Λ(1405) production in the π⁻p -> K⁰πΣ reaction

We discuss the mechanisms of Λ(1405) production in the π⁻p -> K⁰πΣ reaction. We find two mechanisms, which lead to very different shapes of the πΣ mass distributions. The combination of them gives a good description of experimental measurements.

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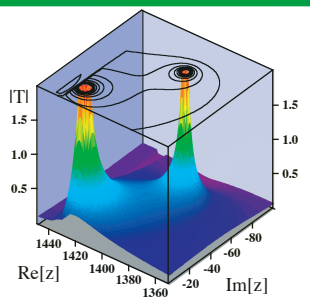
Motivation : Two poles?

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

We calculate s-wave coupled channel meson-baryon scatterings, where $1/2^-$ baryon resonances are generated.

Chiral symmetry

We use the interaction based on the chiral perturbation theory, which well describes hadron dynamics at low energy region.

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

Unitarity of S-matrix

In order to maintain the unitarity condition, N/D method is used.

$$T^{-1}(\sqrt{s}) = -a(s_0) - \frac{s-s_0}{\pi}\int_{s_{th}}^{\infty} ds' \frac{\rho(s')}{(s'-s)(s'-s_0)} + V^{-1}(\sqrt{s})$$

We obtain the T-matrix amplitude in analytic way. Around the resonance energy region, the amplitude can be regarded as sum of the Breit-Wigner and background terms.

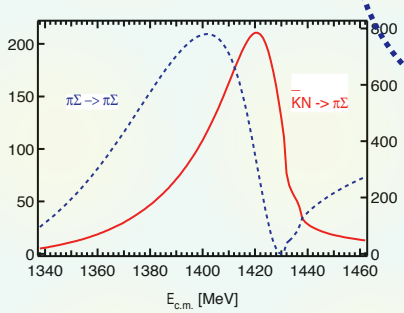
$$T_{ij}(\sqrt{s}) = \frac{g_i g_j}{\sqrt{s} - M_R + i\Gamma_R/2} + T_{ij}^{BG}$$

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

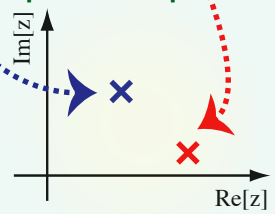
Λ(1405) in the chiral unitary model

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

πΣ mass distribution



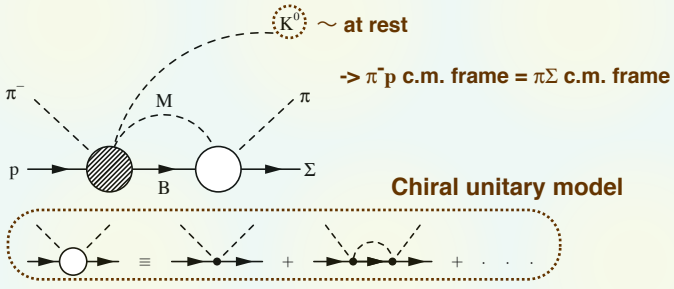
position of poles



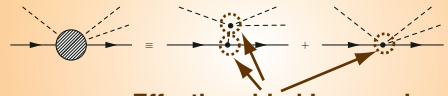
D. Jido, *et al.*, nucl-th/0303062

Model for the reaction

We consider the limit where the final K^0 is almost at rest.



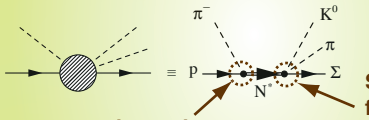
Chiral term



Effective chiral Lagrangian

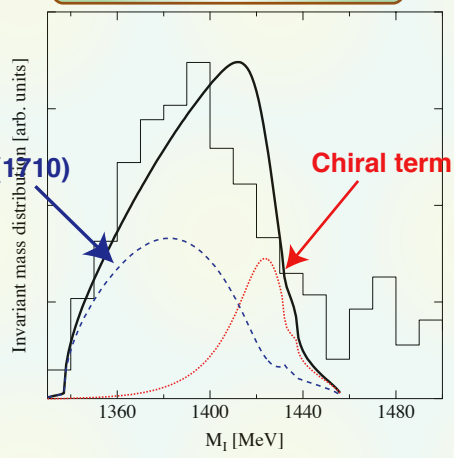
N(1710) contribution

Initial c.m. energy of π⁻p system ~ 1.9 GeV
-> nucleon resonance excitetaion in the initial stage:



πN decay data — SU(3) extrapolation from ππN decay data

Numerical results



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

Conclusions

We calculate the π⁻p -> K⁰πΣ 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