

# $\Lambda(1405)$ production in the $\pi p \rightarrow K^0 \pi \Sigma$ reaction



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## Motivations : Two poles?

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

- Cloudy bag model  
(1990)

Fink *et al.* PRC41, 2720

- Chiral unitary model  
(2001~)

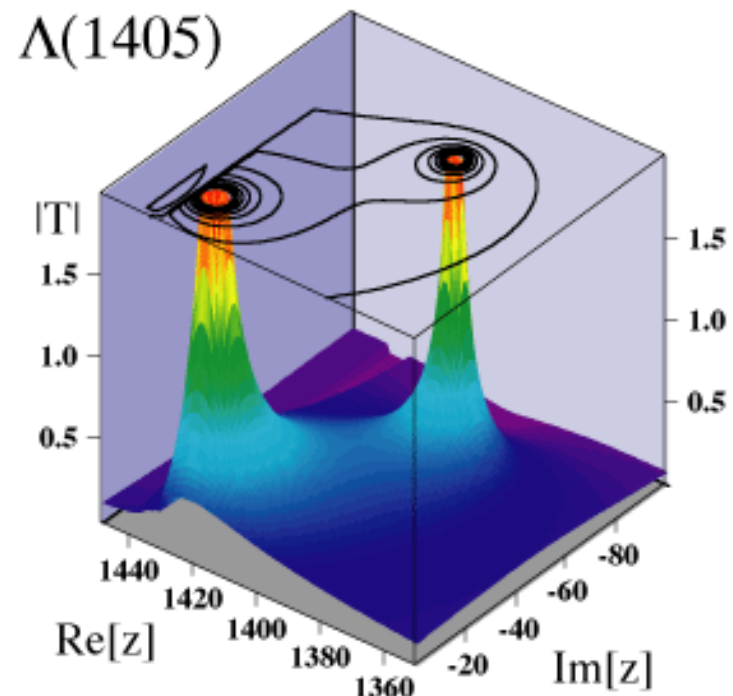
Oller *et al.* PLB500, 263

Oset *et al.* PLB527, 99

Jido *et al.* PRC66, 025203

Hyodo *et al.* PRC68, 018201

$\Lambda(1405) : J^P=1/2^-, I=0$



ChU model, T. Hyodo

# Chiral unitary model

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

**Chiral symmetry**

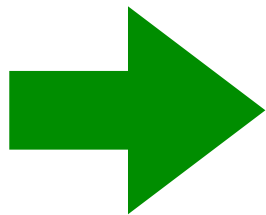
**Low energy  
behavior**



**Unitarity of S-matrix**

**Non-perturbative  
resummation**

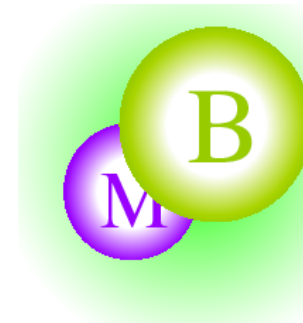
**Dynamical  
generation**



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

**Resonances**

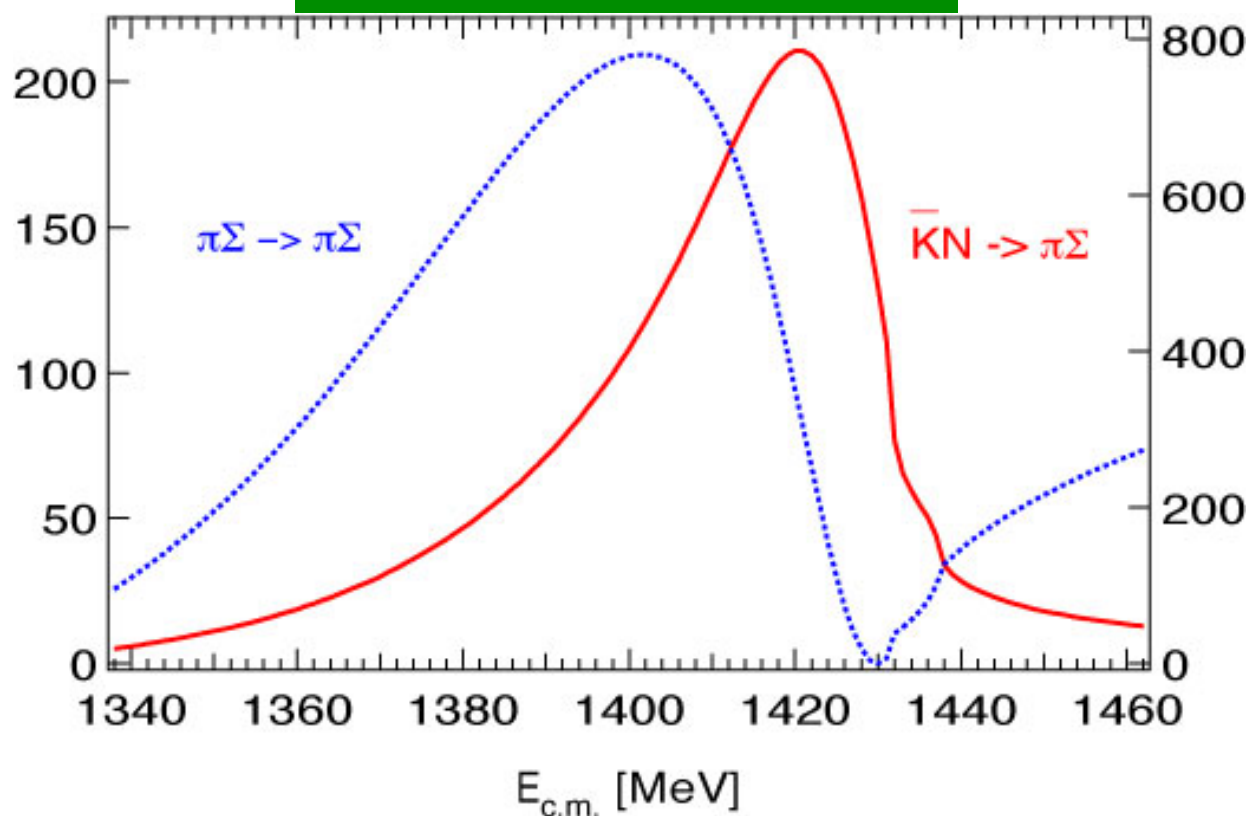
$\Lambda(1405)$ ,  $\Lambda(1670)$ ,  $N(1535)$ ,  
 $\Sigma(1620)$ ,  $\Xi(1620)$



## $\Lambda(1405)$ in the chiral unitary model

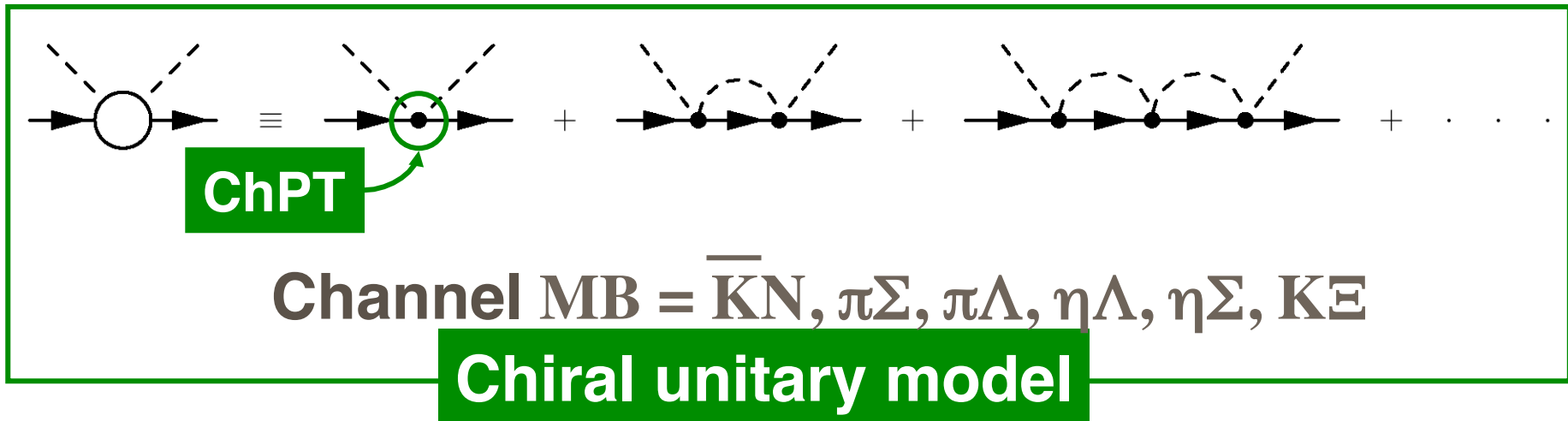
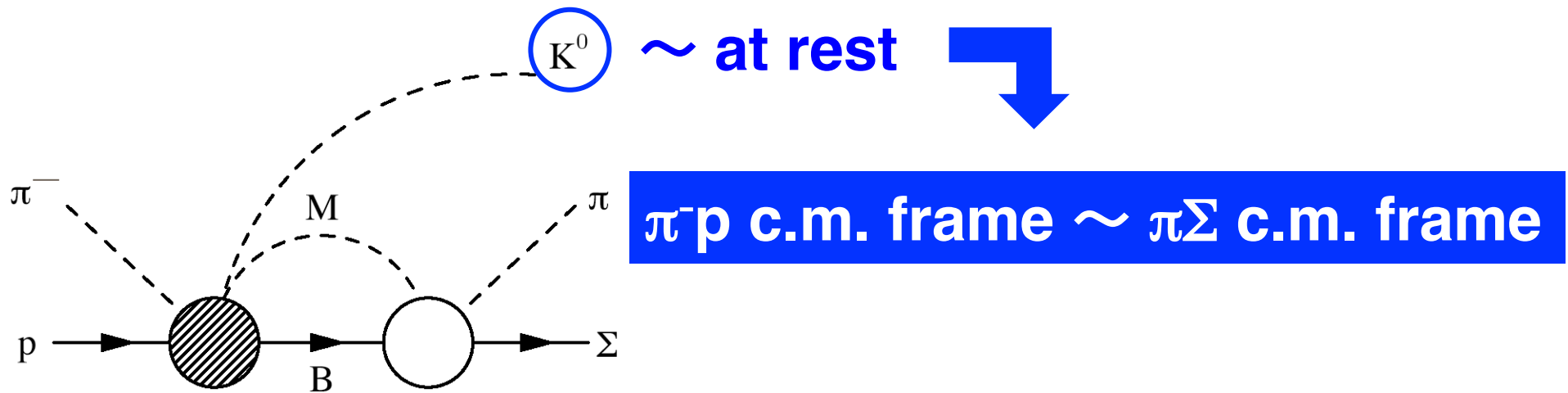
Two poles :  $1390 + 66i$  ( $\pi\Sigma$ ),  $1426 + 16i$  ( $\bar{K}N$ )

### $\pi\Sigma$ mass distribution



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

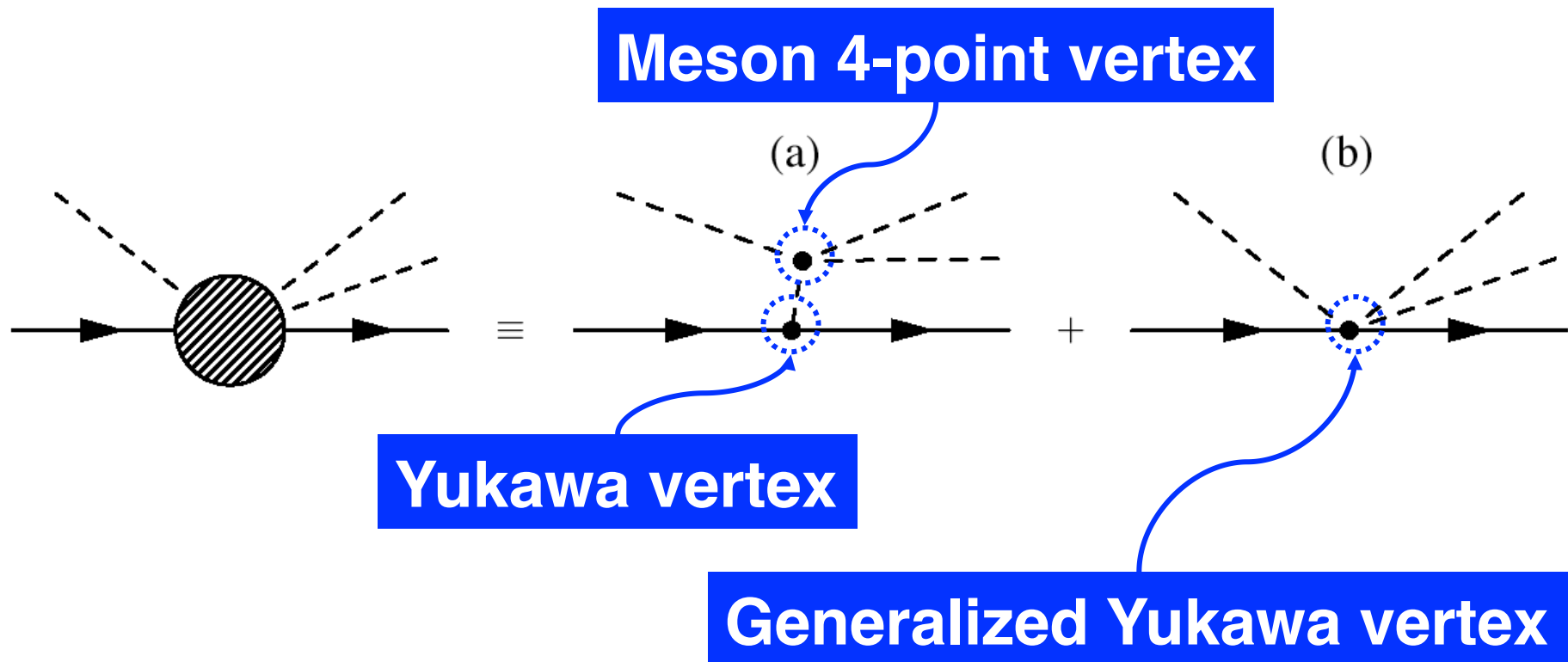
# Mechanism of $\pi^- p \rightarrow K^0 \pi \Sigma$



$\pi\Sigma$  invariant mass distribution  $\rightarrow \Lambda(1405)$

# Chiral amplitude for $\pi^- p \rightarrow K^0 \pi \Sigma$

Construct the initial stage interaction from ChPT.



At low energies, these two diagrams are relevant.

# N(1710) contribution for $\pi^- p \rightarrow K^0 \pi \Sigma$

Initial c.m. energy of  $\pi^- p$  system  $\sim 1.9\text{GeV}$

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

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

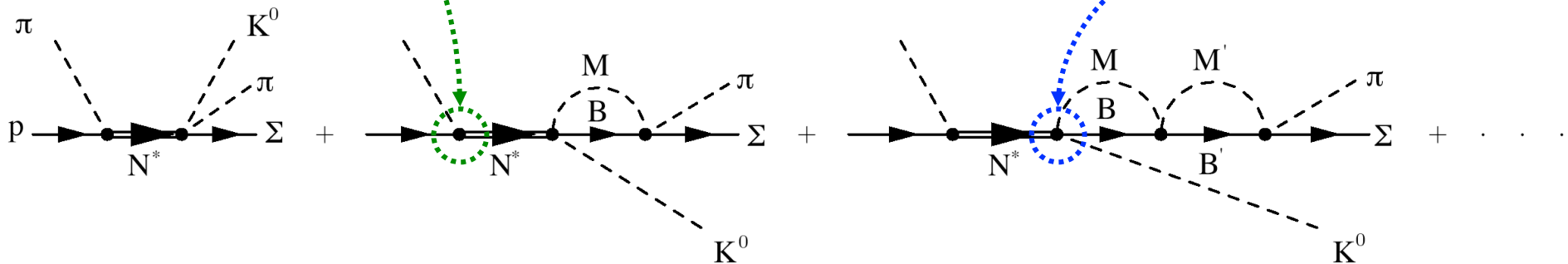
**N(1710)** ->  $\pi N$  (10-20 %)

->  $\pi \pi N$  (40-90 %)

->  $\eta \pi N$  (no)

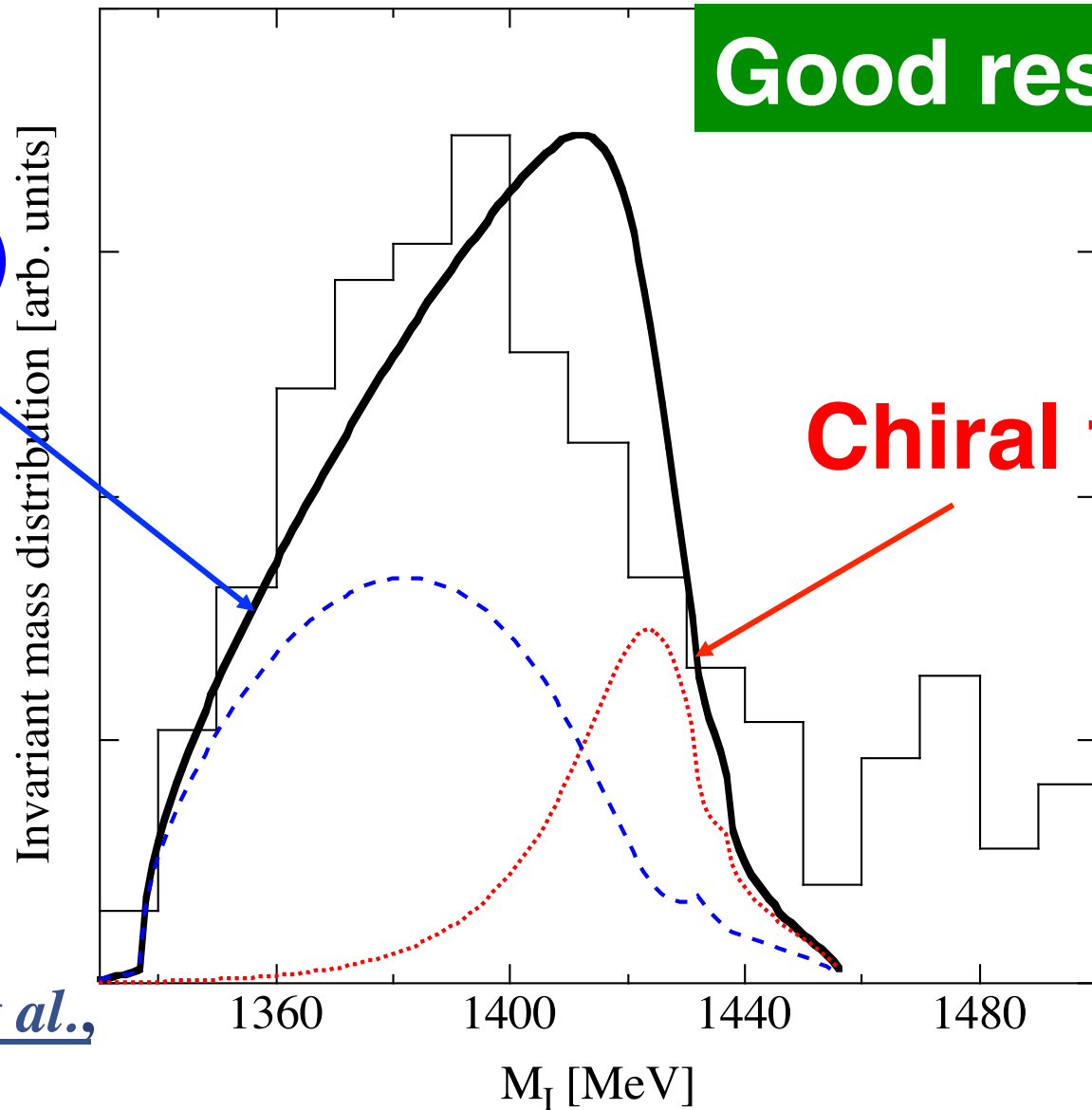
Extrapolation of  $\pi\pi N$  decay

$\pi N$  decay



# Final results for $\pi^-p \rightarrow K^0\pi\Sigma$

**N(1710)**



**Good result!!**

**Chiral terms**

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



## Conclusions

We calculate the  $\pi^-p \rightarrow K^0\pi\Sigma$  reaction using the chiral unitary model.

🍏 There are **two mechanisms** in the initial stage interaction.

🍏 They **filter each one of the resonances.**

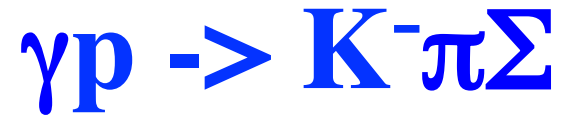
**chiral term** : higher pole (1426+16i)

**N(1710) contribution** : lower pole (1390+66i)

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

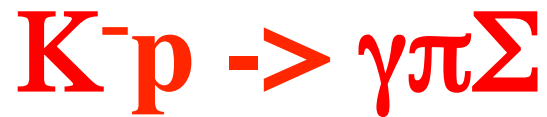
[T. Hyodo, et al., nucl-th/0307005](#)

## Experiments : $\pi\Sigma$ mass distribution



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

Spring-8



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

J-PARC?

