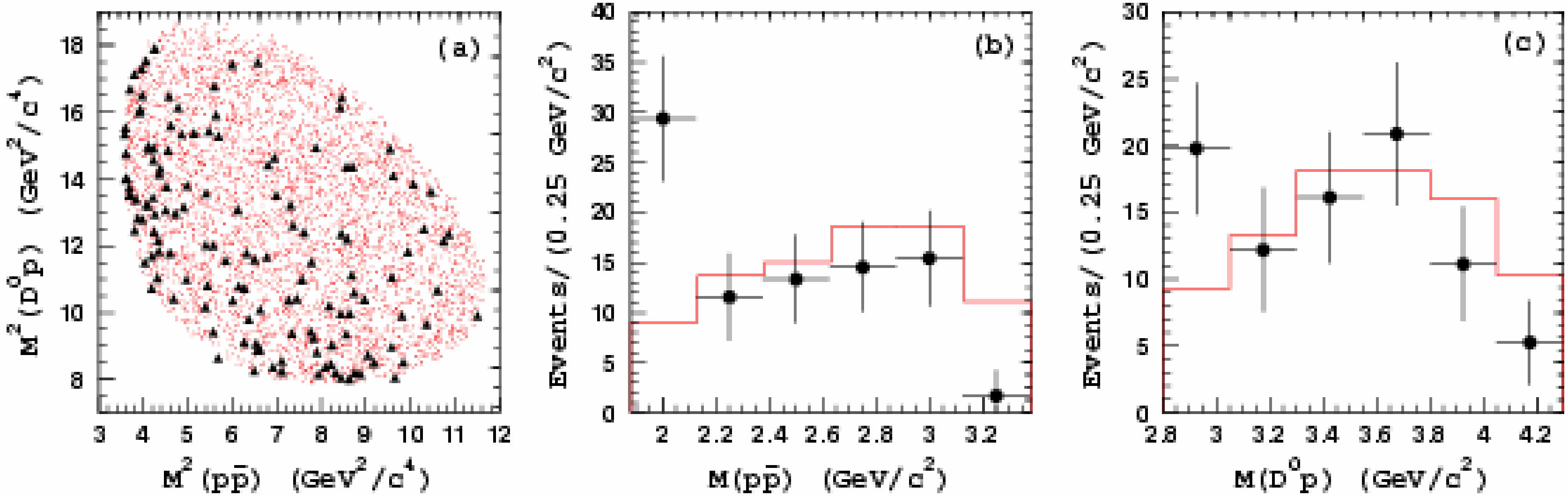
$M = 1876.4 \pm 0.9$ $\quad\Gamma = 4.6 \pm 1.8$

$\chi^2 = 59.0 / 56$

Anomalous “activity” in $p\bar{p}$ pairs close to the $p\bar{p}$ threshold is observed by BELLE

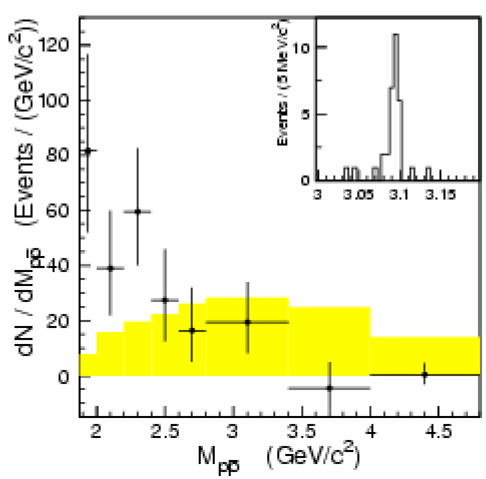
Observation of $\bar{B}^0 \to D^{(*)0} p\bar{p}$

Phys.Rev.Lett. 89:15182, 2002



Observation of $B^\pm \to p\bar{p}K^\pm$

Phys.Rev.Lett. 88:18183, 2002



It might be due to proton FF behaviour (steeply rising close to pp threshold)

2.3 Summarizing:

The situation is *contradictory:*

1 vector state 30 MeV above threshold	E687
1 vector state at ~ threshold	DM-2 + Fenice
1 spin=0 state at threshold	BES

Problems with energy absolute calibration ?
New information from:

BES high statistics
FOCUS
BABAR + BELLE ISR (6 pions and/or pp)
VEPP-2000 (up to 2.0 GeV)

1900 MeV is the energy where many hybrids states are foreseen

N.Isgur, A.Kokosky, J.Paton, Phys.Rev.Lett.54:869, 1985

TABLE I. The dominant decays of the low-lying exotic meson hybrids.

Hybrid state[a]	J^{PG}	(Decay mode)$_{L \text{ of decay}}$	Partial width (MeV)
x_2^{+-} (1900)	2^{++}	$(\pi A_2)_P$	450
		$(\pi A_1)_P$	100
		$(\pi H)_P$	150
y_2^{+-} (1900)	2^{+-}	$(\pi B)_P$	500
z_2^{+-} (2100)	2^{+-}	$[\bar{K}K^*(1420)+\text{c.c.}]_P$	250
		$(\bar{K}Q_2+\text{c.c.})_P$	200
x_1^{-+} (1900)	1^{--}	$(\pi B)_{S,D}$	100,30
		$(\pi D)_{S,D}$	30,20
y_1^{-+} (1900)	1^{-+}	$(\pi A_1)_{S,D}$	100,70
		$[\pi\pi(1300)]_P$	100
		$(\bar{K}Q_2+\text{c.c.})_S$	~ 100
z_1^{-+} (2100)		$(\bar{K}Q_1+\text{c.c.})_D$	80
		$(\bar{K}Q_2+\text{c.c.})_S$	250
		$[\bar{K}K(1400)+\text{c.c.}]_P$	30
x_0^{+-} (1900)	0^{++}	$(\pi A_1)_P$	800
		$(\pi H)_P$	100
		$[\pi\pi(1300)]_S$	900
y_0^{+-} (1900)	0^{+-}	$(\pi B)_P$	250
z_0^{+-} (2100)	0^{+-}	$(\bar{K}Q_1+\text{c.c.})_P$	800
		$(\bar{K}Q_2+\text{c.c.})_P$	50
		$[\bar{K}K(1400)+\text{c.c.}]_S$	800

[a] x, y, and z denote the flavor states $(1/\sqrt{2})(u\bar{u}-d\bar{d})$, $(1/\sqrt{2})(u\bar{u}+d\bar{d})$, and $s\bar{s}$. The subscript on a state is J; the superscripts are P and C_n.

3. Search for $J^{PC} = 1^{-+}$ exotic states

$J^{PC} = 1^{-+}$ not accessible for q-qbar mesons ➔ exotics

E852 at Brookhaven has found 2 states:

$\pi^- p \rightarrow \eta' \pi^- p$	➔ 1^{-+} state	$M=1597 \pm 10\ ^{+45}_{-10}$	$\Gamma=340 \pm 40 \pm 50$
$\pi^- p \rightarrow \rho^0 \pi^- n$	➔ 1^{-+} state	$M=1593 \pm 8\ ^{+29}_{-47}$	$\Gamma=168 \pm 20 \pm 50$
$\pi^- p \rightarrow \eta \pi^- p$	➔ 1^{-+} state	$M=1370 \pm 16\ ^{+50}_{-30}$	$\Gamma=385 \pm 40\ ^{+105}_{-65}$

$\pi^- p \rightarrow \eta \pi^0 n$ ➔ no resonant state in 1^{-+} wave

Phys.Rev.D60,092001 (1999)
Phys.Rev.Lett.80,3977 (2001)
Phys.Rev.D65,072001 (2002)

Crystal Barrel has found 1:

$\bar{p}\, n \rightarrow \pi^0 \pi^- \eta$ ➔ 1^{-+} state $M=1400 \pm 20 \pm 20$ $\Gamma=310 \pm 50\ ^{+50}_{-30}$
$\bar{p}\, p \rightarrow \pi^0 \pi^0 \eta$

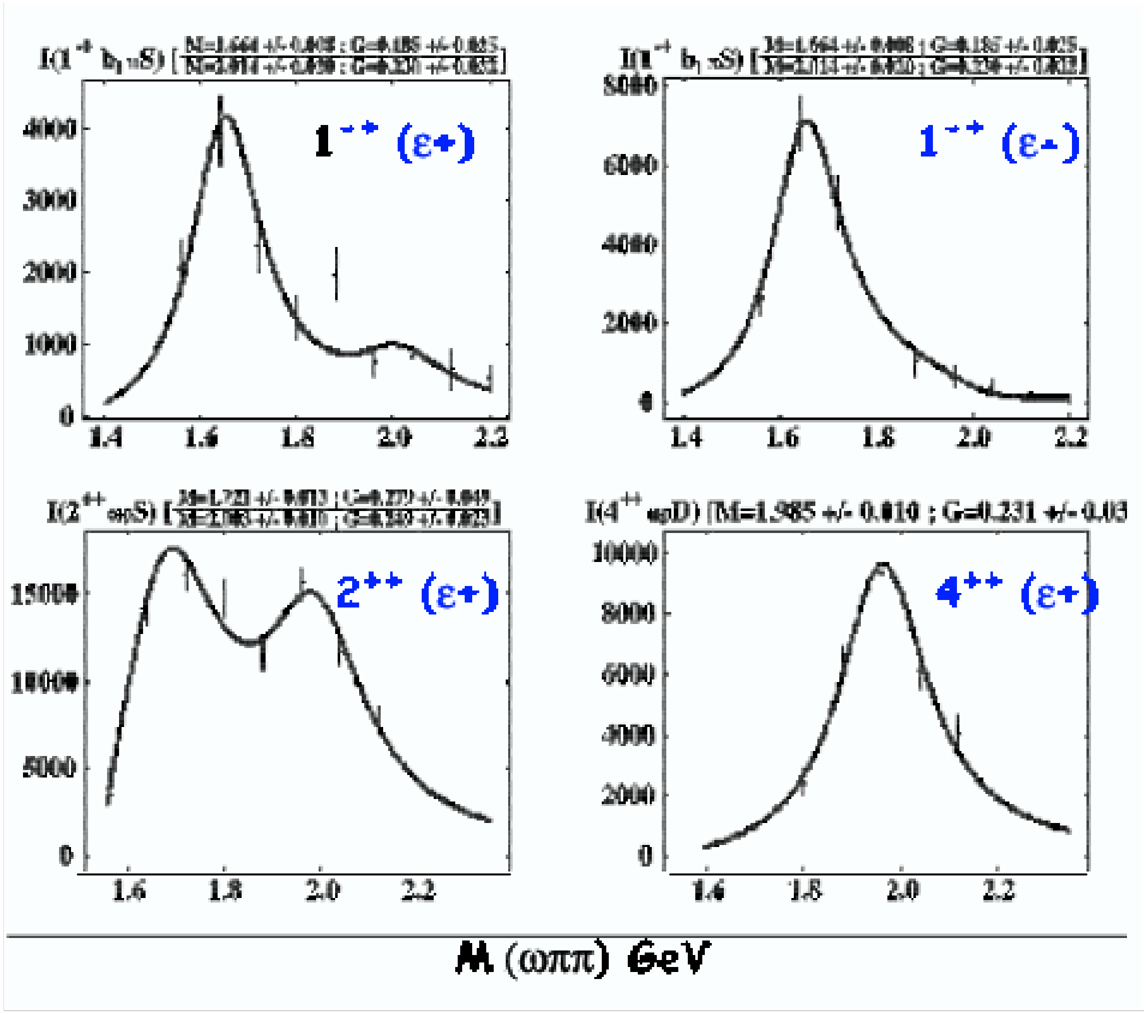
Phys.Lett.B423,175 (1998)
Phys.Lett.B446,349 (1999)

The two states are called $\pi_1(1400)$ and $\pi_1(1600)$

Hybrid states = q-qbar-gluon
(tube-flux model)
N.Isgur, J.Paton, Phys.Rev.D31,2119 (1985)

➔ 1. Mass ~ 1.8 – 2.1 GeV
➔ 2. Decay to at least 1 P-wave meson
(πf_1 , πb_1 , πa_2 , ηa_1 , $K K_1$)
➔ 3. Possible exotic quantum numbers
(0^{+-} , 1^{-+} , 2^{+-})

E852 *preliminary results* of PWA of $b_1\pi$ decay ($b_1\pi \to \omega\pi\pi$)



π_1(1600) is confirmed in a decay to a P-wave and S-wave mesons

E852: π_1**(1600)** observed in $f_1\pi^-$ and in $b_1\pi^-$ decays

hints for a further state π_1**(2000)**

➔ 1^{-+} spectrum is now rich

decay mode	$\pi_1(1400)$	$\pi_1(1600)$	$\pi_1(2000)$
$\eta\pi^-$	1370 ± 16 $(^{+50}_{-30})$		
$\eta'\pi^-$		1593 ± 8 $(^{+29}_{-47})$	
$\rho\pi$		1597 ± 10 $(^{+45}_{-10})$	
$f_1\pi^-$		1709 ± 24 (?)	2001 ± 30 (?)
$b_1\pi^-$		1664 ± 8 (?)	2014 ± 20 (?)

HALL-D experiment at Jefferson Lab will search hybrids in more efficient way

4. Gluonium content of η'(958)

$$|\eta\rangle = X_{\eta}|u\bar{u}+d\bar{d}\rangle + Y_{\eta}|s\bar{s}\rangle + Z_{\eta}|glue\rangle$$
$$|\eta'\rangle = X_{\eta'}|u\bar{u}+d\bar{d}\rangle + Y_{\eta'}|s\bar{s}\rangle + Z_{\eta'}|glue\rangle$$

ϕ is an $s\bar{s}$ state ➔selection of $s\bar{s}$ compon

KLOE measurement *(Phys.Lett.B538,21 (2002))*

$$\frac{\Gamma(\phi\to\eta'\gamma)}{\Gamma(\phi\to\eta\gamma)} = (4.7 \pm 0.47_{stat} \pm 0.31_{syst})\times 10$$

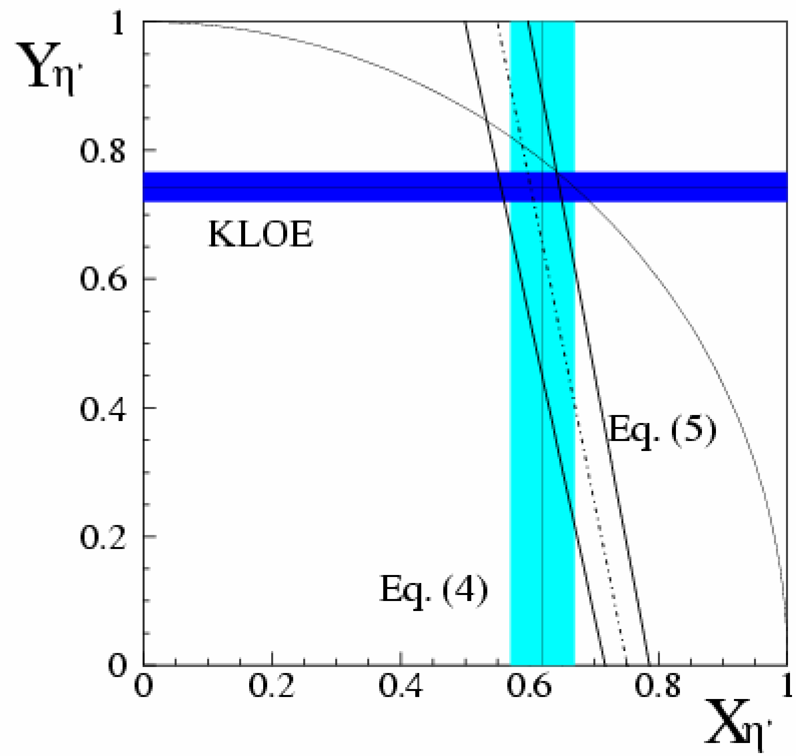
→ Extract the pseudoscalar mixing angle:

$$\frac{\Gamma(\phi\to\eta'\gamma)}{\Gamma(\phi\to\eta\gamma)} = \cot^2\phi_P\left(\frac{p_{\eta'}}{p_{\eta}}\right)^2 F(\phi_V,\phi_P)$$

$$\phi_P = (41.8 \pm 1.9)^o$$

→Check the gluonium content of η':

$X_{\eta'}^2 + Y_{\eta'}^2 = 1$



The other 2 bands are due to:

$$\frac{\Gamma(\eta'\to\rho\gamma)}{\Gamma(\omega\to\pi^0\gamma)} \simeq 3\left(\frac{m_{\eta'}^2-m_\rho^2}{m_\omega^2-m_\pi^2}\frac{m_\omega}{m_{\eta'}}\right)^3 X_{\eta'}^2$$

$$\frac{\Gamma(\eta'\to\gamma\gamma)}{\Gamma(\pi^0\to\gamma\gamma)} = \frac{1}{9}\left(\frac{m_{\eta'}}{m_{\pi^0}}\right)^3 (5X_{\eta'} + \sqrt{2}Y_{\eta'}\frac{f_\pi}{f_s})^2$$

➔ Compatible with **no Gluonium content**

4. Conclusions

Other results to mention

$X(1750) \to K^+K^-$ from FOCUS — *Phys.Lett.B545, 50, (2002)*

$X(1750) \to K_S K_S$ from ZEUS — *(see talk by M.Barbi at Photon03)*

$\xi(2230)$ from BES — *(no news since talk by J.Shan at ICHEP02)*

…..

Other experiments already working:

HERA	➔ meson photoproduction by virtual photons
COSY	➔ study of scalar mesons in $pn \to d\,M$
COMPASS	➔ search for glueballs and hybrids in central production

…..

And others too will start in few years

CLEO-c	at J/ψ (compare with BES) glueball searches
VEPP-2000	e^+e^- up to E_{cm} = 2 GeV
HESR-PANDA	proton beam
HALL-D	photoproduction of hybrids

….

Many thanks to:
G.Adams, R.Baldini, G.Dunwoodie, A.Dzierba, A.Filippi, F.Harris, S.Malvezzi, J.Napolitano, S.Serednyakov, J.Shan, E.P.Solodov, A.Zallo

3. Search for new states

3.1 Conclusive evidence of X(1750) from FOCUS

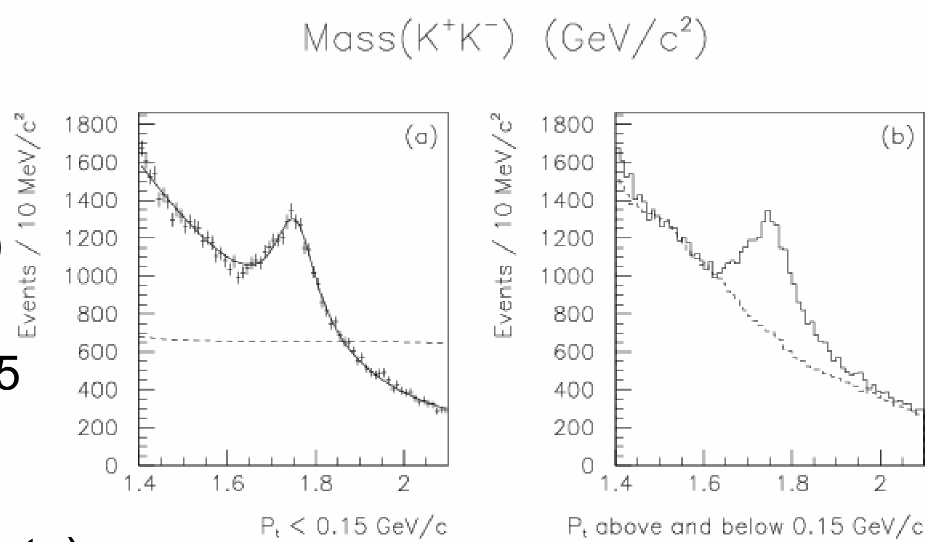
Enhancement in K^+K^- inv.mass

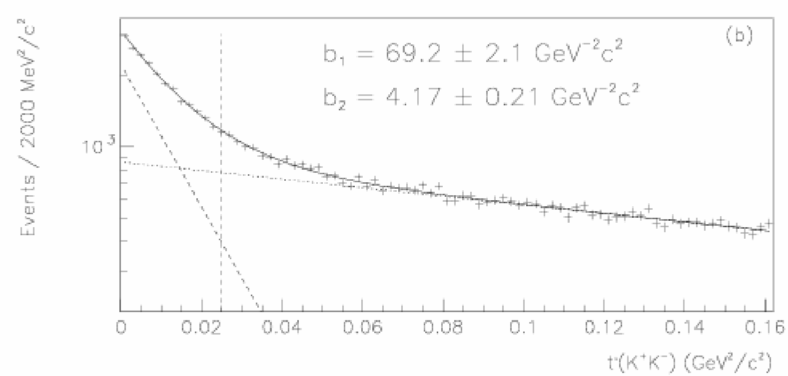
1) M = 1753.5 ± 1.5 ± 2.3 MeV
2) Γ = 122.2 ± 6.2 ± 8.0 MeV
3) $J^{CP} = 1^{--}$ (diffractive photoprod.)
4) No K*K decay:

$\Gamma(X(1750)\rightarrow K^*K)/\Gamma(X(1750)\rightarrow K^+K^-)<0.065$ 90% C.L.

➔ No identification with $\phi(1680)$
M=1680 ± 20 MeV (e^+e^- experiments)
K*K dominant decay

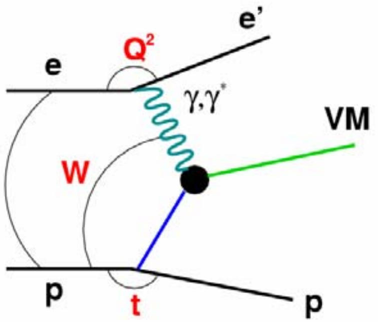
➔ Look at angular distribution
Look at K_SK_S decays





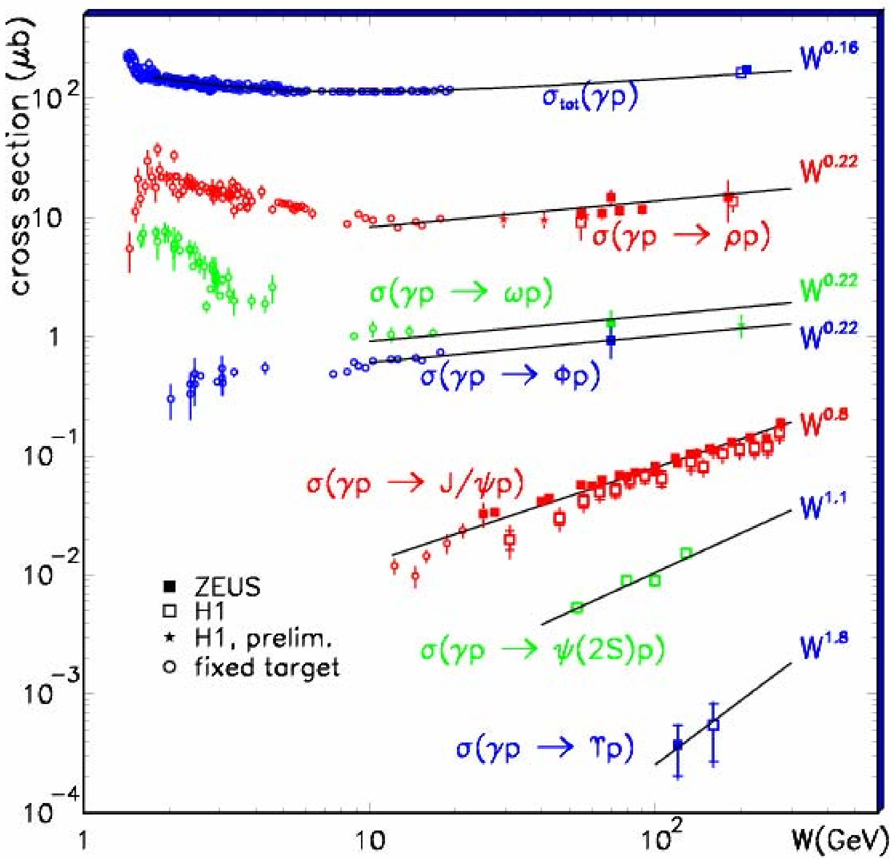
FOCUS: *Phys.Lett.B545, 50, 2002*

3.2 Evidence of “another” X(1750) from ZEUS

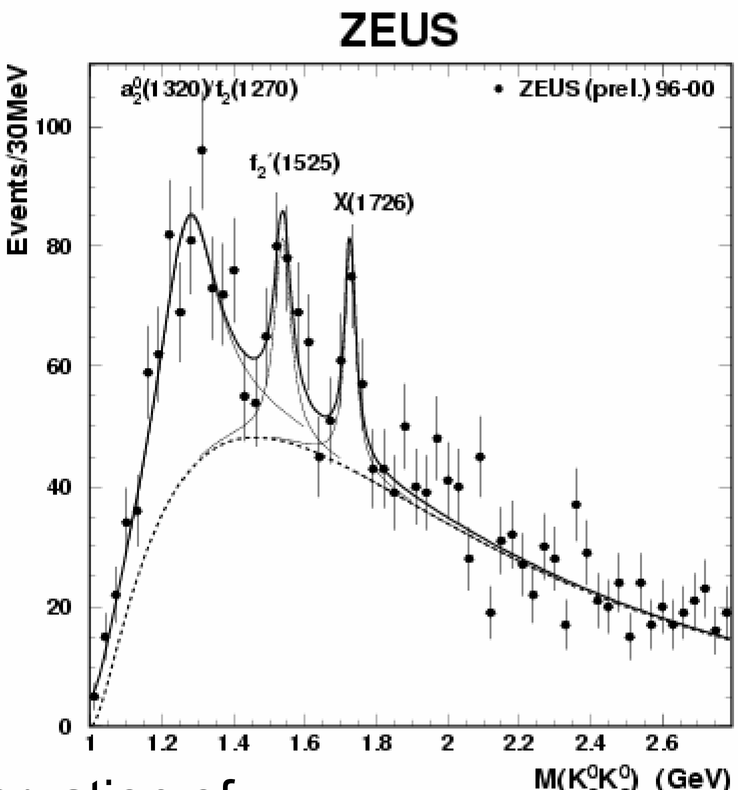


“Similar” to photoproduction:
Several results from HERA

Photoproduction of Vector Mesons:
Fixed target vs. HERA



Inclusive spectrum of $K_S K_S$ pairs

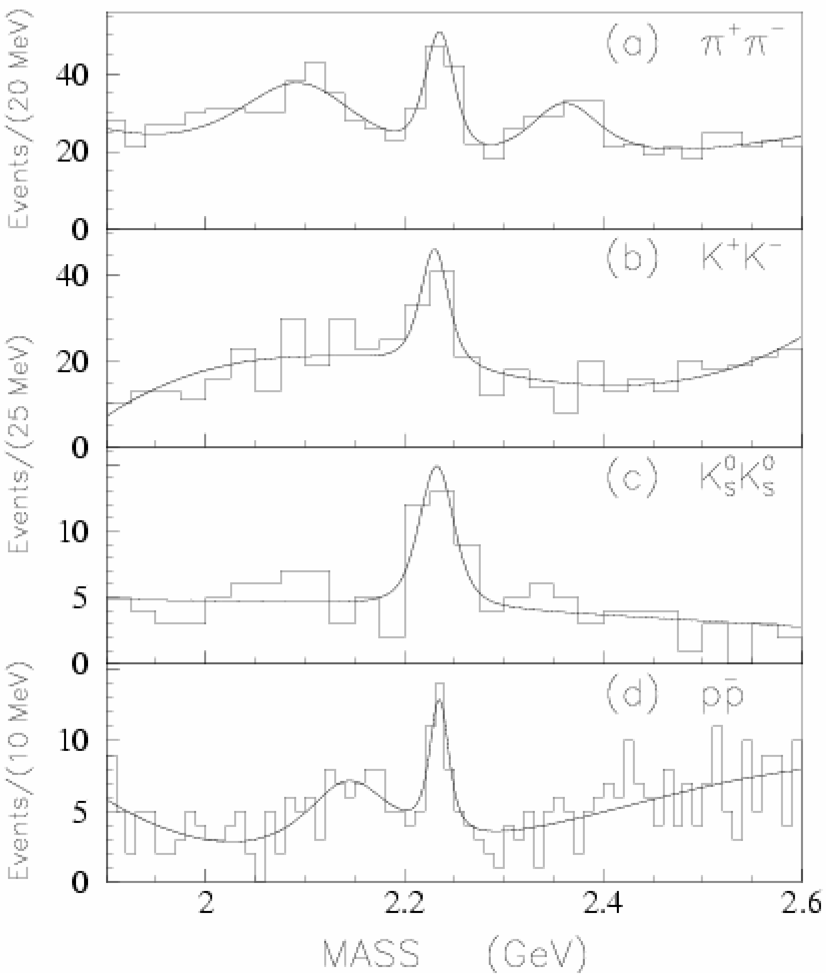


Observation of:

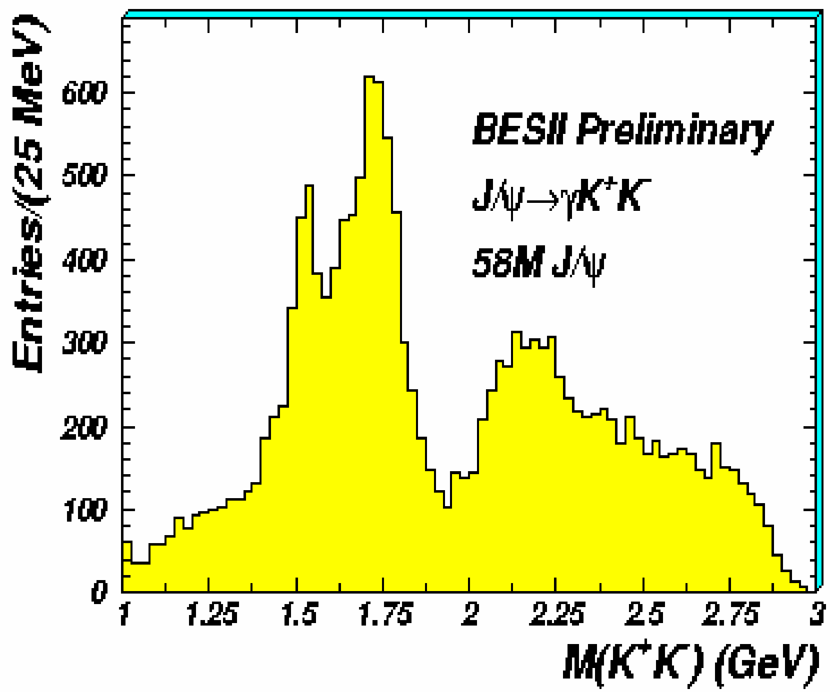
$f'_2(1525)$

$f_0(1710)$? (gluon rich environment)

3.4 Status of $\xi(2230)$



- So far, no clear signal has been observed in the 58 10^6 J/ψ sample.



Exp.	σ Mass	σ Width	κ Mass	κ Width
E791	$478_{-13}^{+24} \pm 17$	$324_{-40}^{+42} \pm 21$	$797 \pm 19 \pm 43$	$410 \pm 43 \pm 87$
FOCUS (preliminary)	443 ± 27	443 ± 80		
BES	390_{-36}^{+60}	282_{-50}^{+77}	$771_{-221}^{+164} \pm 55$	$220_{-169}^{+225} \pm 97$
CLEO	513 ± 32	335 ± 67	not found	