NONSTRANGE PARTNERS OF Θ^+

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Based on work in collaboration with
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Contents

- Is $N^* \equiv N(1710)$?
- How to search for alternatives ?
- Modified PWA
- Theoretical expectations
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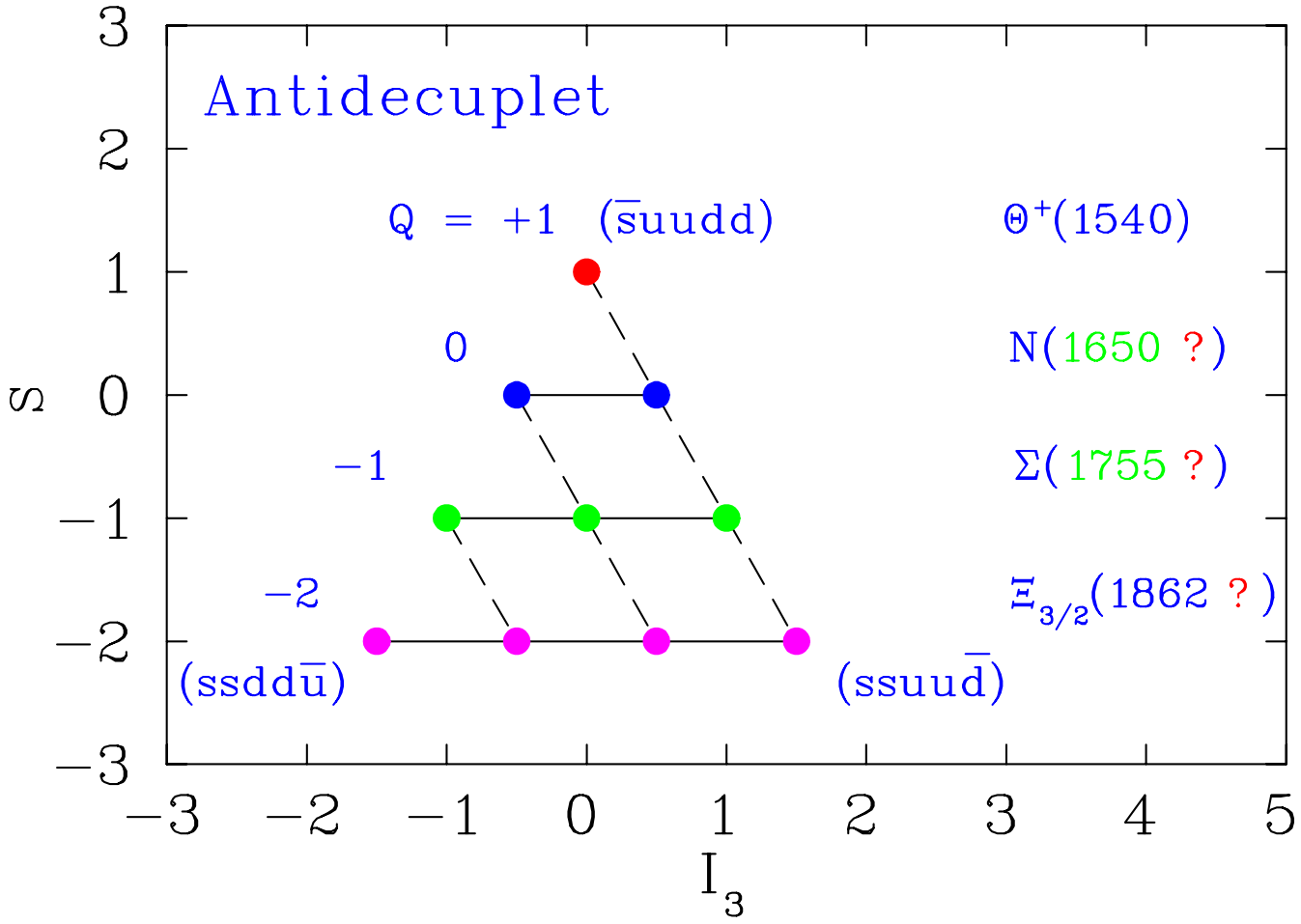
Θ^+ vs N(1710) – What is known

Ref	Mass (MeV)	Width (MeV)	Ref	Mass (MeV)	Width (MeV)
DPP	1530	< 15	DPP	1710	
LEPS	1540±10	< 25			
DIANA	1539±2	< 9			
CLAS/γn	1542±5	< 21			
CLAS/γp	1540±10	< 32			
ELSA	1540±4±2	< 25			
ITEP/ν	1533±5	< 20			
HERMES	1526±2±2	< 18			
USC	1543	< 6	KH	1723±9	120±15
GWU	1540−1550	≤ 1	CMU	1700±50	90±30
Jülich	1545	< 5	KSU	1717±28	480±230



GMO : $(M_\Xi - M_\Theta)/3 \;=\; 107\ MeV$

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- Standard PWA tends to miss Narrow Resonances
- Insertion of Narrow Resonances in PWA
  - Elastic Energy Region

$$e^{2i\delta} \quad \Rightarrow \quad e^{2i\delta^B} \cdot e^{2i\delta_R}$$

$$e^{2i\delta_R} = \frac{M_R - W + i\Gamma_R/2}{M_R - W - i\Gamma_R/2}$$

  - Inelastic Energy Region

$$\eta e^{2i\delta} \quad \Rightarrow \quad \langle a|S|a\rangle = r_a\, A(W)\, e^{2i\delta_R} + (1 - r_a) B(W)$$

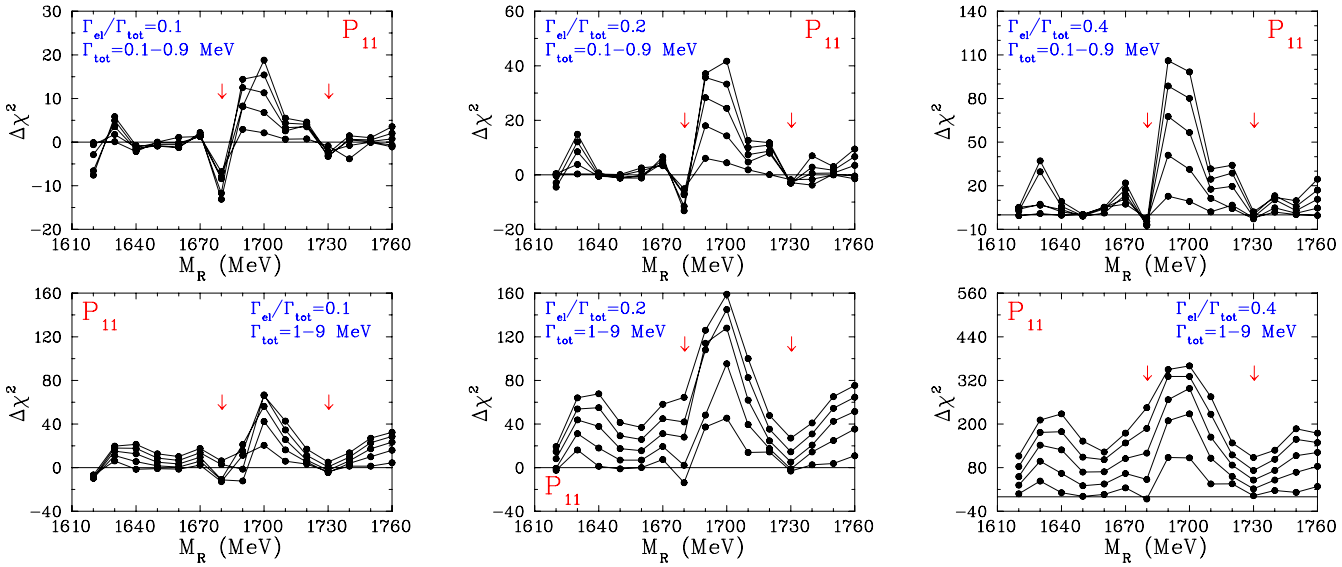
$$|\eta| \leq 1 \qquad\qquad r_a\, |A(W)| + (1 - r_a)|B(W)| \leq 1$$

$$|A(M_R)| = 1 \qquad \sum_a r_a = 1$$

$$r_a = BR(R \to a)$$

- How does this insertion change χ^2 ?
  (Will it decrease ?)

$\Delta\chi^2$ due to insertion of a resonance into P_{11} (preliminary)



At $|M_R - W| >> \Gamma_R$, R contributes $\sim \dfrac{\Gamma_{el}}{M_R - W}$

Two candidates : $M_R = 1680\ MeV$ $1730\ MeV$

$\Gamma_{el} < 0.5\ MeV$ $< 0.3\ MeV$

Resonances or "Resonances" ?

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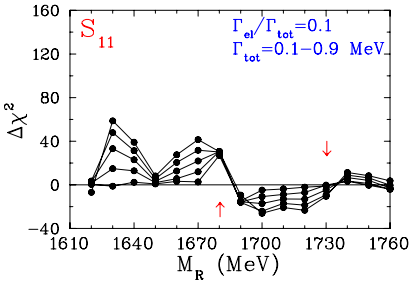
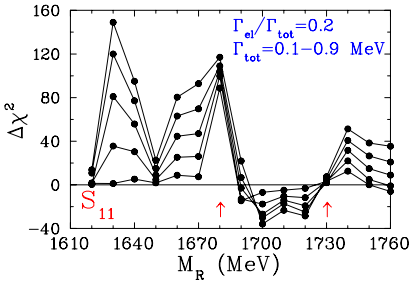
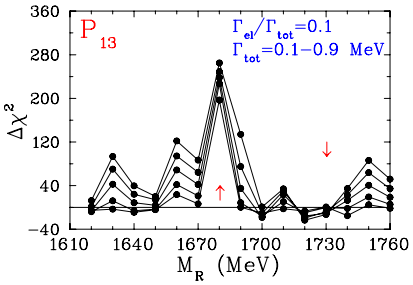
- Check other partial waves

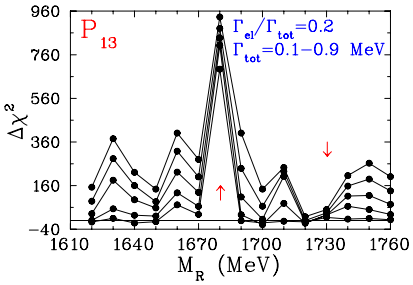
$\Delta\chi^2$ due to insertion of a resonance into S_{11} ($J^P = 1/2^-$) (preliminary)





$\Delta\chi^2$ due to insertion of a resonance into P_{13} ($J^P = 1/2^-$) (preliminary)





Conclusion from PWA

1680 MeV - only one partial wave reveals the effect:
support to the resonance

1730 MeV - other partial waves also reveal the effect,
but differently: resonance is still possible,
if accompanied by other corrections

Thresholds:
$N\omega$ (1720 MeV), $N\rho$ (1710 MeV) ?, $K\Sigma$ (1685)

- Theoretical analysis is rather uncertain
  but nevertheless may be used for orientation

- If $\Gamma_\Theta \leq 1\ MeV$, then expected structure for decays of the Θ-partner looks as follows:
  - $\Gamma(N^* \to \pi\Delta) \ \sim 2\ MeV$
    [forbidden for $\overline{10}$, needs mixing]
  - $\Gamma(N^* \to \eta N) \ \sim 0.5 - 2\ MeV$
  - $\Gamma(N^* \to \pi N) \ \sim 0.2 - 0.5\ MeV$
    [non-trivial cancellation due to mixing]
  - $\Gamma(N^* \to K\Lambda) \ \sim 0.5 - 1.5\ MeV$
  - $\Gamma(N^* \to \pi\pi N)$ [out of $\pi\Delta$] ?
  - $\Gamma(N^* \to K\Sigma)$ is small

Outlook

- Where is N^*, the non-strange partner of Θ^+ ?
  Indirect search with modified PWA may suggest
  two candidates with $J^P = 1/2^+$ (preliminary)
  $M_R = 1680$ MeV (more promising)
  $M_R = 1730$ MeV
- If $\Gamma_\Theta \leq 1$ MeV,
  then for the N^* we expect:

  $\Gamma_{tot} \leq 5\ MeV$
  may have small elasticity $\Gamma_{\pi N}/\Gamma_{tot} \leq 10\%$

  important decay
  $N^* \to \pi\pi N$ ($\pi\Delta$ due to mixing)

  less important, but essential
  $N^* \to K\Lambda$, ηN
- Direct precise measurements
  are necessary !!