Threshold effects for excited Ξ baryons

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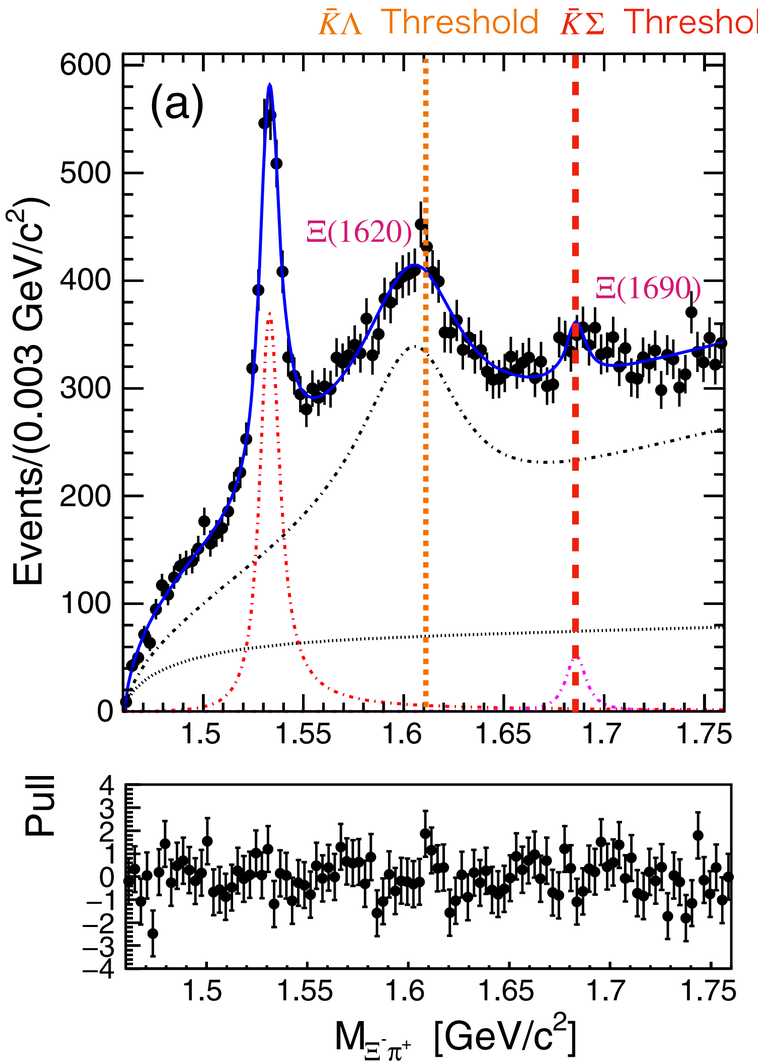
Motivation

- $\Xi(1620)$ and $\Xi(1690)$ peaks in the $\Xi_c \to \pi\pi\Xi$ spectrum by Belle collaboration [1].
- Peaks are close to thresholds of $\bar{K}\Lambda$ and $\bar{K}\Sigma$?
- Aim of this talk
  - Construction of the model of $\Xi(1620)$ which reproduces the Belle data.
  - Study the threshold effect on peak behavior.



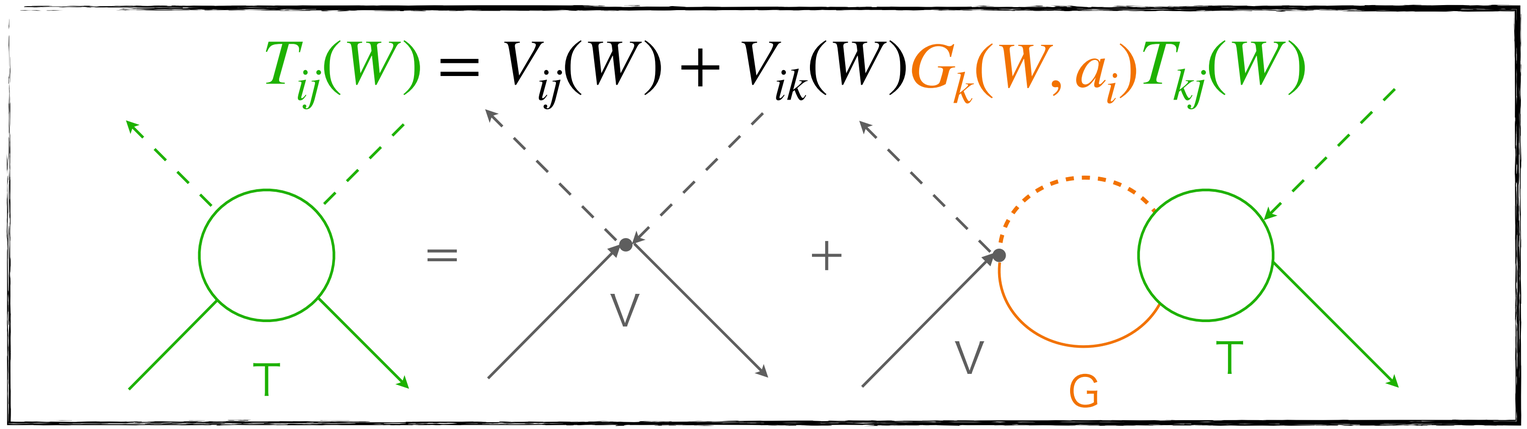
Invariant mass distribution of $\pi\Xi$ in the $\Xi_c \to \pi\pi\Xi$ decay [1].

[1]Belle collaboration, M.Sumihama et al., Phys. Rev. Lett. 122, 072501 (2019).

Formulation

Coupled-channel meson-baryon scattering amplitude $T_{ij}(W)$ at total energy W[2].

$$T_{ij}(W) = V_{ij}(W) + V_{ik}(W)G_k(W, a_i)T_{kj}(W)$$



$V_{ij}(W)$…Interaction kernel (Weinberg-Tomozawa term)

$G_i(W, a_i)$…Loop function

(Removed divergence by dimensional regularization)

a_i: subtraction constant

[2] A.Ramos, E.Oset and C.Bennhold Phys. Rev. Lett. 89.252001 (2002).

Model for Belle result

- Belle result : $M_R = 1610$ MeV, $\Gamma_R = 60$ MeV
- Based on the peak position, we define

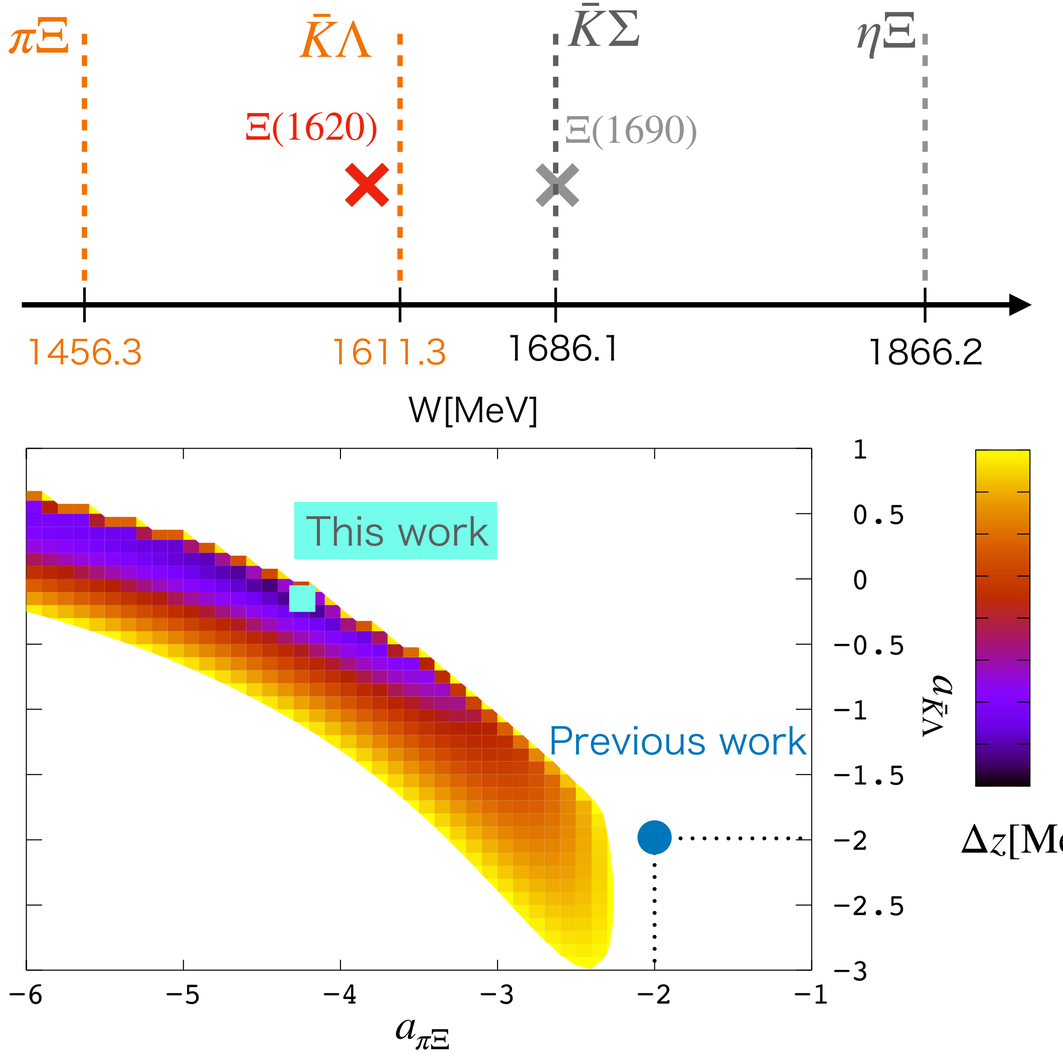
  $z_{ex} = [1610 - 30i]$ MeV.
- z_{th} : Pole in theoretical model

$$\Delta z = |z_{th} - z_{ex}|$$

- We minimize Δz by adjusting subtraction constants $a_{\pi\Xi}$ and $a_{\bar{K}\Lambda}$[3].

  $\Delta z = 0.1$MeV is achieved

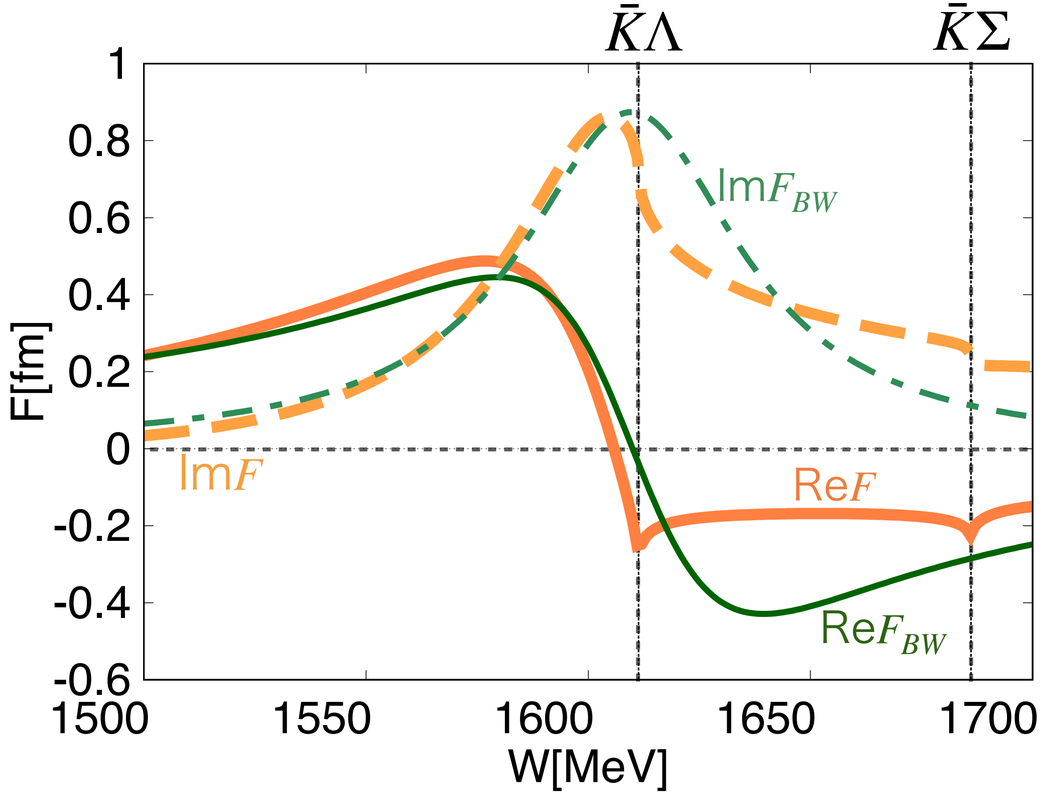
  at $a_{\pi\Xi} = -4.19$ and $a_{\bar{K}\Lambda} = -0.14$.



[3]T. Nishibuchi and T. Hyodo, arXiv:2208.14608 [hep-ph]

Comparison with Breit-Wigner distribution

- Real and imaginary parts of the scattering amplitude (Thick lines).
- Breit-Wigner distribution with a pole at the same position (Thin lines).



We found that the peak of imaginary part of scattering amplitude is shifted by threshold effect.

[3]T. Nishibuchi and T. Hyodo, arXiv:2208.14608 [hep-ph]

Summary

- We construct the coupled-channel scattering amplitude with $\Xi(1620)$ peak as reported by Belle collaboration.

- In comparison with the Breit-Wigner distribution, we find that the near-threshold resonance peak is distorted by the threshold effect[3].

  → Caution must be paid to determine the resonance pole near the threshold.

- Future plan: study of $\Xi(1690)$, calculation of $\Xi_c \to \pi\pi\Xi$ decay.

[3]T. Nishibuchi and T. Hyodo, arXiv:2208.14608 [hep-ph]