Wrap-Up Wednesday

2nd EMMI Workshop: Anti-matter, hyper-matter and exotica production at the LHC

Results and developments

Conclusion

E. Khan

- Microscopic view of universal hypernuclei chart, including strong decay of Λ into Ξ
- Investigation of hypernuclei structure
- Decoupling between hypernuclei physics and the $\rho > 1.5\ \rho_0$ regime
- Large uncertainties due to the NΛ and YY interactions: more data on bond energy ?

- Future: excitations, pairing, deformation, temperature in hypernuclei
- Charmed nuclei ?

Future HY study with e beams

JLab E12-15-008(e,e'K+)
E12-17-003 (nnΛ)

MAMI-Mainz

Decay π Spectroscopy of electroproduced HY

$^{3}_{\Lambda}$H Binding E.

Light Hypernuclei

ELPH-Tohoku

Elementary Strangeness photo-production

$^{3,4}_{\Lambda}$H lifetime (2019-2020 run)

Study of ΛN through nnΛ
(Start Nov. 2018)

First Iso-spin dependence of medium heavy HY w/ best resolution (Prepare for 2020 run)

Compare experimental results with Theoretical Predictions of Binding Energies and Cross Sections
Deduce ΛN interaction including many-body forces

S. Nakamura

Solve Hyperon Puzzle, nnΛ Puzzle, $^{3}_{\Lambda}$H Puzzle

Concluding Remarks

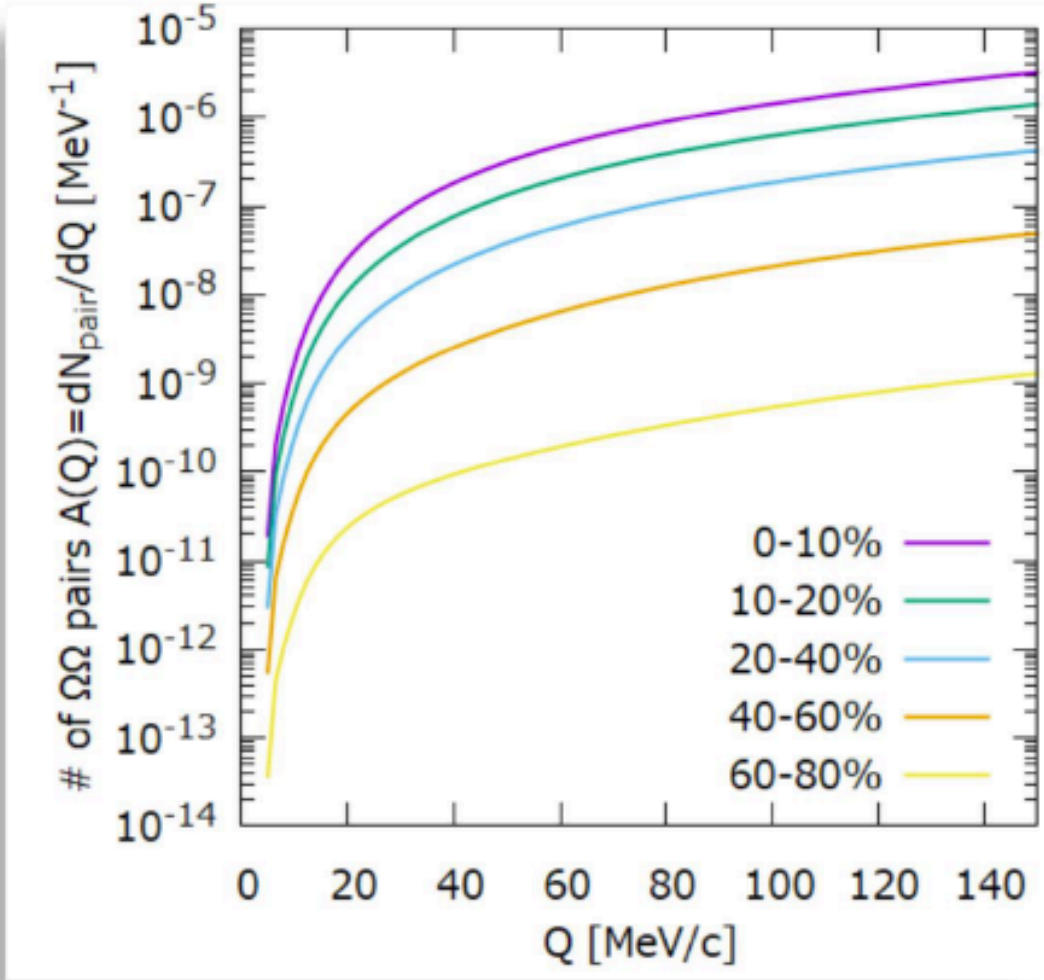
K. Morita

- **Correlation measurement in HIC can constrain low energy scattering param.**
  - New opportunity for multistrange systems
  - FSI contribution is sensitive to system size : Comparing small and large systems via $C_{SL}(Q)$
  - Different systems useful for disentangle other correlation origins
- **Indirect search for dibaryon states**
  - $\Omega\Omega$: Unitary regime, but statistically difficult
  - $p\Omega$: Bound regime - suppression of $C_{SL}(Q)$
  - $p\Xi$: Unitary regime – enhancement of $C_{SL}(Q)$

ΩΩ Correlation: Statistics?

K. Morita

of pair A(Q)



To have 100 pairs at low Q:

Acceptance×Efficiency : 0.01

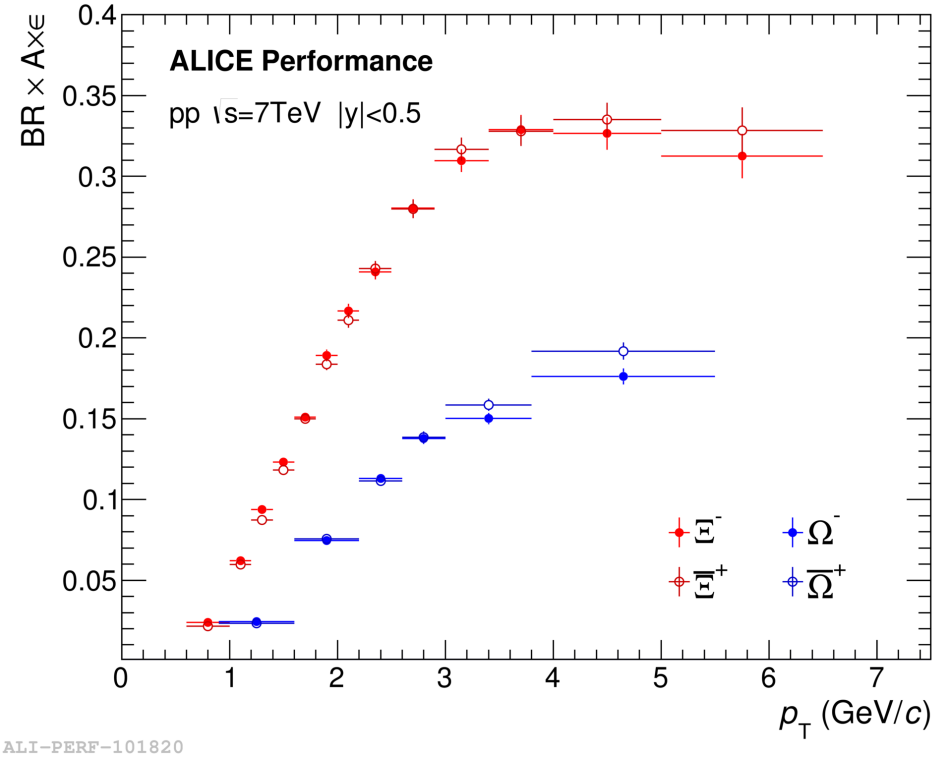
Probability of events with more than 2Ω (assuming Poisson)

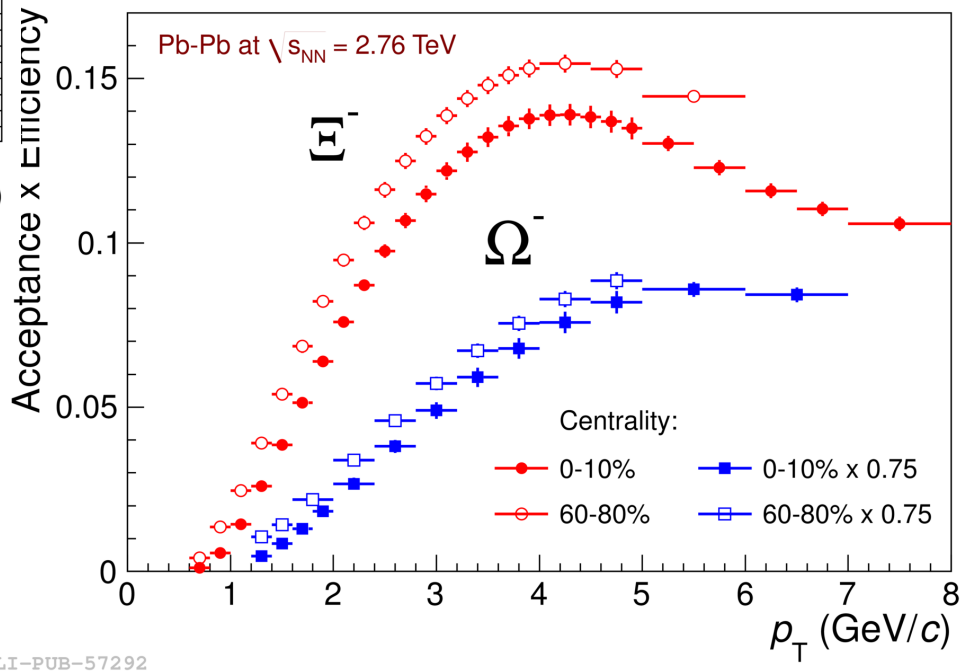
0.12 for 0-10%
10^{-4} for 60-80%

10^{12} – 10^{15} events : unreachable at LHC

Not impossible at Future J-PARC ?(int. rate 10^8 Hz)

Omega in ALICE





Summary and Outlook

- Femtoscopy in small systems is feasible
- New method to calculate different contributions to the total correlation function based on single particle properties
- Modelling of the correlation function with CATS
- Analysis of Run 2 Data in p-p at 13 TeV and p-Pb Collisions at 5 TeV ongoing
  - Additionally obtain the Σ and Ξ Correlation Function
- Universal and Robust Femto Analysis Tool
  - Fit the correlation function of various systems simultaneously in combination with CATS

L. Fabbietti

Summary

TECHNISCHE UNIVERSITÄT DARMSTADT

- Effective field theory for unitary limit
- Universal aspects of (Discrete) Scale Invariance $\Leftrightarrow$ Efimov physics
  - Effective field theory for threshold states
  - ....
- Applications in atomic, nuclear, and particle physics
  - Cold atoms close to Feshbach resonance
  - Few-body nuclei: triton, hypertriton, halo nuclei, ...
  - Hadronic molecules: $X(3872)$, ...
- Factorization for breakup and recombination reactions
  - Application to production of weakly-bound objects in heavy ion collisions?

H.-W. Hammer

Shopping lists

Summary

1. In Λ hypernuclei, if possible, it is interesting to produce nnnnΛ system at ALICE or GSI.
2. Now, we found that ΞN interaction is attractive.
3. At Alice, it might be good idea to produce s-shell Ξ hypernuclei to determine Spin-isospin term of ΞN inyteraction.

5. Next, we should know the information on spin- and isospin-independent force. For this purpose, I would like to suggest to produce A=7 and 10 Ξ Hypernuclei using ^{7}Li and ^{10}B targets at J-PARC.

6 . ΛΛ-ΞN interaction is also important. For this purpose, I suggest to produce $^{5}_{\Lambda\Lambda}$H using 7Li target at J-PARC. And it might be good to produce $^{4}_{\Lambda\Lambda}$H at ALICE.

E. Hiyama

Conclusions

1) ESC08c models predict stable and unstable di- tri- and up –baryons.
2) Other models (chiral quark models, effective field theories, lattice models) contain also considerable amounts of attraction and may generate similar results.

H. Garcilazo

Summary & Outlook

- ΛN hypernuclear spin dependence deciphered.
- How small is Λ spin-orbit splitting and why?
- Role of 3-body ΛNN interactions in hypernuclei & neutron stars?
- Resolve the ${}^{3}_{\Lambda}$H lifetime puzzle from HIC.
- Re-measure the ${}^{4}_{\Lambda}$H–${}^{4}_{\Lambda}$He complex **(E13→E63)**.
- Search for n-rich ${}^{A}_{\Lambda}$Z; ${}^{6}_{\Lambda}$H? **(E10)**.
- Repulsive Σ-nuclear interaction; how strong? (relevant to neutron star matter & to strange hadronic matter).
- Search for H dibaryon in (K^-, K^+) **(E42)**.

A. Gal

- Onset of $\Lambda\Lambda$ binding: ${}^{4}_{\Lambda\Lambda}\mathrm{H}$ or ${}^{5}_{\Lambda\Lambda}\mathrm{Z}$? (E07).
- Shell model works well for g.s. beyond ${}^{6}_{\Lambda\Lambda}\mathrm{He}$.
- Study excited states by slowing down Ξ^- from $\bar{p}p \to \Xi^-\bar{\Xi}^+$ in FAIR (PANDA).
- Do Ξ hyperons quasi-bind in nuclei ($\Xi N \to \Lambda\Lambda$)? No quasibound Ξ established yet (E05).
- Onset of Ξ stability: ${}^{6}_{\Lambda\Xi}\mathrm{He}$ or ${}^{7}_{\Lambda\Lambda\Xi}\mathrm{He}$?
- No $\bar{K}$ condensation in self-bound matter. $\{N, \Lambda, \Xi\}$ provides Strange-Hadronic-Matter g.s.

Thanks for your attention!

A. Gal

Future

Strangeness Nuclear Physics

strangeness in nuclei

- *Y^nN^m interaction are important*
- *precision studies are needed*
- *after 60 still many puzzles*

PANDA offers a broad physics program

- *antihyperons in nuclei → PANDA day-1*
- *excited state spectroscopy of double hypernuclei*

many things could not be mentioned

- *hyper atoms*
- *neutron skin*
- *hyperon structure e.g. E2(Ω) ?*
- *mini $\bar{p}\,p$ collider ?*

J. Pochodzalla