Λ(1405) production in the $\pi^- p$ -> $K^0 \pi \Sigma$ reaction

Tetsuo Hyodo[a]

A. Hosaka[a], E. Oset[b], A. Ramos[c] and M. J. Vicente Vacas[b]

[a] RCNP, Osaka [b] IFIC, Valencia [c] Barcelona Univ.

2003, July 31st

Contents

1. Motivation
2. Chiral unitary model
3. □(1405) in the chiral unitary model
4. Model for □□p -> K^0□□
5. Results
6. Conclusions
7. Experiments + □

MB scattering

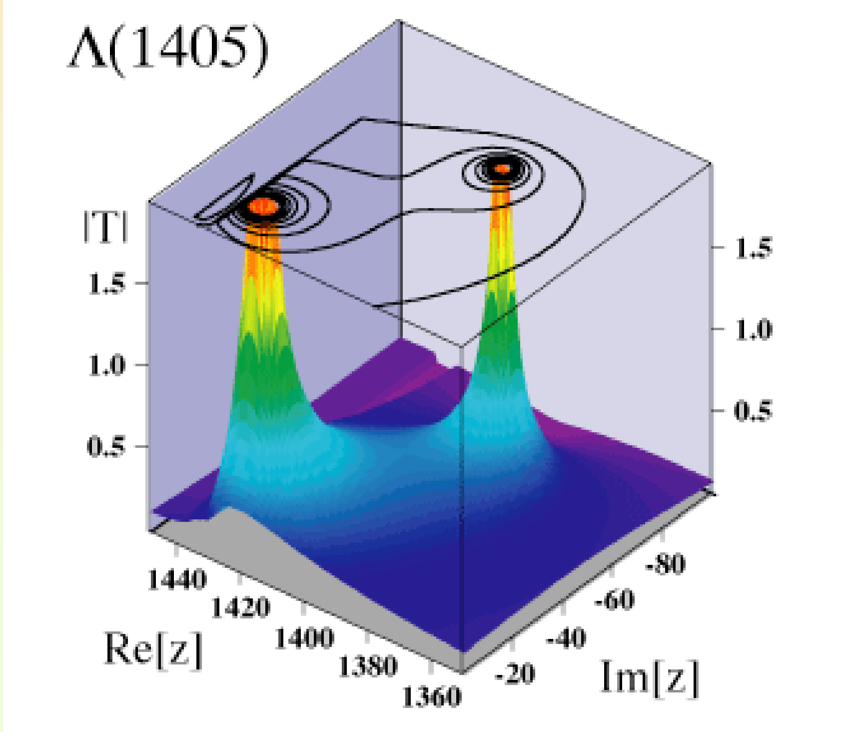
T. Hyodo, *et al.*, nucl-th/0307005

Motivations : Two poles?

There are two poles of the scattering amplitude around nominal Λ(1405) energy region.

- **Cloudy bag model (1990)**
  - Fink *et al.* PRC41, 2720
- **Chiral unitary model (2001~)**
  - Oller *et al.* PLB500, 263
  - Oset *et al.* PLB527, 99
  - Jido *et al.* PRC66, 025203
  - Hyodo *et al.* PRC68, 018201

Λ(1405) : $J^P=1/2^-$, I=0



Chiral unitary model

Flavor SU(3) meson-baryon scatterings (s-wave)

Chiral symmetry

Low energy behavior

+

Unitarity of S-matrix

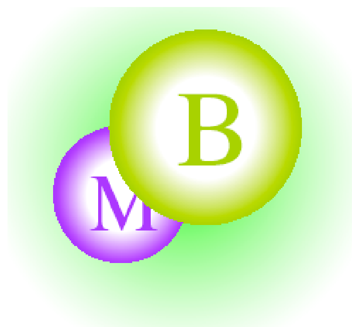
Non-perturbative resummation

Dynamical generation

$$J^P = 1/2^-$$

Resonances

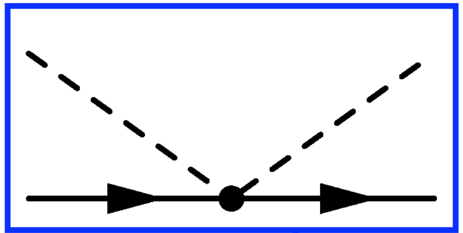
□(1405), □(1670), N(1535),
□(1620), □(1620)



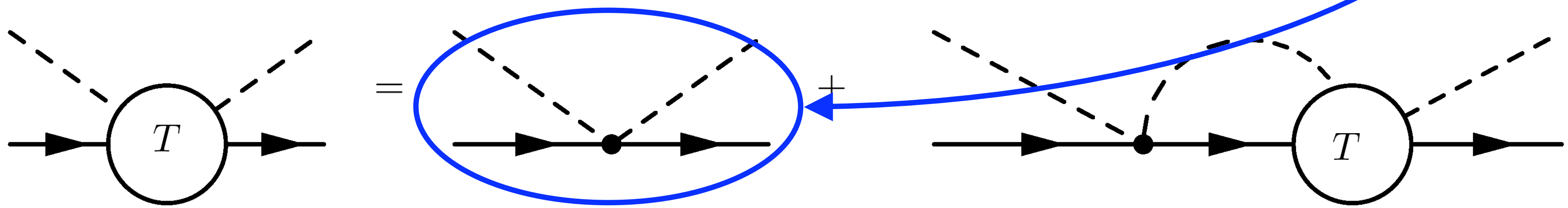
Framework of the chiral unitary model

Chiral perturbation theory

$$\mathcal{L}_{WT} = \frac{1}{4f^2}\mathrm{Tr}(\bar{B}i\gamma^{\mu}[(\Phi\partial_{\mu}\Phi - \partial_{\mu}\Phi\Phi), B])$$



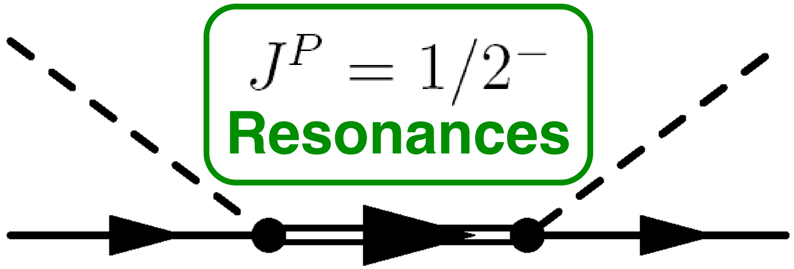
Unitarization



$$T_{ij}(\sqrt{s}) \sim \frac{g_i g_j}{\sqrt{s} - M_R + i\Gamma_R/2} + T_{ij}^{BG}$$

Generated resonances are expressed as poles of the scattering amplitude.

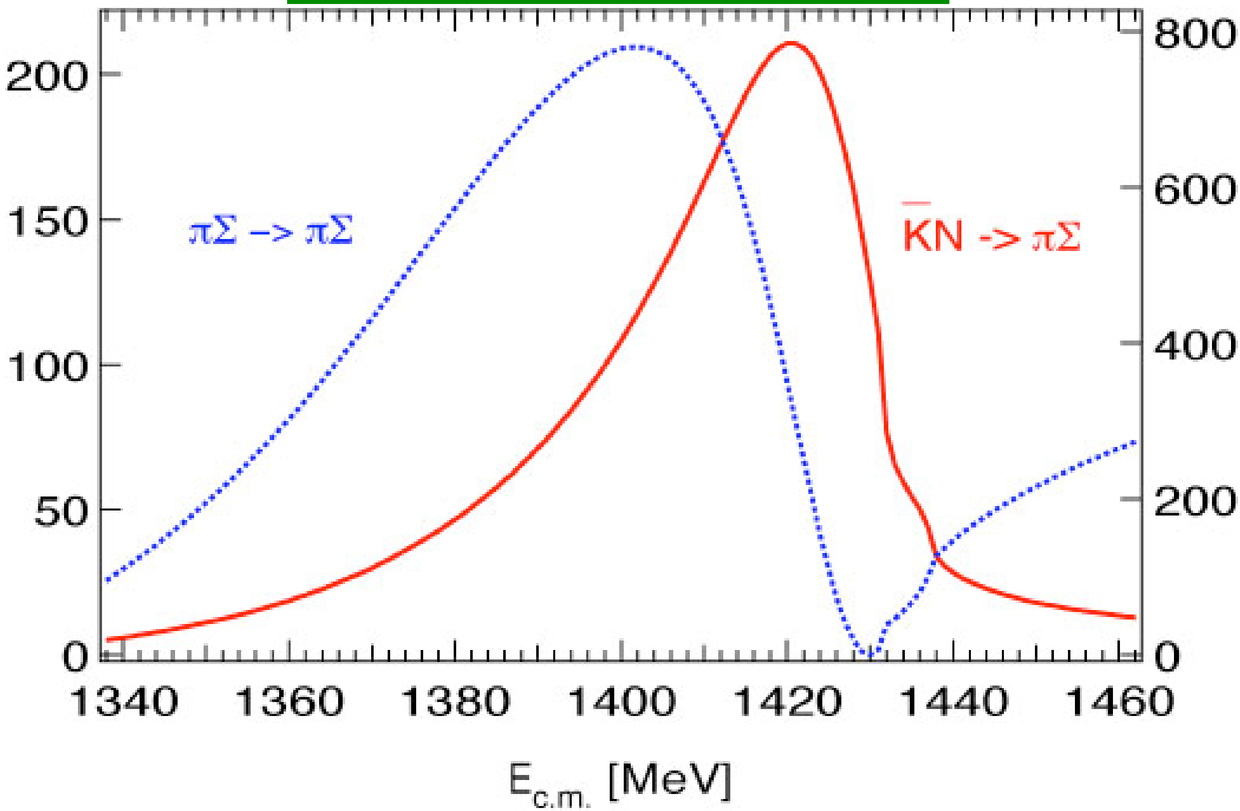
$\sim$



Λ(1405) in the chiral unitary model

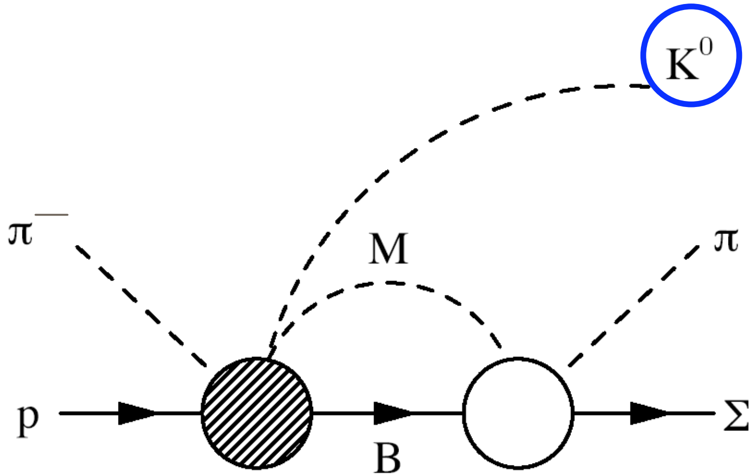
Two poles : 1390 + 66i (πΣ), 1426 + 16i ($\bar{K}N$)

πΣ mass distribution



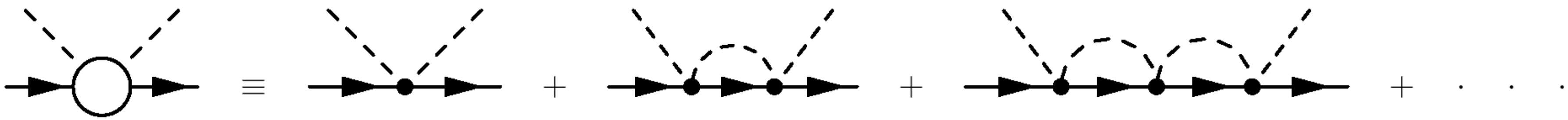
D. Jido, *et al.*, nucl-th/0303062

Mechanism of □□p -> K^0□□



~ at rest

□□p c.m. frame ~ □□ c.m. frame



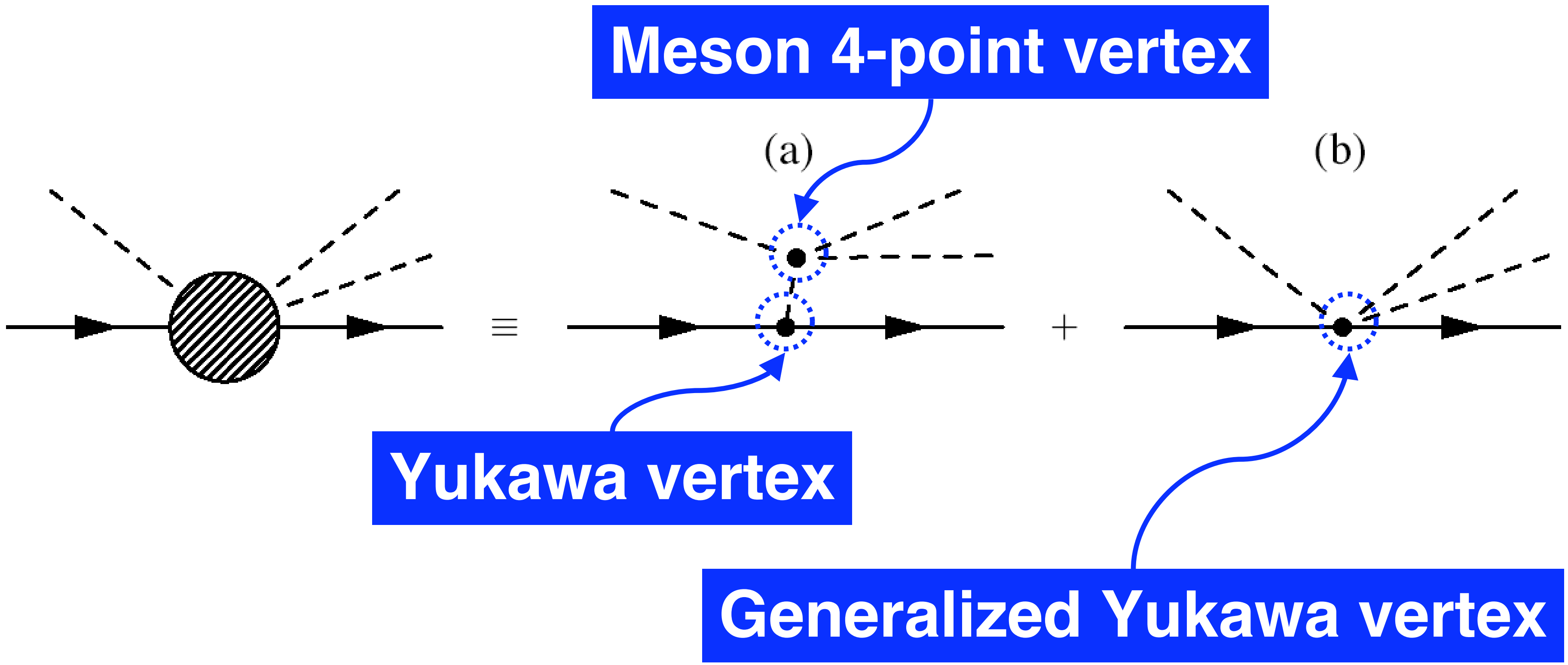
Channel MB = $\bar{K}$N, □□, □□, □□, □□, K□

Chiral unitary model

□□ invariant mass distribution -> □(1405)

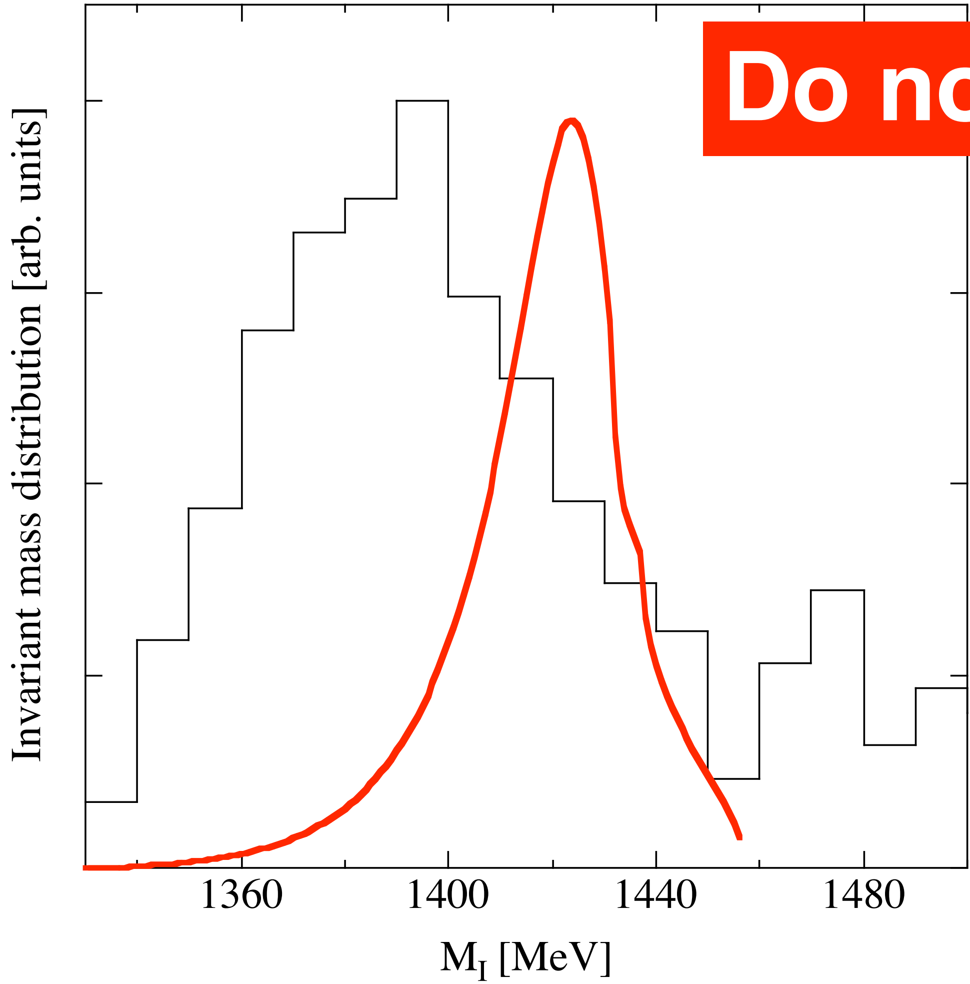
Chiral amplitude for □□p -> K^0□□

Construct the initial stage interaction from ChPT.



At low energies, these two diagrams are relevant.

Chiral amplitude for □□p -> K^0□□ : results



Do not agree!!

Experiment : D. W. Tomas, *et al.*, NPB56, 15(1973)

N(1710) contribution for □□p -> K^0□□

Initial c.m. energy of □□p system ~ 1.9GeV

-> **resonance excitation** in the initial stage

P_{11} resonance : s-wave coupling to MMB

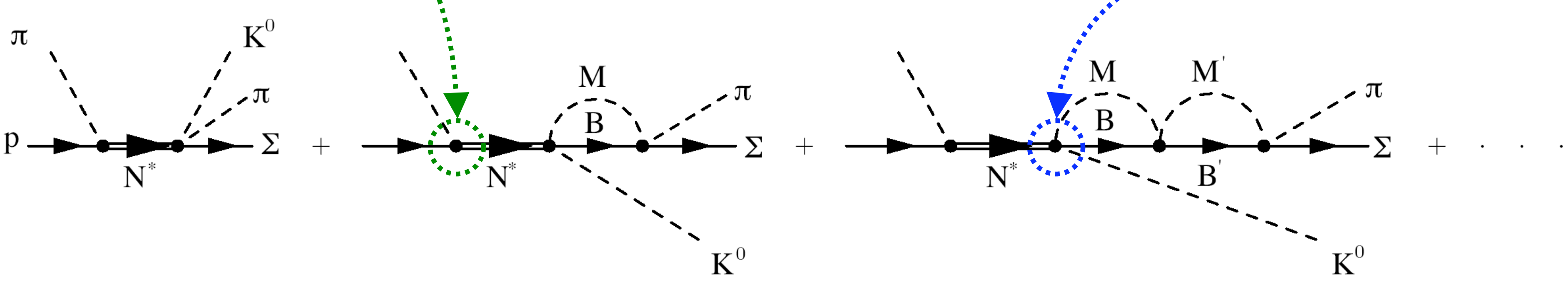
N(1710) -> □ N (10-20 %)

-> □ □ N (40-90 %)

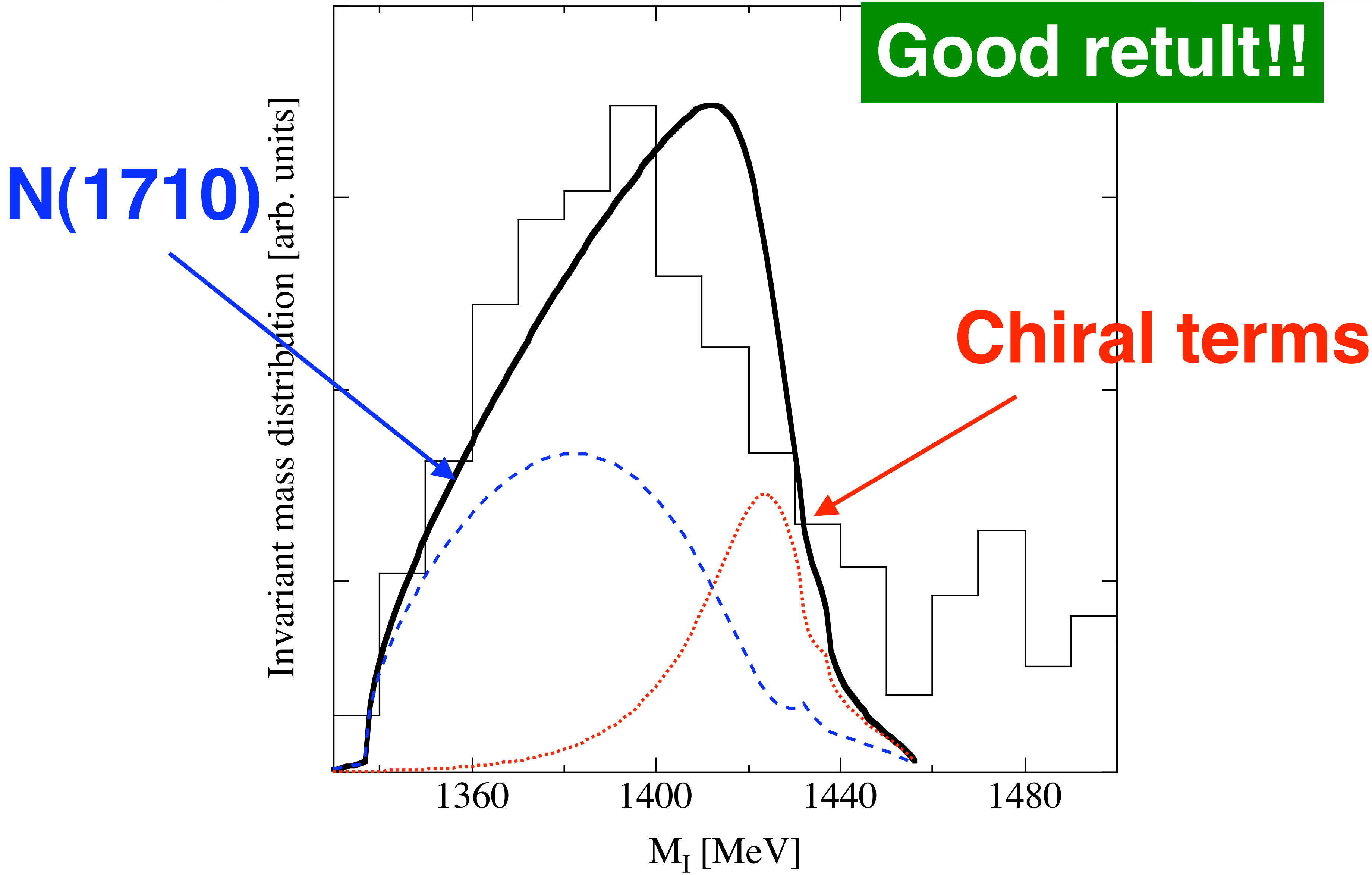
-> □ □ N (no)

Extrapolation of □□N decay

□N decay



Final results for □□p -> K⁰□□



Conclusions

We calculate the □$^{□}$p -> K^0□□ reaction using the chiral unitary model.

- There are **two mechanisms** in the initial stage interaction.
- They **filter each one of the resonances**.

chiral term : higher pole (1426+16i)
N(1710) contribution : lower pole (1390+66i)

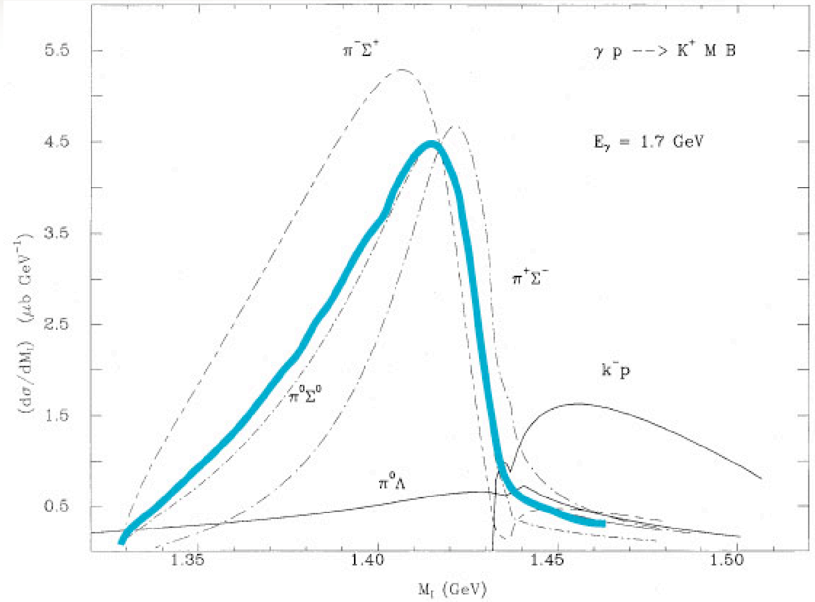
- **Combination** of the two mechanisms gives a good description of data.

Experiments : □□ mass distribution

□p -> K□□□

J.C. Nacher, *et al.*, PLB445, 55(1999)

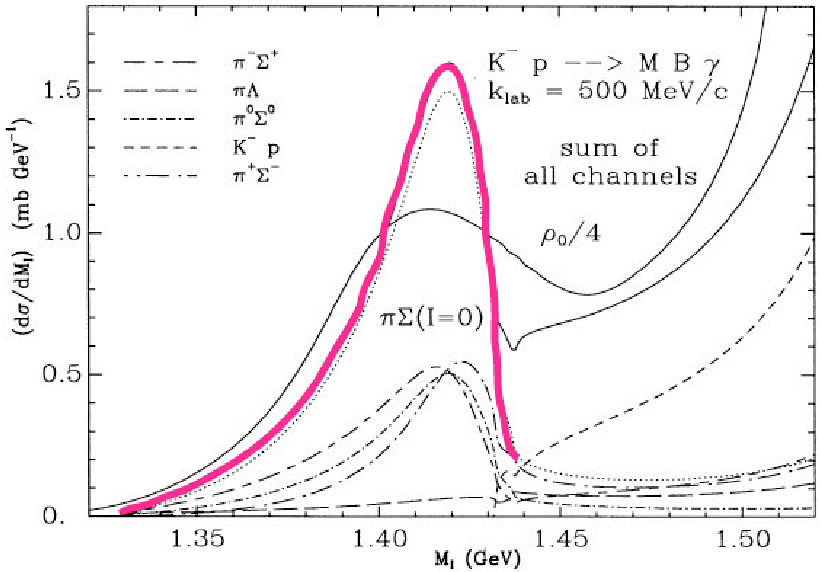
Spring-8



□□p -> □□□

J.C. Nacher, *et al.*, PLB461, 299(1999)

J-PARC?



+ □ : □ production in □$^+$p -> □$^+$K$^+$n

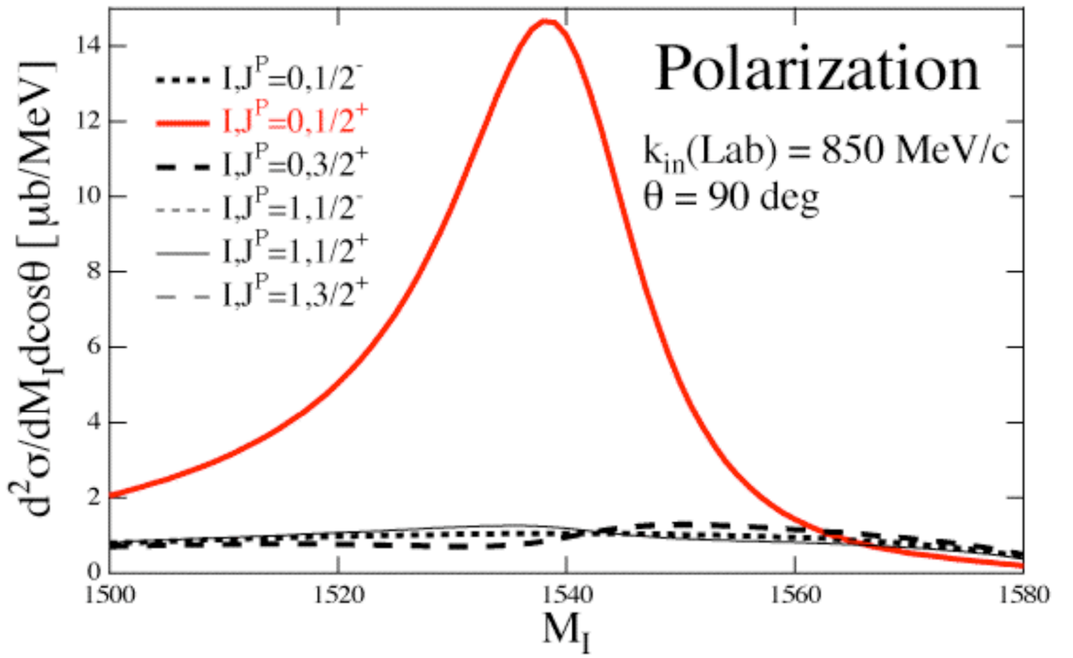
□$^+$: 5-quark (4 quark + 1 anti-quark)

LEPS, T. Nakano *et al.*, Phys. Rev. Lett. 91 (2003) 012002

Parity : 1/2$^+$? 1/2$^□$? …

K$^+$p -> □$^+$K$^+$n

Polarization test



T. Hyodo, A. Hosaka, and E. Oset, nucl-th/0307105