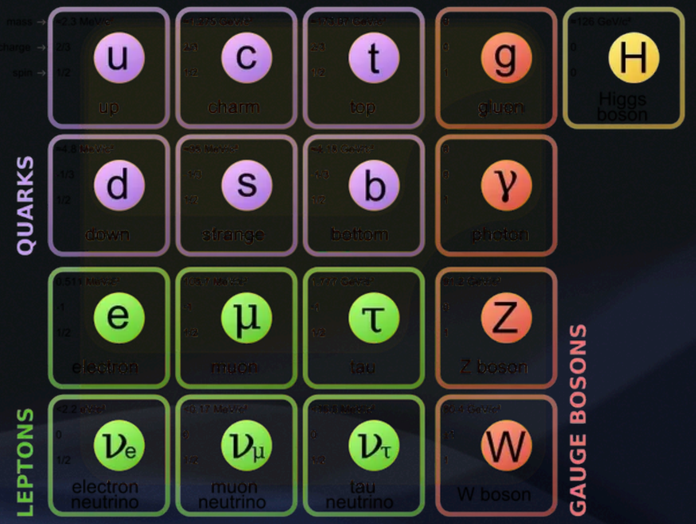
ELUCIDATING STRANGENESS WITH CLAS12

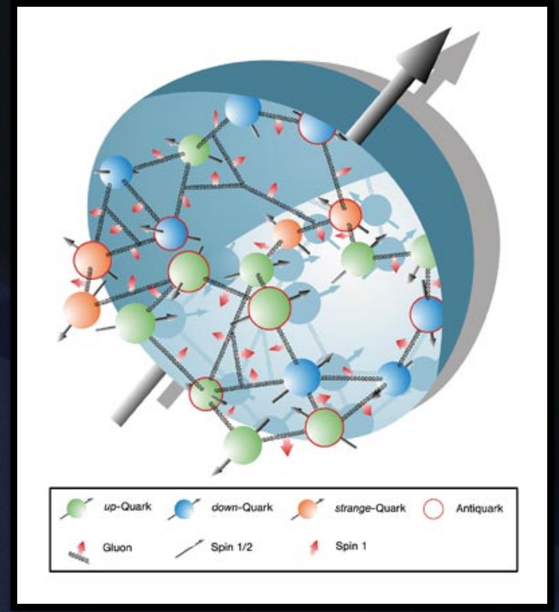


104 MeV/c^2

$-\frac{1}{3}$

$\frac{1}{2}$ **S**

strange



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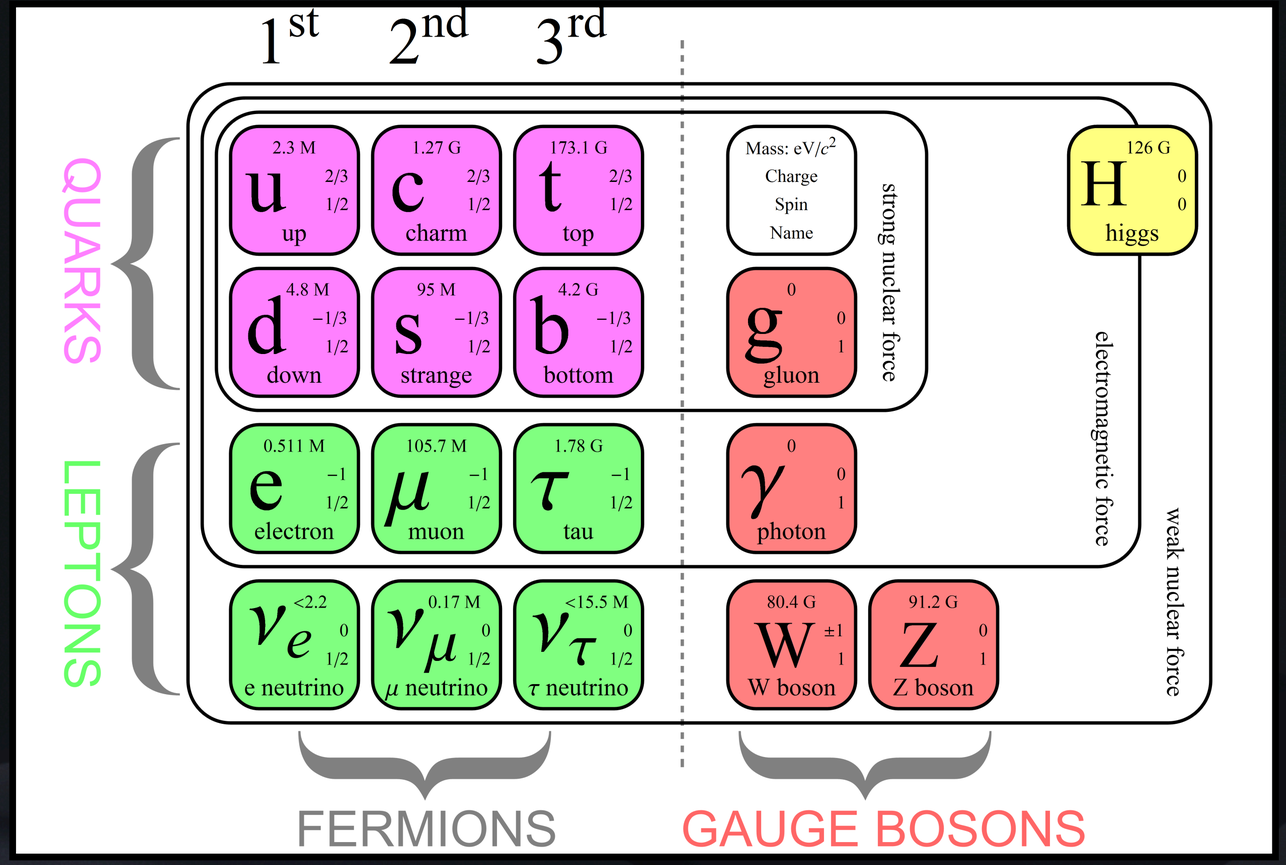
THE STANDARD MODEL



ex: π, K ...

⇒ MESONS

ex: p, n ...

⇒ BARYONS

HADRONS

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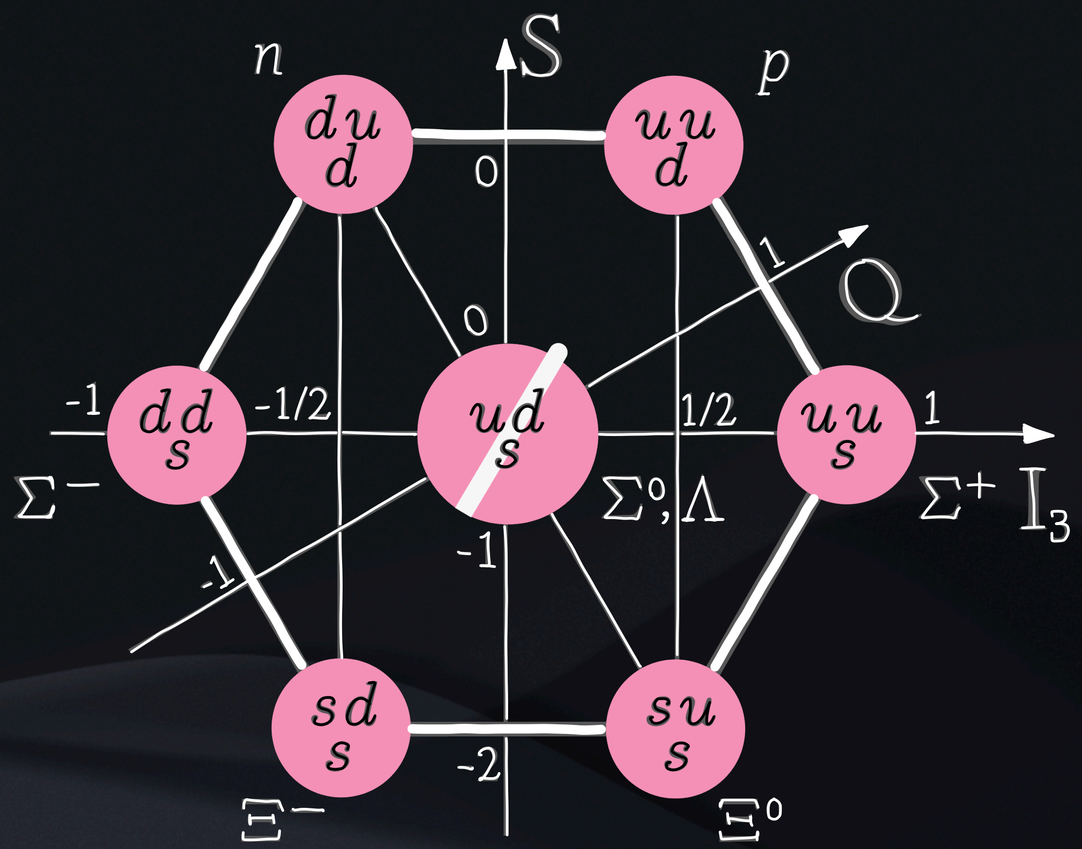
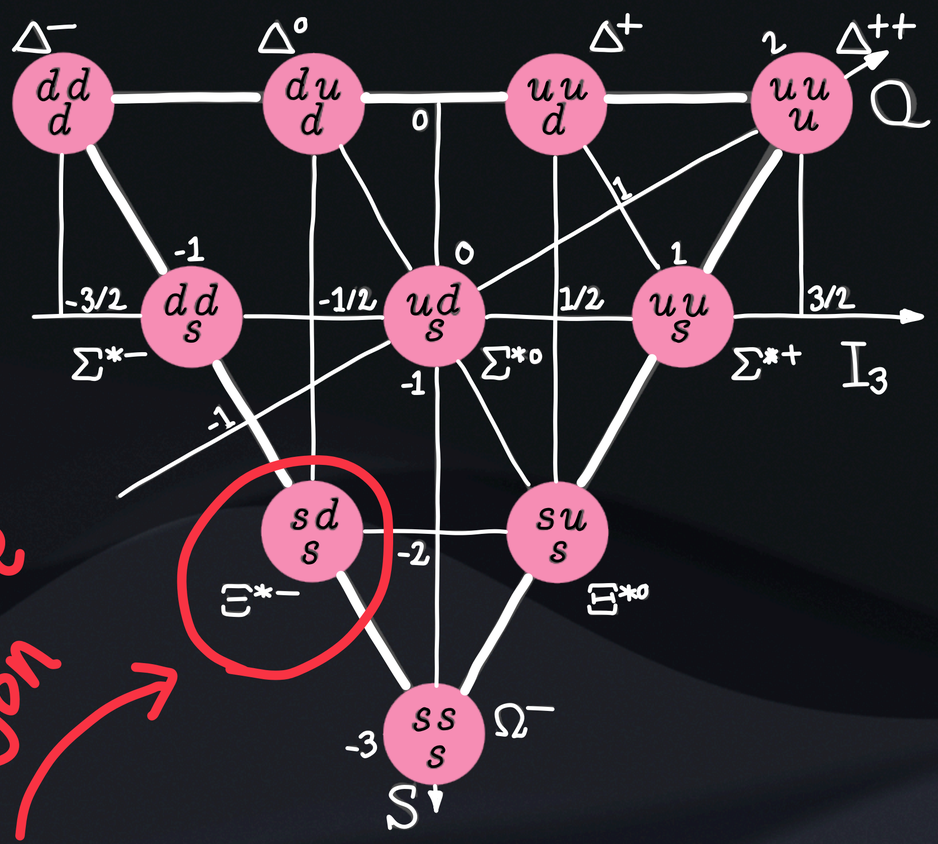
BARYONS

OCTET



DECOUPLET



The cascade baryon

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QCD PUZZLES

ISGUR & CAPSTICK (1986)

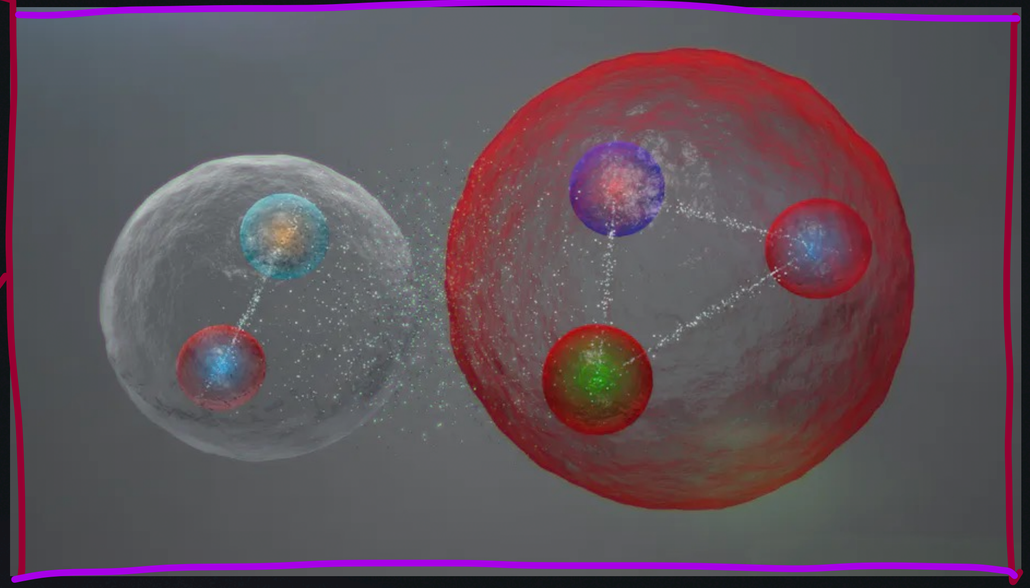
TABLE VIII. The Ξ and Ω baryons below 2400 and 2500 MeV, respectively.

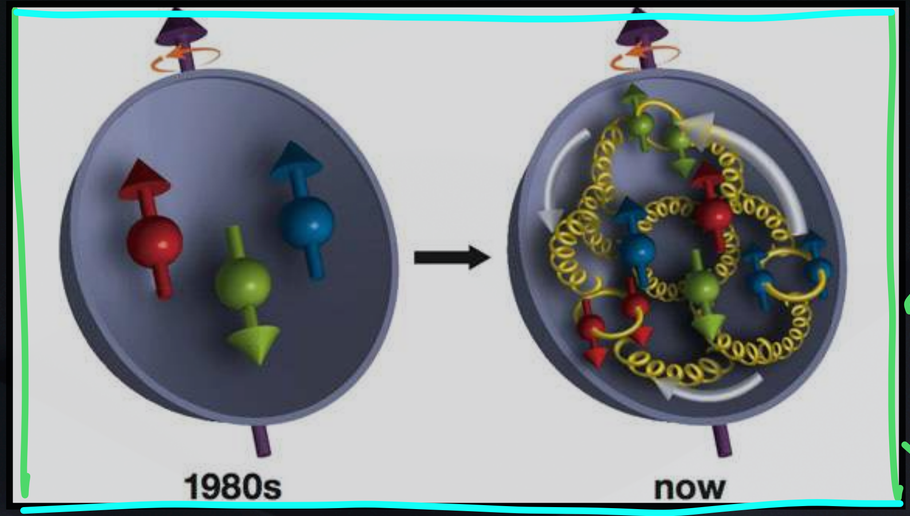
State, J^P	Predicted masses (MeV)							
$\Xi\frac{1}{2}^+$	1305							
$\Xi\frac{3}{2}^+$	1505							
$\Xi^*\frac{1}{2}^-$	1755	1810	1835	2225	2285	2300	2320	2380
$\Xi^*\frac{3}{2}^-$	1785	1880	1895	2240	2305	2330	2340	2385
$\Xi^*\frac{5}{2}^-$	1900	2345	2350	2385				
$\Xi^*\frac{7}{2}^-$	2355							
$\Xi^*\frac{1}{2}^+$	1840	2040	2100	2130	2150	2230	2345	
$\Xi^*\frac{3}{2}^+$	2045	2065	2115	2165	2170	2210	2230	2275
$\Xi^*\frac{5}{2}^+$	2045	2165	2230	2230	2240			
$\Xi^*\frac{7}{2}^+$	2180	2240						

44 STATES PREDICTED ...

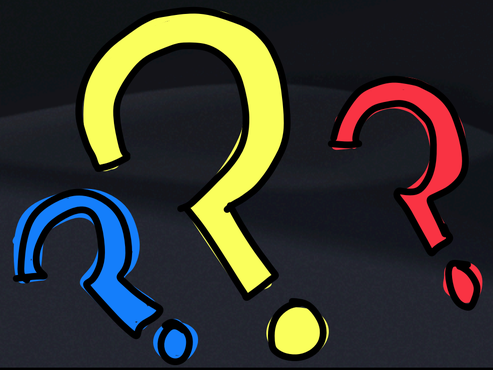
RELATIVIZED QUARK MODEL

MESON–BARYON MOLECULES





DO WE ACTUALLY UNDERSTAND BARYONS?



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THE MISSING STATES

Current Particle	Current Status	Previous Mass	Previous Status	Mass from MPS (MeV)
$\Xi(1318)$	****	1320	****	1320 ± 6
$\Xi(1530)$	****	1530	****	1541 ± 12
$\Xi(1620)$	*	1630	**	
$\Xi(1690)$	***	1680	**	
$\Xi(1820)$	***	1820	***	1822 ± 6
$\Xi(1950)$	***	1940	**	
$\Xi(2030)$	***	2030	***	2022 ± 7
$\Xi(2120)$	*	2120	*	
$\Xi(2250)$	**	2250	*	2214 ± 5
$\Xi(2370)$	**	2370	**	2356 ± 10
$\Xi(2500)$	*	2500	**	2505 ± 10

well established

NOW

1981

Only 6 states established.

Not much progress in the last 4 decades

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MISSING QUANTUM NUMBERS & BRANCHING RATIOS

Ξ(1690)

$I(J^P) = \frac{1}{2}(?^?)$

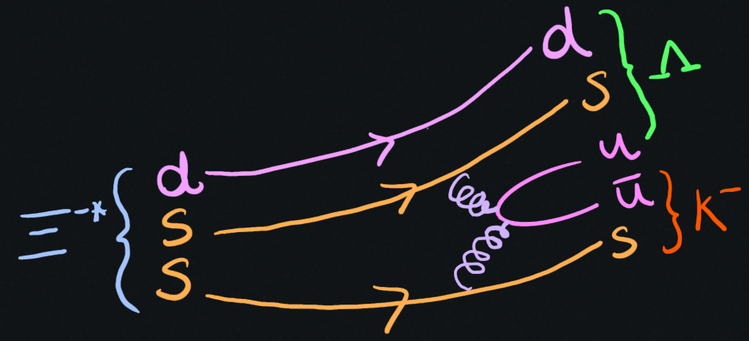
Mass $m = 1690 \pm 10$ MeV [c]
Full width $\Gamma < 30$ MeV

Ξ(1690) DECAY MODES	Fraction (Γ_i/Γ)	p (MeV/c)
$\Lambda\overline{K}$	seen	240
$\Sigma\overline{K}$	seen	70
$\Xi\pi$	seen	311
$\Xi^-\pi^+\pi^-$	possibly seen	213

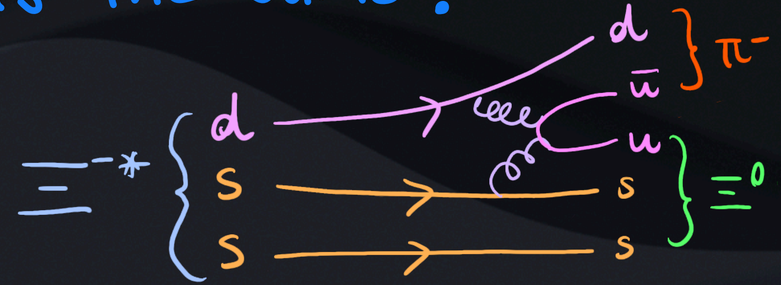
Missing

FROM PDG

POSSIBLE DECAY MODES



final quark composition is the same!



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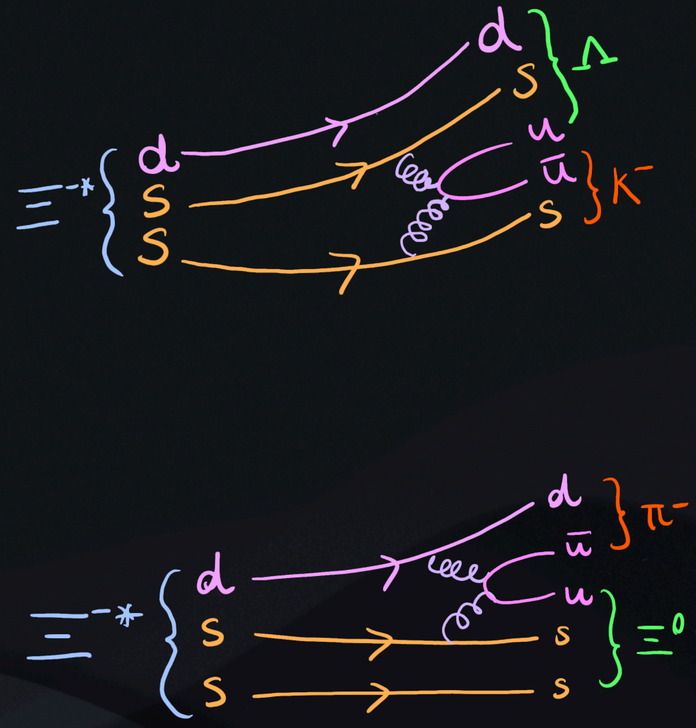
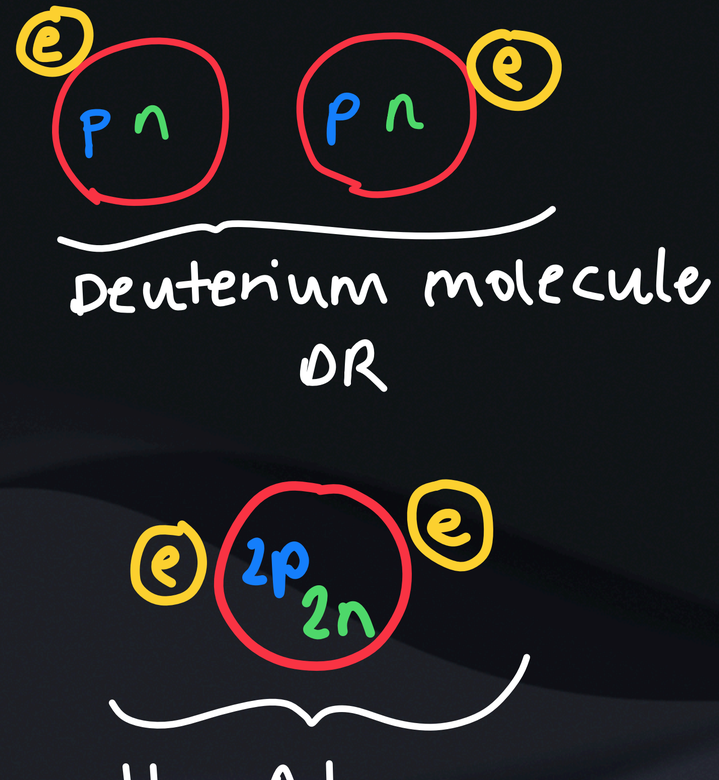
THEORETICAL CONTROVERSIES

3q state



Molecular state

EXAMPLE:



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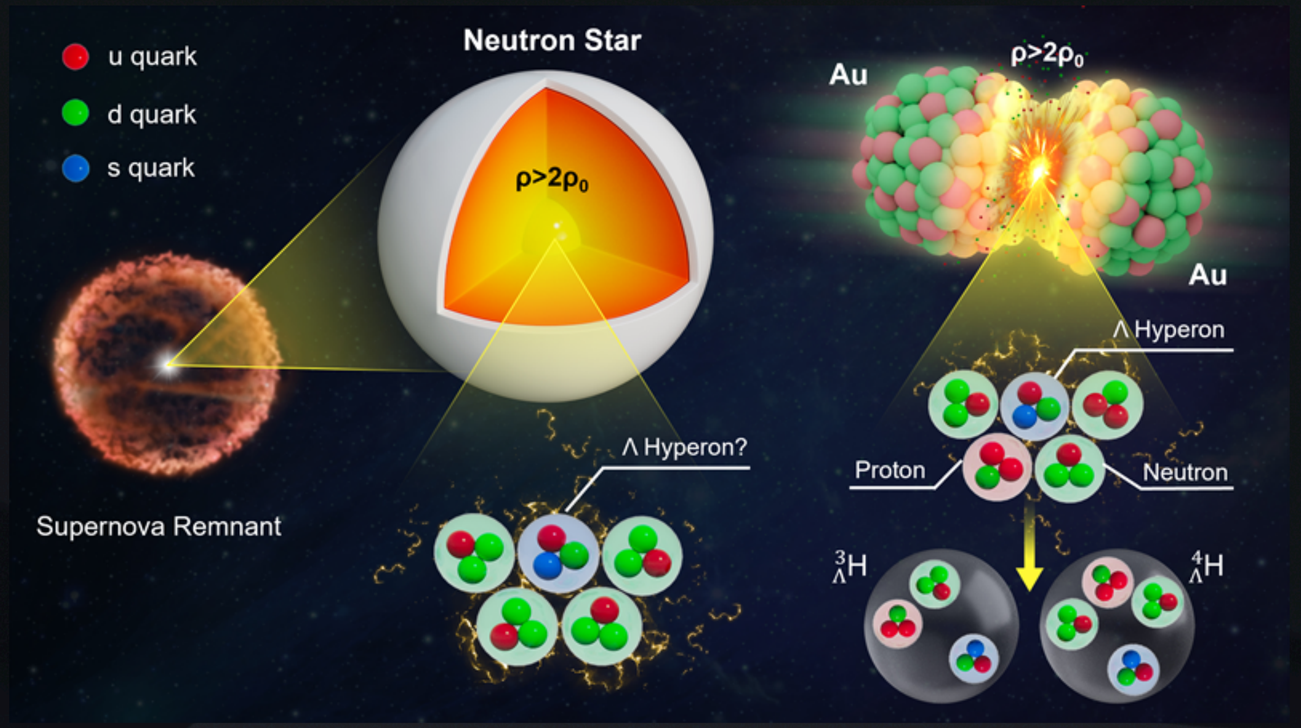
THE HYPERON PUZZLE



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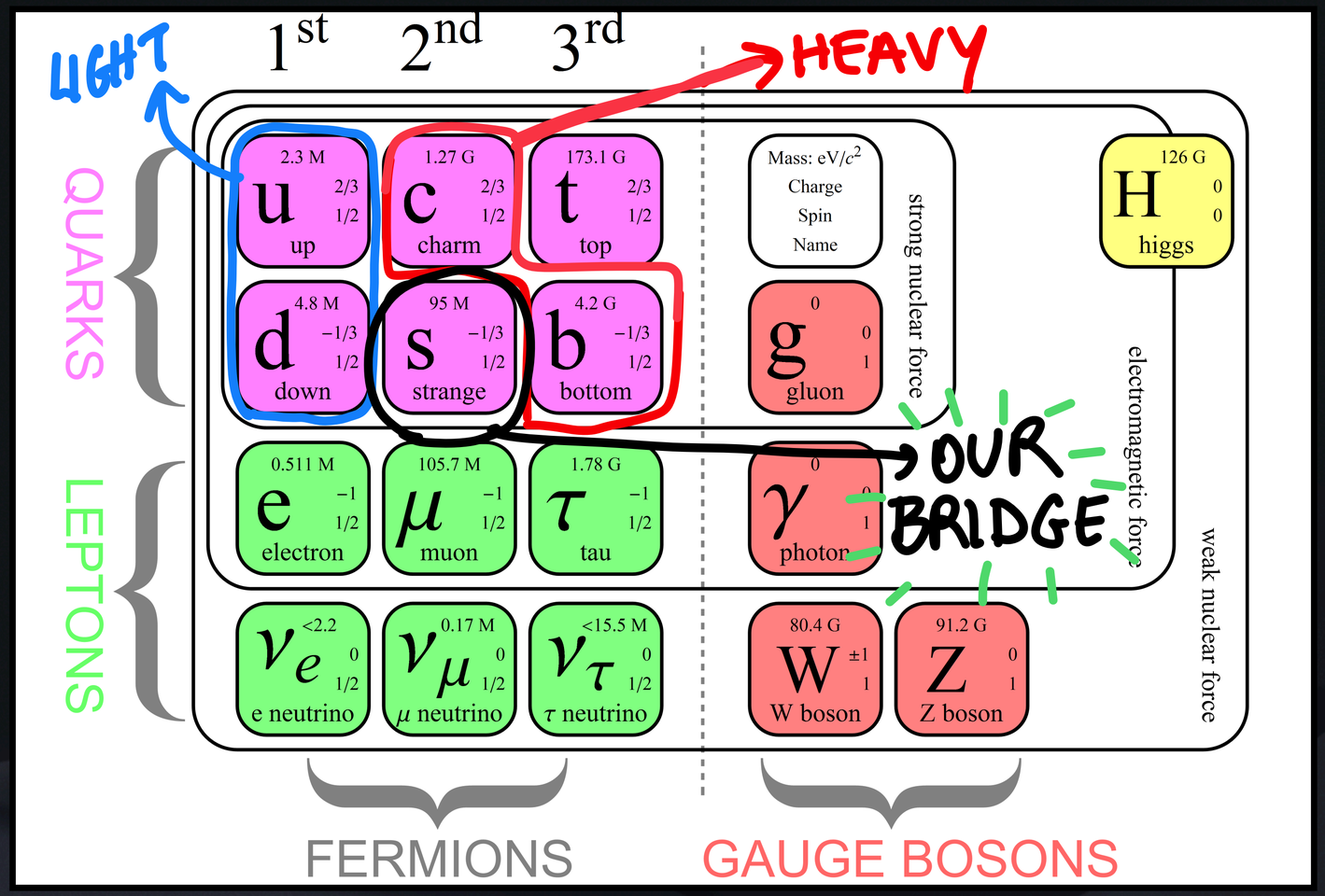
THE LIGHT, THE HEAVY & THE STRANGE



1.27 GeV
⅔
½
c
charm

104 MeV
-⅓
½
s
strange

2.4 MeV
⅔
½
u
up

4.2 GeV
-⅓
½
b
bottom

4.8 MeV
-⅓
½
d
down

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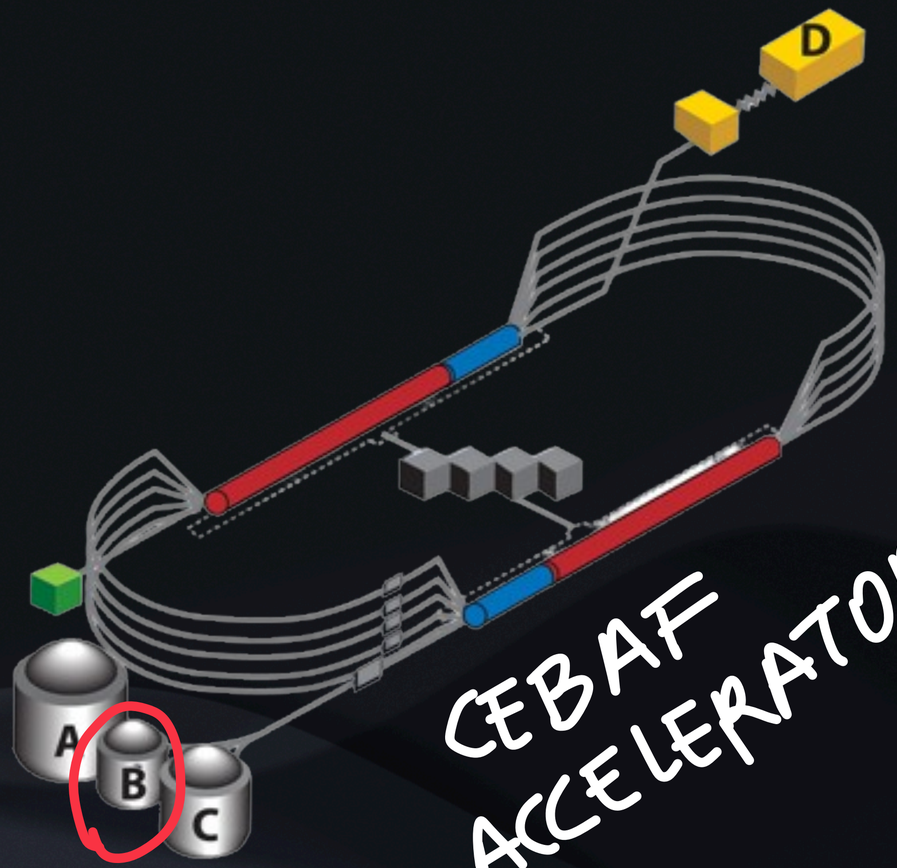
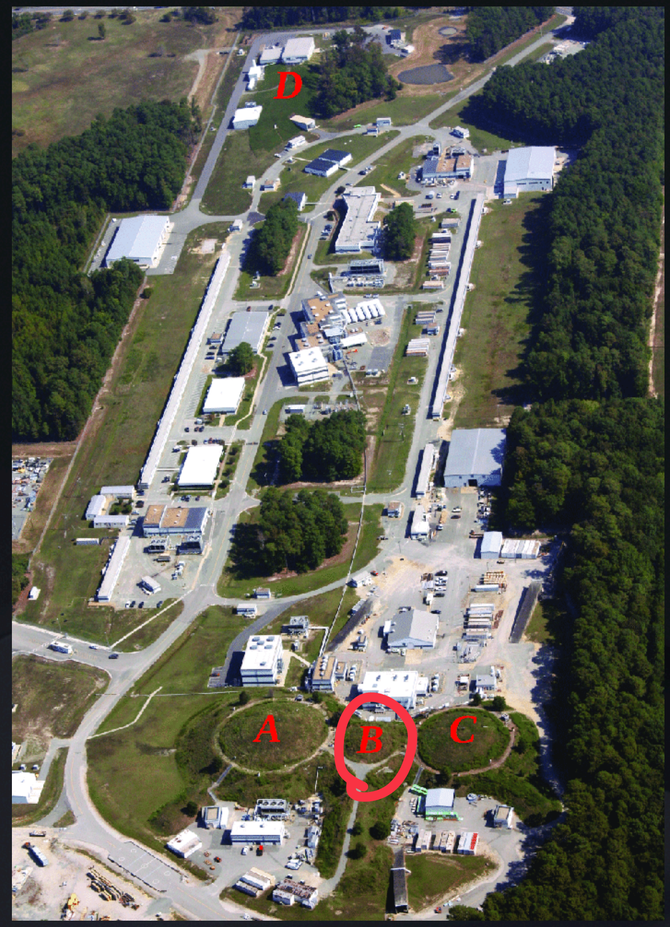


CEBAF ACCELERATOR



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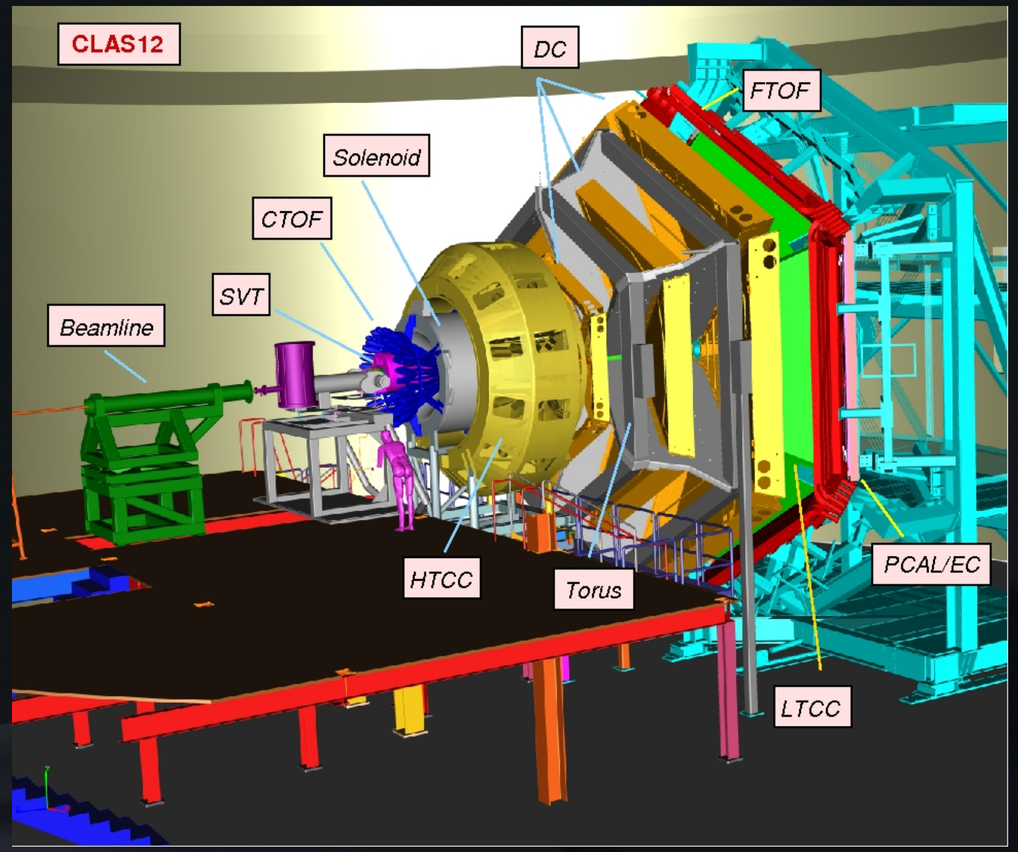
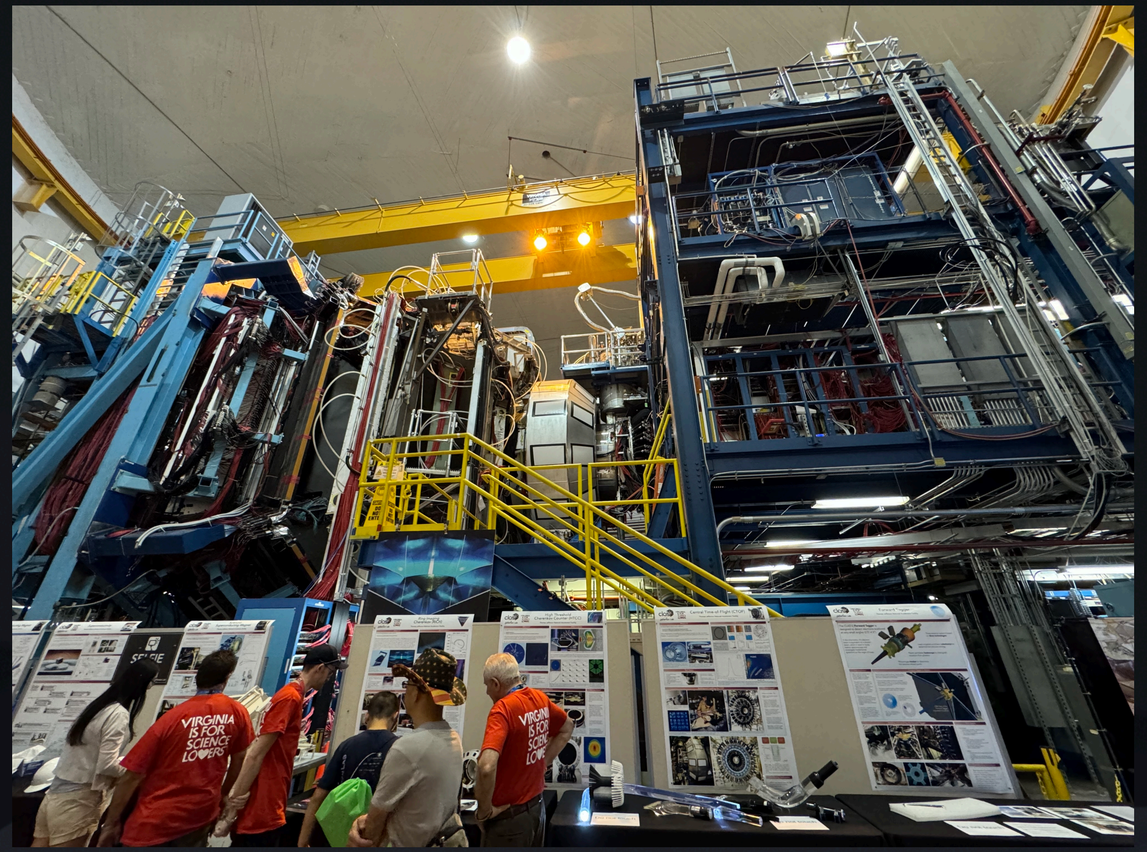
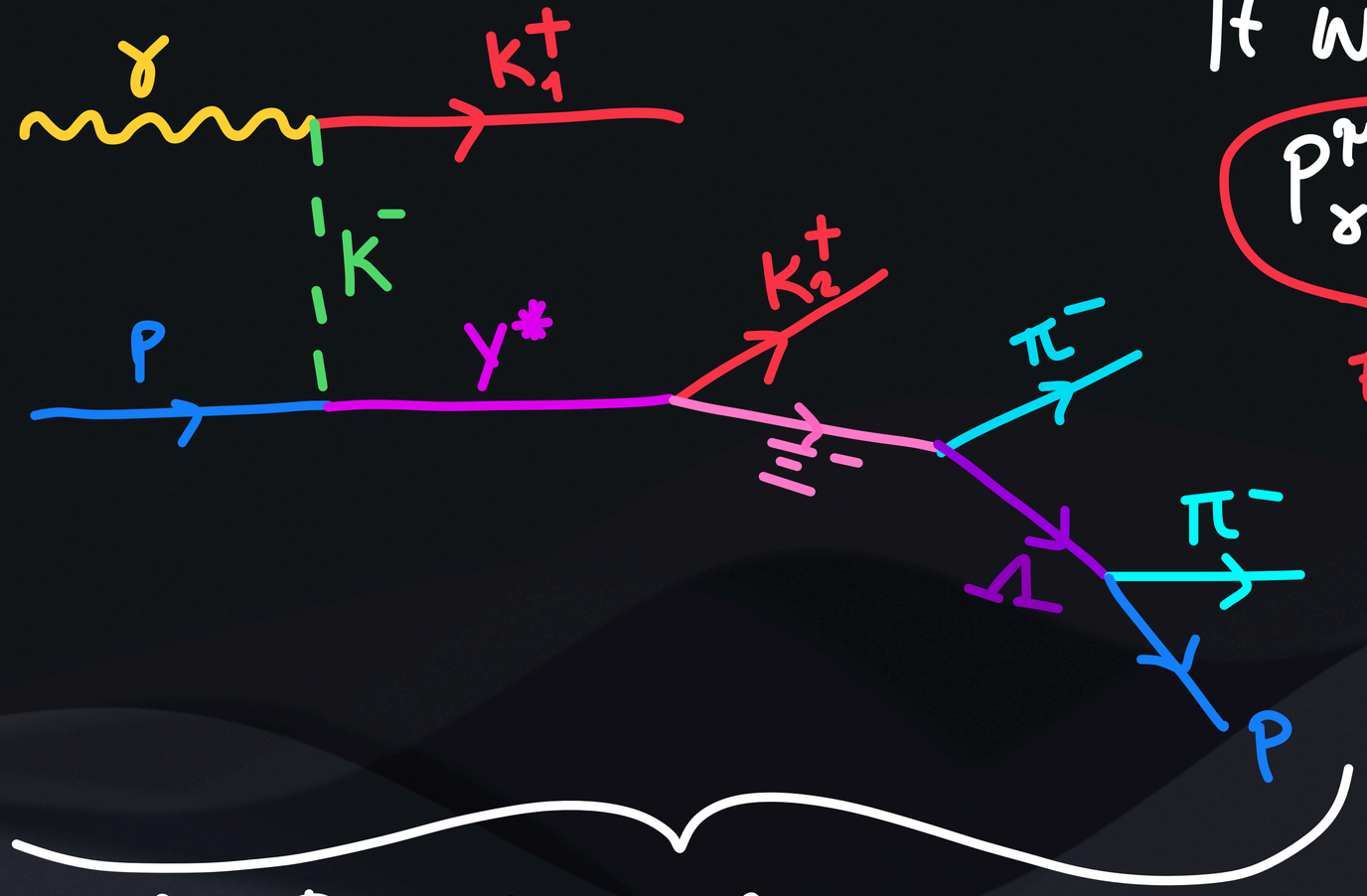
HALL B & CLAS12





CASCADES & MISSING MASS



GROUND STATE CASCADE

If we want to see the Ξ^- :

$$P^{\mu}_{\gamma} + P^{\mu}_{p} = P^{\mu}_{K_1^+} + P^{\mu}_{K_2^+} + P^{\mu}_{\Xi^-}$$

FOUR MOMENTUM CONSERVATION

$$P^{\mu}_{\Xi^-} = P^{\mu}_{\gamma} + P^{\mu}_{p} - P^{\mu}_{K_1^+} - P^{\mu}_{K_2^+}$$

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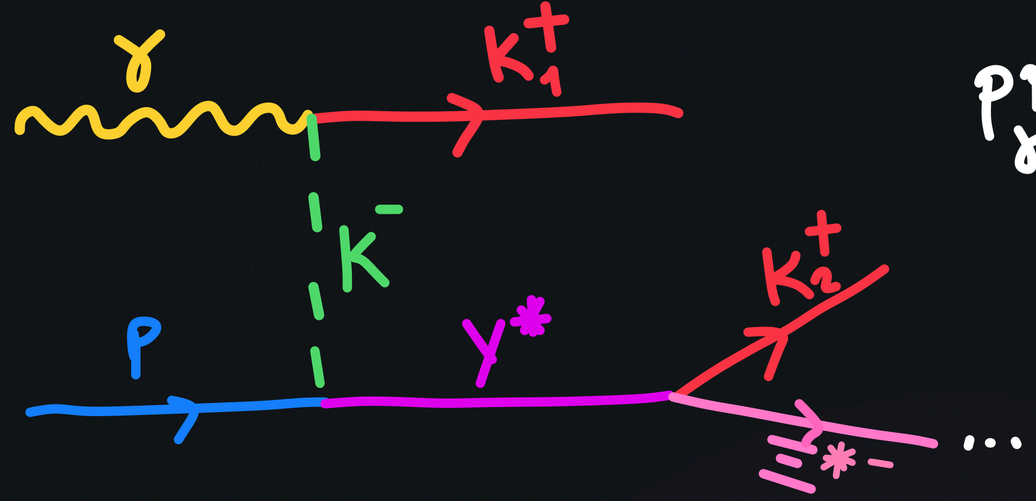
CASCADES & MISSING MASS



$$p^{\mu}_{\gamma} + p^{\mu}_{p} = p^{\mu}_{K_1^+} + p^{\mu}_{K_2^+} + p^{\mu}_{\Xi^{*-}}$$

$$p^{\mu}_{\Xi^{*-}} = p^{\mu}_{\gamma} + p^{\mu}_{p} - p^{\mu}_{K_1^+} - p^{\mu}_{K_2^+}$$

EXCITED CASCADE

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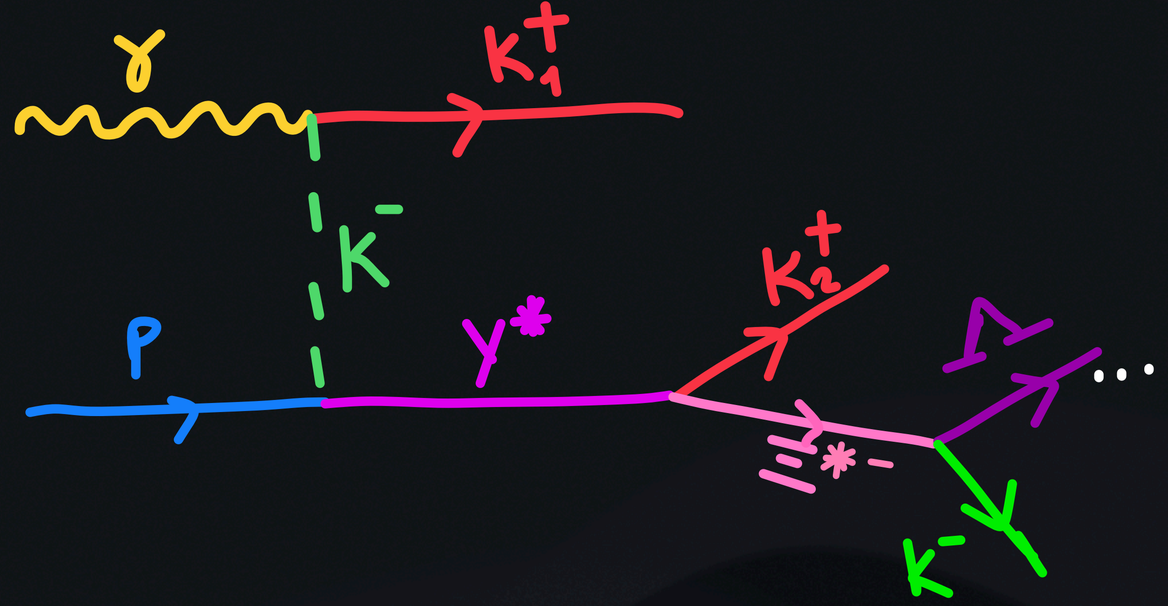
CASCADES & MISSING MASS



EXCITED CASCADE

$$p_\gamma^\mu + p_p^\mu = p_{K_1^+}^\mu + p_{K_2^+}^\mu + p_{K^-}^\mu + p_\Lambda^\mu$$

$$p_\Lambda^\mu = p_\gamma^\mu + p_p^\mu - p_{K_1^+} - p_{K_2^+} - p_{K^-}^\mu$$

↳ observe a Λ peak in the spectrum

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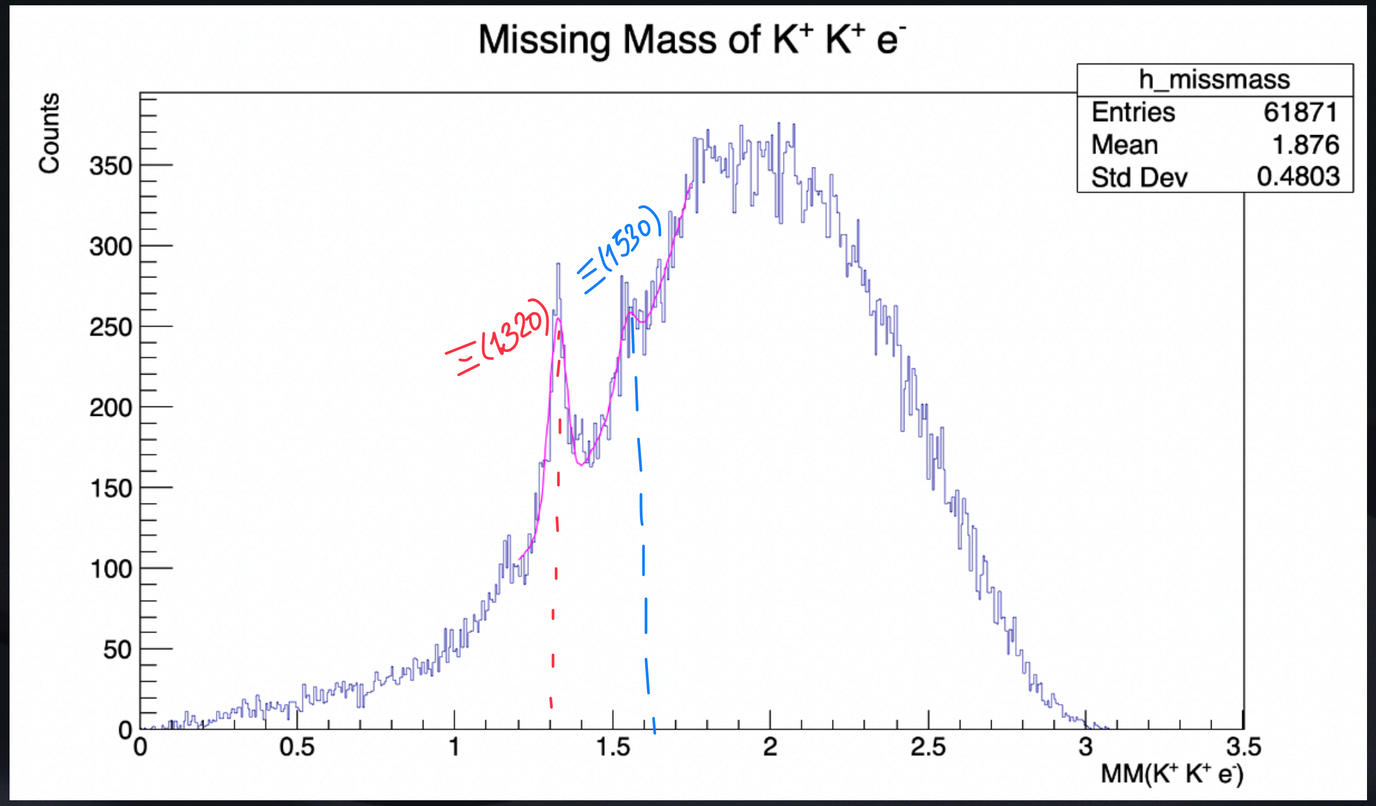
DATA ANALYSIS

Quarter of the dataset from Jefferson Lab:



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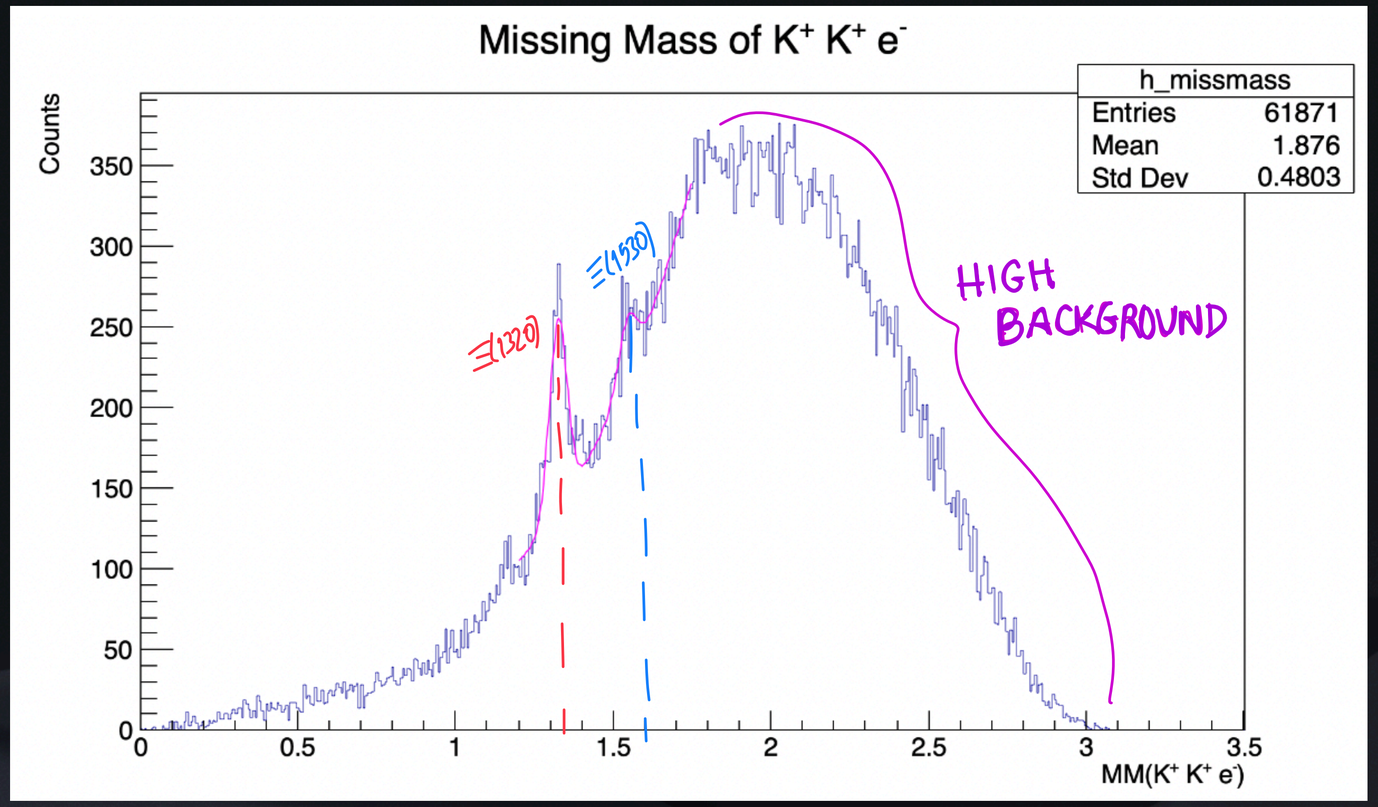
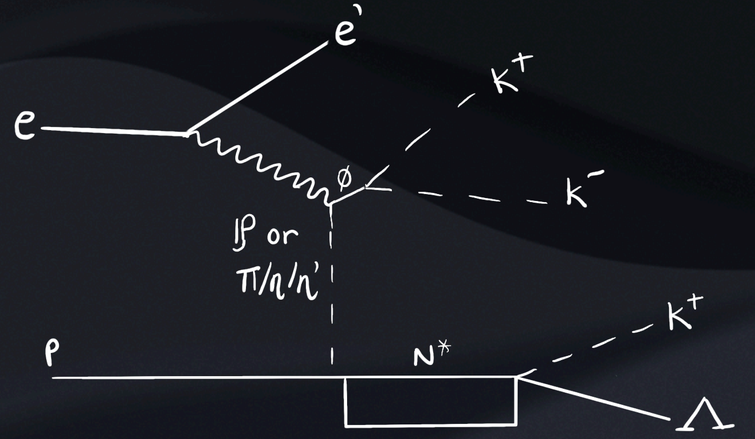
DATA ANALYSIS



WHY HIGH BACKGROUND?

1. Kaon/pion misidentification
2. Out of time particles
3. Other processes involving 2 K^+



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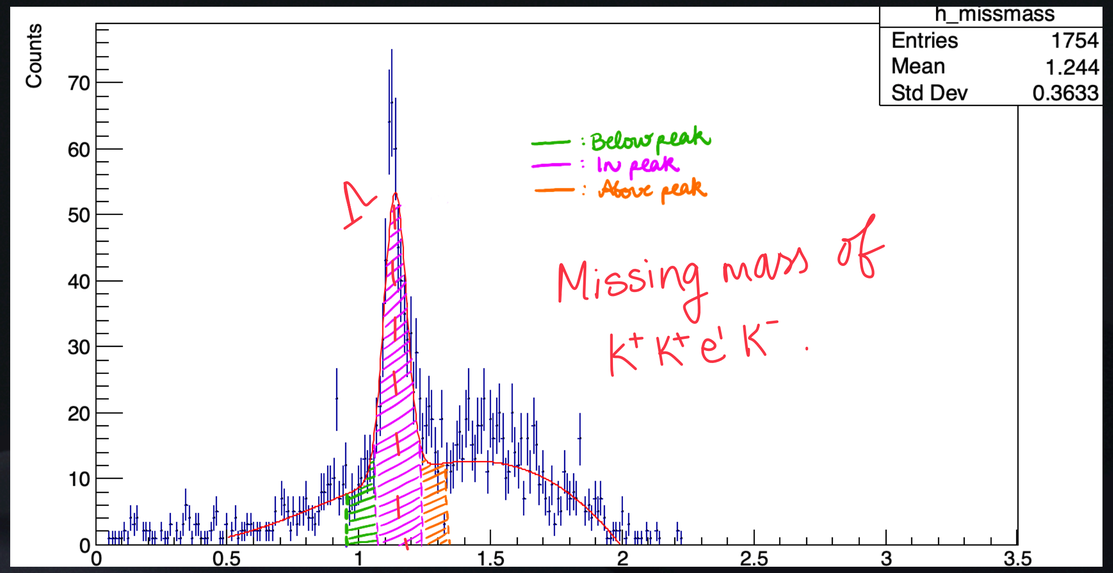
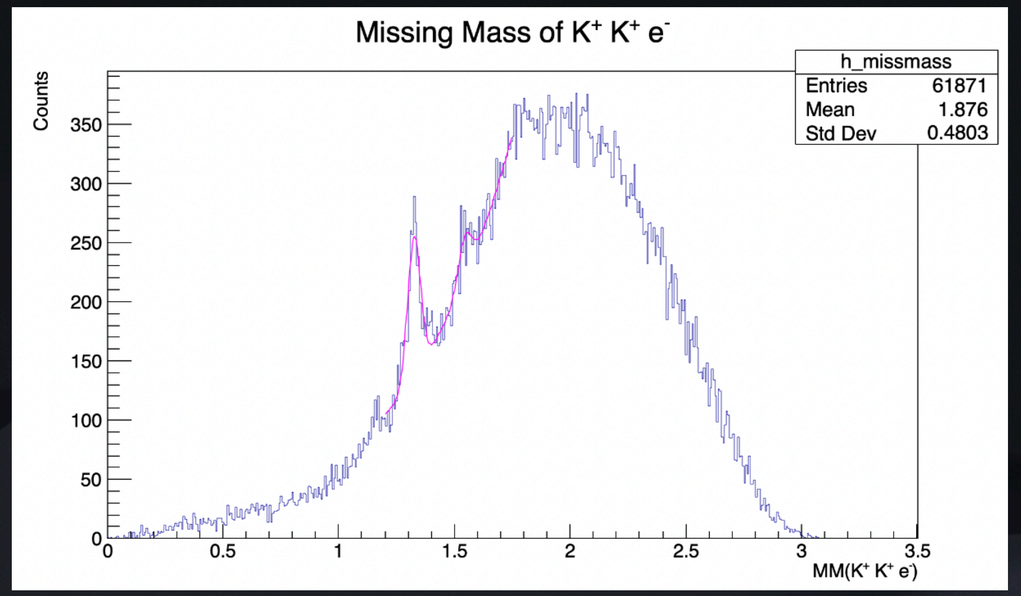
BACKGROUND SUBTRACTION

Using the missing mass concept from before, we can perform sideband subtraction.





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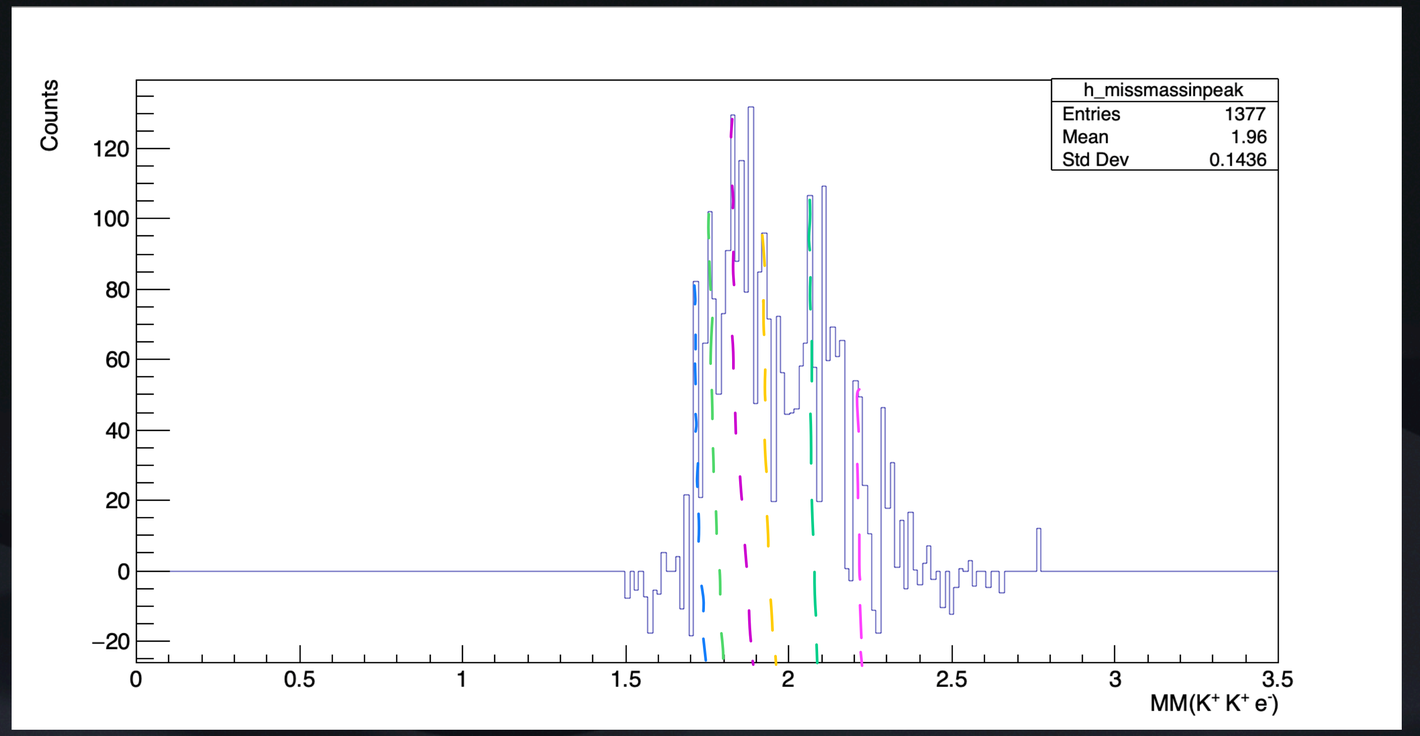
DATA ANALYSIS

Using the missing mass concept from before, we can perform sideband subtraction.



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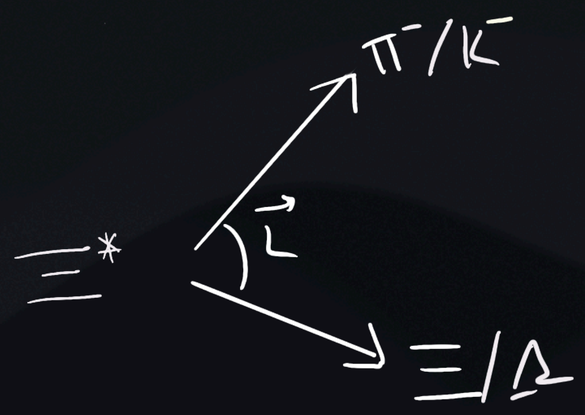
TOWARDS QUANTUM NUMBERS

Extracting quantum numbers using $\vec{L}$:



$$J = (\vec{L} + \vec{S})$$

$$P = (-1)^L P_\pi P_\Xi = (-1)^L (-1)(+1) = (-1)^{L+1}$$

$$J^P = (L + S_\Xi)^{(-1)^{L+1}}$$

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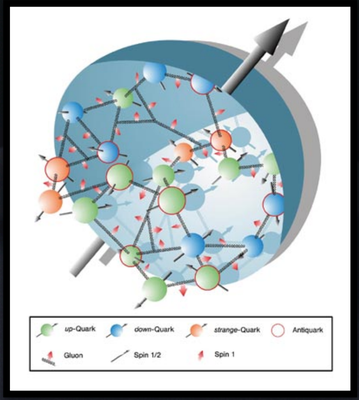
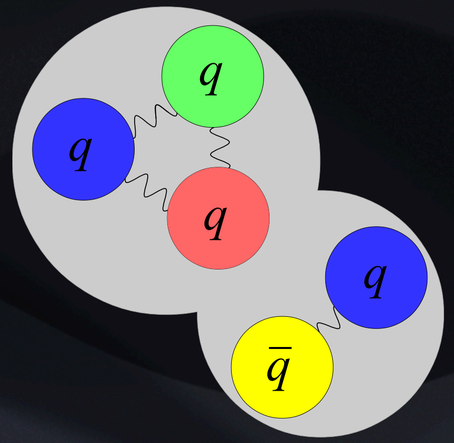
104 MeV/c^2
$-\frac{1}{3}$
$\frac{1}{2}$ S
strange

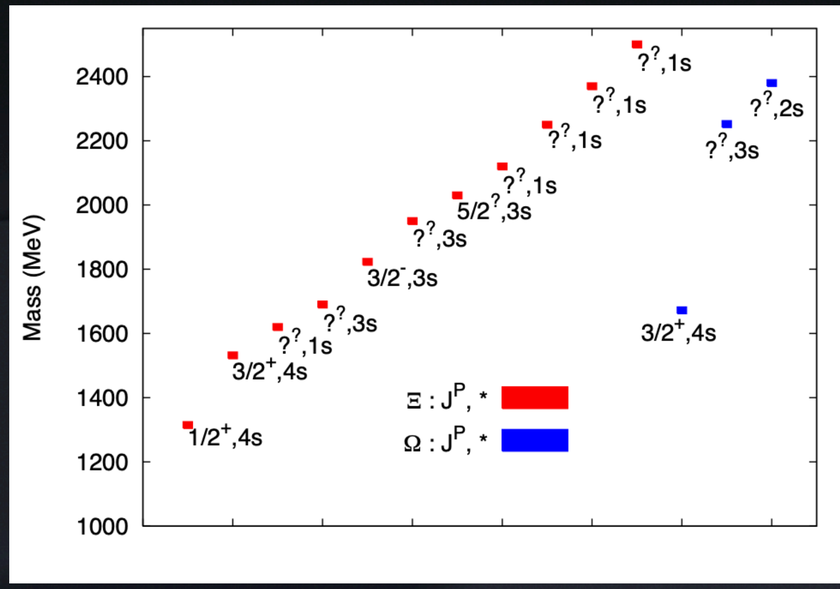
CONCLUSIONS

104 MeV/c^2
$-\frac{1}{3}$
$\frac{1}{2}$ S
strange

1. Promising new results - First measurement in electro-production
2. ~4 times more statistics to come
3. Quantum number & branching ratio determination
4. Probing internal structure of cascades?







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THANKS FOR LISTENING!

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