ON THE QUESTION OF WIDTHS

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Content

Why the DISTO line is so broad ?

Why so far away from calculations ?

1) Shape of the line
2) Estimates for non-mesic decay channels
3) Experimental checks

Lifetime of unstable state

$\Psi(t) = \int d E \quad \exp(-iEt) \, (E - E_r + i \, \Gamma/2)^{-1}$

$\sim \exp(-iE_r t - \Gamma/2)$ Exponential decay for small Γ

If $E_r(E)$ and $\Gamma(E)$

$E - E_r(E) + i \, \Gamma(E) / 2 = 0$, Decay is exponential + polynomial

Line shape - not Lorentzian
Maximum of the line – not at pole position

DISTO , FINUDA

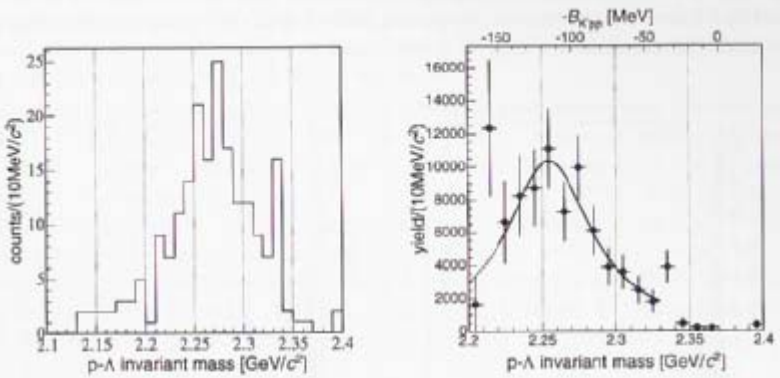
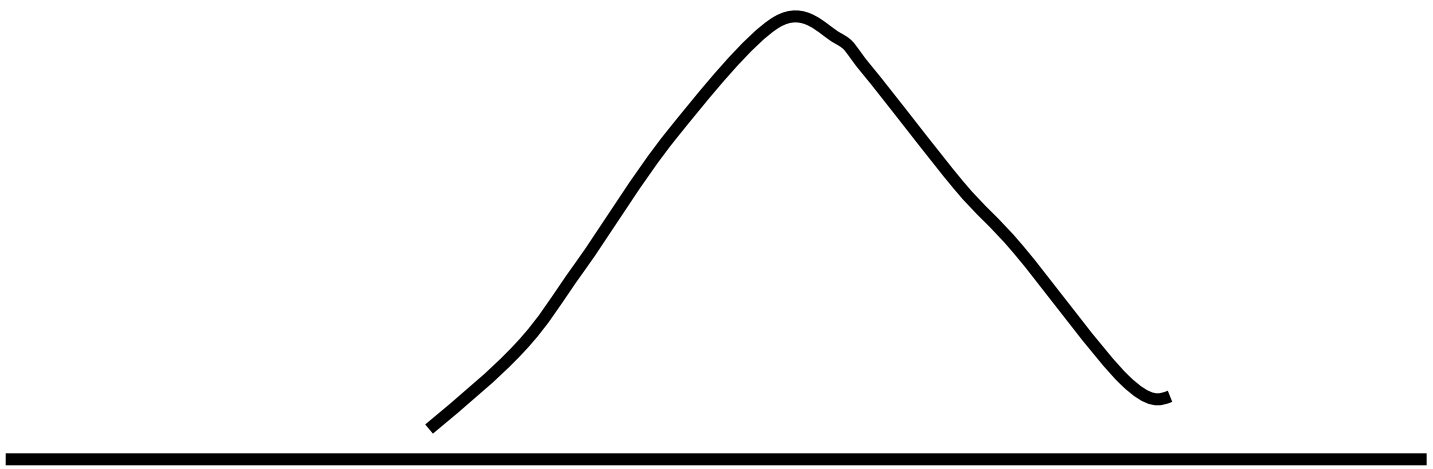


Figure 4: Invariant mass of a Λ and a proton in back-to-back correlation ($\cos\theta^{\mathrm{Lab.}} < -0.8$) from light targets before the acceptance correction (left). The figure on the right shows the result after the acceptance correction for the events which have two protons with well-defined good tracks. Only the bins between 2.22–2.33 GeV/c^2 are used for the fitting. The curve shows the best fit (see text).

Disto line



ΛN ΣN ΛπN ΣπN KNN

Main modes ? included in calculations

Crude model for the line shape

ΛπN	-	weak coupling
ΣπN , KNN	-	included in calculations
ΛN , ΣN	-	dominant „ external „ modes

Dominant isospin structure of „DISTO”

$$\{\{N\,N\}^{1}\,K^{1/2}\}^{1/2} =$$

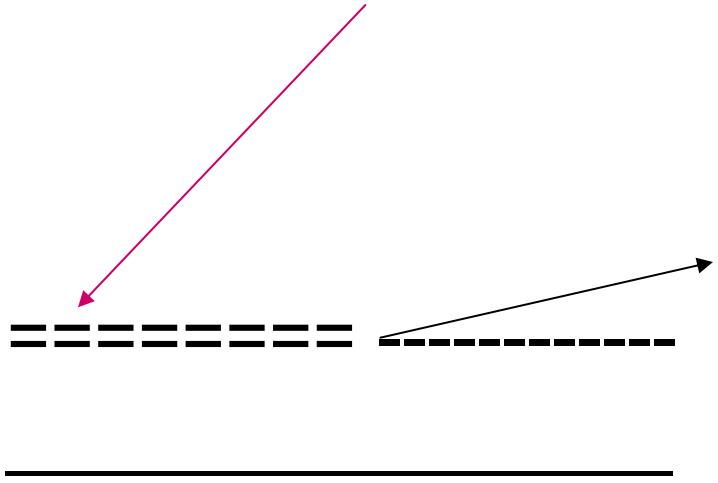
$$\sqrt{3}/2\,\{\{K\,N\}^{0}\,N^{1/2}\}^{1/2} + 1/2\,\{\{KN\}^{1}\,N^{1/2}\}^{1/2}$$

↑

Λ(1405) N 75 % of structure

NΛ π weak mode

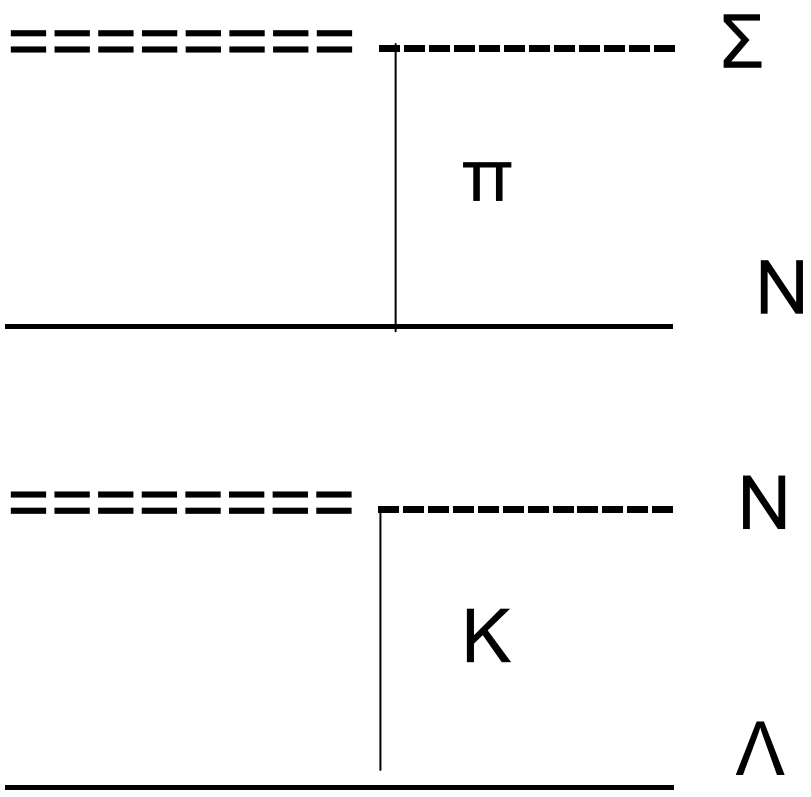
ΣN π almost closed



Λπ

N

„External” decay channels



$\gamma_\Sigma(q)$

$\gamma_\Lambda(q)$

Decay amplitudes

$\gamma_\Sigma(q) = \sim \kappa / (q^2 + \kappa^2)$

$\kappa \sim 2.5$ / fm

$\gamma_\Lambda(q) = \sim \kappa / (q^2 + \kappa^2)$

$\kappa \sim 5.5$ / fm

κ - determined by „D" wave function
exchanged meson mases

Line shape

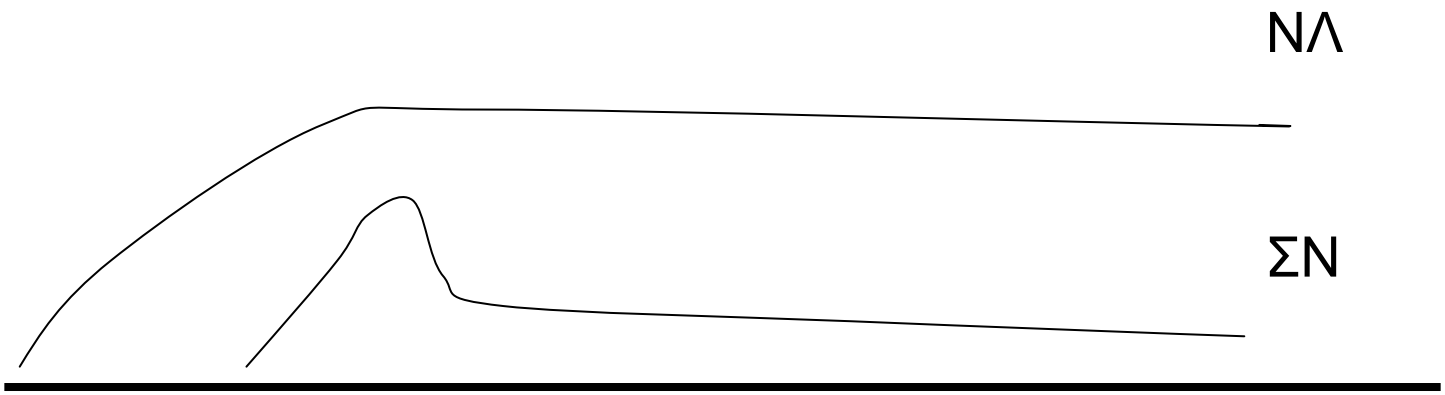
$$T_{i,f} = \frac{\gamma_i(q)\,\gamma_f(q)}{E - E_r + i\,\Gamma_r/2 - \Sigma(E)}$$

$$\Sigma(E) = 1/\pi \int [\gamma(q)]^2 / (E - E(q))$$

Sum over „external” decay channels

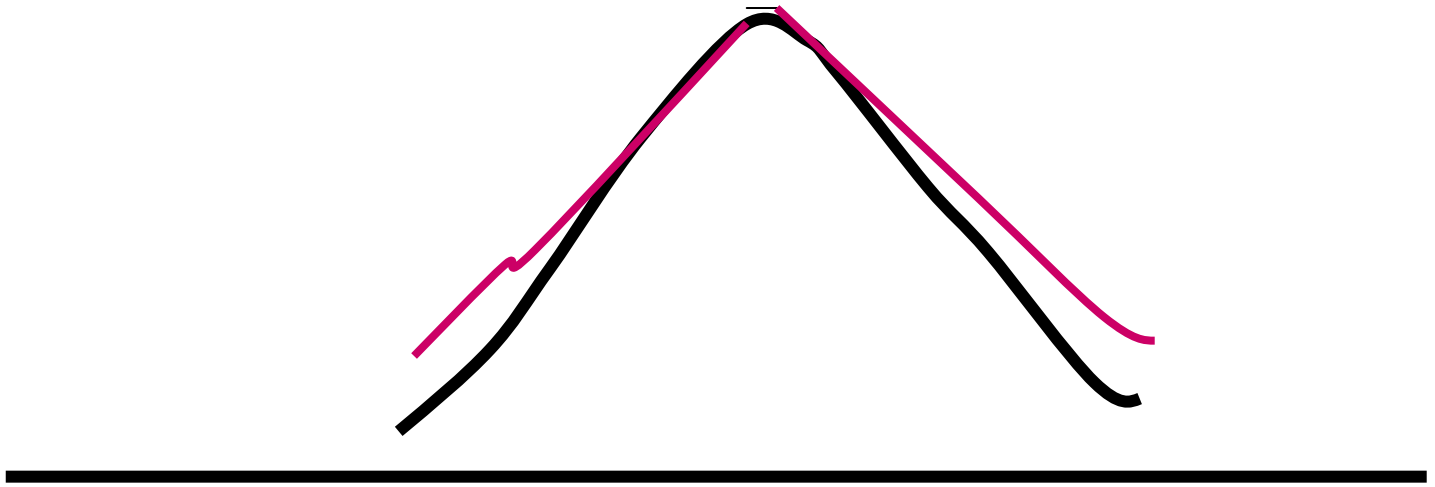
Decay widths couplings from compilation

$$\Gamma_{\Sigma N}/2 = \mathrm{Im}\ \Sigma_{\Sigma N}(E) = q_{\Sigma N}\ [\gamma_{\Sigma N}(q)]^2$$



NΛ ΣN ENERGY

NΛ -Line shape compared to B-W-Lorentzian



15-25 % change at ½ width

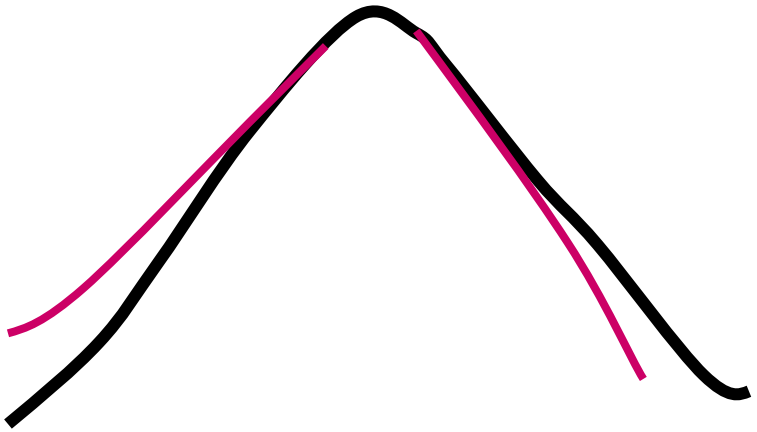
Change of parameters

Width at the pole $\Gamma = 100$ MeV
Width of the line $\Gamma = 120$

Binding at the pole $E_в = 95$ MeV
Maximum of the line $E_в = 110$

Closer to some calculations

Differences in ΣN , NΛ lines



~ 20% different at half widths

Summary

1) Two body decays (KNN) → Y N

Induce structure in line shapes

2) Effects up to 20 %

makes energy , width closer to calculated

3) Sizable differences in ΣN and NΛ lines

Problems

Nonmesic decays KNN → YN

Atomic region 20% in He 1 % in De

Extrapolation to deep region

Γ ~ 20 MeV polish – nucleus

japanese – KNNN

~ 50 MeV from Prague - nucleus