Short comment :

Possibility for studying Doubly Strange Systems

CERN WA75 (Hybrid Emulsion exp.)

Kazuma NAKAZAWA
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●ビューティ粒子の正体をあばく
●時間の逆転する宇宙
●クォーク-グルーオンプラズマは見つかったか?

news

ビューティ粒子の正体をあばく
B⁻ B̄⁰対発生の直接観測

質量5 GeV近くの5番目のbクォーク; dクォークと異なり普通には存在しない。そこで高エネルギー粒子衝突が使われる。その際必ずbとb̄の対で作られる。したがって，bを含むハドロンの発生点の様子を確認し，崩壊までの飛跡を直接観測すれば，bクォーク物理に多くの情報が与えられよう。

的に美しく観測したのは初めてである。間接的観測はすでに電子-陽電子衝突器を使い，スタンフォード大学，コーネル大学，DESY(ハンブルク)で行

原子核乾板実験では3個もの相互作用事例が記録されているが，ビューティ粒子の生成断面積は小さい(~10 nb)ので膨大な量のバックグラウンド

パリティ 00 (1985) p. 6

First observation of B meson [τ ~ 10^{-13}sec]

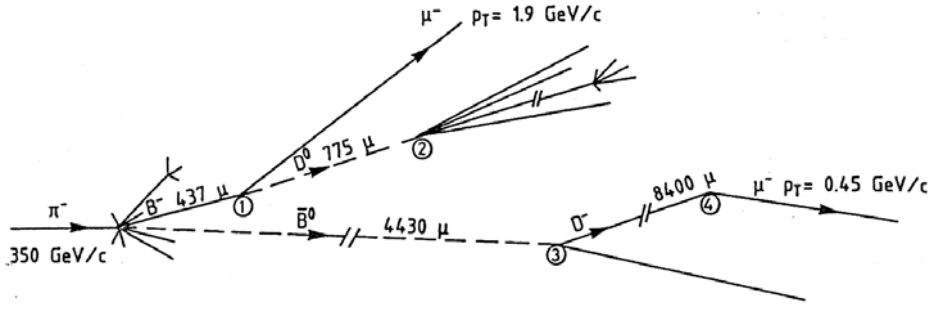
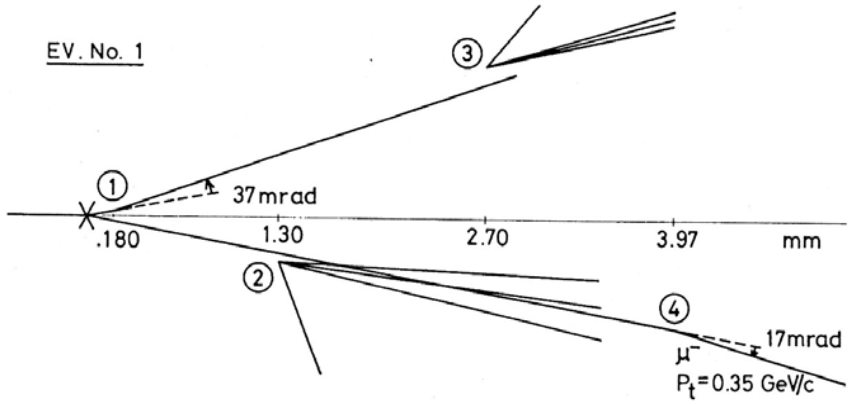


Fig. 3. Sketch of the $B^- - \bar{B}^0$ event.

J.P.Albanese et al., Phys. Lett. 158B (1985)186

Observation two charm pairs production
２対チャーム(4個)生成事象



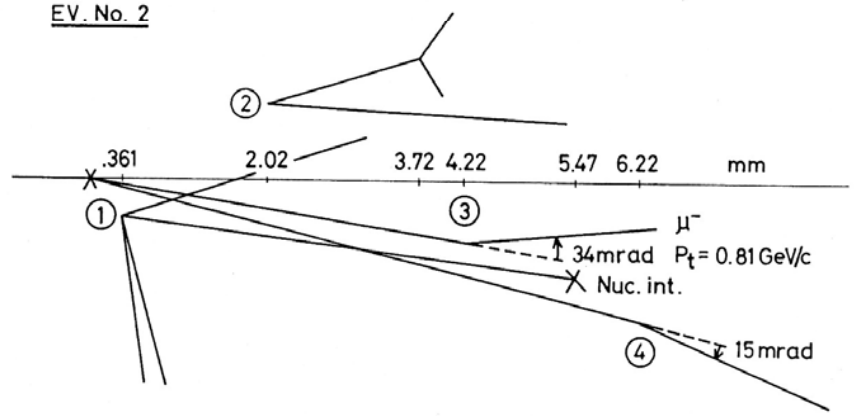


Fig. 1. Sketches of the events.

S.Aoki et al., Phys. Lett. 187B (1987)185

Short comment :

Possibility for studying Doubly Strange Systems

using Ξ^- hyperons and Be (at IP)
given by KEKB

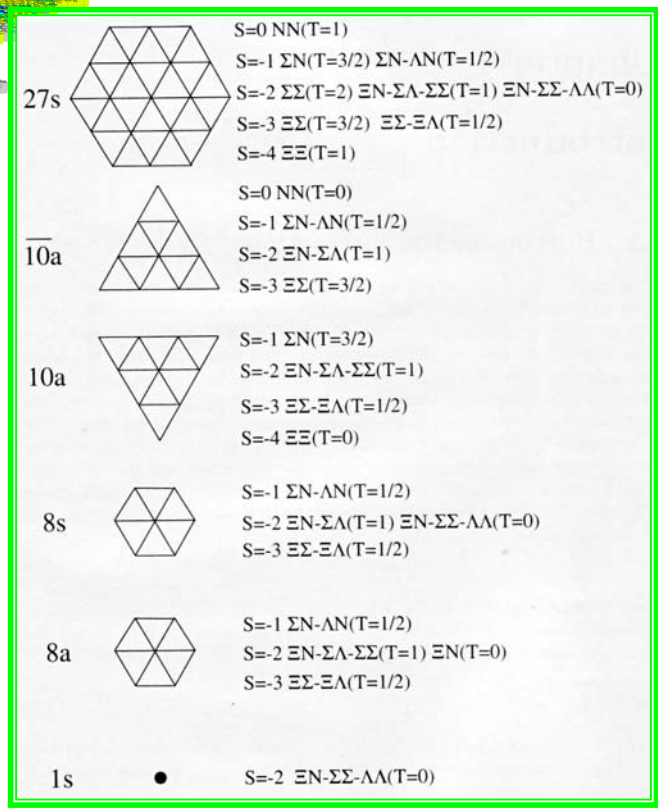
Kazuma NAKAZAWA
(Gifu Univ.)

extend our knowledge on NN-int.
toward the unified understanding
of B-B int. based on $SU(3)_{flavor}$ sym.

Nu ~ Nd ~ Ns

3-dimensional Nucl. Chart

p,n,
Λ,Ξ⁰,Ξ⁻



Irreducible representation for two-baryon system based on $SU(3)_{flavor}$ symmetry.

Neutron Stars

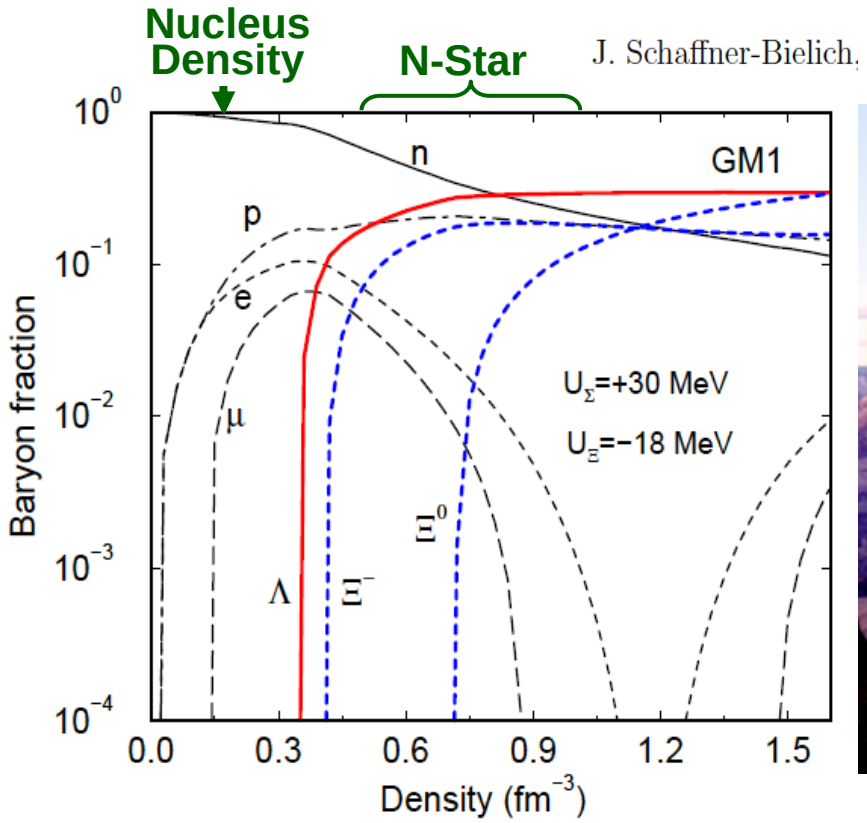
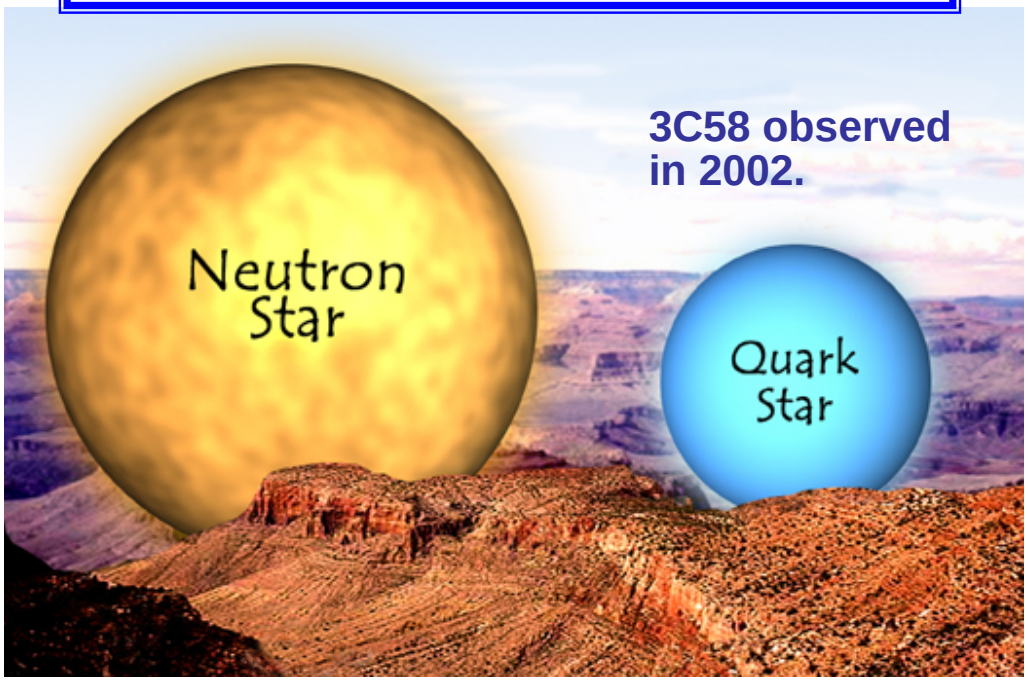


Illustration of relative sizes of Grand Canyon, neutron star and quark star
The Grand Canyon is 18 miles rim to rim. A neutron star is about 12 miles in diameter, and a quark star is about 7 miles in diameter. (Illustration: CXC/D. Berry)



- It is quite important to study
  Λ–N, Λ–Λ, Ξ–N
  interaction.

Strange quarks exist in ordinal neutron stars.

➔ What is those feature?

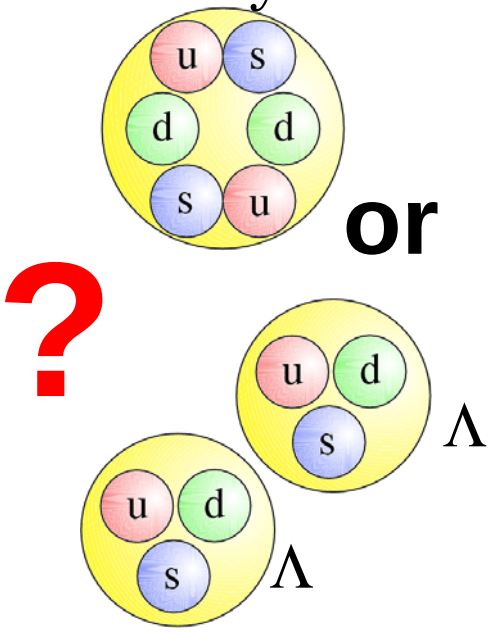
Few body system of nucleon or quarks?

- QCD

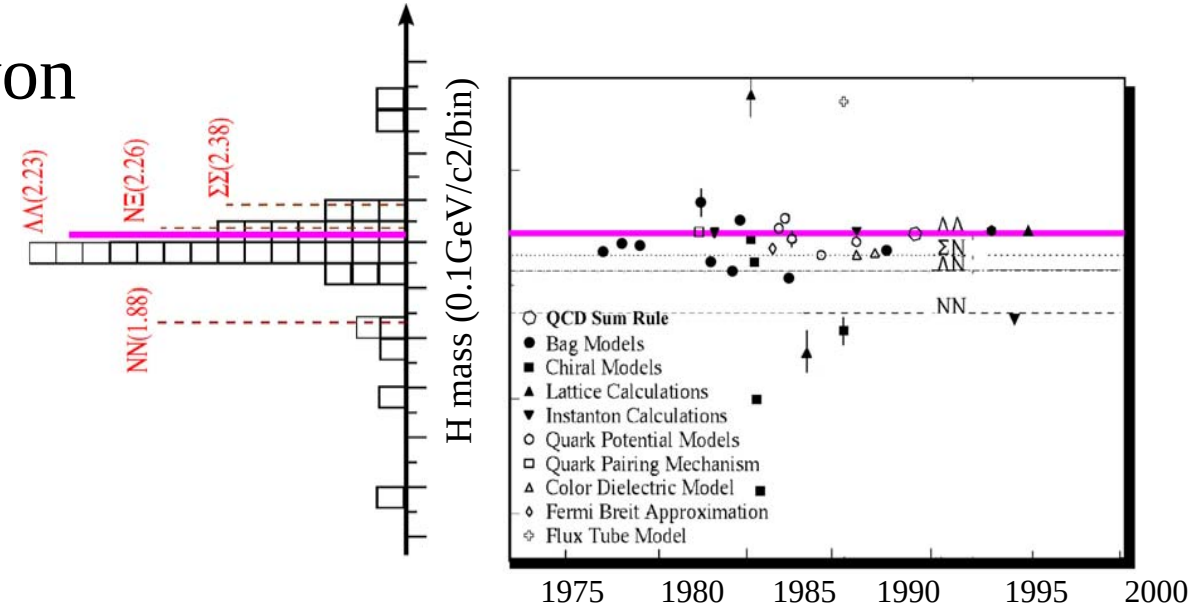
typical example

−> H-dibaryon

H–dibaryon



Predicted masses



Updated from the year 1995, referred on
S.V.Bashinsky, R.L.Jaffe, Nucl. Phys. A625(1997)167,
and W.J.Lope, talk given at '12th Winter Workshop on Nuclear Dynamics'

Evidence is not seen, yet.

Ξ^- hyperons are useful

Average Hadron Multiplicities in Hadronic e^+e^- Annihilation Events

Table 40.1: Average hadron multiplicities per hadronic e^+e^- annihilation event at $\sqrt{s} \approx 10$, 29–35, 91, and 130–200 GeV. The rates given include decay products from resonances with $c\tau < 10$ cm, and include the corresponding anti-particle state. Correlations of the systematic uncertainties were considered for the calculation of the averages. (Updated August 2007 by O. Biebel, LMU, Munich)

Particle	$\sqrt{s} \approx 10$ GeV	$\sqrt{s} = 29$–35 GeV	$\sqrt{s} = 91$ GeV	$\sqrt{s} = 130$–200 GeV
Pseudoscalar mesons:				
π^+	6.6 ± 0.2	10.3 ± 0.4	17.02 ± 0.19	21.24 ± 0.39
π^0	3.2 ± 0.3	5.83 ± 0.28	9.42 ± 0.32	
K^+	0.90 ± 0.04	1.48 ± 0.09	2.228 ± 0.059	2.82 ± 0.19
K^0	0.91 ± 0.05	1.48 ± 0.07	2.049 ± 0.026	2.10 ± 0.12
η	0.20 ± 0.04	0.61 ± 0.07	1.049 ± 0.080	
$\eta'(958)$	0.03 ± 0.01	0.26 ± 0.10	0.152 ± 0.020	
D^+	$0.194 \pm 0.019^{(k)}$	0.17 ± 0.03	0.175 ± 0.016	
D^0	$0.446 \pm 0.032^{(k)}$	0.45 ± 0.07	0.454 ± 0.030	
D_s^+	$0.063 \pm 0.014^{(k)}$	$0.45 \pm 0.20^{(a)}$	0.131 ± 0.021	
B^+, B_d^0		—	$0.165 \pm 0.026^{(b)}$	
B_u^+	—		$0.178 \pm 0.006^{(b)}$	
B_s^0			$0.057 \pm 0.013^{(b)}$	
Baryons:				
p	0.253 ± 0.016	0.640 ± 0.050	1.050 ± 0.032	1.41 ± 0.18
Λ	0.080 ± 0.007	0.205 ± 0.010	0.3915 ± 0.0065	0.39 ± 0.03
Σ^0	0.023 ± 0.008		0.076 ± 0.011	
Σ^-			0.081 ± 0.010	
Σ^+		—	0.107 ± 0.011	
$\Sigma^\pm$			0.174 ± 0.009	
Ξ^-	0.0059 ± 0.0007	0.0176 ± 0.0027	0.0258 ± 0.0010	
$\Delta(1232)^{++}$	0.040 ± 0.010	—	0.085 ± 0.014	
$\Sigma(1385)^-$	0.006 ± 0.002	0.017 ± 0.004	0.0240 ± 0.0017	
$\Sigma(1385)^+$	0.005 ± 0.001	0.017 ± 0.004	0.0239 ± 0.0015	
$\Sigma(1385)^\pm$	0.0106 ± 0.0020	0.033 ± 0.008	0.0462 ± 0.0028	
$\Xi(1530)^0$	0.0015 ± 0.0006	–	0.0068 ± 0.0006	
Ω^-	0.0007 ± 0.0004	0.014 ± 0.007	0.0016 ± 0.0003	
Λ_c^+	$0.074 \pm 0.031^{(i)}$	0.110 ± 0.050	0.078 ± 0.017	
Λ^0			0.031 ± 0.016	

D^+ $0.194 \pm 0.019^{(k)}$
D^0 $0.446 \pm 0.032^{(k)}$
D_s^+ $0.063 \pm 0.014^{(k)}$

several * 10^8 DD-bar

Ξ^- 0.0059 ± 0.0007

several * 10^6 Xi- hyperons

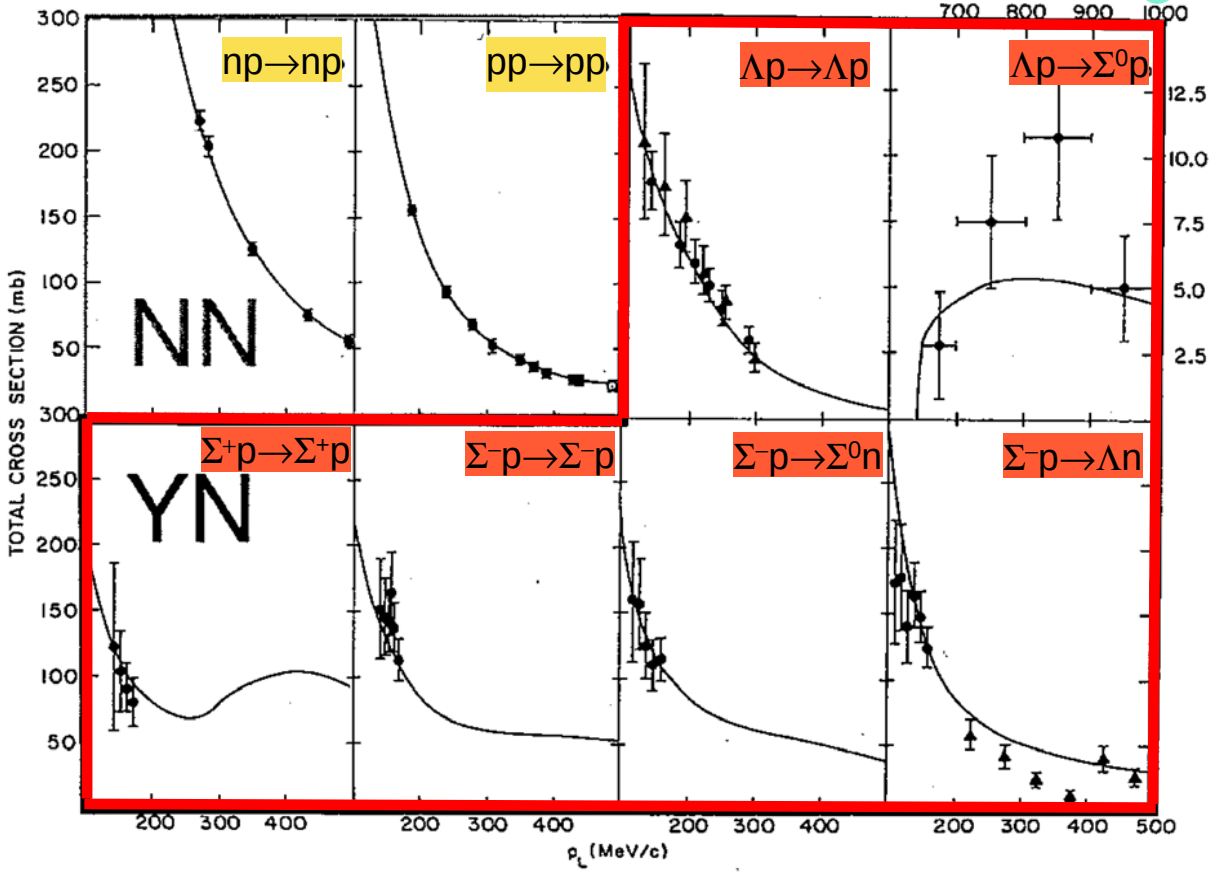
Event selection

S=+2

ex.(K+, K+) (K+, K°-bar)

1. Ξ^-N scattering?

S= -1 → **S= -2**



Ξ^- scattering
with Be at IP

Analysis
Off vtx.
decayed Ξ^- hyperon

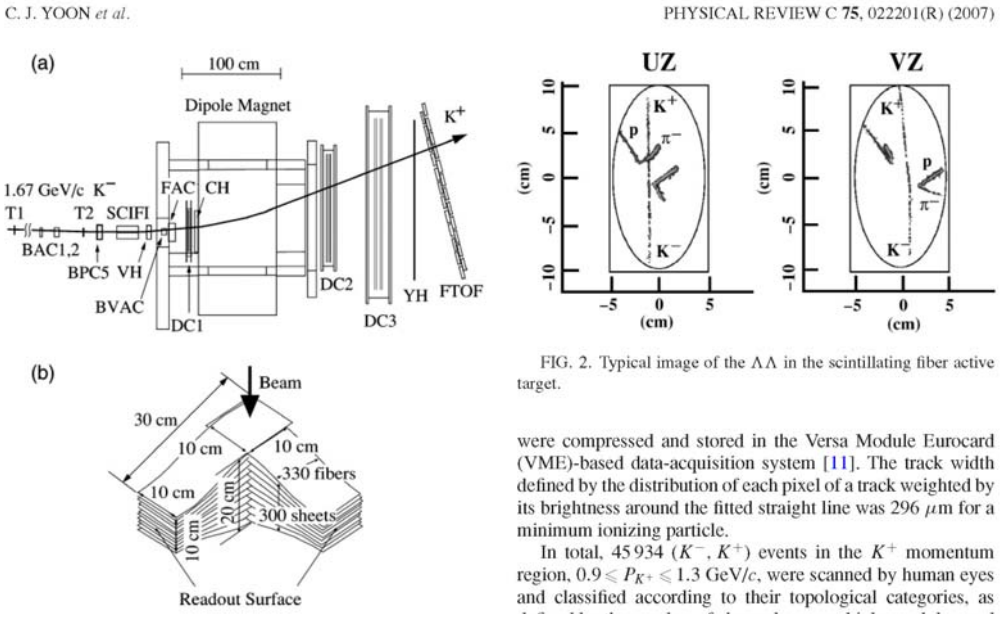
2. ΞN <=> ΛΛ mixing with the H ?
Resonance of the H ?

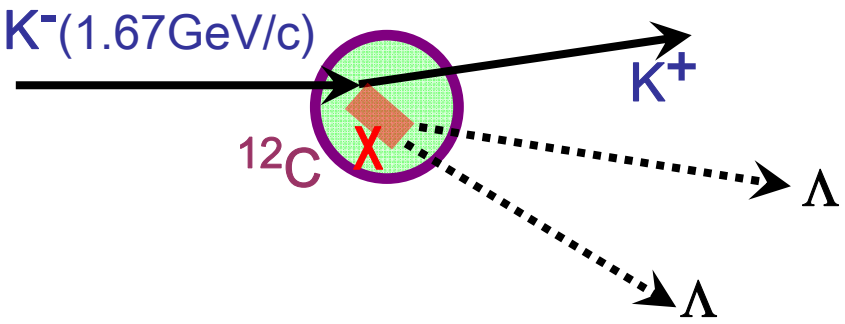
n p Λ

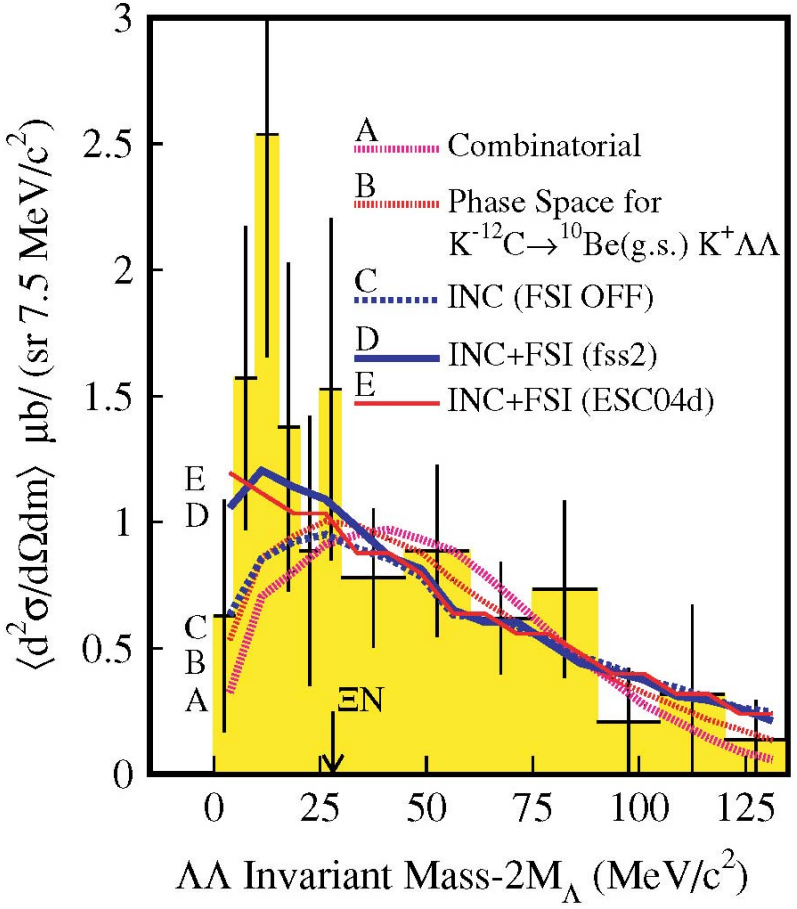
$\Xi^- p \Rightarrow \Lambda\Lambda + 28\text{MeV}$

PS-E522 (KEK)

C.J.Yoon et al., PRC 75 (2007) 022201(R)

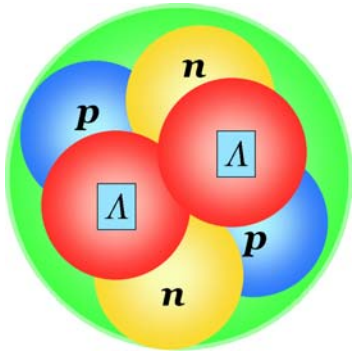






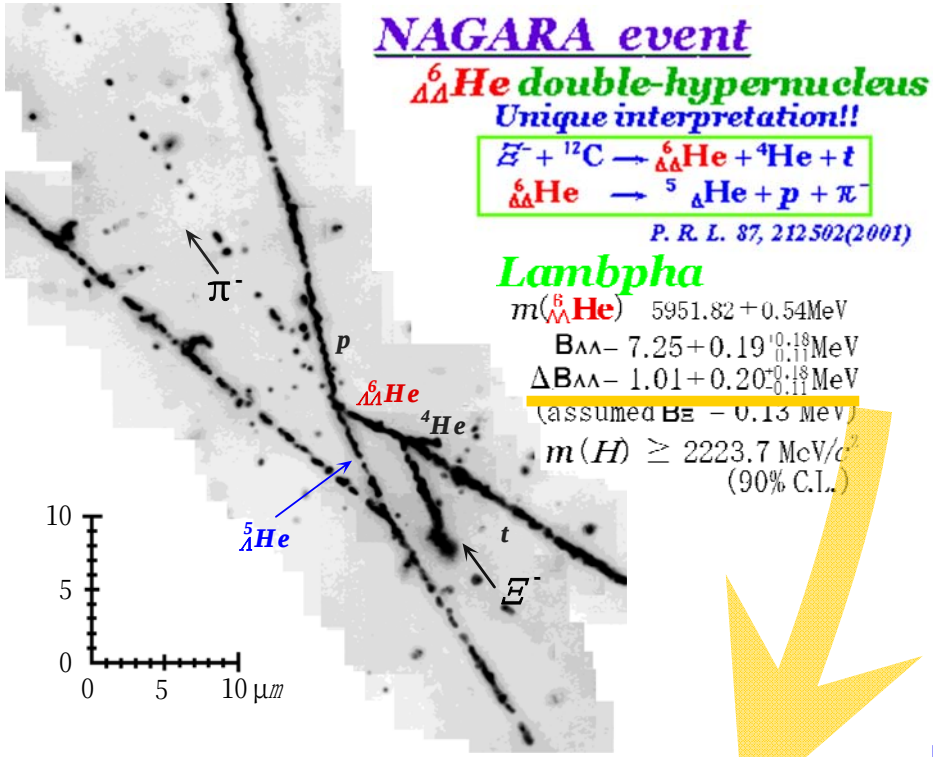
Ξ^-Be =(?)=> ΛΛ

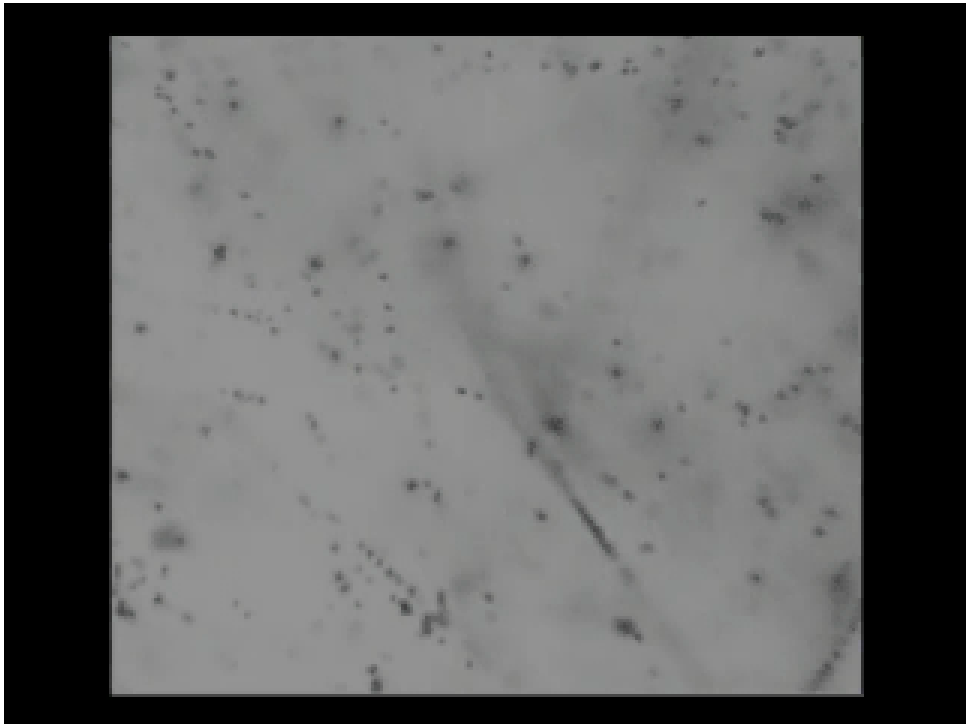
3. ΛΛ hypernucleus?



NAGARA event

Observation of a Lambpha





$\Delta B_{\Lambda\Lambda}$: ΛΛ Interaction Energy

$\Delta B_{\Lambda\Lambda} = B_{\Lambda\Lambda}({}_{\Lambda\Lambda}{}^{A}Z) - 2B_{\Lambda}({}^{A-1}_{\Lambda}Z)$

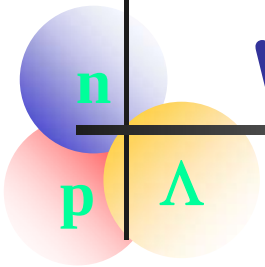
Found

Weakly attractive ΛΛ Interaction *!*

" the most significant result of the past 5 years in hypernuclear physics. "

Final Report of the 2004 KEK PS

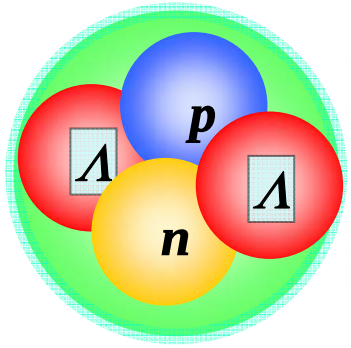
External Review Committee (August 30, 2004),p5.



What is the lightest ΛΛ hypernucleus?

Production of ${}^{\ 4}_{\Lambda\Lambda}\mathrm{H}$ Hypernuclei

J.K.Ahn et al., PRL 87 (2001) 132504



An experiment demonstrating the production of double-Λ hypernuclei in (K^-, K^+) reactions on ^{9}Be was carried out at the D6 line in the BNL alternating-gradient synchrotron. The technique was the observation of pions produced in sequential mesonic weak decay, each pion associated with one unit of strangeness change. The results indicate the production of a significant number of the double hypernucleus ${}^{\ 4}_{\Lambda\Lambda}\mathrm{H}$ and the twin hypernuclei ${}^{4}_{\Lambda}\mathrm{H}$ and ${}^{3}_{\Lambda}\mathrm{H}$. The relevant decay chains are discussed and a simple model of the production mechanism is presented. An implication of this experiment is that the existence of an $S = -2$ dibaryon more than a few MeV below the ΛΛ mass is unlikely.

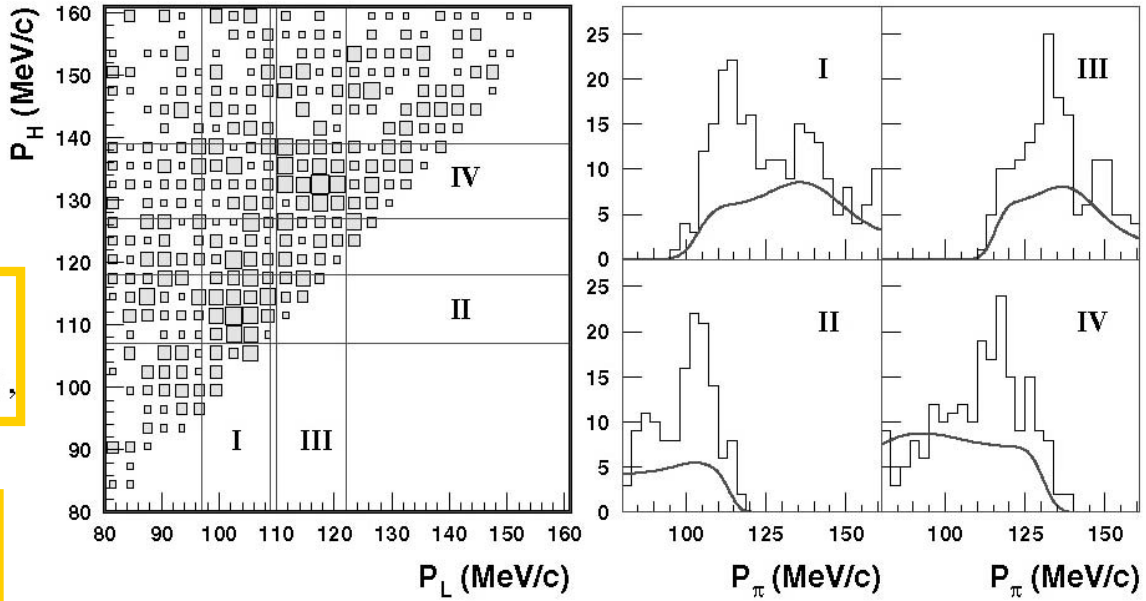
$$
\begin{aligned}
{}^{3}_{\Lambda}\mathrm{H} &\rightarrow {}^{3}\mathrm{He} + \pi^-_L \qquad (114.3\ \mathrm{MeV}/c),\\
{}^{4}_{\Lambda}\mathrm{H} &\rightarrow {}^{4}\mathrm{He} + \pi^-_H \qquad (132.9\ \mathrm{MeV}/c).
\end{aligned}
$$

or

$$
\begin{aligned}
{}^{\ 4}_{\Lambda\Lambda}\mathrm{H} &\rightarrow {}^{4}_{\Lambda}\mathrm{He} + \pi^-_H \qquad (\sim 114\ \mathrm{MeV}/c),\\
{}^{4}_{\Lambda}\mathrm{He} &\rightarrow {}^{3}\mathrm{He} + p + \pi^-_L \qquad (97\ \mathrm{MeV}/c),
\end{aligned}
$$

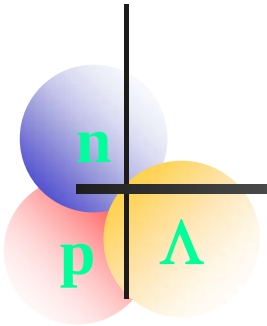
or

$$
\begin{aligned}
{}^{\ 4}_{\Lambda\Lambda}\mathrm{H} &\rightarrow {}^{4}_{\Lambda}\mathrm{He}^* + \pi^-_L \qquad (\sim 104\ \mathrm{MeV}/c)\\
{}^{4}_{\Lambda}\mathrm{He}^* &\rightarrow {}^{3}_{\Lambda}\mathrm{H} + p\,,\\
{}^{3}_{\Lambda}\mathrm{H} &\rightarrow {}^{3}\mathrm{He} + \pi^-_H \qquad (114.3\ \mathrm{MeV}/c).
\end{aligned}
$$



S=-2 sticking prob. ~few% for Xi capture at rest

Momentum correlation of two π⁻ mesons



Summary

0. Selecting events with Ξ^- hyperon

   S=+2 with e.g. [K+,K+] or [K+,K^o-bar] (?)

1. Ξ^- scattering

   Analysis of off vtx. decayed Ξ^- hyperon

2. Resonance of the H dibaryon (?)

   Analysis of $\Lambda\Lambda$ invariant mass

3. Lightest $\Lambda\Lambda$ hypernucleus (?)

   Check Momentum correlation of two π^- mesons

??? reality ???