Bonn-Gatchina partial wave analysis: search for missing baryon states

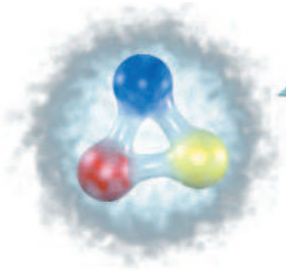
A. Sarantsev

HISKP, Uni-Bonn (Bonn) and PNPI (Gatchina)

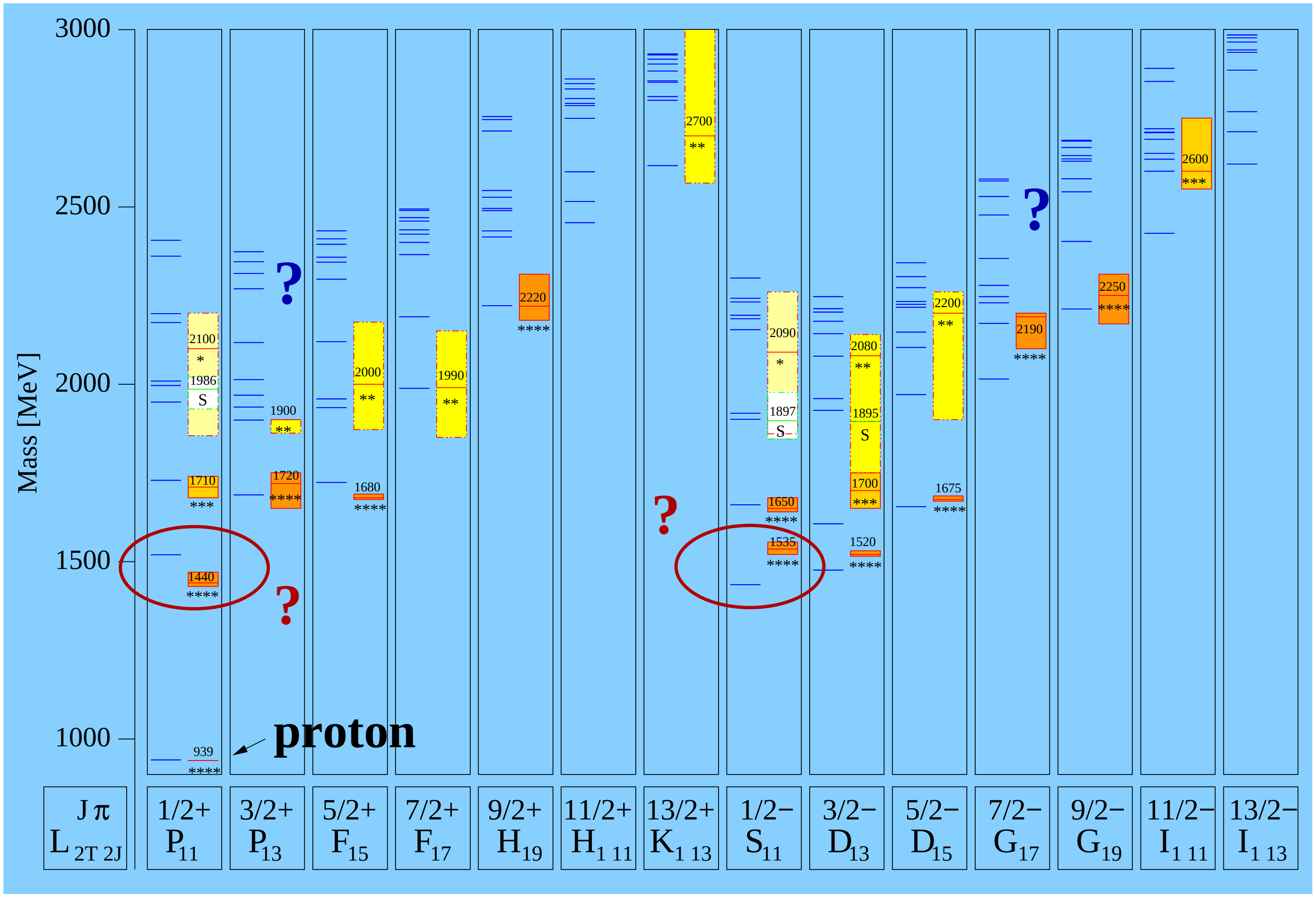
N*- resonances in the quark model

Nukleon

10^{-15} m



U. Loering, B. Metsch, H. Petry et al. (Bonn)



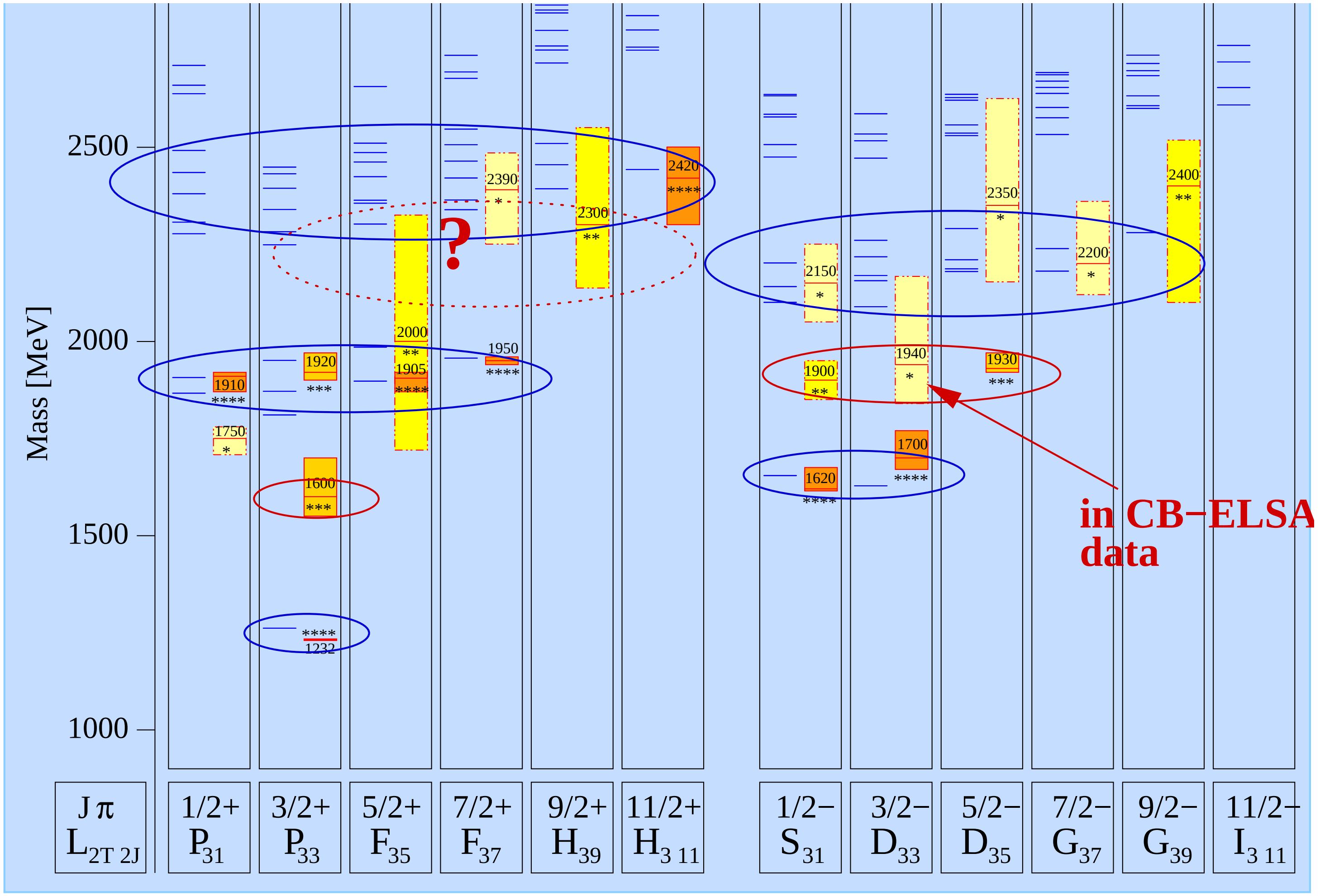
↔

Constituent quarks

Confinement-potential

Residual interaction

The Δ^*- states



Quark model
U. Löring, B. Metsch,
H. Petry et al.

model
$\sim 2n + \ell$

data
$\sim n + \ell$?

$\longleftrightarrow$ **Parity doublets ?**

⇔ **Additional experimental information needed !!**

Problems in the baryon spectroscopy and/or quark model:

1. **Problem:** The number of predicted three quark states exceeds dramatically the number of discovered baryons.

2. **Possible solution:** Most of the information comes from the analysis of meson induced reactions and meson-baryon final states. Photoproduction data taken by CLAS, GRAAL, LEPS and CB-ELSA can provide an important information about missing states.

   (a) **problem:** The unambiguous analysis of photoproduction reactions can not be done without polarization information available.

   (b) **problem:** Signals in simple reactions are expected to be mostly weak. Strong signals from new resonances can be found in multi-meson final states.

   (c) **Possible solution 1:** The single polarization observables are measured now by almost all collaborations. In the nearest future single and double polarization data will be available from CLAS and CB-ELSA.

   (d) **Possible solution 2:** A combined analysis of the large data sets.

Bonn-Gatchina partial wave analysis group:

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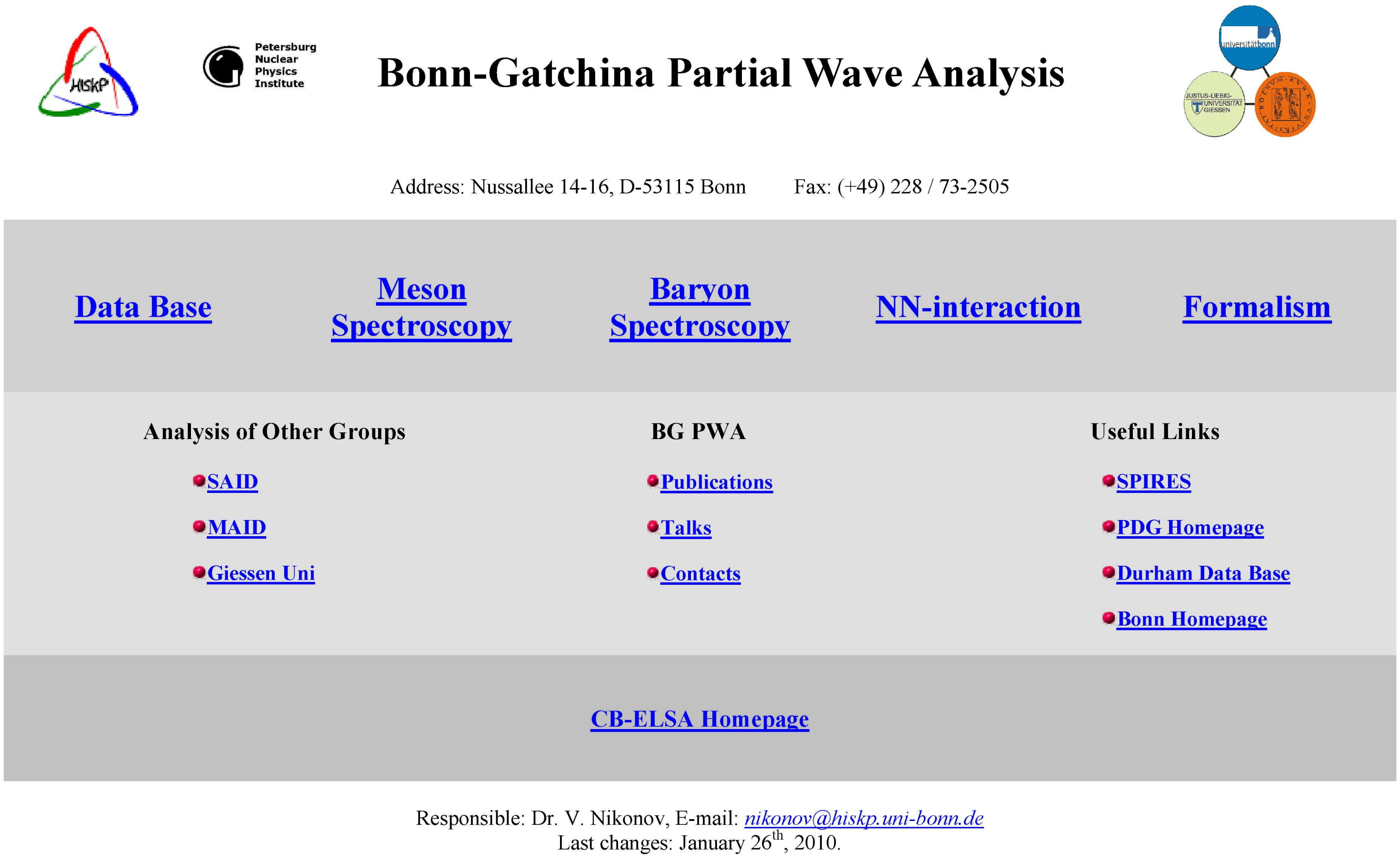
http://pwa.hiskp.uni-bonn.de/



Bonn-Gatchina Partial Wave Analysis

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Data Base | Meson Spectroscopy | Baryon Spectroscopy | NN-interaction | Formalism

Analysis of Other Groups

- SAID
- MAID
- Giessen Uni

BG PWA

- Publications
- Talks
- Contacts

Useful Links

- SPIRES
- PDG Homepage
- Durham Data Base
- Bonn Homepage

CB-ELSA Homepage

Responsible: Dr. V. Nikonov, E-mail: *nikonov@hiskp.uni-bonn.de*
Last changes: January 26th, 2010.

The latest analysis of SAID (GWU) of πN elastic data as well as $\gamma p \rightarrow \pi^0 p$ and $\gamma p \rightarrow \pi^+ n$ did not confirm the set of states observed in earlier analysis of πN elastic data. CLAS (M. Dugger et al.). Phys.Rev.C79:065206,2009.

State	PDG (Pole position)(MeV)		Bonn-Gatchina PWA (MeV)	
	Mass	**Width**	**Mass**	**Width**
$P_{11}(1710)^{***}$	1720 ± 50	230 ± 150	1725 ± 25	200 ± 20
$P_{33}(1600)^{***}$	1550 ± 100	300 ± 100	1540^{+40}_{-80}	230 ± 40
$P_{33}(1920)^{***}$	1900 ± 50	200^{+100}_{-50}	1910 ± 50	330 ± 50
$D_{13}(1720)^{***}$	1680 ± 50	100 ± 50	1730 ± 30	140 ± 35
$P_{13}(1900)^{*}$	~ 1900	498 ± 78	1920 ± 30	200 ± 30
$D_{33}(1940)^{*}$	~ 1940	$200 - 500$	1990 ± 40	350 ± 50

The fitted pion induced reactions.

Observable	$N_{\rm data}$	$\frac{\chi^2}{N_{\rm data}}$		**Observable**	$N_{\rm data}$	$\frac{\chi^2}{N_{\rm data}}$	
$\mathrm{N}^*_{1/2-}$ $\mathrm{S}_{11}(\pi\mathrm{N}\to\pi\mathrm{N})$	**104**	**1.81**	**SAID**	$\Delta_{1/2-}$ $\mathrm{S}_{31}(\pi\mathrm{N}\to\pi\mathrm{N})$	**112**	**2.27**	**SAID**
$\mathrm{N}^*_{1/2+}$ $\mathrm{P}_{11}(\pi\mathrm{N}\to\pi\mathrm{N})$	**112**	**2.49**	**SAID**	$\Delta_{1/2+}$ $\mathrm{P}_{31}(\pi\mathrm{N}\to\pi\mathrm{N})$	**104**	**2.01**	**SAID**
$\mathrm{N}^*_{3/2+}$ $\mathrm{P}_{13}(\pi\mathrm{N}\to\pi\mathrm{N})$	**112**	**1.90**	**SAID**	$\Delta^*_{3/2+}$ $\mathrm{P}_{33}(\pi\mathrm{N}\to\pi\mathrm{N})$	**120**	**2.53**	**SAID**
$\Delta^*_{3/2-}$ $\mathrm{D}_{33}(\pi\mathrm{N}\to\pi\mathrm{N})$	**108**	**2.56**	**SAID**	$\mathrm{N}^*_{3/2-}$ $\mathrm{D}_{13}(\pi\mathrm{N}\to\pi\mathrm{N})$	**96**	**2.16**	**SAID**
$\mathrm{N}^*_{5/2-}$ $\mathrm{D}_{15}(\pi\mathrm{N}\to\pi\mathrm{N})$	**96**	**3.37**	**SAID**	$\Delta_{5/2+}$ $\mathrm{F}_{35}(\pi\mathrm{N}\to\pi\mathrm{N})$	**62**	**1.32**	**SAID**
$\Delta_{7/2+}$ $\mathrm{F}_{37}(\pi\mathrm{N}\to\pi\mathrm{N})$	**72**	**2.86**	**SAID**				
$d\sigma/d\Omega(\pi^-p\to n\eta)$	**70**	**1.96**	**Richards *et al.***	$d\sigma/d\Omega(\pi^-p\to n\eta)$	**84**	**2.67**	**CBALL**
$d\sigma/d\Omega(\pi^-p\to K\Lambda)$	**479**	**1.55**	**RAL**	$P(\pi^-p\to K\Lambda)$	**261**	**1.76**	**RAL+ANL**
$d\sigma/d\Omega(\pi^+p\to K^+\Sigma)$	**609**	**1.91**	**RAL**	$P(\pi^+p\to K^+\Sigma)$	**420**	**2.74**	**RAL**
$d\sigma/d\Omega(\pi^-p\to n\pi^0\pi^0)$			**CBALL**				

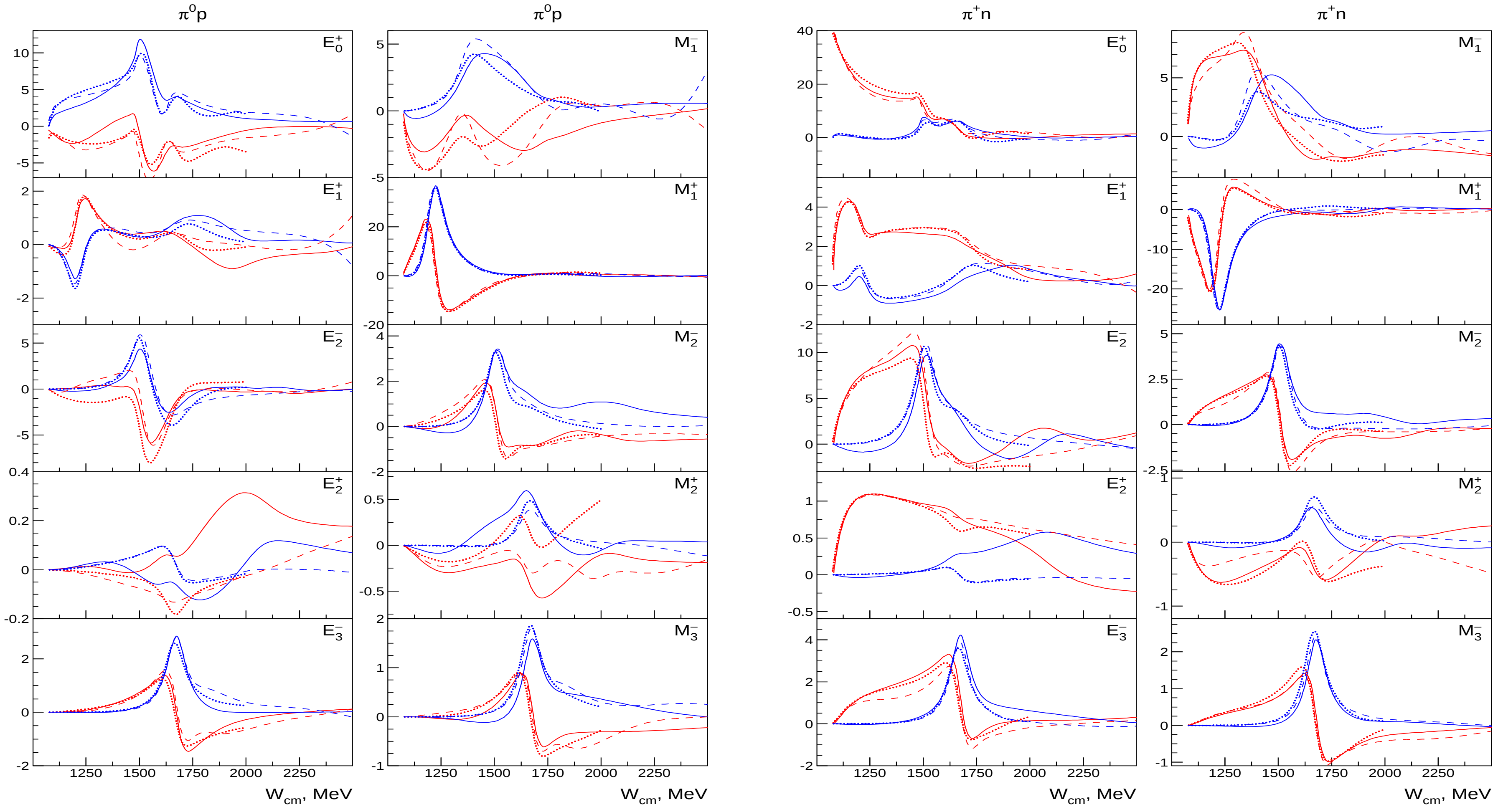
The fitted single meson photoproduction reactions.

Observable	$N_{\rm data}$	$\frac{\chi^2}{N_{\rm data}}$		**Observable**	$N_{\rm data}$	$\frac{\chi^2}{N_{\rm data}}$	
$d\sigma/d\Omega(\gamma p\to p\pi^0)$	**1106**	**1.34**	**CB-ELSA**	$d\sigma/d\Omega(\gamma p\to p\pi^0)$	**861**	**1.46**	**GRAAL**
$d\sigma/d\Omega(\gamma p\to p\pi^0)$	**592**	**2.11**	**CLAS**	$d\sigma/d\Omega(\gamma p\to p\pi^0)$	**1692**	**1.25**	**TAPS@MAMI**
$E(\gamma p\to p\pi^0)$	**140**	**1.23**	**A2-GDH**	$\Sigma(\gamma p\to p\pi^0)$	**1492**	**3.26**	**SAID db**
$P(\gamma p\to p\pi^0)$	**607**	**3.23**	**SAID db**	$T(\gamma p\to p\pi^0)$	**389**	**3.71**	**SAID db**
$H(\gamma p\to p\pi^0)$	**71**	**1.26**	**SAID db**	$G(\gamma p\to p\pi^0)$	**75**	**1.50**	**SAID db**
$O_x(\gamma p\to p\pi^0)$	**7**	**1.77**	**SAID db**	$O_z(\gamma p\to p\pi^0)$	**7**	**0.46**	**SAID db**
$d\sigma/d\Omega(\gamma p\to n\pi^+)$	**1583**	**1.64**	**SAID db**	$d\sigma/d\Omega(\gamma p\to n\pi^+)$	**408**	**0.62**	**A2-GDH**
$\Sigma(\gamma p\to n\pi^+)$	**899**	**3.48**	**SAID db**	$E(\gamma p\to n\pi^+$	**231**	**1.55**	**A2-GDH**
$P(\gamma p\to n\pi^+)$	**252**	**2.90**	**SAID db**	$T(\gamma p\to n\pi^+)$	**661**	**3.21**	**SAID db**
$H(\gamma p\to p\pi^+)$	**71**	**3.90**	**SAID db**	$G(\gamma p\to p\pi^+)$	**86**	**5.64**	**SAID db**
$d\sigma/d\Omega(\gamma p\to p\eta)$	**680**	**1.47**	**CB-ELSA**	$d\sigma/d\Omega(\gamma p\to p\eta)$	**100**	**2.16**	**TAPS**
$\Sigma(\gamma p\to p\eta)$	**51**	**2.26**	**GRAAL 98**	$\Sigma(\gamma p\to p\eta)$	**100**	**2.02**	**GRAAL 07**
$T(\gamma p\to p\eta)$	**50**	**1.48**	**Phoenics**				

The fitted reactions with strange meson production and multi-meson photoproduction.

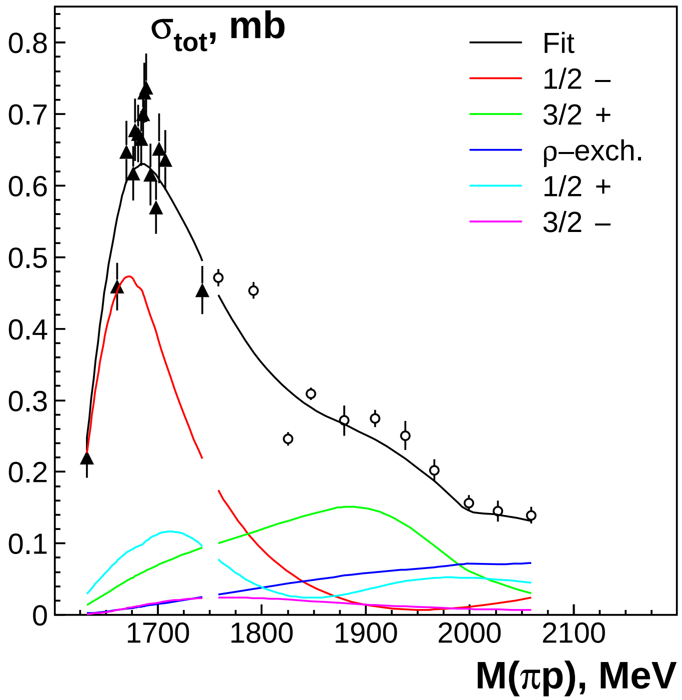
Observable	$N_{\rm data}$	$\frac{\chi^2}{N_{\rm data}}$		Observable	$N_{\rm data}$	$\frac{\chi^2}{N_{\rm data}}$	
$C_x(\gamma p\to\Lambda K^+)$	160	1.23	CLAS	$C_x(\gamma p\to\Sigma^0 K^+)$	94	2.20	CLAS
$C_z(\gamma p\to\Lambda K^+)$	160	1.41	CLAS	$C_z(\gamma p\to\Sigma^0 K^+)$	94	2.00	CLAS
$d\sigma/d\Omega(\gamma p\to\Lambda K^+)$	1377	1.81	CLAS	$d\sigma/d\Omega(\gamma p\to\Sigma^0 K^+)$	1280	2.06	CLAS
$P(\gamma p\to\Lambda K^+)$	202	2.03	CLAS	$P(\gamma p\to\Sigma^0 K^+)$	95	1.45	CLAS
$\Sigma(\gamma p\to\Lambda K^+)$	66	1.53	GRAAL	$\Sigma(\gamma p\to\Sigma^0 K^+)$	42	0.90	GRAAL
$\Sigma(\gamma p\to\Lambda K^+)$	45	1.65	LEP	$\Sigma(\gamma p\to\Sigma^0 K^+)$	45	1.11	LEP
$T(\gamma p\to\Lambda K^+)$	66	1.26	GRAAL 09	$d\sigma/d\Omega(\gamma p\to\Sigma^+ K^0)$	48	3.76	CLAS
$O_x(\gamma p\to\Lambda K^+)$	66	1.30	GRAAL 09	$d\sigma/d\Omega(\gamma p\to\Sigma^+ K^0)$	160	0.98	CB-ELSA
$O_z(\gamma p\to\Lambda K^+)$	66	1.54	GRAAL 09	$P(\gamma p\to\Sigma^+ K^0)$	72	0.61	CB-ELSA
$d\sigma/d\Omega(\gamma p\to p\pi^0\pi^0)$	CB-ELSA (1.4 GeV)			$E(\gamma p\to p\pi^0\pi^0)$	16	1.91	MAMI
$d\sigma/d\Omega(\gamma p\to p\pi^0\eta)$	CB-ELSA (3.2 GeV)			$\Sigma(\gamma p\to p\pi^0\eta)$	180	2.37	GRAAL
$d\sigma/d\Omega(\gamma p\to p\pi^0\pi^0)$	CB-ELSA (3.2 GeV)			$\Sigma(\gamma p\to p\pi^0\pi^0)$	128	0.96	GRAAL

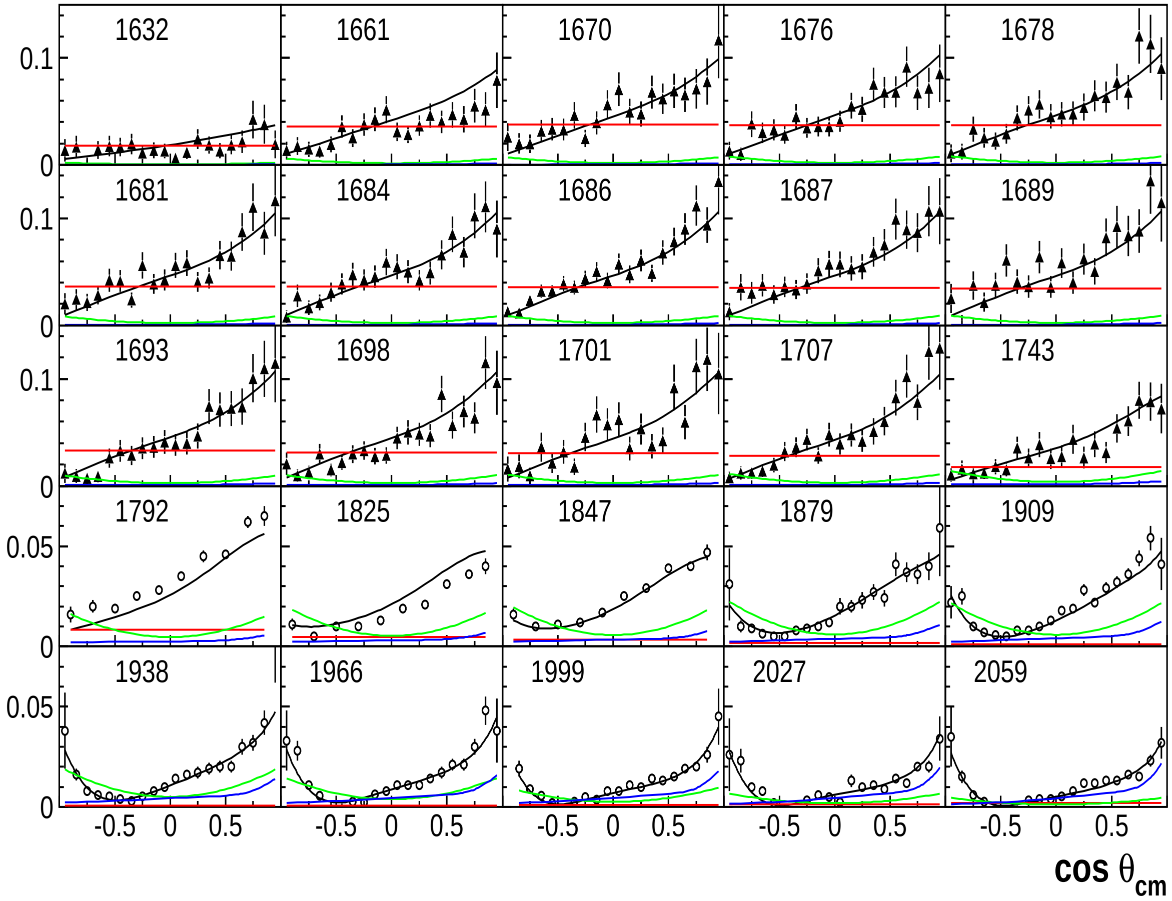
The multipoles for single pion production. Red - real part, Blue - imaginary part. Solid curves BoGa -solution, dashed curves - SAID solution, dotted - MAID 2009.



The $P_{11}(1710)$ and $P_{13}(1900)$ states

The differential cross section for the $\pi^- p \to K\Lambda$ reaction shows a clear contribution from this state ($S_{11} - P_{11}$ interference):

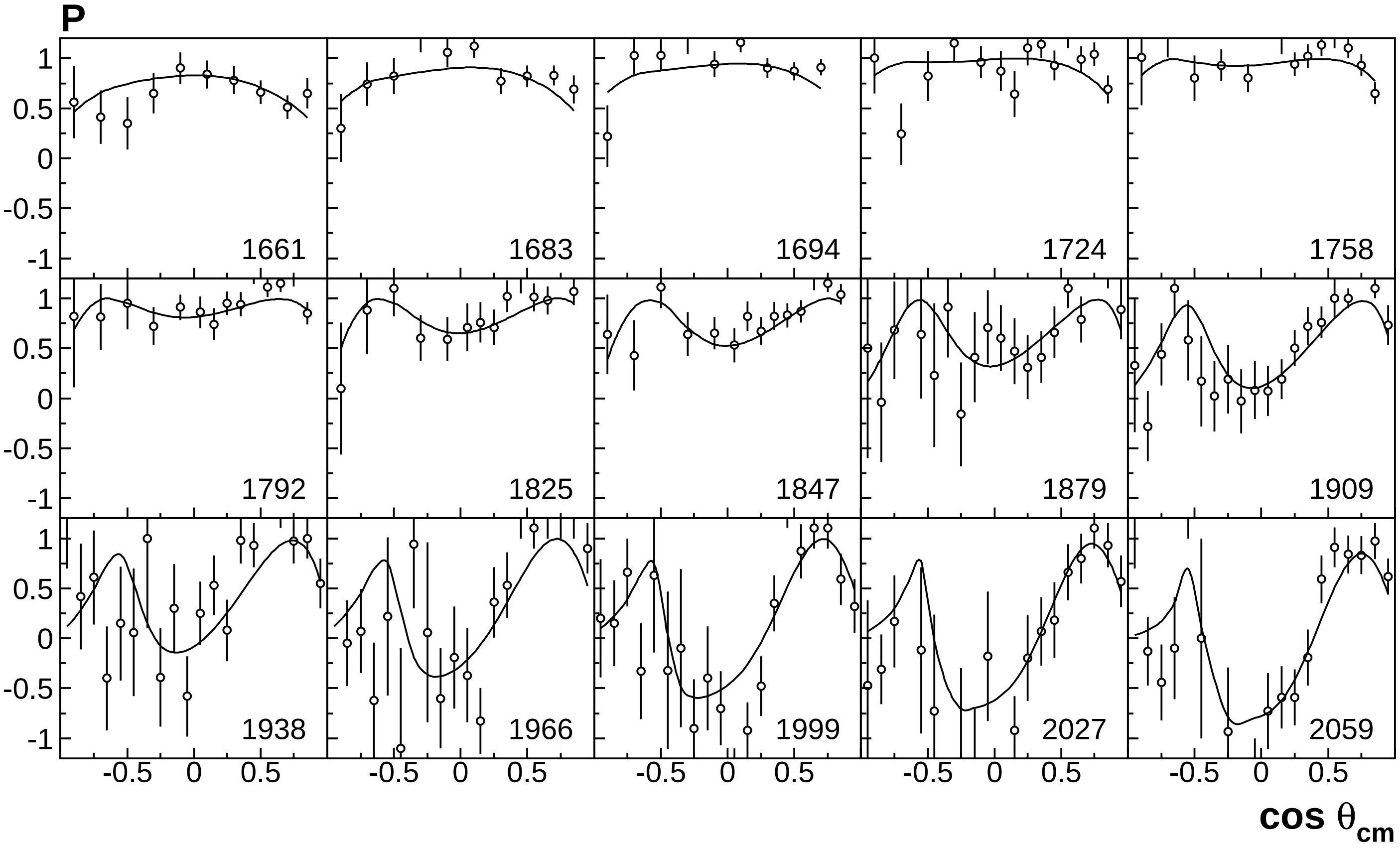




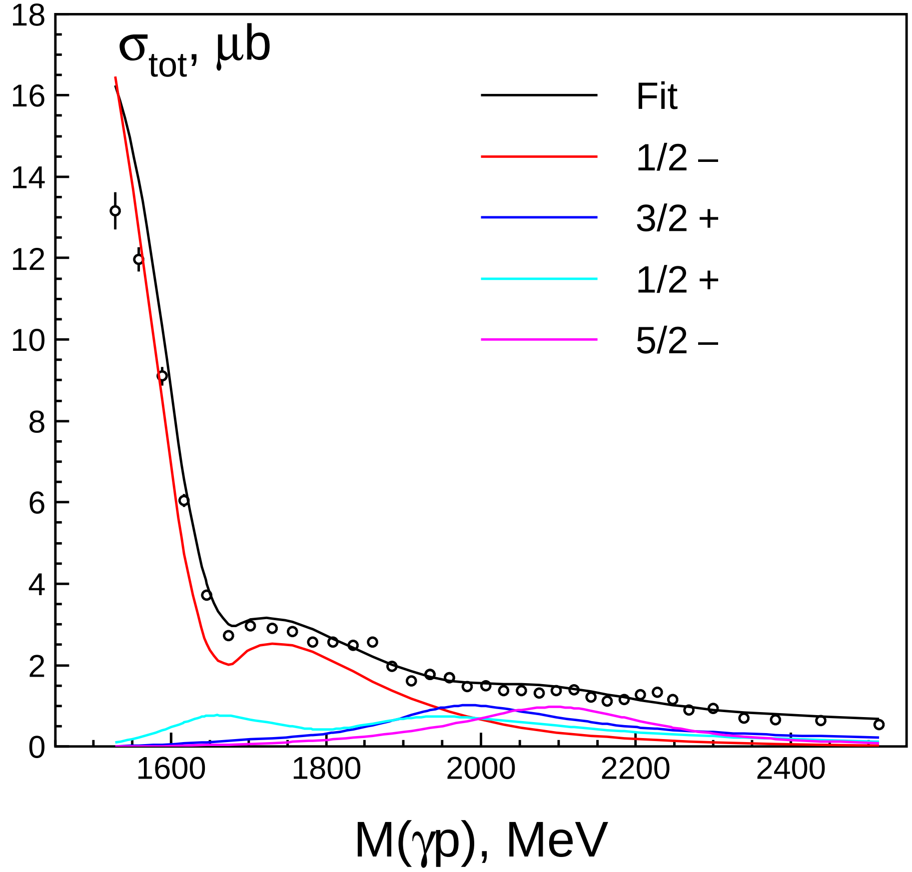
The $P_{11}(1710)$ and $P_{13}(1900)$ states

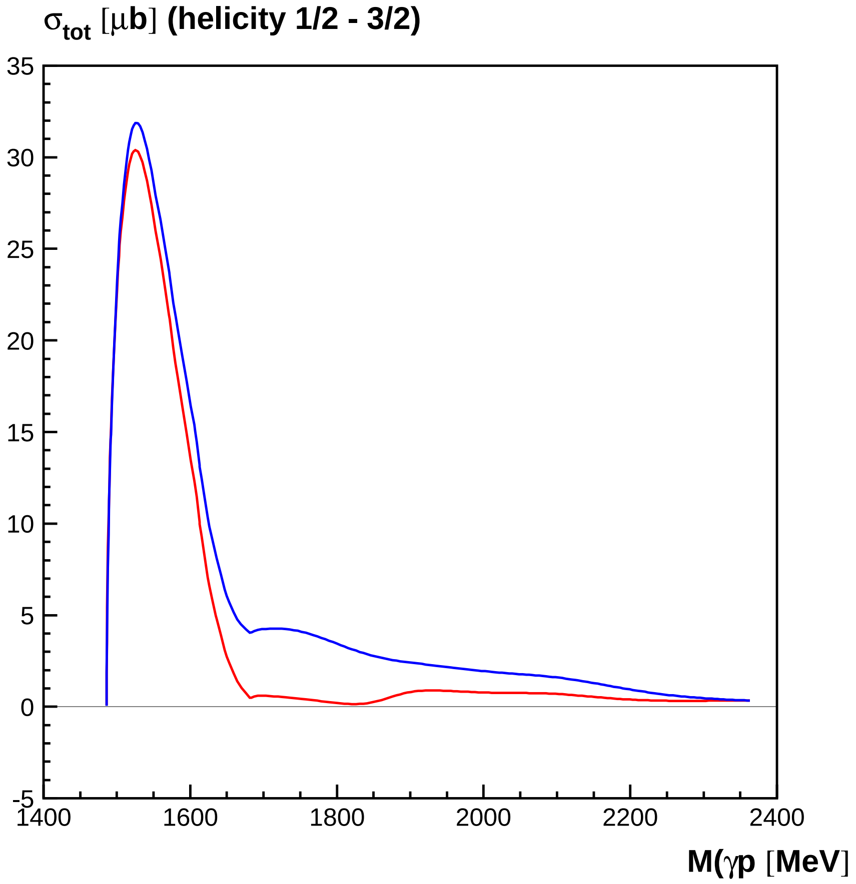
The recoil asymmetry for the $\pi^- p \to K\Lambda$ reaction.

Near threshold only S and P-wave contribute:

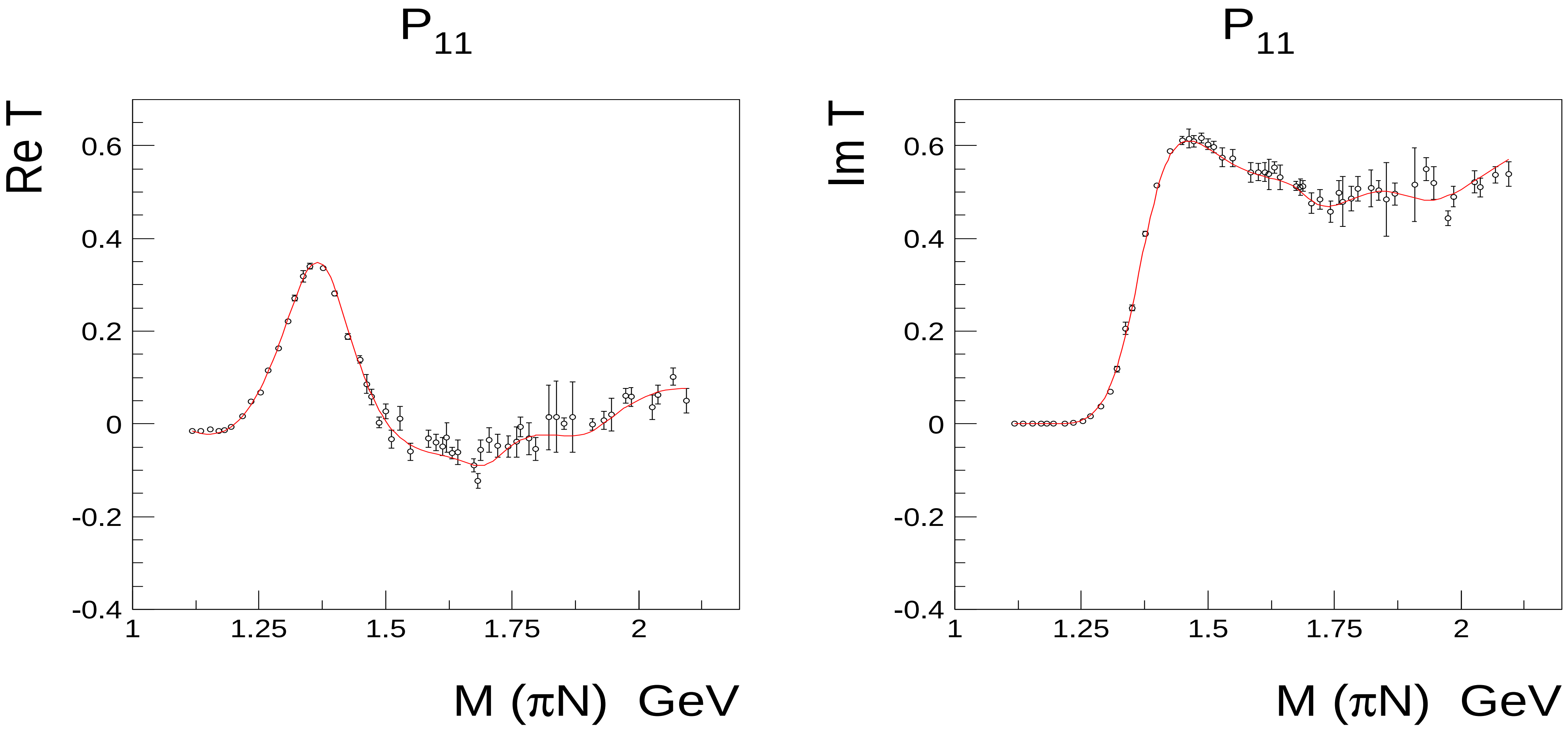


The $P_{11}(1710)$ and $P_{13}(1900)$ states





$\mathrm{N}\pi \rightarrow \mathrm{N}\pi\ P_{11}$ wave (3 pole 4 channel K-matrix)

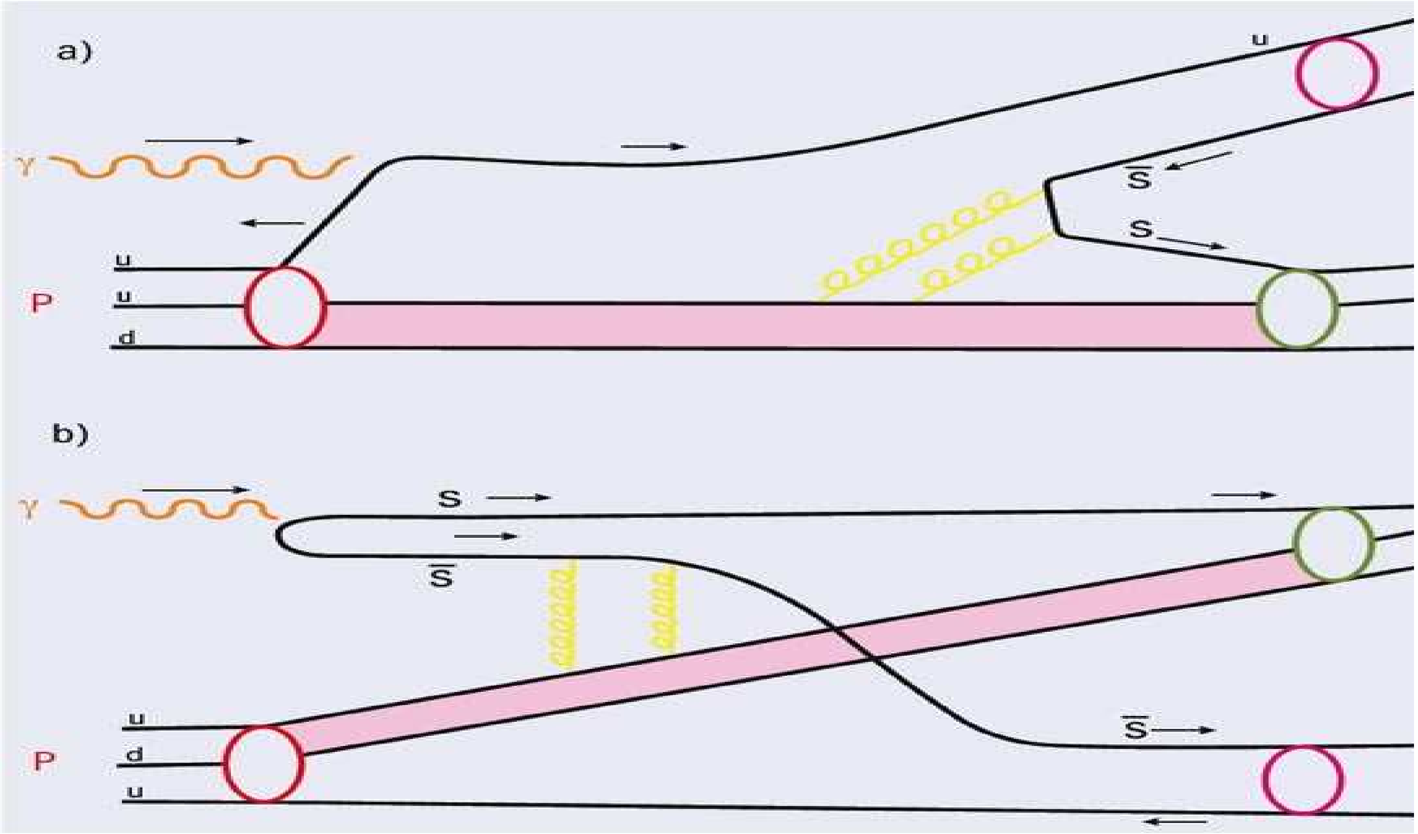


T-matrix poles: $M = 1371 \pm 7$ **MeV,** $2\ Im = 192 \pm 20$ **MeV;**
$M = 1720 \pm 25$ **MeV,** $2\ Im = 190 \pm 50$ **MeV**
$M = 1850 - 2000$ **MeV,** $2\ Im = 150 - 250$ **MeV**

Polarization transfer in open strangeness photoproduction reactions.

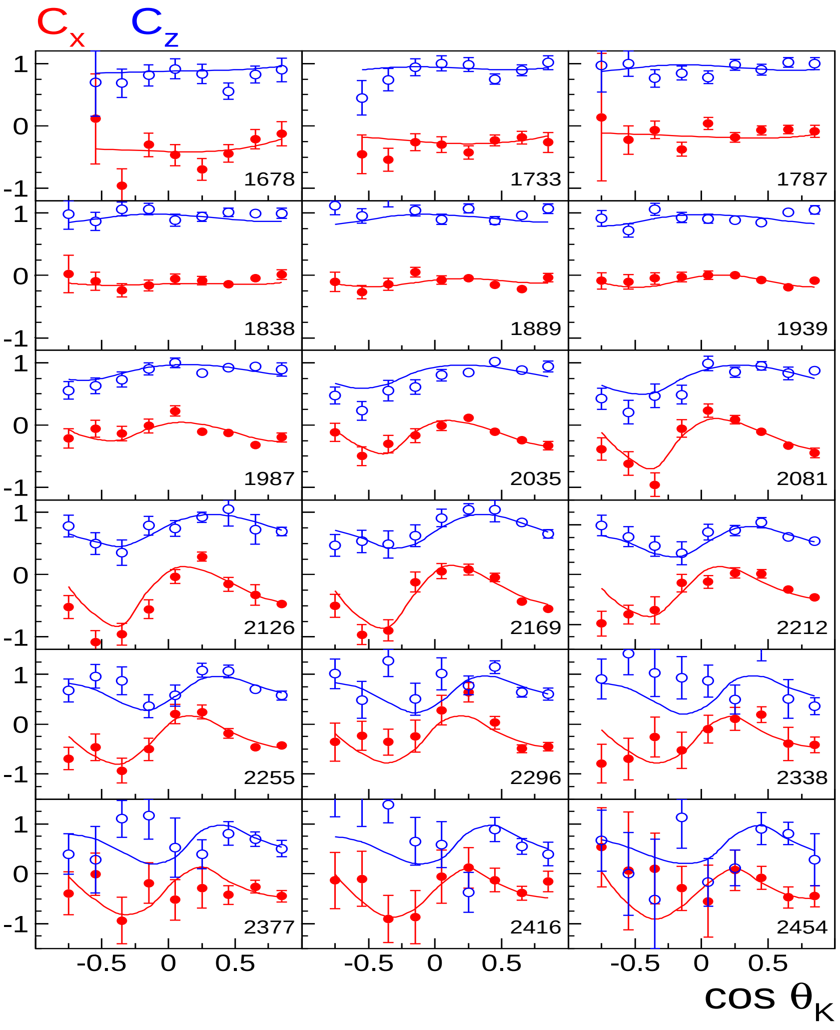
$C_z \sim 1$ up to 2 GeV mass region for $\gamma p \rightarrow K\Lambda$ and $\gamma p \rightarrow K\Sigma$

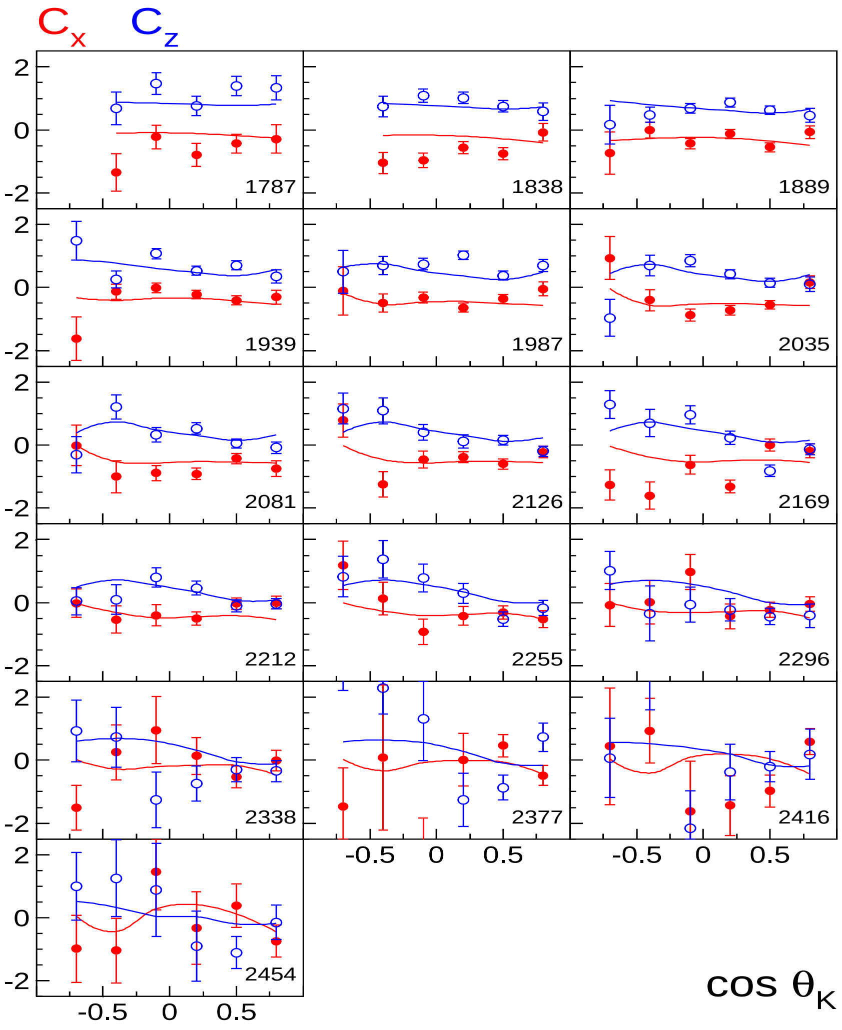
(R. Bradford et al. Phys.Rev.C75:035205,2007).



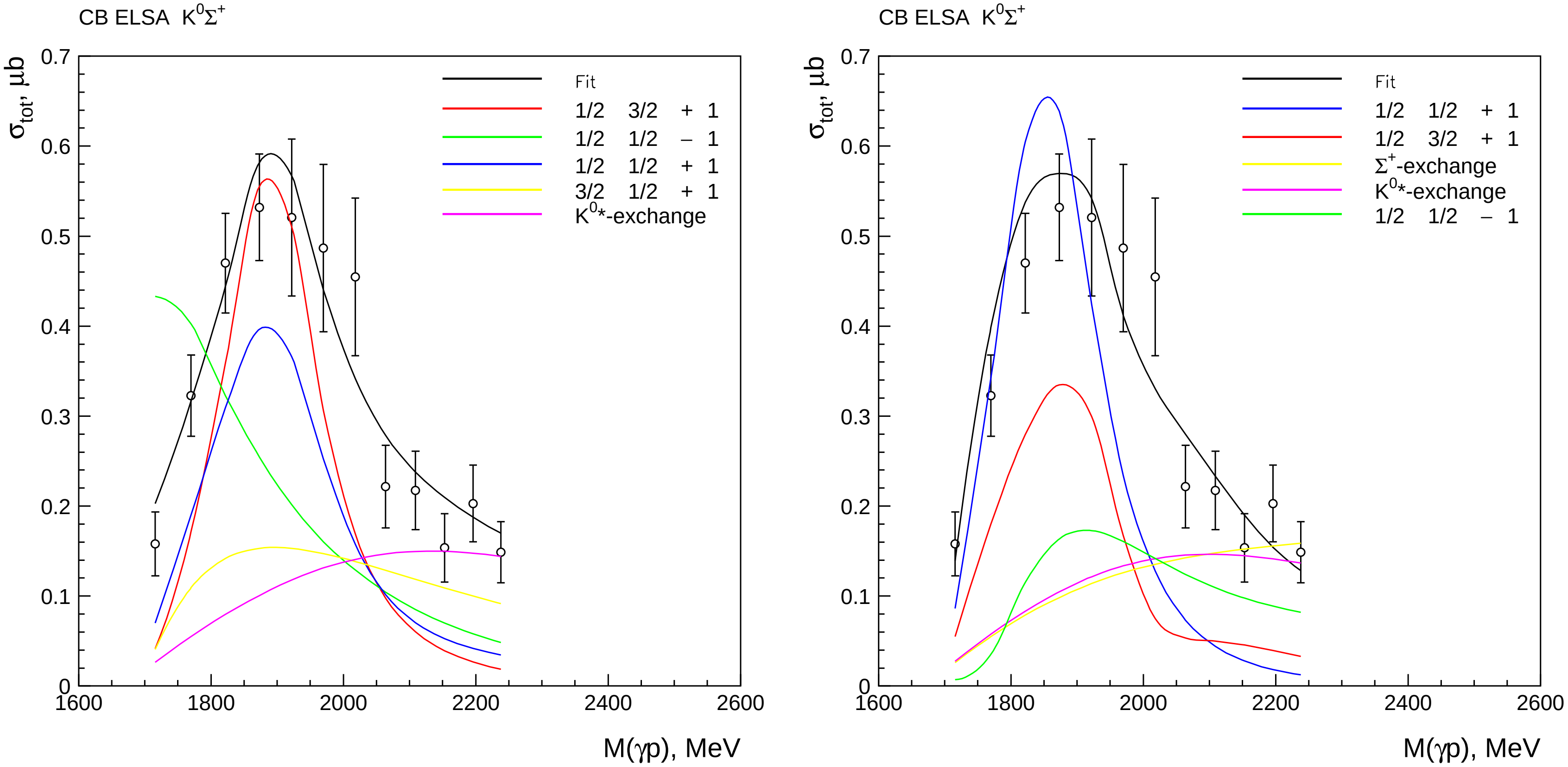
D.S. Carman, T.S.Harry Lee, Mac Mestayer, Reinhard Schumacher, CERN Cour.47N7:32-33,2007.

The only existing explanation of the C_x and C_z observables in $\gamma p \to K\Lambda$ and $\gamma p \to K\Sigma$ reactions is due to presence of $P_{13}(1900)$:





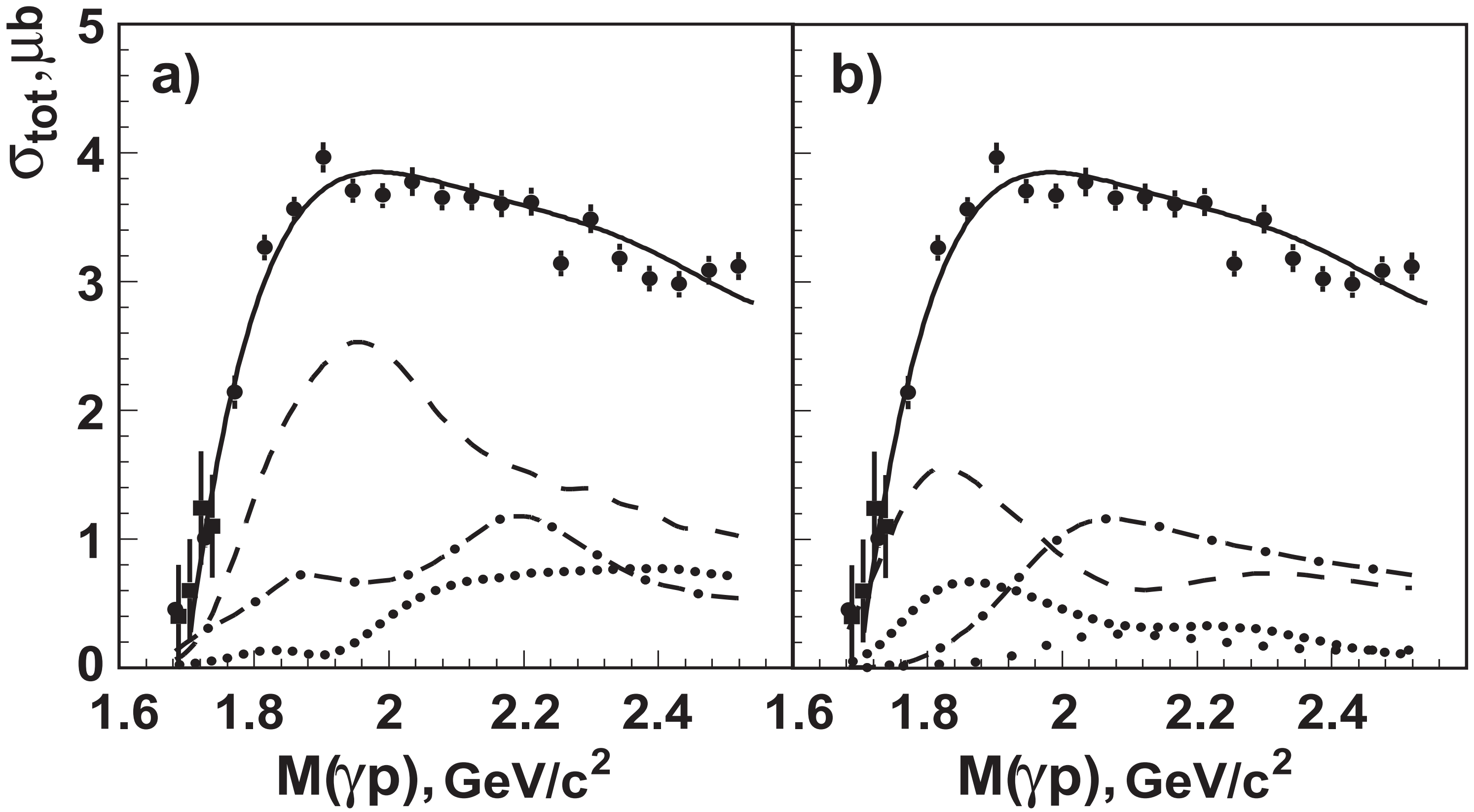
$\sigma_{tot}(\gamma p \to K^0\Sigma^+)$ from CB-ELSA



Red line – $P_{13}(1900)$

Blue line – $P_{11}(1860)$ **(improved P in $K\Lambda$ and $K\Sigma$ data)**

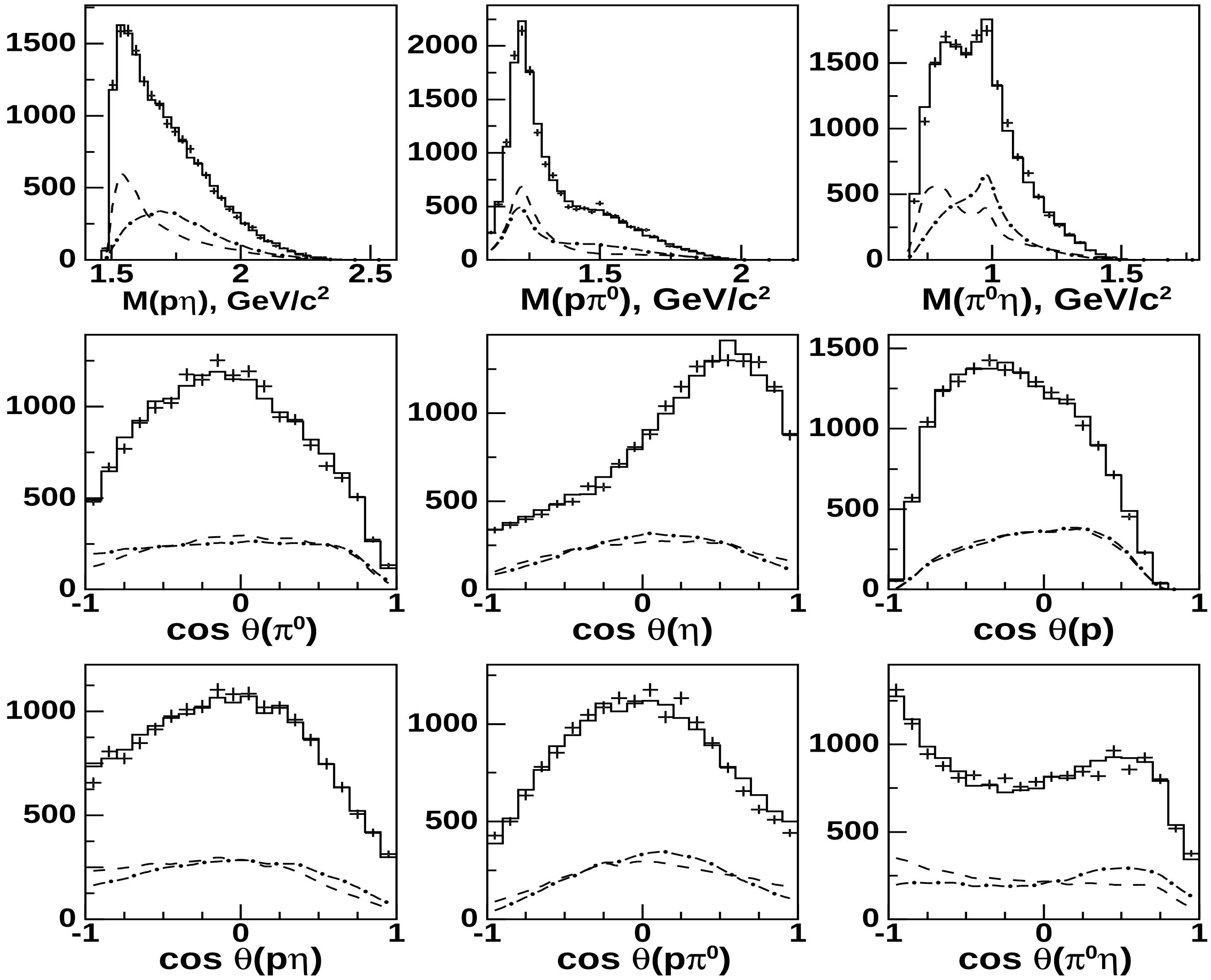
$\gamma p \to p\pi^0\eta$ (CB-ELSA)



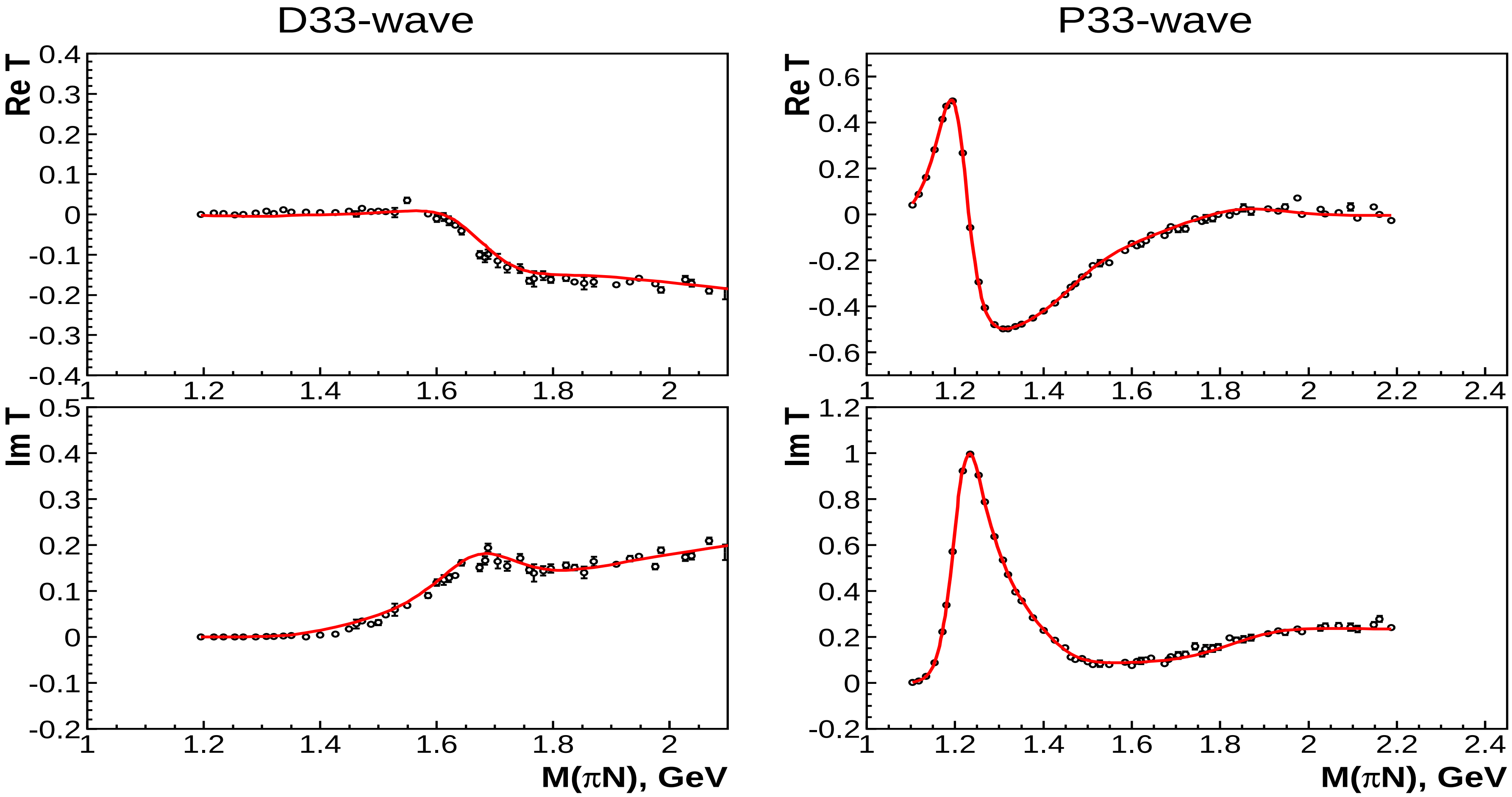
Left panel : contributions from $\Delta(1232)\eta$ (dashed), $S_{11}(1535)\pi$ (dashed-dotted) and $N\,a_0(980)$ final states.

Right panel: D_{33} partial wave (dashed), P_{33} partial wave (dashed-dotted), $D_{33} \to \Delta(1232)\eta$ (dotted) and $D_{33} \to N\,a_0(980)$ (wide dotted).

The $\gamma p \to \pi^0 \eta p$ differential cross section for the total energy region.



$\mathrm{N}\pi \rightarrow \mathrm{N}\pi$ D_{33} and P_{33} waves

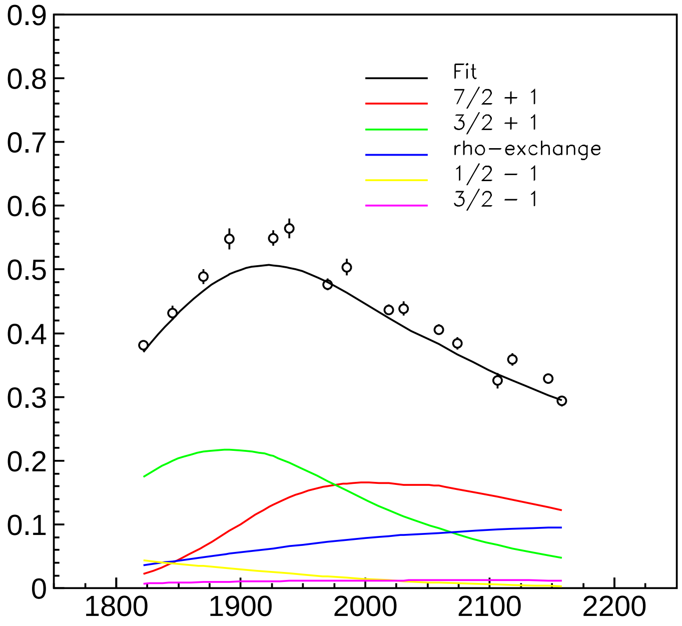


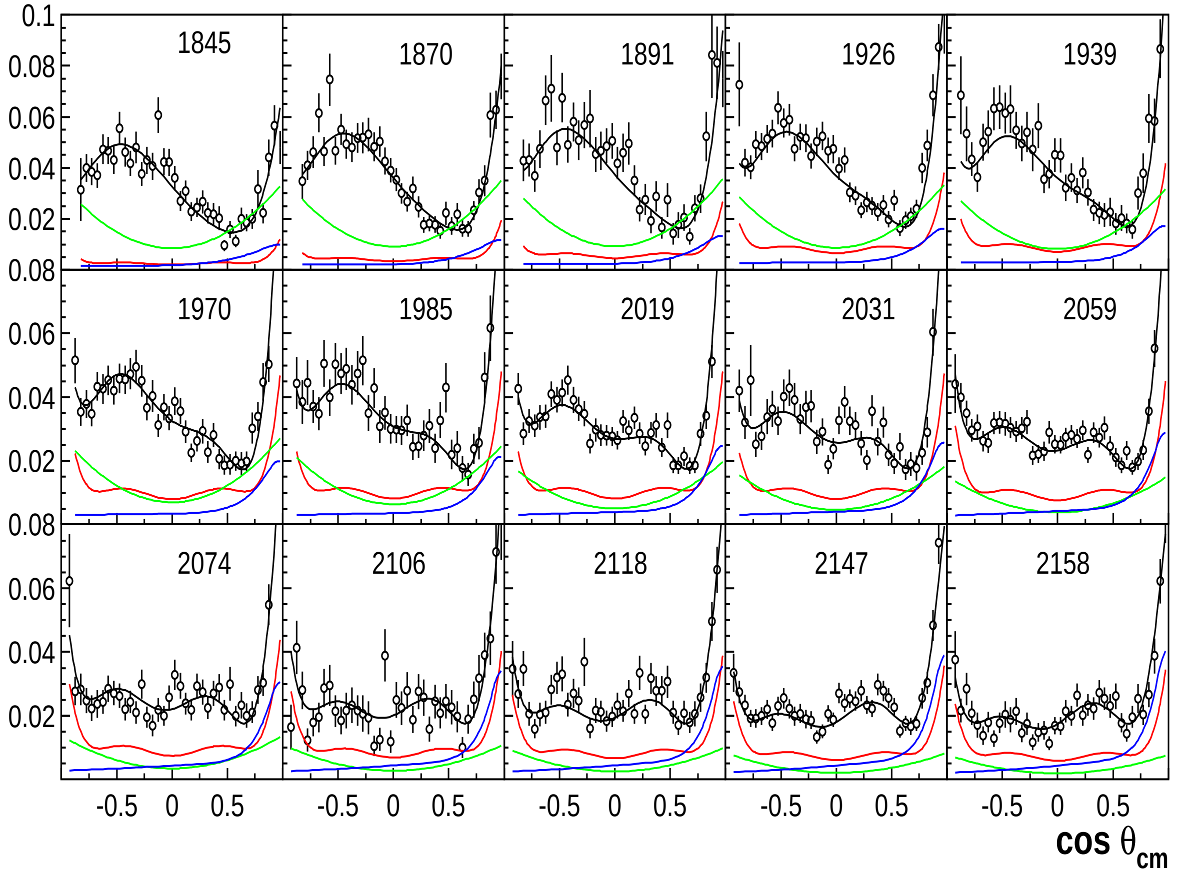
Properties of the $\Delta(1920)P_{33}$ and $\Delta(1940)D_{33}$ resonances.

	M_{pole}	Γ_{pole}	M_{BW}	Γ^{BW}_{tot}
$\Delta(1920)P_{33}$	1980^{+25}_{-45}	350^{+35}_{-55}	1990 ± 35	375 ± 50
$\Delta(1940)D_{33}$	1985 ± 30	390 ± 50	1990 ± 40	410 ± 70

	$\mathrm{Br}_{N\pi}$	$\mathrm{Br}_{\Delta\eta}$	$\mathrm{Br}_{N(1535)\pi}$	$\mathrm{Br}_{Na_0(980)}$
$\Delta(1920)P_{33}$	15 ± 8	18 ± 8	7 ± 4	4 ± 2
$\Delta(1940)D_{33}$	9 ± 4	5 ± 2	2 ± 1	2 ± 1

The Δ-states decaying into $K\Sigma$ can be fixed from the $\pi^+ \to K^+\Sigma$ data. The main contribution comes from $P_{33}(1920)$ -green curves and $F_{37}(1900)$ - red curves.





Parity doublets of N and Δ resonances at high mass region

Leonid Glozman suggested a restoration of chiral symmetry in high-mass excitations.

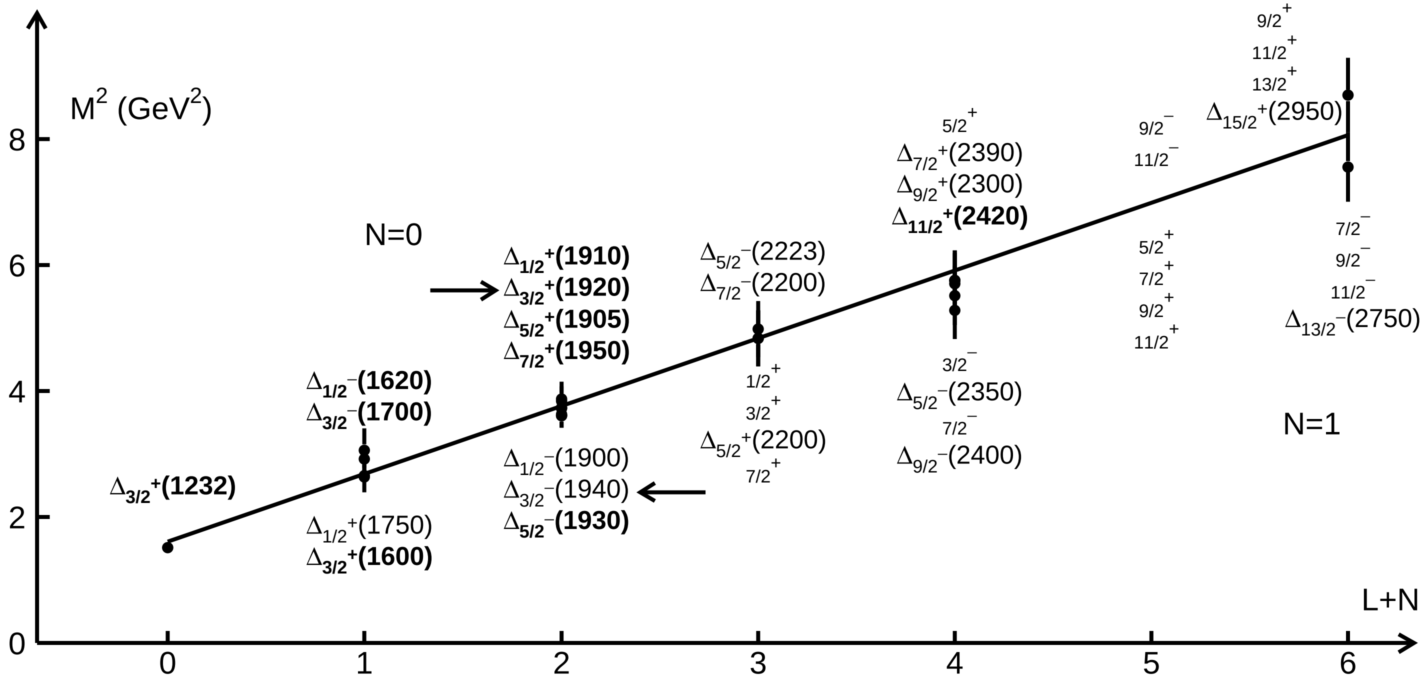
Parity doublets must not interact by pion emission and could have a small coupling to πN.

$J=\frac{1}{2}$	$N_{1/2+}(2100)^a$	*	$N_{1/2-}(2090)^a$	*	$\Delta_{1/2+}(1910)$	****	$\Delta_{1/2-}(1900)^a$	**
$J=\frac{3}{2}$	$N_{3/2+}(1900)^a$	**	$N_{3/2-}(2080)^a$	**	$\Delta_{3/2+}(1920)^a$	***	$\Delta_{3/2-}(1940)^a$	*
$J=\frac{5}{2}$	$N_{5/2+}(2000)^a$	**	$N_{5/2-}(2200)^a$	**	$\Delta_{5/2+}(1905)$	****	$\Delta_{5/2-}(1930)^a$	**
$J=\frac{7}{2}$	$N_{7/2+}(1990)^a$	**	$N_{7/2-}(2190)$	****	$\Delta_{7/2+}(1950)$	****	$\Delta_{7/2-}(2200)^a$	*
$J=\frac{9}{2}$	$N_{9/2+}(2220)$	****	$N_{9/2-}(2250)$	****	$\Delta_{9/2+}(2300)$	**	$\Delta_{9/2-}(2400)^a$	**

$J=\frac{3}{2}$	$N_{3/2+}(1900)$	$N_{3/2-}(1875)$	$\Delta_{3/2+}(1980)$	$\Delta_{3/2-}(1985)$
$J=\frac{5}{2}$	$N_{5/2+}(1960)$	$N_{5/2-}(2070)$	$\Delta_{5/2+}(1945)$	$\Delta_{5/2-}(1930)$
$J=\frac{7}{2}$	$N_{7/2+}(1990)$	$N_{7/2-}(????)$	$\Delta_{7/2+}(1910)$	$\Delta_{7/2-}(????)$

Holographic QCD (AdS/QCD)

Soft-wall model prediction: $M^2_{N,L} = 4\lambda^2 \left(N + L + \frac{3}{2}\right)$



$$M^2_{N,L} = 4\lambda^2 \left(N + L + \frac{3}{2}\right) - 2\left(M^2_{\Delta} - M^2_{N}\right)\kappa_{gd}$$

κ_{gd} **is the fraction of most attractive color-antitriplet isosinglet diquark.**

κ_{gd}**=0 for** Δ **and N(S=3/2) states,** $\frac{1}{2}$ **for** $S = 1/2\ (70 SU_6)$ **and** $\frac{1}{4}$ **for** $S = 1/2\ (56 SU_6)$**.**

Hilmar Forkel and Eberhard Klempt, hep-ph:0810.2959v1

L, S, N	κ_{gd}	Resonance					Pred.
$0,\frac{1}{2},0$	$\frac{1}{2}$	$N(940)$				input:	0.94
$0,\frac{3}{2},0$	0	$\Delta(1232)$					1.27
$0,\frac{1}{2},1$	$\frac{1}{2}$	$N(1440)$					1.40
$1,\frac{1}{2},0$	$\frac{1}{4}$	$N(1535)$	$N(1520)$				1.53
$1,\frac{3}{2},0$	0	$N(1650)$	$N(1700)$	$N(1675)$			1.64
$1,\frac{1}{2},0$	0	$\Delta(1620)$	$\Delta(1700)$		L, S, N=$0,\frac{3}{2},1$:	$\Delta(1600)$	1.64
$2,\frac{1}{2},0$	$\frac{1}{2}$	$N(1720)$	$N(1680)$		L, S, N=$0,\frac{1}{2},2$:	$N(1710)$	1.72
$1,\frac{1}{2},1$	$\frac{1}{4}$	$N(????)$	$N(1875)$				1.82
$1,\frac{3}{2},1$	0	$\Delta(1900)$	$\Delta(1940)$	$\Delta(1930)$			1.92
$2,\frac{3}{2},0$	0	$\Delta(1910)$	$\Delta(1920)$	$\Delta(1905)$	$\Delta(1950)$		1.92
$2,\frac{3}{2},0$	0	$N(1880)$	$N(1900)$	$N(1990)$	$N(2000)$		1.92
$0,\frac{1}{2},3$	$\frac{1}{2}$	$N(2100)$					2.03
$3,\frac{1}{2},0$	$\frac{1}{4}$	$N(2070)$	$N(2190)$	L, S, N=$1,\frac{1}{2},2$:	$N(2080)$	$N(2090)$	2.12
$3,\frac{3}{2},0$	0	$N(2200)$	$N(2250)$	L, S, N=$1,\frac{1}{2},2$:	$\Delta(2223)$	$\Delta(2200)$	2.20
$4,\frac{1}{2},0$	$\frac{1}{2}$	$N(2220)$					2.27
$4,\frac{3}{2},0$	0	$\Delta(2390)$	$\Delta(2300)$	$\Delta(2420)$	L, N=3,1:	$\Delta(2400)$ $\Delta(2350)$	2.43
$5,\frac{1}{2},0$	$\frac{1}{4}$	$N(2600)$					2.57

L	S	n	quark-diquark (D_1^1) states				with $SU(6)$ relations for L=0,1			
0	$\frac{1}{2}$				$N(\frac{1}{2}^+)$					
		1			(938±2)					
		2			(1400±40)					
	$\frac{3}{2}$								$\Delta(\frac{3}{2}^+)$	
		1							(1230±2)	
		2							(1635±40)	
2	$\frac{1}{2}$			$N(\frac{3}{2}^+)$	$N(\frac{5}{2}^+)$			$\Delta(\frac{3}{2}^+)$	$\Delta(\frac{5}{2}^+)$	
		1		(1770±100)	(1683±3)			∼ 1750	∼ 1750	
		2		∼ 2000	(2000±100)			∼ 2040	∼ 2040	
	$\frac{3}{2}$		$N(\frac{1}{2}^+)$	$N(\frac{3}{2}^+)$	$N(\frac{5}{2}^+)$	$N(\frac{7}{2}^+)$	$\Delta(\frac{1}{2}^+)$	$\Delta(\frac{3}{2}^+)$	$\Delta(\frac{5}{2}^+)$	$\Delta(\frac{7}{2}^+)$
		1	(1890±50)	(1915±60)	∼ 1880	(2020±60)	(1935±90)	(1935±40)	(1885±25)	(1928±8)
		2	∼ 2150	∼ 2150	∼ 2150	∼ 2150	∼ 2150	∼ 2151	∼ 2150	∼ 2150
1	$\frac{1}{2}$			$N(\frac{1}{2}^-)$	$N(\frac{3}{2}^-)$			$\Delta(\frac{1}{2}^-)$	$\Delta(\frac{3}{2}^-)$	
		1		(1535±20)	(1524±5)			(1625±10)	(1720±50)	
		2		∼ 1900	(1870±25)			(1910±50)	(1995±40)	
	$\frac{3}{2}$			$N(\frac{1}{2}^-)$	$N(\frac{3}{2}^-)$	$N(\frac{5}{2}^-)$				
		1		(1680±40)	(1730±40)	(1680±10)				
		2		∼ 2010	∼ 2000	(2060±35)				
3	$\frac{1}{2}$			$N(\frac{5}{2}^-)$	$N(\frac{7}{2}^-)$			$\Delta(\frac{5}{2}^-)$	$\Delta(\frac{7}{2}^-)$	
		1		(2160±80)	(2150±30)			∼ 2230	(2230±50)	
		2		∼ 2390	∼ 2390			∼ 2460	∼ 2460	
	$\frac{3}{2}$		$N(\frac{3}{2}^-)$	$N(\frac{5}{2}^-)$	$N(\frac{7}{2}^-)$	$N(\frac{9}{2}^-)$	$\Delta(\frac{3}{2}^-)$	$\Delta(\frac{5}{2}^-)$	$\Delta(\frac{7}{2}^-)$	$\Delta(\frac{9}{2}^-)$
		1	∼ 2260	∼ 2260	∼ 2260	(2250±50)	∼ 2320	(2350±50)	∼ 2320	∼ 2320
		2	∼ 2490	∼ 2490	∼ 2490	∼ 2490	∼ 2550	∼ 2550	∼ 2550	∼ 2550

Summary

1. **For a given quantum number only the lowest state couples strongly to the πN channel. All other states should be identified from analysis of non-elastic reactions.**
2. **The new analysis strongly supports the new baryon state observed in hyperon photoproduction $P_{13}(1900)$.**
3. **The η-photoproduction data reveal the baryon resonance $D_{15}(2070)$.**
4. **The $D_{33}(1940)$ and $P_{33}(1920)$ states are needed for the description of the $\gamma p \rightarrow \pi^0 \eta p$ data.**
5. **The data on $\pi^- p \rightarrow K\Lambda$ and $\gamma p \rightarrow \eta n$ prove the existence of $P_{11}(1710)$.**
6. **The data on $\pi^- p \rightarrow K\Sigma$ support the existence of $P_{33}(1600)$ and $P_{33}(1920)$ states.**
7. **The spectrum of observed states is in direct contradiction with a classical quark model. Restoration of chiral symmetry? Ads QCD? Quark-vector diquark? Or something else?**