High Precision Hypernuclear Spectroscopy at JLab

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The JLab Hypernuclear Physics Collaboration

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57 Institutes from 10 countries

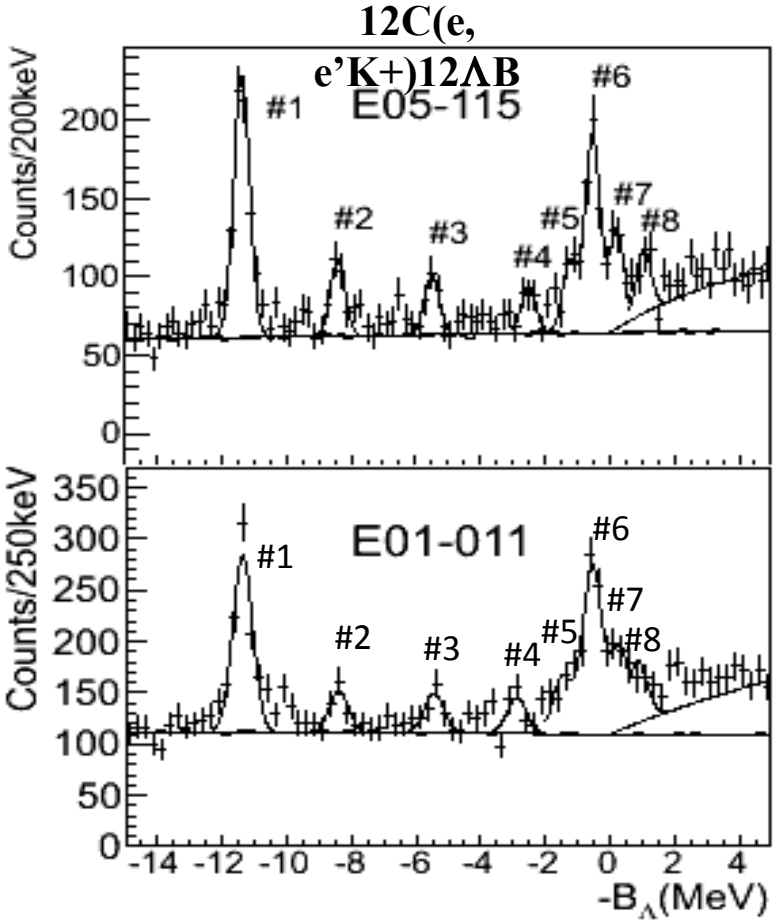
Hypernuclear Physics

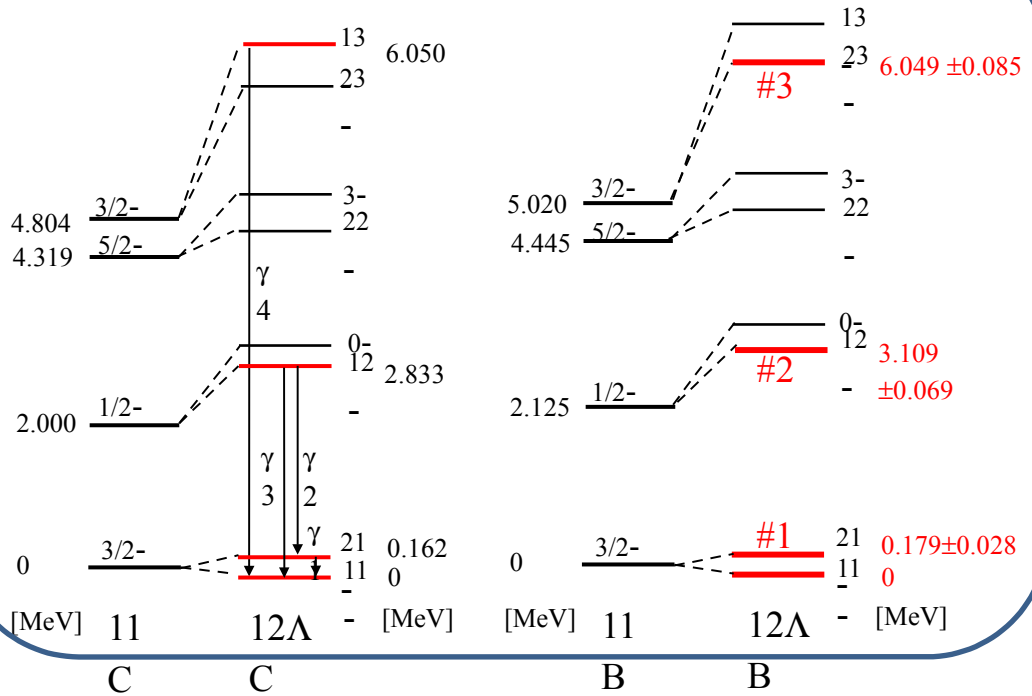
- Baryonic interactions and many body baryonic system
  – *Primary effort of nuclear physics*
- New flavor in SU(3): *YN* and *YY*
- Important linkage to Astrophysics: neutron stars, hyperon matter, …
- Short range baryonic interactions: *ΛN* - *ΛN*
- Baryonic structure of the nuclear medium probed by Λ
- Λ-Σ coupling: Charge Symmetry Breaking (CSB) and 3BF(*ΛNN)*
- Past: Hypernuclear Program at JLab (a hadron physics facility):
  - Proven the feasibility and technique of electro-production
  - Achieved the highest possible precision in mass spectroscopy

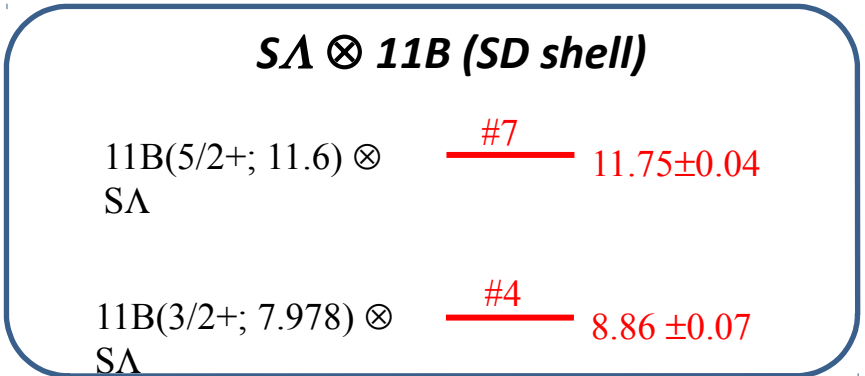
  (δE ~ 500 keV FWHM and $\delta B\Lambda$ < ±100 keV) – Unique
    - Studied the spectroscopy of a sequence of Λ-hypernuclei:

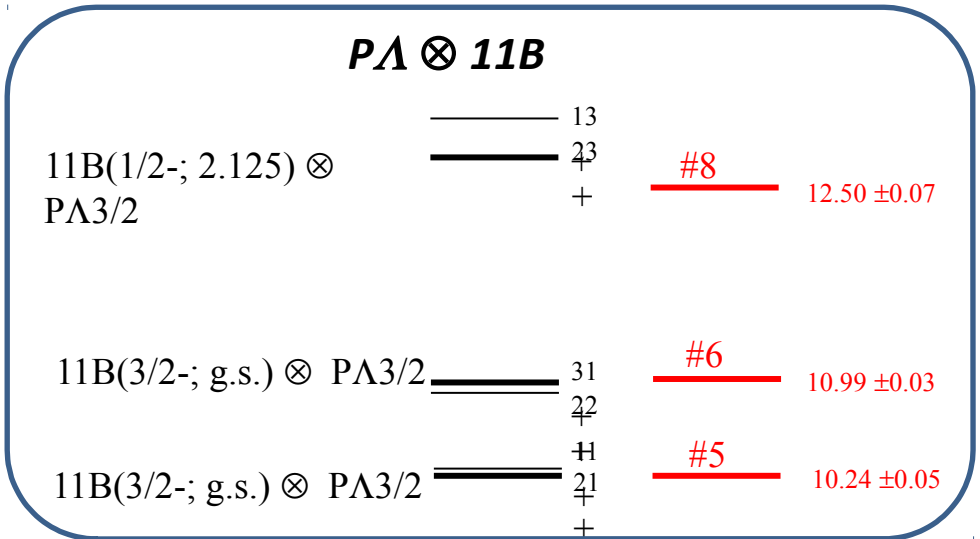
  7ΛHe, 9ΛLi, 10ΛBe, 12ΛB, 16ΛN, 28ΛAl, and 52ΛV – the only new results exist in the past decade and near future

Example: Precision 12ΛB Spectroscopy and Shell Model





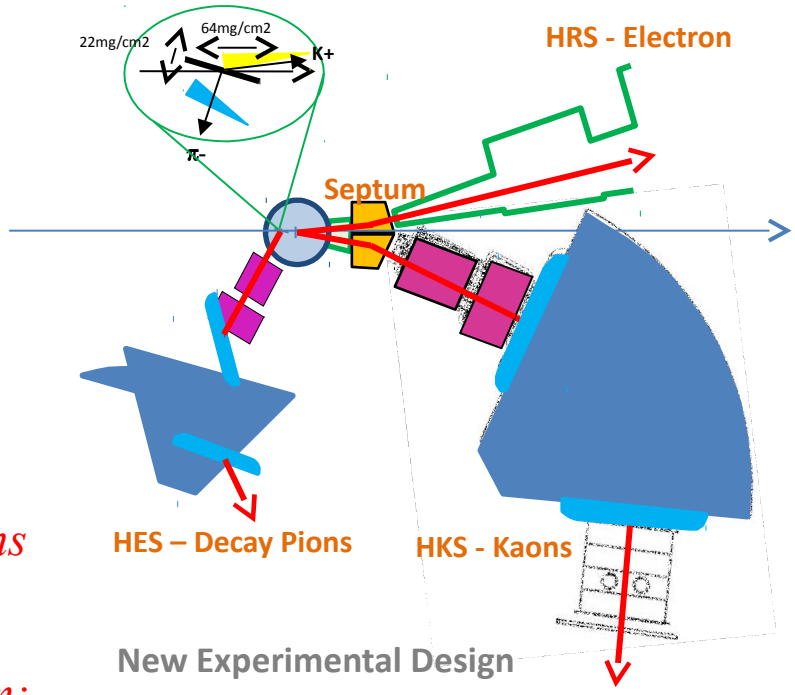




Future: Program on Hypernuclear Spectroscopy

Technical Features:

- High precision and high yield
  ($\delta E \sim 600$ keV FWHM and $\delta B_\Lambda \sim \pm 50$ keV)
- "Free" of accidental background
- All major equipment already exist



Physics:

- Few body
  Charge Symmetry Breaking (CSB) in ΛN interactions
- Medium heavy hypernuclei
  LS force; shell model on baryonic many-body system;
  structure or deformation of the core nuclei probed by Λ
- Heavy hypernuclei (A~200) – precise B_Λ and level spacing
  Importance of 3B/4B forces; many body vs QCD descriptions
- Decay pion spectroscopy (Ground state of light hypernuclei; $\delta E \sim 130$ keV & $\delta B_\Lambda \sim \pm 20$ keV)
  ΛN interactions; CSB; Λ-Σ coupling; drip line hypernuclei (${}^{6}_{\Lambda}$H)

Hypernuclear Physics Programs and Facilities

JLAB program plays a unique role in the global effort on the strangeness nuclear physics

JLAB
Electroproduction

- Λ hypernuclei (few-body to heavy)
- High precision mass spectroscopy and precise B_Λ determination
- *The only facility at the moment and near future*

J-PARC
Hadronic production

- γ spectroscopy of Λ hypernuclei
- S = -2 Ξ and ΛΛ hypernuclei
- Kaonic nuclei (*K-NNN*, …)

MAMI
Decay pion spectroscopy

- Ground state of light Λ hypernuclei
- Precise B_Λ on the ground state

PANDA @ Fair
Heavy Ion Collision

- Multi-strangeness
- Extreme p and n numbers
- Anti-hypernuclei
- Charm-hypernuclei