UNIVERSITY of York

Hyperon spectroscopy at KLF

"To Do List"

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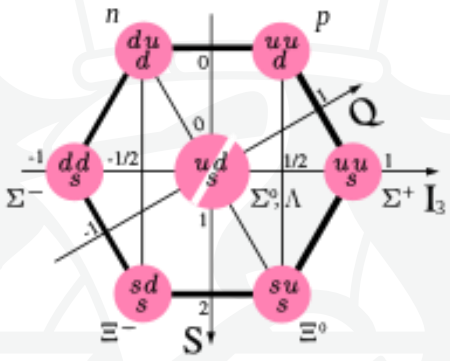
Outlook

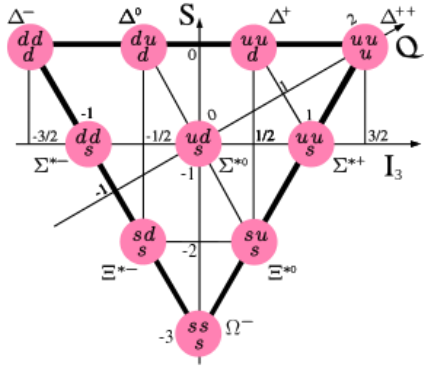
- KAON INDUCED REACTIONS
  - Simulation & reconstruction
- 2&3 BODY REACTIONS
- PHYSICS MOTIVATION
  - Hybrids
  - Molecules
  - Isospin violations

Hyperons



Octet: N^*, Λ^*, Σ^*, Ξ^*

Decuplet: Δ^*, Σ^*, Ξ^*, Ω^*



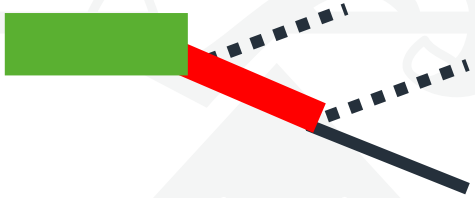
	Quark Models Predicted	"Observed", PDG
N^*	64	16
Δ^*	22	10
Λ^*	17	14
Σ^*	43	10
Ξ^*	42	6
Ω^*	24	2

Theory limitations

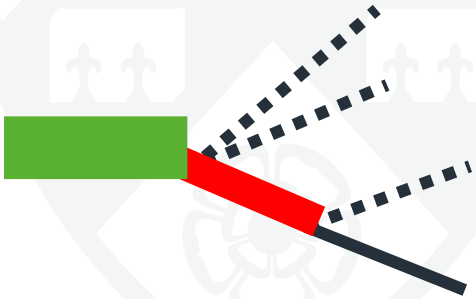
Good

Kaon beam brings one unit of strangeness:

- No associated kaons for Λ^*, Σ^* production
- 1 associated kaon for Ξ^*
- 2 associated kaons for Ω^*



Acceptable



Simplified,
model dependent analysis only

Simulated Reactions

$K_L p \rightarrow K_s p$
$K_L p \rightarrow \pi^+ \Lambda$
$K_L p \rightarrow K^+ \Xi^0$

2 Body Final state
Pure Σ^* channels

$K_L n \rightarrow K^+ \Xi^-$

Measurement on neutron target
Σ^*, Λ^* interplay

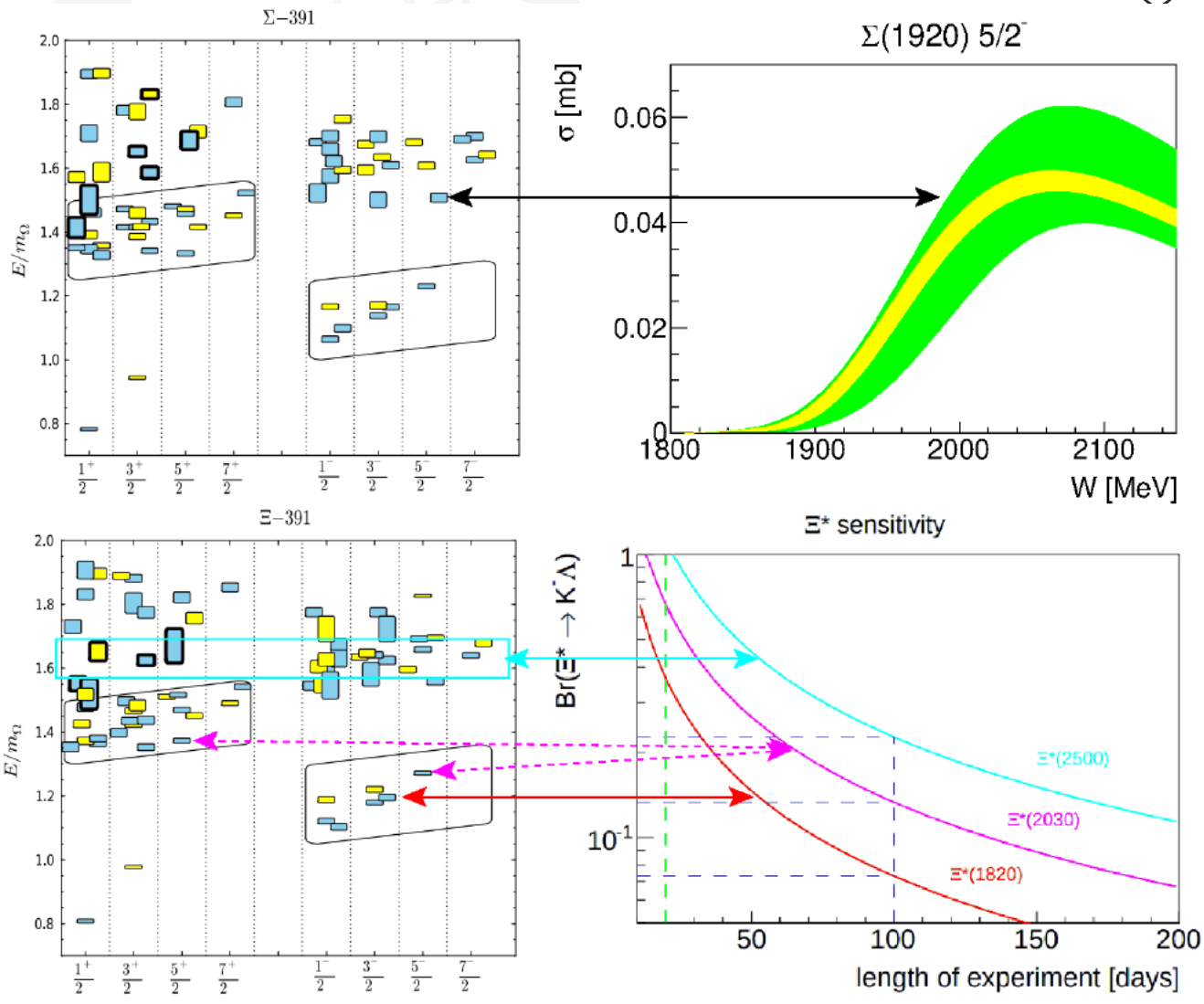
$K_L n \rightarrow K^+ \Xi^{*-}$

Excited Ξ^*, associated production

$K_L p \rightarrow K^+ n$

Non-resonant background

Results


Σ−391
Ξ−391
Σ(1920) 5/2⁻
σ [mb]
W [MeV]
Ξ* sensitivity
Br(Ξ* → K⁻Λ)
Ξ*(2500)
Ξ*(2030)
Ξ*(1820)
length of experiment [days]

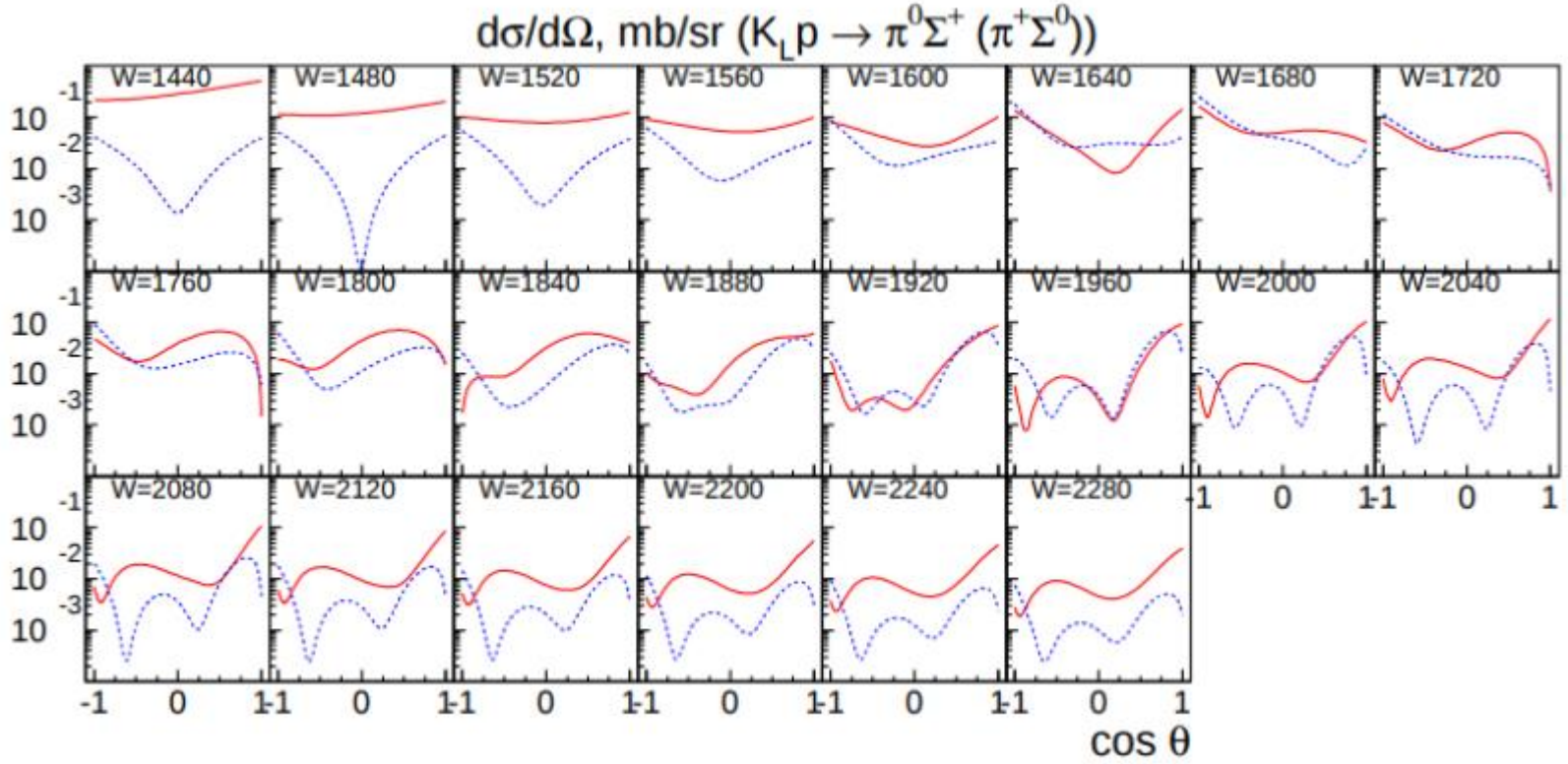
New findings: $\pi\Lambda/\pi\Sigma$

Isospin amplitudes

$$|A(K^-p)|^2 = \frac{1}{2}(|A_1|^2 + |A_0|^2 + 2Re(A_1A_0^*))$$

$$|A(K^0n)|^2 = \frac{1}{2}(|A_1|^2 + |A_0|^2 - 2Re(A_1A_0^*))$$

$$|A(K^0p)|^2 = |A_1|^2.$$



To Do: Reactions with Σ

- $K_L p \to \Sigma\pi$ ($\Sigma^+\pi^0/\Sigma^0\pi^+$) – very sensitive for Σ^* (according to BoGa)

- $K_L p \to \Sigma^+\eta$
- $K_L p \to \Sigma^+\omega$
- $K_L p \to \Sigma^+\eta'$
- $K_L p \to \Sigma^+\phi$

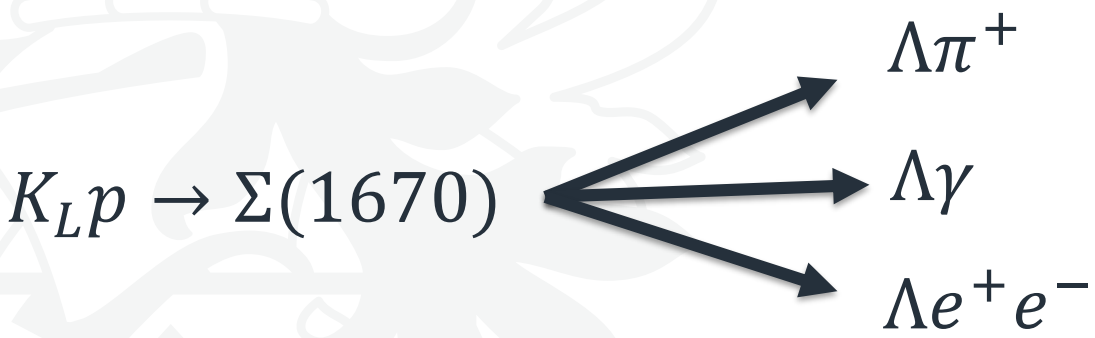
Literature, Theory, Simulations

- $K_L p \to \Sigma^+\rho$
- $K_L p \to \Sigma^+ a_0/f_0$
- $K_L p \to \Sigma^+\sigma$

Broad resonances, links to N^*/Δ^*

Nice BSc projects

Further studies

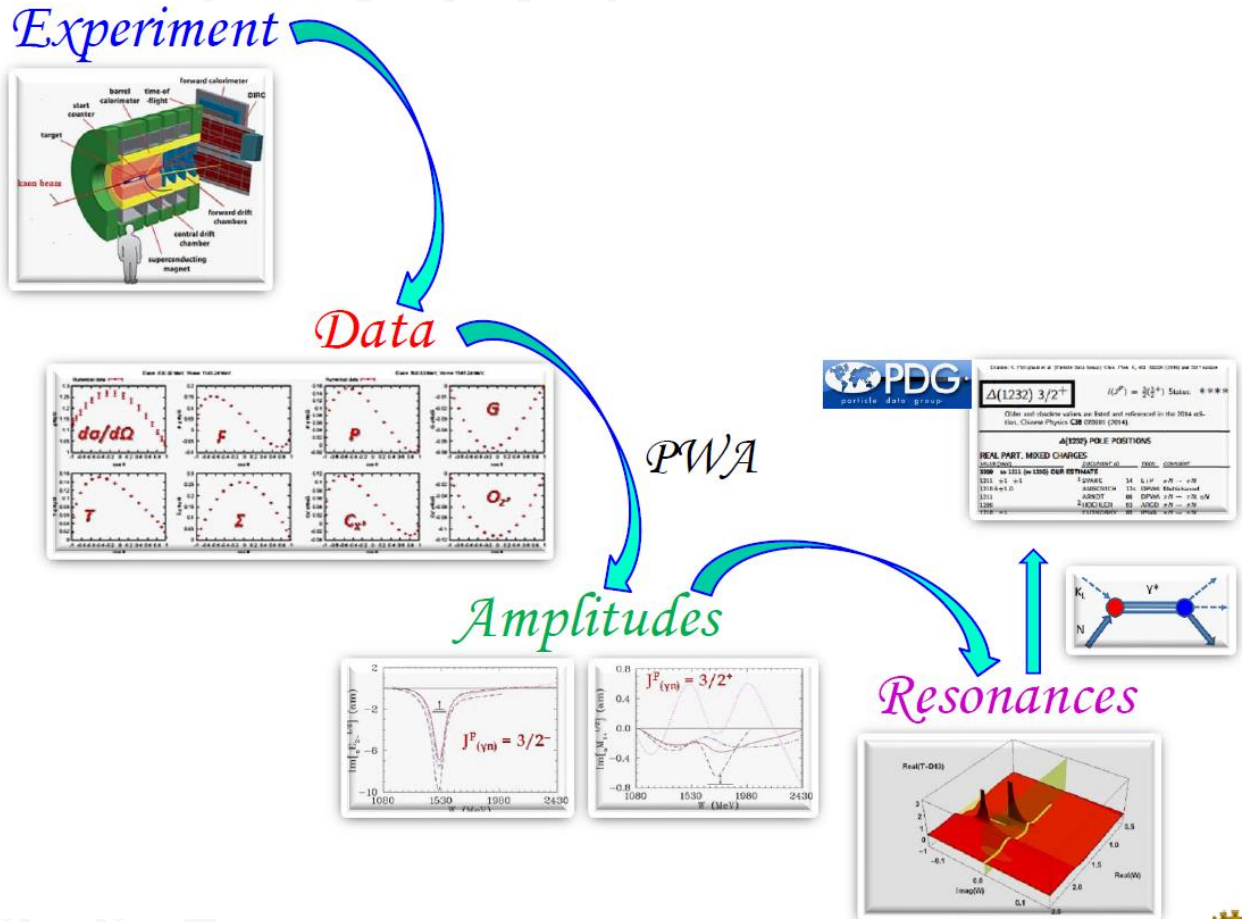


Kevin Luckas

Other hyperons/transition FF ?

Shopping list

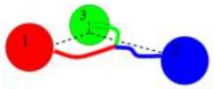
Strategies: bottom → up vs top → down



from I. Strakovsky

Hybrids

Baryonic hybrids



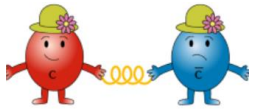
- **NO** Exotic quantum numbers

- Preferable decays?

$$\frac{\Sigma^H \to \Sigma K K}{\Sigma^H \to \Sigma \pi \pi} \quad ?$$

$$\frac{\Sigma^H \to \Sigma \phi}{\Sigma^H \to \Sigma \omega} \quad ?$$

Mesonic hybrids



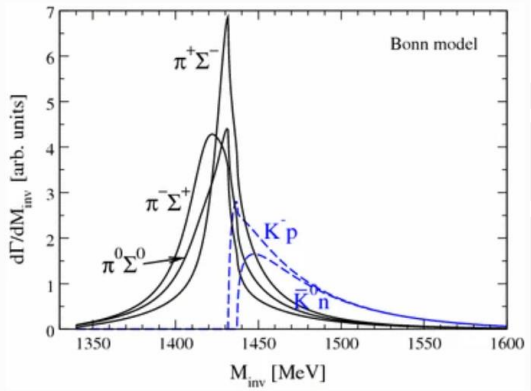
- Exotic quantum numbers

$$\pi_1 \to b_1 \pi \to \omega \pi \pi$$

- Σ^H vs Λ^H vs Ξ^H
- Can we do Ω^H?

Molecules and cusps

$\Lambda_b \to J/\psi \Lambda(1405)$



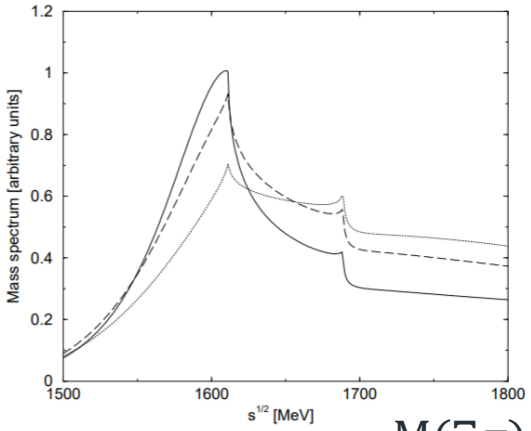
•L. Roca, M. Mai, E. Oset & Ulf-G. Meißner

- Many thresholds
  - Cusps
  - Molecules
  - Dynamic resonances

- $\Lambda(1670)$, $\bar{K}N$ vs $\pi\Sigma$ vs $\eta\Lambda$
- $\Sigma(1620)$

States?
Decay channels?
Resolution?

$\Xi(1620)$



$M(\Xi\pi)$

$\Xi\pi, \Lambda\bar{K}, \Sigma\bar{K}, \Xi\eta$

A. Ramos, E. Oset , C. Bennhold

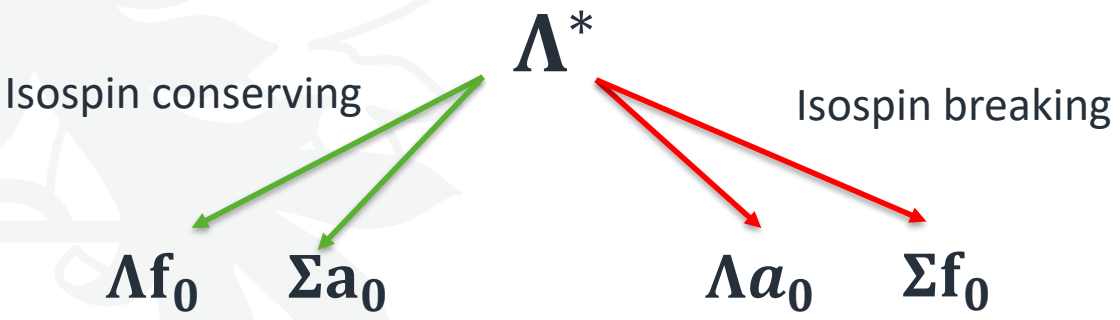
Isospin violations?

- $\Lambda(1116) - \Sigma(1192)$ mixing

- $\Lambda^* - \Sigma^*$ mixing ?
  - Can be closer in mass?
  - $\Lambda(1600) - \Sigma(1660)$, $J^P = \frac{1}{2}^+$
  - $\Lambda(1670) - \Sigma(1750)$, $J^P = \frac{1}{2}^-$

Dan-Olof Riska

Isospin violations: baryons vs mesons



- Example $\mathrm{np} \rightarrow d\pi^0$
  - Isospin conserving reaction
  - Isospin breaking distribution (forward-backward asymmetry)

Isospin filtering

$$K_L n \rightarrow X \rightarrow \vec{\Lambda}\vec{\omega}$$

I=0 or 1

I=0 I=0

Isospin filtering

$$K_L n \rightarrow X \rightarrow \vec{\Lambda}\vec{\omega}$$

I=0 or 1 I=0 I=0

$$K_L n \rightarrow X \rightarrow \vec{\Lambda}\pi^0\pi^0$$

I=0 or 1 I=0 I=0 or 2

- Fully neutral final state
- Detached vertex for the Λ
- Start time
- Primary vertex

Conclusion

- Need to identify interesting channels
- Simulate and find out most sensitive distributions
  - A lot of opportunities for BSc and MPhys projects
- Decide if equipment modification is necessary