PRESENTATION

Search for Excited States of Σ Hypernucleus in the J-PARC E13 Experiment

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  - ΣN interaction
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- Summary

Study of YN interaction in S=-1

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- Nucleon-Nucleon(NN) interaction
  - Studied through **NN scattering** and structure of nuclei
- Hyperon-Nucleon(YN) interaction in S=-1
  - ΛN interaction (isospin=0)
    - Study through **structure of Λ hypernuclei**
  - ΣN interaction (strong isospin dependence)
    - Non-isospin dependence part
      - Σ- atom study and **heavy Σ hypernuclei** search → stdied
    - isospin dependence part
      - Only one bound state of Σ hypernucleus

Strong isospin dependency

- Σ - nucleus potential

$$U_0^{\Sigma} + U_{\tau}^{\Sigma}(T_{\mathrm{core}} \cdot t_{\Sigma}) / \mathrm{A}_{\mathrm{core}}$$

Isospin independent

Lane's term
Isospin dependent

Mass number of core nucleus

  - U^{Σ}_0
    - KEK-PS E438 C, Si, In, Bi(K^-,π^+) → repulsive force
  - Lane's term
    - T_{core} and t_{Σ} : isospin operator

      →depends on the total isospin (T) of hypernuclei
    - Comparable to U^{Σ}_0 term in light nuclei

Strong attractive force appears depending on isospin combination
→ Observation of bound state in four-body system

Observation of $^{4}_{\Sigma}$He bound state

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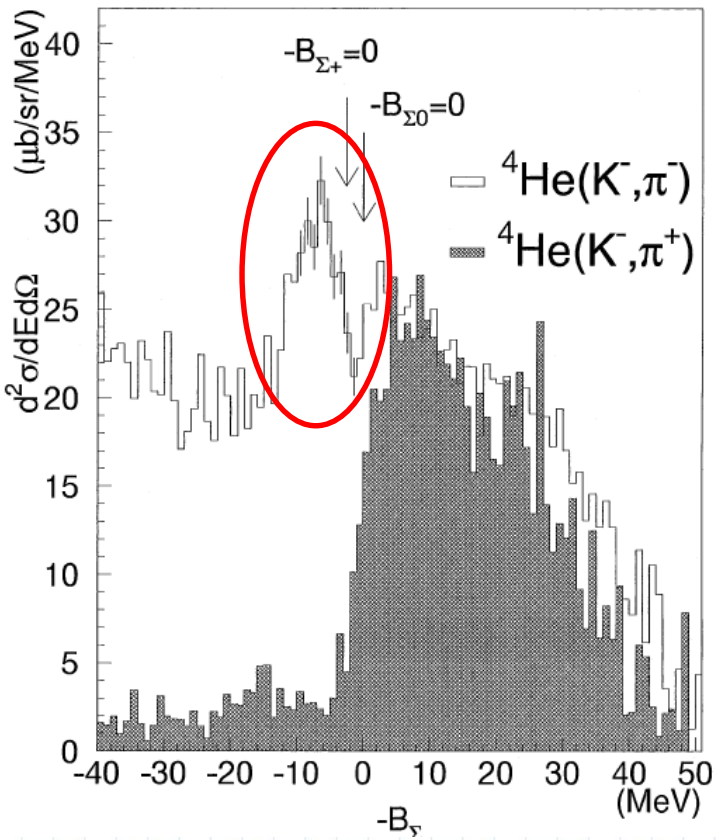
- KEK-PS E167
  - Bump structure
- BNL-AGS E905
  - ^{4}He(K^-,π^+) → T=3/2
    - repulsive
  - ^{4}He(K^-,π^-) → T=1/2 , 3/2
    - Attractive →Bound state
- $^{4}_{\Sigma}$He ground state
  - Γ = 7±0.7 MeV
  - $-B_{\Sigma+}$ = -4.4±0.3 MeV
    - **s-state (0^+)** : Narrow peak

T.Nagae *et al.*, Phys.Rev.Lett. 80(1998)1605.

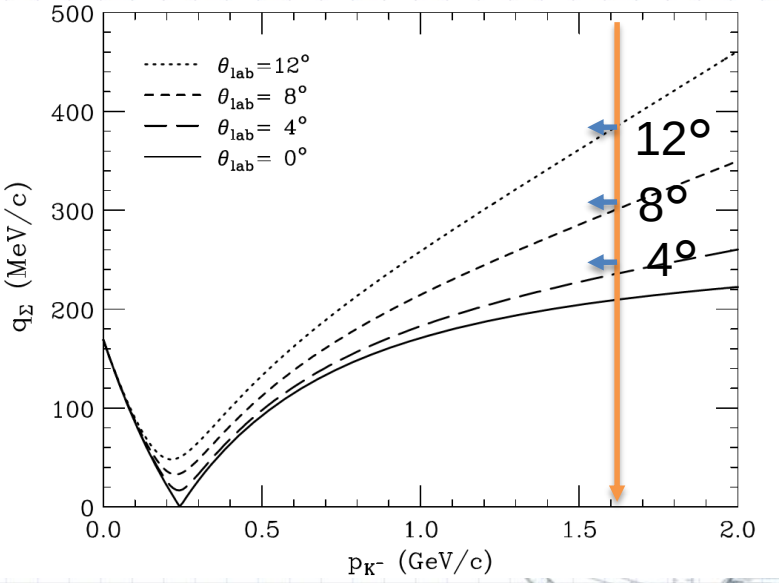


Excited states of Σ hypernucleus

- Information of ΣN interaction
  - Information of s-wave is dominant →Not enough
    - Only ground state search experiment
- To obtain Information of p-wave in ΣN interaction
  - Search for Excited states of Σ hypernucleus
    - High recoil momentum
    - Select reaction angle

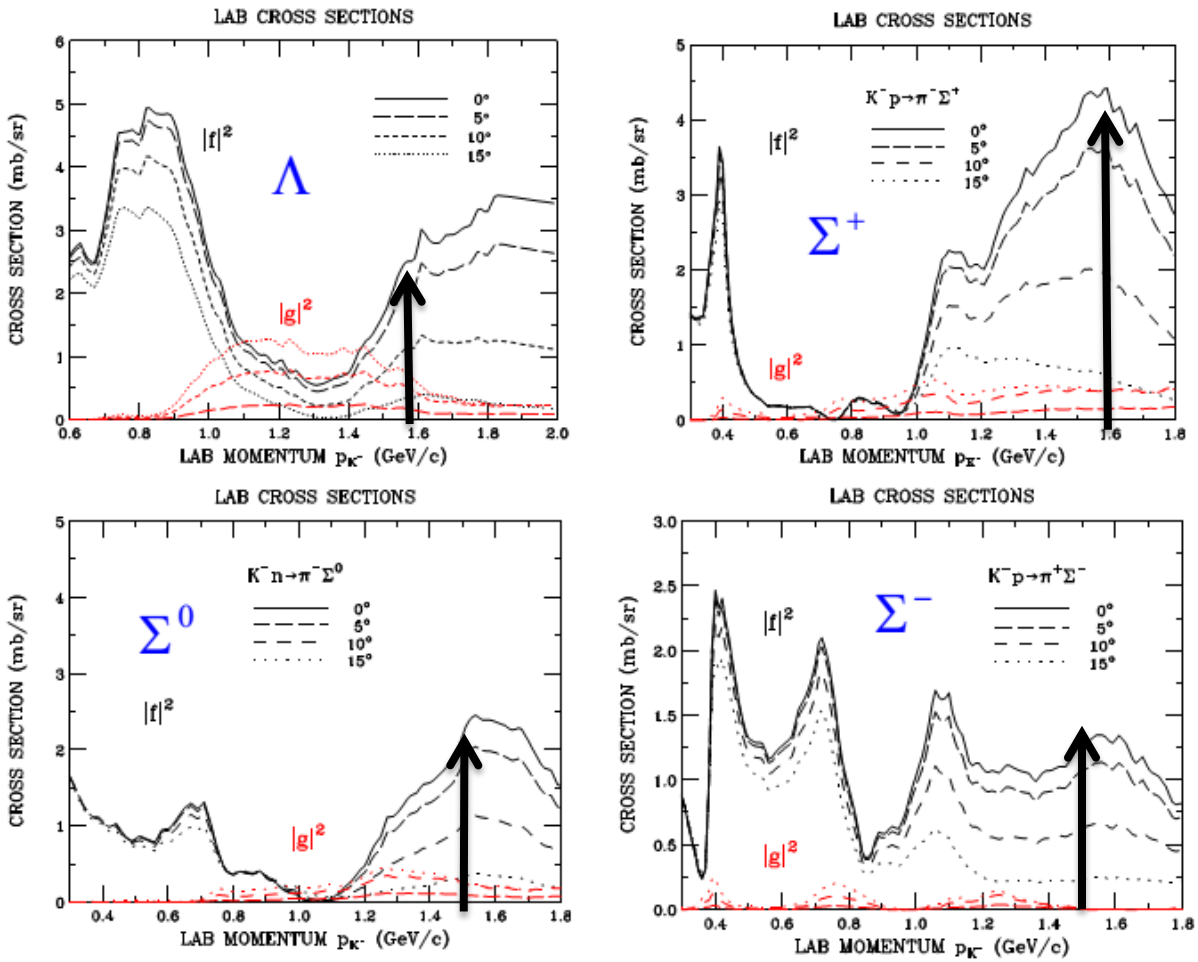
→ High momentum

(K^-,π^-) reaction



$\omega = E_K - E_\pi$, $q_\Sigma = p_K - p_\pi$

Cross section of Λ and Σ



Expected results

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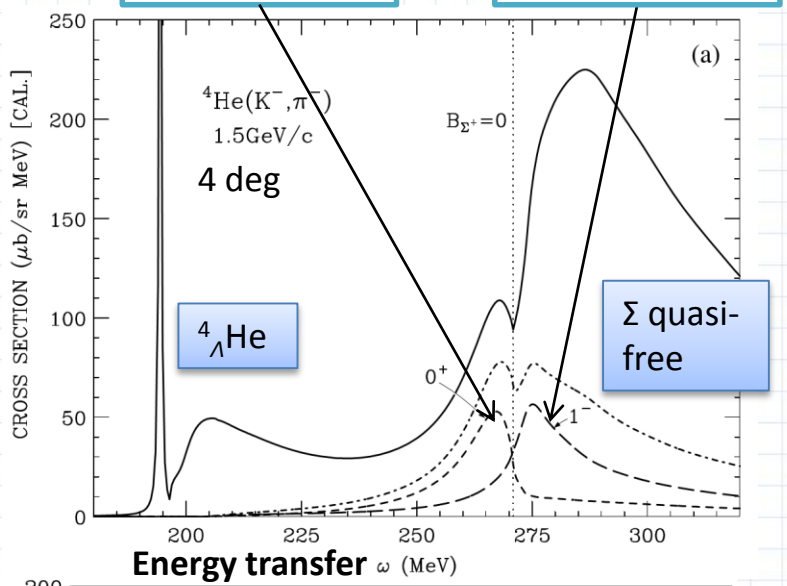
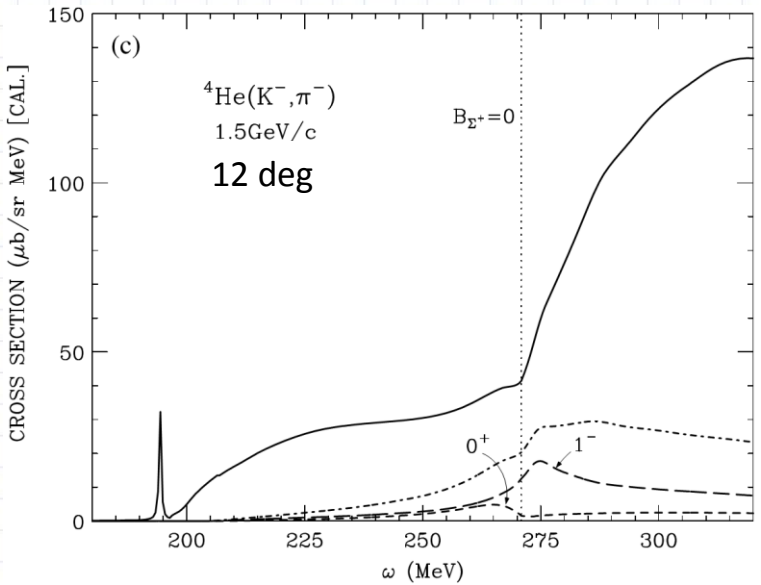
T.Harada *et al.*, PLB 740(2015)312.

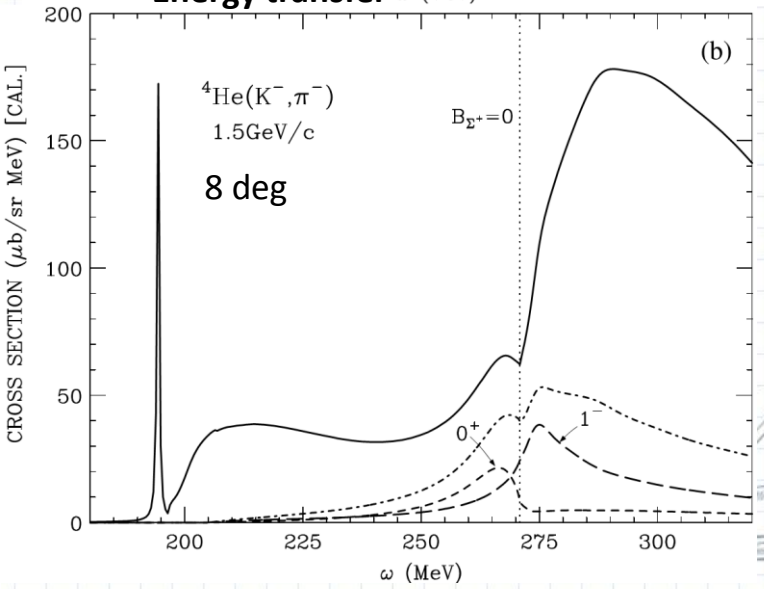
* Including ΣN→ΛN conversion

- Angular distributions of the π^- spectra at **θlab=4,8,12°**
  - controlling the momentum transfer q_Σ by the scattering angle of θlab.



detector resolution of 3 MeV FWHM





Expected results

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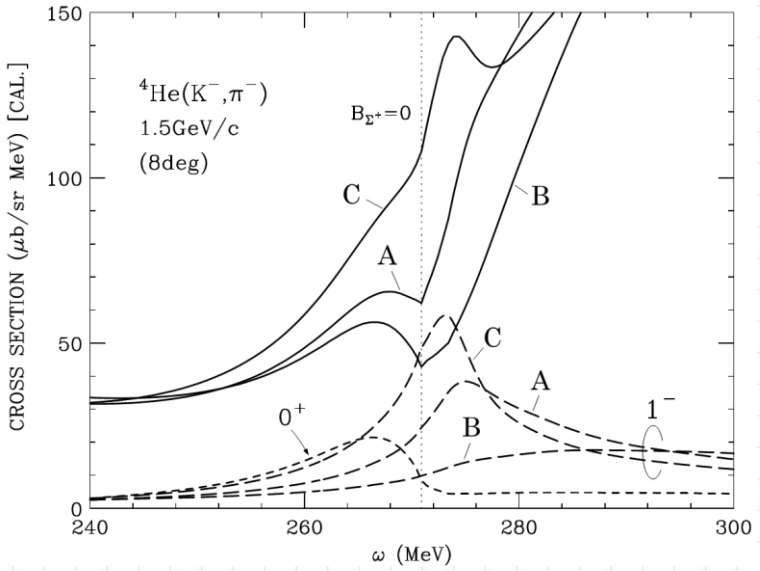
- Changing artificially strength factors of (N_R, N_I)
  - Case A: (0.6,0.9)
    - Factors are determined in the $^4He(K^-,\pi^{\pm})$ reaction at 0.6 GeV/c
  - Case B: (0.0,0.9)
    - The magnitude is quite reduced
  - Case C: (1.0,1.0)
    - 1- is significantly enhanced



U(p-wave) → factor x U(s-wave)
$V_{\Sigma,T}$ → N_R x $V_{\Sigma,T}$: Real potential strength
$W_{\Sigma,T}$ → N_I x $W_{\Sigma,T}$: Imaginary potential strength

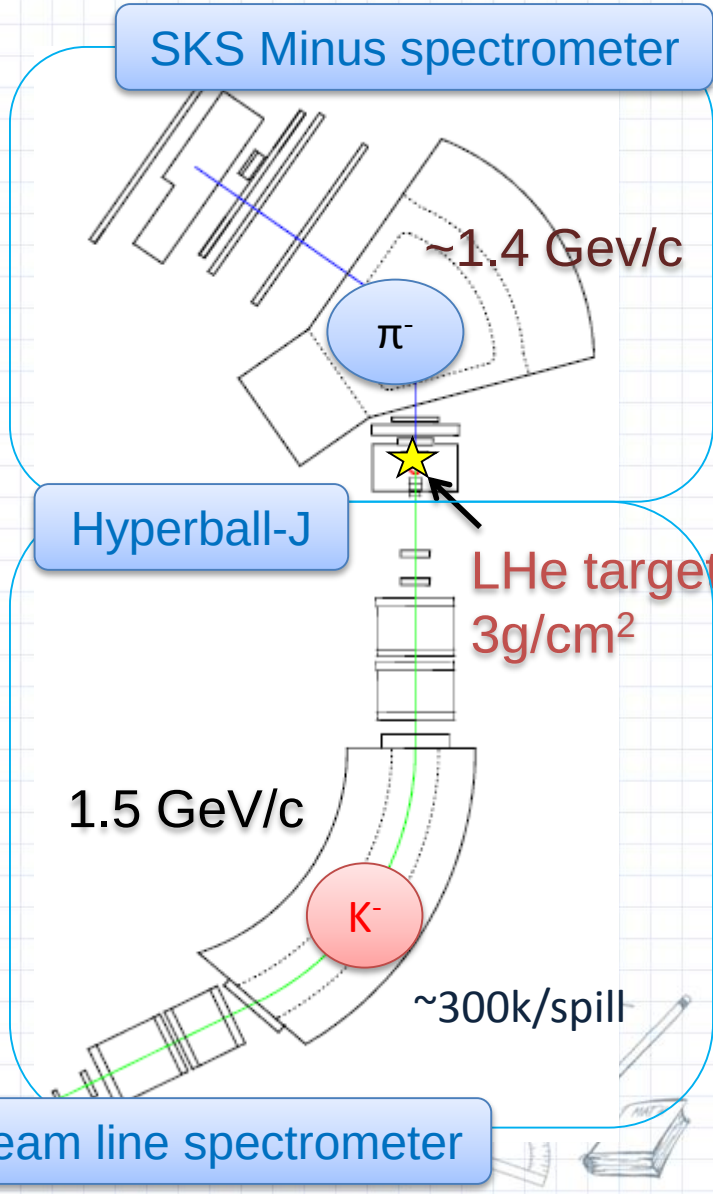
Ability to determine the strength of the *Σ*-nucleus potential for *p*-wave states

J-PARC E13 experiment

J-PARC E13 Experiment

PRESENTATION

- Purpose
  - $^{4}_{\Lambda}$He γ-ray spectroscopy
  - Search for **excited states of Σ hypernucleus**
- Missing mass spectroscopy of ^{4}He(K^-,π^-) reaction
  - High momentum K^- beam :1.5GeV/c
  - Liquid ^{4}He target : 3g/cm^2
  - Reaction angle : 0° -20°
    - π- momentum : 1.0 – 1.5 GeV/c



Data summary

- K^- beam condition
  - Beam intensity : 300 k/spill(2s) — K-/pi- ratio : ~2
  - Total beam time : ~138h — 23 G K-
- Data taking
  - ^{4}He physics run : 1.5 GeV/c
    - Yield of 1- state of $^4_\Sigma$He : ~10^6 events
  - Sigma+ production : 1.5, 1.8 GeV/c
  - Beam through : 1.2, 1.37, 1.5, 1.8 GeV/c
  - Empty target : 1.5 GeV/c

Analysis is on-going

Summary

PRESENTATION

- Study of ΣN interaction in S=-1
  - Search for excited state of Σ hypernucleus
    - Extract Σ-nucleus potential for p-wave
- J-PARC E13 experiment
  - ^{4}He(K^{-},π^{-}) reaction at 1.5 GeV/c
    - Angular distribution
  - Obtained the missing mass spectrum is similar to Harada-san's calculation in CaseA

Back up

Cross section of Λ and Σ

PRESENTATION