March 7, FB16@ Taipei

Hyperon Distribution and Correlation in (K^-, K^+) Reactions

A. Ohnishi, Y. Hirata	Hokkaido Univ.
Y. Nara	JAERI & BNL
S. Shinmura	Gifu Univ.
Y. Akaishi	KEK, Tanashi

1. From $\Lambda\Lambda$ Corr. to $\Lambda\Lambda$ Int.

   ⋆ KEK-E224 $\rightarrow$ BNL-E906 & KEK-E373

2. Is the INC Source Func. Reliable ?

   ⋆ Meson-Baryon Cross Section

   $\leftrightarrow$ K^+ Spectra

   ⋆ Hyperon-Nucleon Cross Section

   $\leftrightarrow$ Hyperon Spectra

   ⋆ Reaction Mechanism:

   Fast Cascade Processes are Enough ?

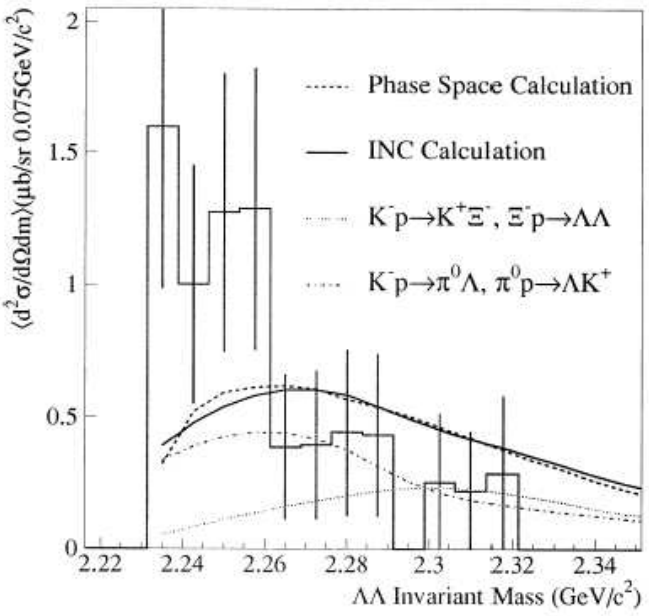
3. Stat. Decay of Hyperon-Compound Nuclei

4. Summary

From $\Lambda\Lambda$ Corr. to $\Lambda\Lambda$ Interaction

- $\Lambda\Lambda$ Int.: Important but No Scattering Data
  - ⋆ Threshold Channel in SU(3) Singlet BB (BB Int.)
  - ⋆ Related to the Existence of H-particle (QCD)
  - ⋆ Abundant in Neutron Star Core (Mass, Supernova)
- $\Lambda\Lambda$ Inv. Mass Spec. KEK-E224 Exp. (J.K. Ahn et al.)

$K^- + {}^{12}\mathrm{C} \to K^+\Lambda\Lambda \to$ Strong Enh. at Low-E



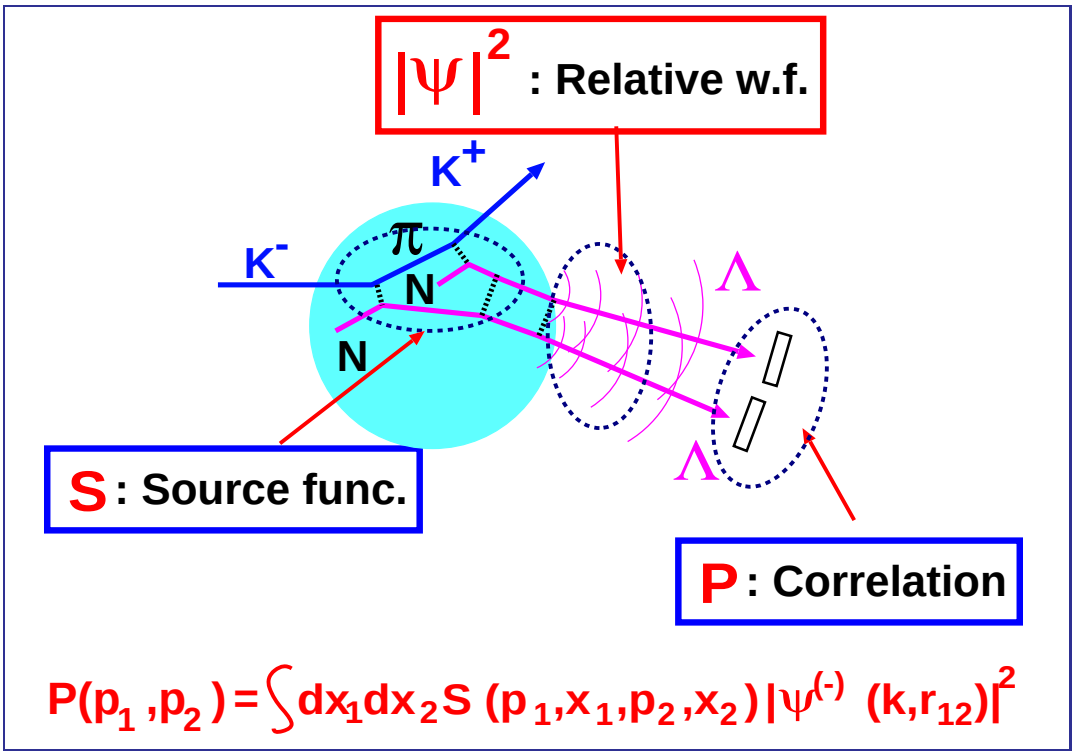
- Possible Explanations
  - ⋆ Resonance H particle, $2M_\Lambda < M_H < M_N + M_\Xi$
  - ⋆ Virtual Pole Effect in $\Lambda\Lambda$ channel
  - ⋆ FSI Correlation

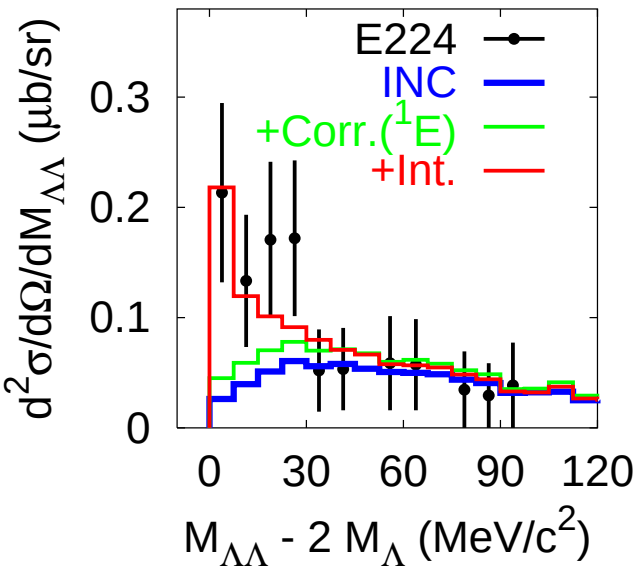
  ⋯ It must be clarified both from theoretical side and from experimental side ($\to$ BNL-E906 & KEK-E373)

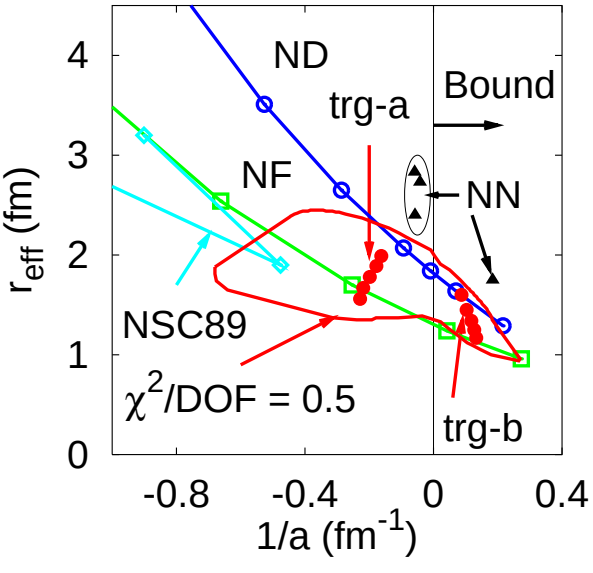
Our Approach: Cascade + FSI Corr.

H.-B. & T	···	$\gamma\gamma \to$ Star (Symmetry)
Goldhaber/Shuryak	···	$\pi\pi \to$ HIC (+Coulomb)
Pratt/Koonin	···	$NN, AA \to$ HIC (+Strong)
Bauer et al.	···	BUU Source $\to$ HIC (+Dyn.)
This Work	···	INC & Corr. & Data $\to \Lambda\Lambda$ Int.

Ohnishi et al., nucl-th/9903021; Slaus, Akaishi, Tanaka, Phys.Rep.173(1989)

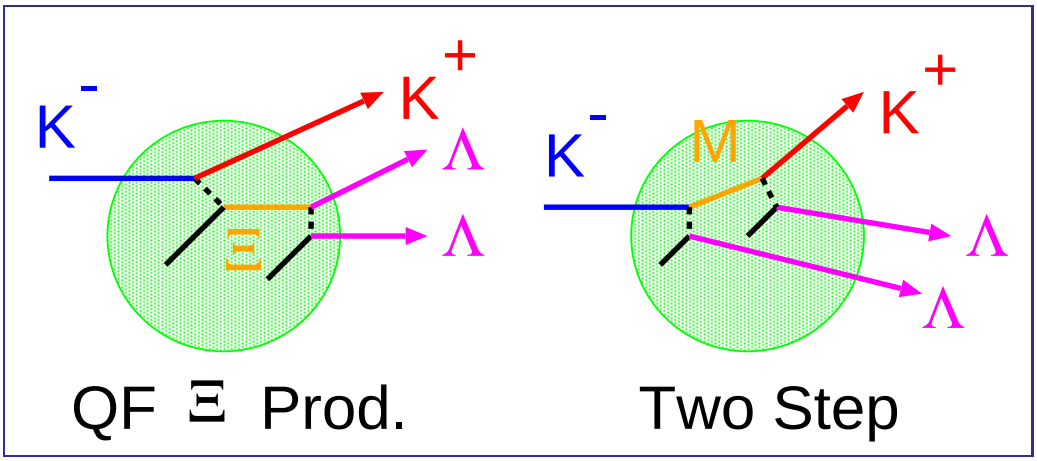






Is the INC Source Reliable ?

$\cdots$ We have to Check it out !



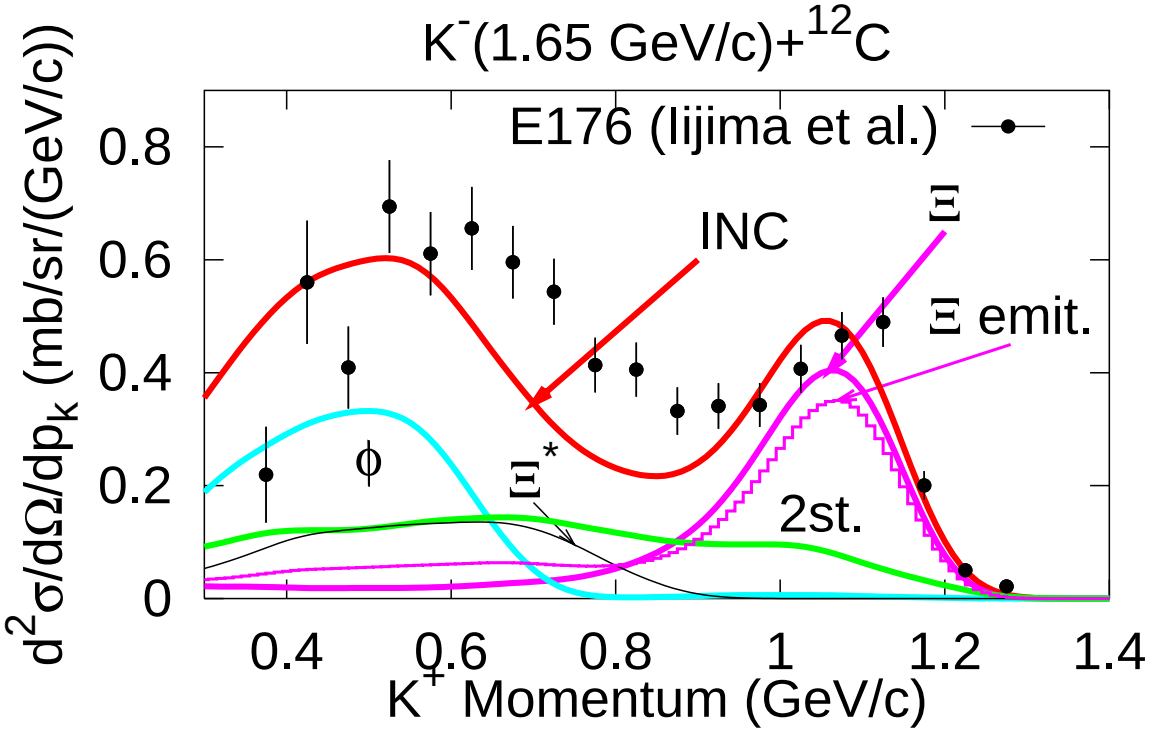
Check List

1. $MB \to M'B'$ Cross Section $\leftarrow$ K^+ Spectra, HIC Data
   - $\star$ Breit-Wigner (s-channel, Res. Region)
     + Reggeon Exchange (t, u- chan.)
2. $BB \to B'B'$ Cross Section $\leftarrow$ Y Spectra
   - $\star$ N, Δ, N^*... ($S = 0$ Sector): Exclusive Data Fit
   - $\star$ YN ($S = -1$): Nijmegen Model D
   - $\star$ $\Xi N \to \Lambda\Lambda$ ($S = -2$): ND, $R_c = 0.5$ fm (assumed)
3. Mean Field for Baryons $\leftarrow$ K^+ tail, Y Spectra
   - $\star$ $U_N = -40$ MeV, $U_\Lambda = -30$ MeV, $U_\Sigma = -10$ MeV,
   - $\star$ $U_\Xi = -16$ MeV (Twin, KEK-E224, BNL-E885)
4. Reaction Mechanism
   - $\star$ Spin-Singlet for $\Lambda\Lambda$
   - $\star$ No Λ Evap. from Hyperon Compound

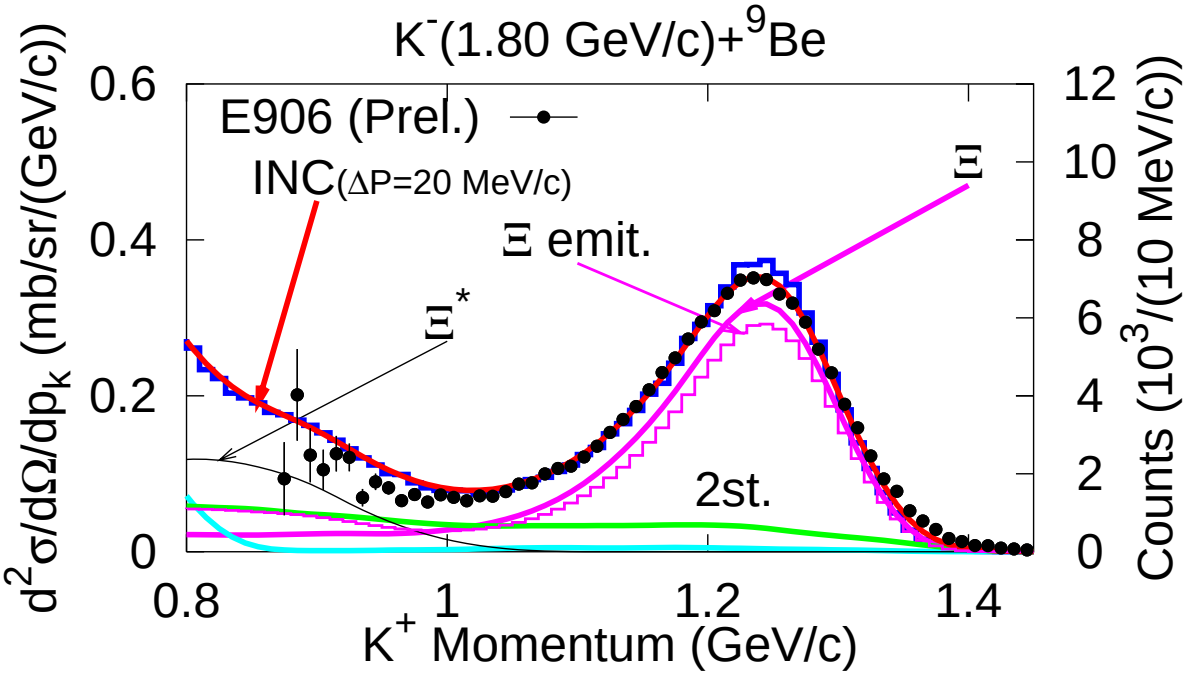
K^+ Spectrum:

Test of MB Cross Sections and Prod. Mech.

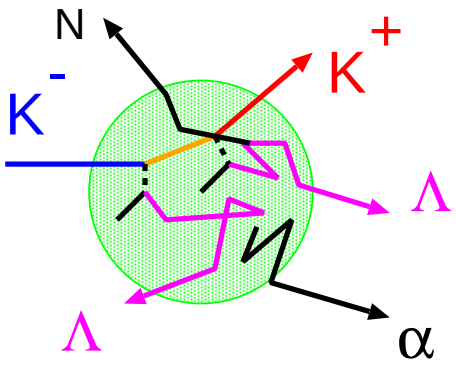
- KEK-E176 data (Iijima et al.)



- BNL-E906 data (Tamagawa et al.)



Stat. Decay of Hyperon Compound Nucleus



⋆ Idea: Yamazaki

⋆ Stopped K^- → ${}^{4}_{\Lambda}\mathrm{H}$

Tamura, Wakai, Yamamoto et al.

Nara et al. (AMD + Stat. Dec.)

⋆ Stopped Ξ^-

→ Single, Double, Twin Hyp.

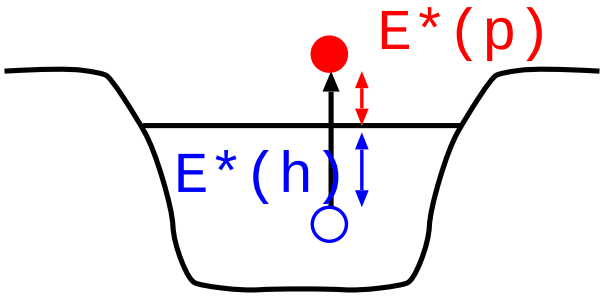
Hirata et al.

(AMD-QL + Stat. Dec.)

• Theoretical Inputs of Statistical Decay

⋆ Compound Nuclei: $A, Z, S \ldots$ INC results

⋆ Excitation Energy: Exciton Model Estimate



· · · Hole Energy + Trapped Particle Energy

⋆ Level Density Parameter: $a = A/8$ (assumed)

$\cdots E^* = aT^2 \leftrightarrow S = 2\sqrt{aE^*} \leftrightarrow \rho \propto \exp(2\sqrt{aE^*})$

• Statistical Decay Model

⋆ Simplified Multistep Evaporation model (Weiskopf)

· · · Successive Evaporation of p, n, Λ, α

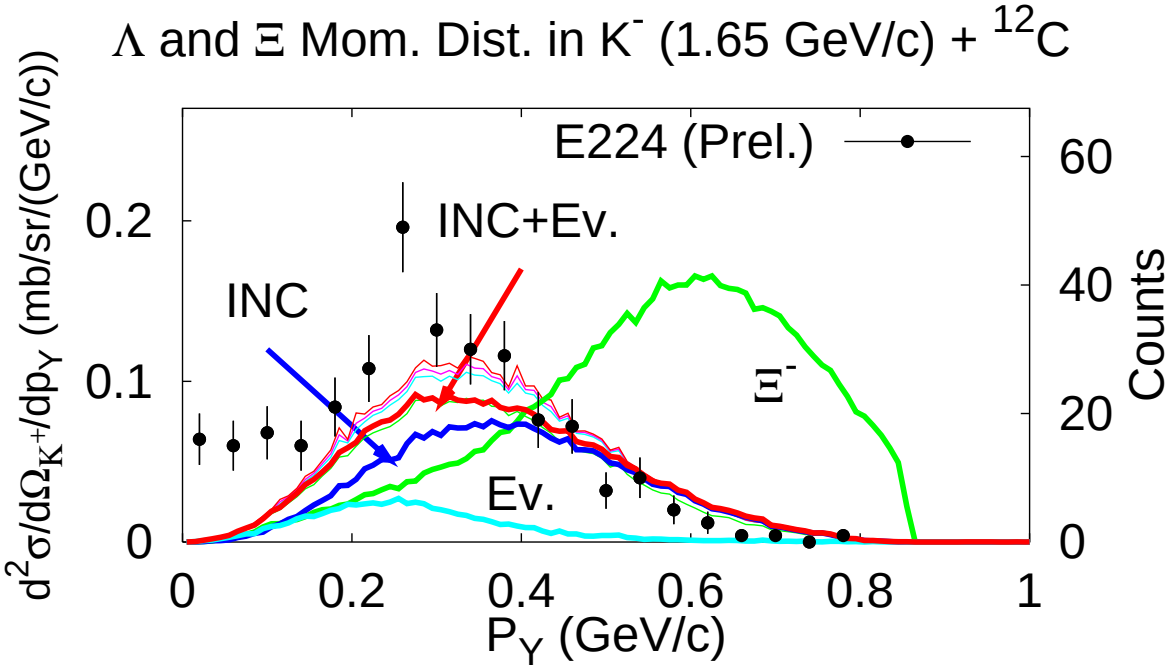
↔ Simultaneous Multifragmentation Model

(Berlin, NBI, Yamamoto-Wakai-Sano)

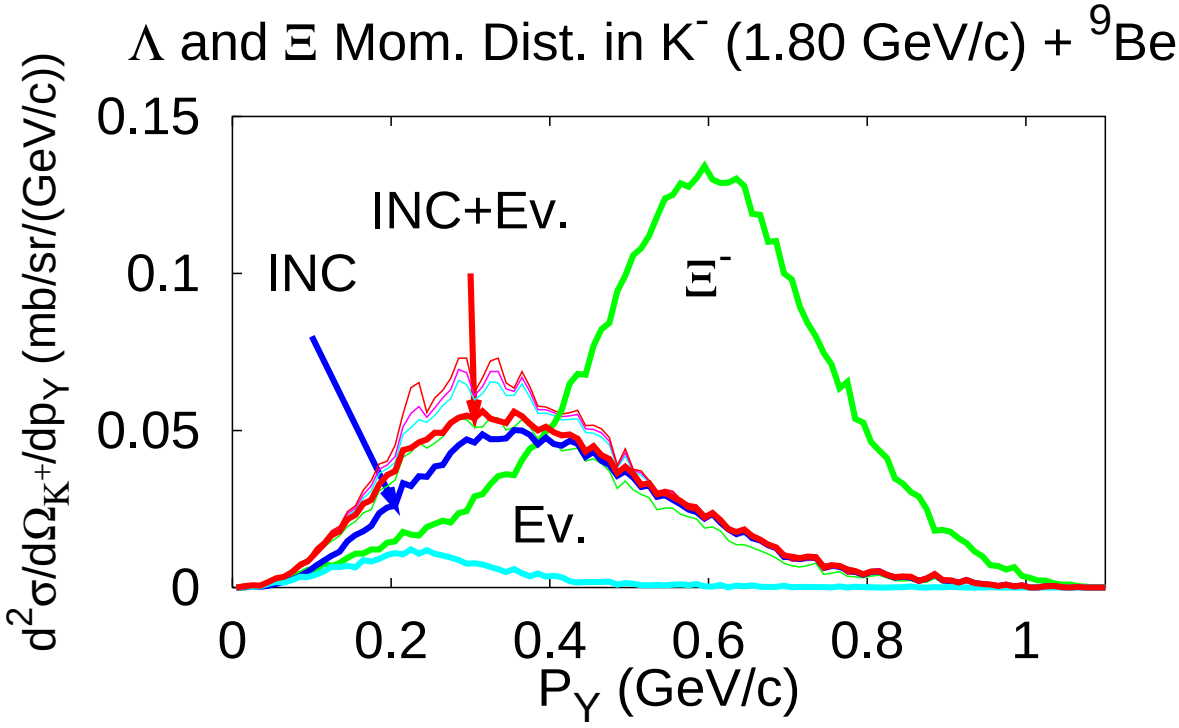
Hyperon Spectrum:

Test of $\sigma(YN)$, Mean Fields, and Reac. Mech.

- KEK-E224 data (Ahn et al.) $(P(K^+) > 0.95$ GeV/c)

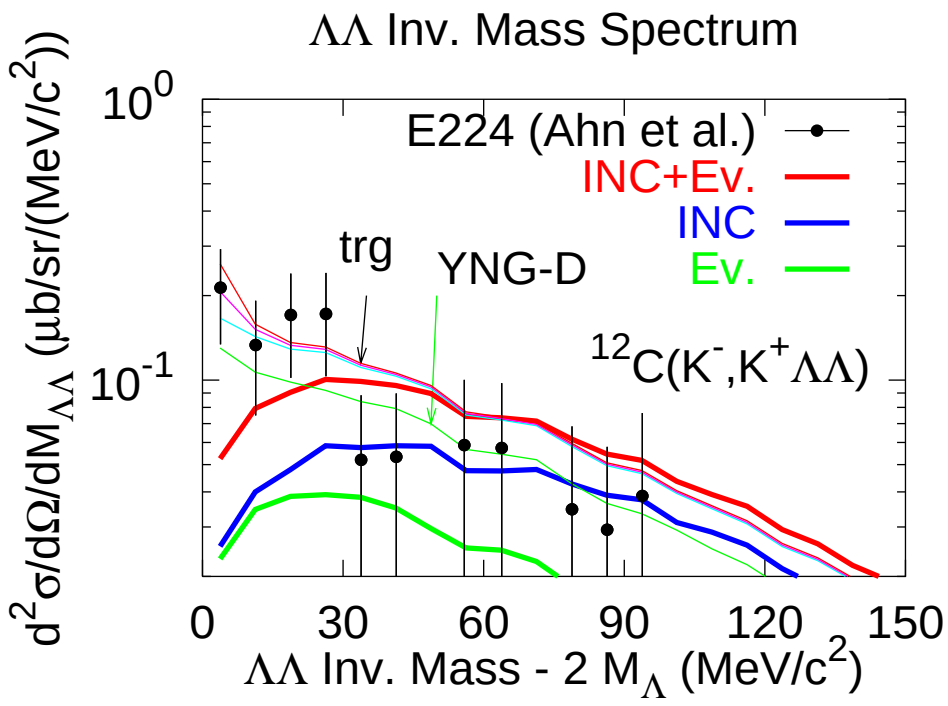


- K^- (1.8 GeV/c) + ^{9}Be $\rightarrow \Lambda, \Xi$ $(P(K^+) > 0.95$ GeV/c)

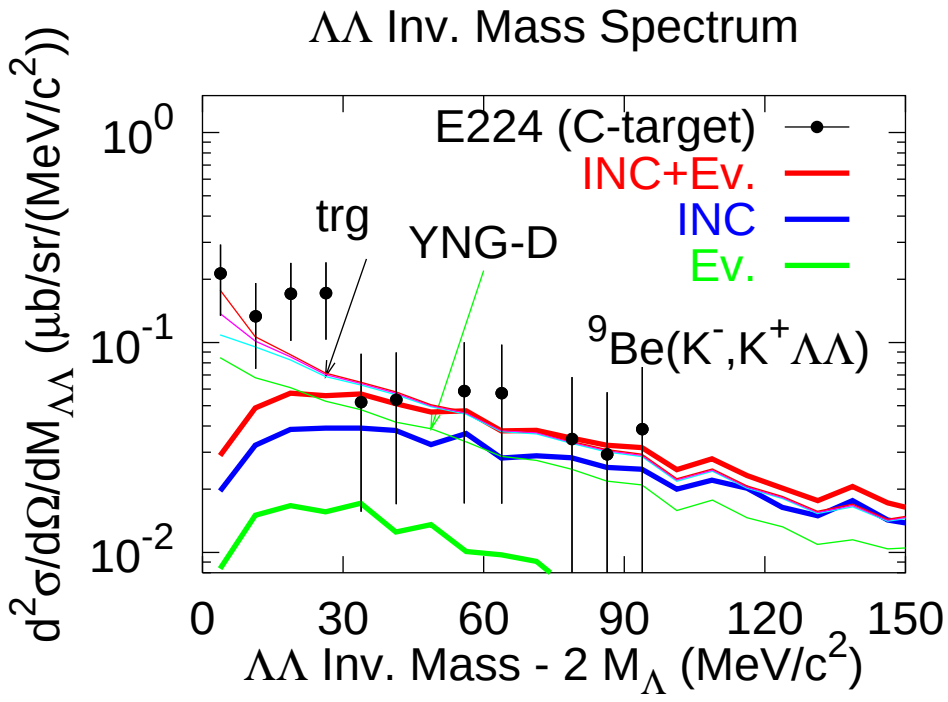


Λ-Λ Inv. Mass Spectrum: Test of $\Lambda\Lambda$ Interaction

- KEK-E224 data (Ahn et al.) $(P(K^+) > 0.95$ GeV/c)



- K^- (1.8 GeV/c) + ^{9}Be $\rightarrow \Lambda, \Xi$ $(P(K^+) > 0.95$ GeV/c)



YNG-D: (a, r_{eff}) = (-3.9, 3.28) fm

trg: (a, r_{eff}) = (-2.9, 2.8), (-4.5, 2.5), (-8.2, 2.3) fm

Summary

1. Source Func. (INC + Evaporation) + Λ-Λ Corr. (Inv. Mass Spec.)
   $\rightarrow$ Λ-Λ Interaction
   (We can use HBT INVERSELY)

2. Necessity of Λ Evaporation from Hyperon Compound Nuclei

   $\star$ Has been shown in Hyperfragment Formations
   from Stopped K^- and Stopped Ξ

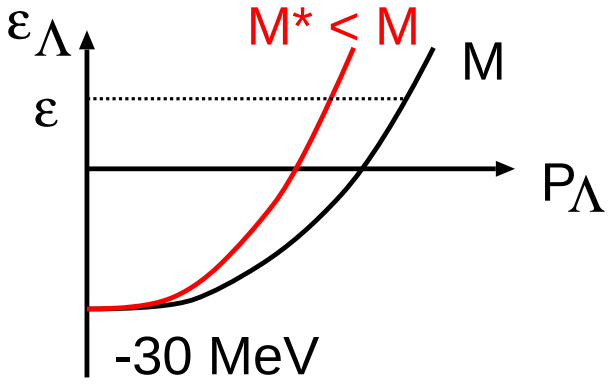
   $\star$ Seen in Λ Momentum Dist. in $(K^-, K^+\Lambda)$ Reaction
   (Not Fully Understood Yet)

   $\star$ Enhances Low Invariant Mass $\Lambda\Lambda$ Pair

3. Todo

   $\star$ YN Cross Section,
   Especially $\Xi N \rightarrow \Lambda\Lambda$ (Fukuda's Talk)

   $\star$ Momentum Dependent (or Relativistic) Mean Field



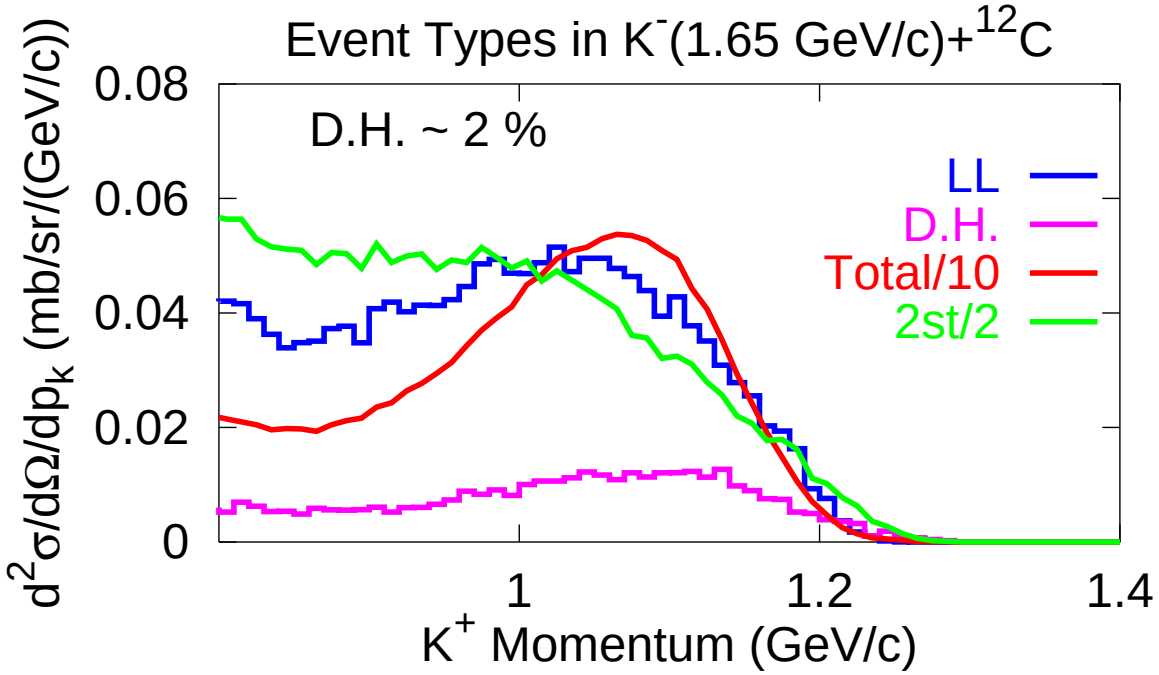
   $\rightarrow$ $M^*_\Lambda < M_\Lambda$?

   $\star$ Fully Quantum Mechanical Two-Step calculation

Event Type Analysis

How Much Double Hypernuclei are Formed ?

- K^- (1.65 GeV/c) + ^{12}C



↔ Yamamoto,Wakai,Motoba,Fukuda: $1 \sim 1.8$ %

- K^- (1.8 GeV/c) + ^{9}Be