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THE OBSERVATION OF STABLE $\tilde{H}(S = -2)$ AND $A^{\circ}(S = -3)$ DIBARYONS

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Two events observed on photographs of the JINR 2m propane bubble chamber exposed to 10 GeV/c proton beam were interpreted as $\tilde{H}(S = -2)$ and $A^{\circ}(S = -3)$ stable dibaryons of (2408.9 ± 11.2) and (2480.2 ± 32.5) MeV/c^2 masses, respectively.

The investigation has been performed at the Laboratory of High Energies, JINR.

Наблюдение стабильных $\tilde{H}(S = -2)$ и $A^{\circ}(S = -3)$ дибарионов

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Два события, обнаруженные на фотографиях 2-метровой пропановой камеры ОИЯИ, облученной протонами с импульсом 10 ГэВ/с, интерпретируются как стабильные дибарионы $\tilde{H}(S = -2)$ и $A^{\circ}(S = -3)$ с массами (2408.9 ± 11.5) и (2480.2 ± 32.3) МэВ/c^2 соответственно.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

At present a number of theoretical models of elementary particles, e.g. [1—8], predict the existence of dibaryons, stable against strong decays. The numerical values of their masses vary from a model to another one (Table 1). But all these predictions have one distinctive feature in common. Namely, the strangeness and the hypercharge of the members of this new class of hadrons should satisfy the conditions $S \leq -2$ and $Y \leq 0$, respectively. The quark and skyrmion model mass spectra, which have the same quantum number content for $B = 1$, differ radically for $B = 2$. Certainly differ the lowest-lying, i.e., the stable dibaryonic states. In Q^6 models the H $(I = 0,$ $J = 0^+$, $Y = 0$, $B = 2$, $S = -2)$ is SU(3)-flavour singlet $\{f\} = \{1\}$ for which the colour-magnetic attraction due to quark-gluon exchange is maximized and its mass lies below the $\Lambda\Lambda$ threshold. In contrast to the quark model predictions on H, its analogue in the Skyrme model, the $\tilde{H}$, is $I = 1$, $J = 0^+$, $\{f\} = \{10*\}$ of a mass ~ 2370 MeV/c^2, thereby being above the $\Lambda\Lambda$, ΞN, $\Lambda\Sigma$ thresholds [8].

Recently Goldman and Stephenson with collaborators [13] have demonstrated using two different quark models of hadrons that there

Table 1. The predicted and measured masses of $S = -2$ dibaryons (MeV/c^2), times of flight $T(10^{-10}$ s) and formally estimated production cross section σ (nb)

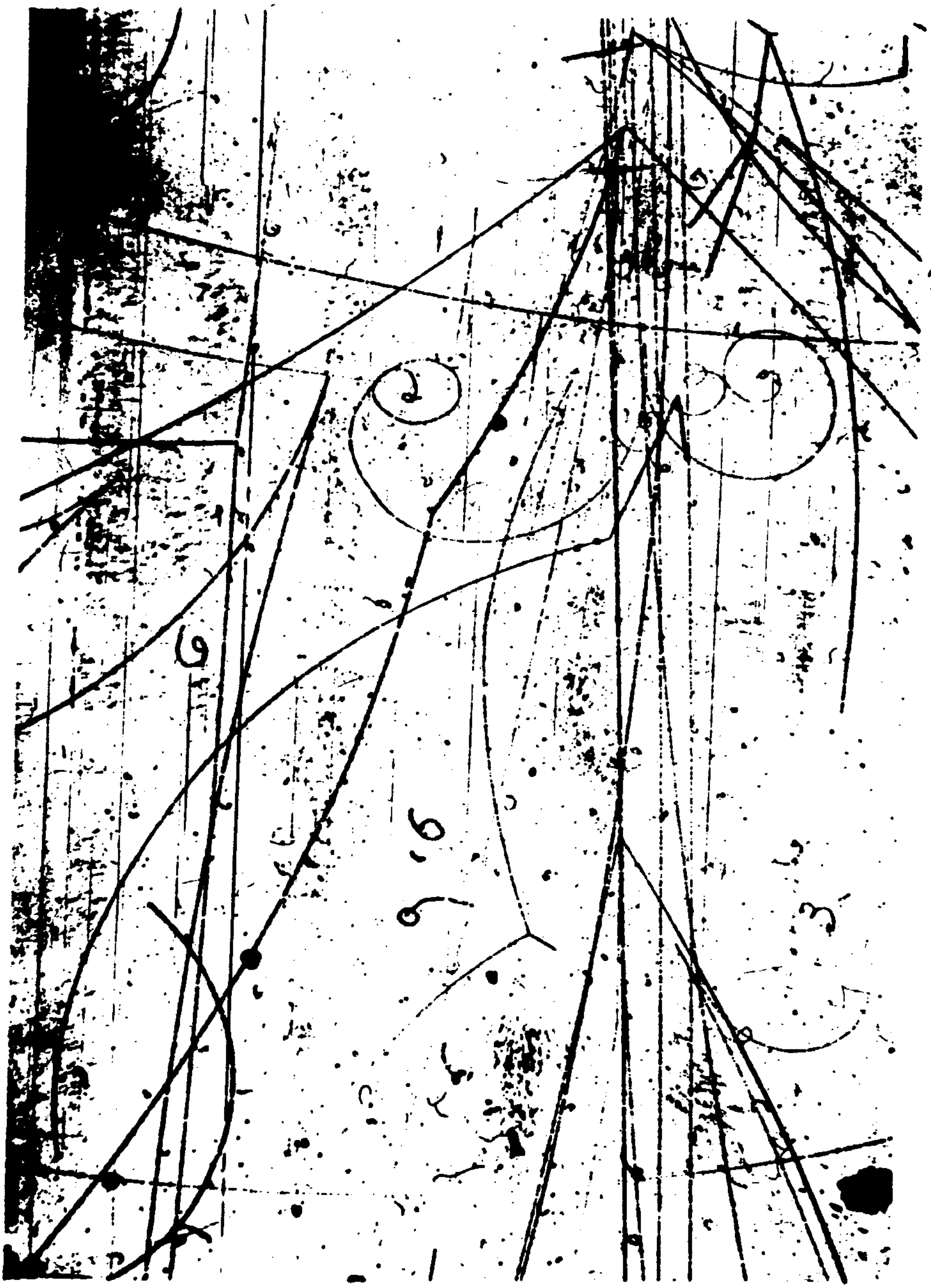
Theoretical predictions						Experiment		
S, Y	Model	$\{f\}$	I	J	Mass	Mass	T	σ
−2,0	Q^6	{1}	0	0^+	2150 [1]			
					2178 [2]			
					2164 [3]	2174.6±13.0 [9]	0.668	100
					2216±5 [4]	2218.0±12.0 [10]	6.674*	100
					2090 [5]	2220.1±5.4 [11]	—	138
					2110 [6]			
	Lattice QCD				2217 [7] at M_Λ=1109			
	Skyrme	{10*}	1	0^+	2370 [8]	2408.9±11.2 [12]	>5.236	100

*Unfortunately, an erroneous value for T had been cited in [10].

should be isodoublets of dibaryons with strangeness $S = -3$ and $J = 1,2$, which are stable with respect to strong decay. The predicted masses of these $A^{\pm}(I = 1/2, Y = -1, B = 2, S = -3)$ dibaryons are for the Spherical Bag Model 2470.7 and for the Potential Model 2366.2 MeV/c^2 in agreement with our result (2480.2 ± 32.5) MeV/c^2.

This brief introduction is important later on when we will try to interpret two new events found in this experiment.

1. In February, 1991, a noteworthy event has been detected (Figure). A neutral particle is emitted from the vertex of a one-prong neutral star marked in the Figure as P_r. The only track of the star of $I/I_0 \cong 1.56$ ionization most probably being due to a proton of (795.3 ± 229.1) MeV/c momentum is 10.95 cm long. The V^0 after covering a range of 12.83 cm decays into a slow proton of a black track which after a faint rescattering stops in propane, and a fast negative particle of a kinked track. This particle of (1800.1 ± 688.6) MeV/c momentum (for the Σ^- hypothesis) and of 7.60 cm long track before the kink cannot be identified visually because the ionization measurements in propane are feasible only up to 1.0 GeV/c momenta. And the track after the kink certainly belongs to a slow negative pion which after covering a range of 49 cm stops in propane, is captured by a ^{12}C nucleus and knocks out two slow protons from it. The invariant mass



The observed weak decay $\tilde{H} \rightarrow p + \Sigma^-$ of the stable dibaryon emitted from the vertex of the recoil proton (marked as P_r) with the subsequent $\Sigma^- \rightarrow n + \pi^-$ weak decay

Table 2. The results of the kinematic two-vertex, 4- and 3-constraint fits to the observed event, $\chi^2(2V-4C)$ and $\chi^2(2V-3C)$ are averaged over eight and ten measurements respectively, n stands for the neutron

№	Possible imitating reactions		$\chi^2(2V-4C)$	$\chi^2(2V-3C)$
1	$\Lambda \to p + \pi^-$;	$\pi^- + n \to \pi^- + n$	1538.22	979.78
2		$\pi^- + {}^{12}\mathrm{C} \to \pi^- + {}^{12}\mathrm{C}$	1538.89	939.17
3	$\Xi^0 \to p + \pi^-$;	$\pi^- + n \to \pi^- + n$	1423.33	865.08
4		$\pi^- + {}^{12}\mathrm{C} \to \pi^- + {}^{12}\mathrm{C}$	1740.36	1100.35
5	$\Lambda + n \to p + \Sigma^-$;	$\Sigma^- \to n + \pi^-$	447.64	430.92
6	$\bar{K}^0 + n \to p + K^-$;	$K^- \to \pi^0 + \pi^-$	1340.00	1203.50
7		$K^- + n \to \Lambda + \pi^-$	1136.10	1185.95
8		$K^- + n \to \Sigma^0 + \pi^-$	1248.64	2703.31

of the V^0 for the $V^0 \to p + \pi^-$ hypothesis is (1828.5 ± 97.2) MeV/c^2 (the error of the average over eight measurements is cited). Hypotheses on combinations of sequences of two-body weak decay, rescattering on a neutron or ^{12}C nucleus as well as reactions able to imitate the observed event were tried (Table 2).

As far as the negative particle momentum (1800.1 ± 688.6) MeV/c (688.6 MeV/c is the s.d. for eight measurements) was measured much less accurately (38%) than that of the decay proton (2%) and negative pion (2%), two vertex, four- and three-constraint fits have been tried, with the negative particle momentum treated in the last case as an unmeasurable parameter. Clearly all hypotheses on imitating processes have to be rejected. The estimated probability of the sequence of reactions $n + n \to n + p + \pi^-$, $\pi^- + n \to \pi^- + n$ or $\pi^- + {}^{12}\mathrm{C} \to \pi^- + {}^{12}\mathrm{C}$ of $2 \cdot 10^{-5}$ on 10^5 K photographs [10] holds for this event also. Furthermore the track length of the ^{12}C recoiled as a whole in the reactions 1—4 of Table 2 would have been 0.6 cm long, which would be quite reliably detected. Any of the lighter fragments of a ^{12}C nucleus would produce longer tracks. Thus we have independent proofs that the kink of the V^0 negative track does not result in the above reactions.

Then we have tried the hypotheses of the three exotic weak decay modes of the observed V^0 (Table 3) with unknown masses. Only the hypothesis $\tilde{H} \to p + \Sigma^-$, $\Sigma^- \to n + \pi^-$ fits the observed event. The best-fit mass is $M_{\tilde{H}} = (2408.9 \pm 11.2)$ for the $(2V-3C)$-fit and

Table 3. The results of the kinematical two-vertex 3- and 2-constraint fits of the exotic two-body weak decays to the observed event. $\chi^2(2V—3C)$ and $\chi^2(2V—2C)$ are averaged over eight and ten measurements, respectively

№	Two-body exotic weak decays	$\chi^2(2V—3C)$	C.L. (%)	$\chi^2(2V—2C)$	C.L. (%)
1.	$N(S=-4) \rightarrow p + \Omega^-$; $\Omega^- \rightarrow \Xi^0 + \pi^-$	171.45	—	69.15	—
2.	$A^0(S=-3) \rightarrow p + \Xi^-$; $\Xi^- \rightarrow \Lambda + \pi^-$	63.11	—	52.94	—
3.	$\tilde{H}(S=-2) \rightarrow p + \Sigma^-$; $\Sigma^- \rightarrow n + \pi^-$	1.97	57.9	1.42	49.0

Table 4. The measured (M) and fitted (F) momenta p, the tangents of the dip angles tg α_i and the azimuthal angles β_i from the sequence of the weak decays $\tilde{H} \rightarrow p + \Sigma^-$, $\Sigma^- \rightarrow n + \pi^-$

Weak decays		M	F
		p_i (MeV/c)	
$\tilde{H} \rightarrow p + \Sigma^-$	p	293.8 ± 6.7	291.7 ± 6.6
	Σ^-	1800.1 ± 688.7	1760.8 ± 43.3
$\Sigma^- \rightarrow n + \pi^-$	n	—	1659.0 ± 42.6
	π^-	174.5 ± 3.5	173.5 ± 3.4
$\tilde{H}$-dibaryon		—	1970.1 ± 44.7
		tg α_i	
$\tilde{H} \rightarrow p + \Sigma^-$	p	0.96296 ± 0.04441	0.96580 ± 0.03466
	Σ^-	0.09722 ± 0.00735	0.095309 ± 0.00562
$\Sigma^- \rightarrow n + \pi^-$	n	—	0.08527 ± 0.00668
	π^-	0.15177 ± 0.02738	0.15192 ± 0.02743
$\tilde{H}$-dibaryon		0.18924 ± 0.00660	0.19100 ± 0.00404
		β_i (rad)	
$\tilde{H} \rightarrow p + \Sigma^-$	p	1.71804 ± 0.02019	1.71106 ± 0.01734
	Σ^-	1.16441 ± 0.00372	1.16350 ± 0.00177
$\Sigma^- \rightarrow n + \pi^-$	n	—	1.26485 ± 0.00431
	π^-	0.26897 ± 0.01307	0.27345 ± 0.01197
$\tilde{H}$-dibaryon		1.21986 ± 0.00097	1.22002 ± 0.00094

(2407.7 ± 11.5) MeV/c^2 for the $(2V$—$2C)$-fit. The best-fit parameters in these two fits coincide within the tenth of a per cent. Therefore only the $(2V$—$3C)$ best-fit parameters are shown in Table 4.

The above full kinematical analysis, performed for each interaction vertex which have occurred in this frame, both seen and not seen in the Figure, proved to be successful only for the neutral one-prong star (P_r). We have tried even the following eccentric possibility. Let us assume that from the vertex of the star seen in the right lower part of the Figure, a «V^0»-particle is emitted in the backward hemisphere, its decay vertex coinciding with the decay vertex of the true Σ^--hyperon, the negative «decay» track with stopping π^- track and with the «positive» one, forming at the end point a one-proton star — the true Σ^- track but this time «emitted» from the «V^0» vertex (i.e. from the weak decay vertex of the true Σ^-). Of all possible decay modes of all known neutral particles survive only those of $\pi^- p$ and $\pi^- \pi^+$ final states. One has $\langle\chi^2_K(1V$—$3C)\rangle = 1402.4$, $\langle\chi^2_\Lambda(1V$—$3C)\rangle = 1286.4$ and $\langle\chi^2_{\Xi^0}(1V$—$3C)\rangle = 293.7$.

Returning to the true topology we have not succeeded in fitting the hypotheses $\Lambda + p \rightarrow \tilde{H} + K^+(2V - 2C)$ and $\Xi^0 + d \rightarrow \tilde{H} + p(2V - 2C)$ either. Here Λ and Ξ^0 were assumed to be emitted from unknown interactions, d being a hypothetical intranuclear dibaryon fluctuon of the deuteron mass.

Finally we have succeeded in fitting the hypotheses $\tilde{H} + p \rightarrow \tilde{H} + p$ for the measured mass of $M_{\tilde{H}} = (2408.9 \pm 11.2)$ MeV/c^2 with $\chi^2(1V - 1C) = 1.52$, C.L. = 21.8%. This result means that the $\tilde{H}$ perhaps had been produced either in the bubble chamber front wall or even in the primary channel. Therefore one has to take that the time of flight of the $\tilde{H}$ is more than the time of flight between the recoil proton and decay vertices, i.e. $T_{\tilde{H}} > 5.236 \cdot 10^{-10}$ s.

Besides, the following hypotheses and tests have been tried in addition. (i) Special attention had been paid to the possibility of imitating the event observed by the two-body reaction $\Lambda + n \rightarrow p + \Sigma^-$, resulting in the same final state particles as the weak decay $\tilde{H} \rightarrow p + \Sigma^-$. The target neutron in reaction 5 of Table 2 is assumed to be at rest. The fit proceeded in two steps. In the first one the hypotheses on $\Lambda + n \rightarrow p + \Sigma^-$ conversion fail to fit the event with $\chi^2(1V - 3C) = 344.66$ demonstrating thereby that the V^0 observed is not created in the above binary reaction and particularly that the neutral

Table 5. The transversal Σ^- and p momenta (MeV/c), normal to the straight line, connecting the interaction and V^0 vertices in the (Σ^-, p) plane and the noncoplanarity angle η (mrad) between the above line and plane

	$p^{\perp}_{\Sigma^-}$	$p^{\perp}_{p}$	η
measured	190.3 ± 26.0*	194.0 ± 4.4	0.9 ± 5.0
fitted $(\tilde{H} \to p + \Sigma^-)$	187.1 ± 4.6	192.4 ± 4.4	1.2 ± 6.0

*Here the error of the average over eight measurements is cited.

particle is not a Λ-hyperon. In the second step the hypothesis on weak decay $\Sigma^- \to n + \pi^-$ fits well the event with $\chi^2(1V - 1C) = 0.185$, C.L. = 66.8% proving thereby that the negative kinked track of the V^0 is due to the weak decay of a Σ^--hyperon. The total hypothesis on the sequence of $\Lambda + N \to p + \Sigma^-$ conversion and $\Sigma^- \to n + \pi^-$ weak decay fails to fit the event observed with $\chi^2(1V - 1C) = 447.64$ and has to be rejected.

Nevertheless one has to consider in detail the hypothesis on ΛΣ conversion on a Fermi-moving neutron of a ^{12}C nucleus. In order to reveal the possible Fermi-motion of the presumed neutron target we have computed: a) the noncoplanarity angle η, i.e. the angle between the straight line connecting the emission and decay vertices and the plane formed by the proton- and sigma-momenta. Let us stress that this angle depends only on emission angles of the particles involved, which are measured with better precision than the respective momenta even for the short track of the Σ^-, as it can be seen in Table 4; b) the components of the p- and Σ^--momenta in the (p, Σ^-)-plane, transversal to the projection of the above straight line on this plane. These parameters, both the measured and for the comparison the best-fit ones for the sequence of hypotheses $\tilde{H} \to p + \Sigma^-$, $\Sigma^- \to n + \pi^-$, are shown in Table 5. The differences of both measured and fitted transversal momenta $\Delta p^{\perp}_{m} = p^{\perp}_{pm} - p^{\perp}_{\Sigma^- m} = (3.70 \pm 26.37)$ and $\Delta p^{\perp}_{f} = p^{\perp}_{pf} - p^{\perp}_{\Sigma^- f} = (5.3 \pm 6.4)$ MeV/c as well as the respective noncoplanarity angles are well compatible with zero. But such a situation also can be well realized if the ΛΣ conversion takes place on a neutron moving with a Fermi-momentum either parallel or antiparallel to the momentum of the incident Λ-hyperon. The $(2V$-$3C)$-kinematical fits of these two hypotheses proved to be unsuccessful.

Finally let us estimate the probabiluty of the $\Lambda\Sigma$ conversion on a Fermi-moving neutron. Let us assume that the Fermi-momentum transversal component in the (p, Σ^-)-plane is $q_F^\perp = \delta(\Delta p_m^\perp) = 26.37$ or $q_F^\perp = 3 \cdot \delta(\Delta p_m^\perp) = 79.11$ MeV/c. Taking into account the normal to the (p, Σ^-)-plane component of the «fitted» Λ-momentum from the reaction $\Lambda + n \to p + \Sigma^-$, $p_\Lambda^f \cdot \sin \eta_f = 3.18$ MeV/c ($p_\Lambda^f = (1271.3 \pm 25.3)$ MeV/c $\eta_\Lambda^f = (2.5 \pm 5.8)$ mrd, «f» stands for «fitted») we obtain the total Fermi-momenta $q_F = \sqrt{(26.37)^2 + (3.18)^2} = 25.56$ and $3q_F = 79.68$ meV/c. The probabilities to meet neutrons of these momenta in a ^{12}C nucleus can be easily calculated. Indeed, the proton momentum distribution in a ^{12}C nucleus had been measured long ago and rather well described by distributions $\exp(-q_F/q_s)^2$ and $(q_F/q_p)^2 \exp(-q_F/q_p)^2$ deduced from the harmonic oscillator model for the s- and p-shells respectively [14]. The full normalized distribution is given by the following formula

$$P(q_F) = 0.376(q_s^{-1} \mathrm{e}^{-q_F/q_s)^2} + 4q_p^{-3} q_F^2 \mathrm{e}^{-(q_F/q_p)^2}) dq_F, \tag{1}$$

where $q_s = 160$ MeV/c, $q_p = 95$ MeV/c.

The probabilities to meet neutrons of $q_F = 26.56$ and 79.68 MeV/c in a ^{12}C nucleus within the momentum intervals $dq_F =$ 26.56 and 79.68 MeV/c, respectively, are $P(26.56) = 0.09$ and $P(79.68) = 0.62$.

Let us now calculate the yield of the $\Lambda\Sigma$ conversion process. As far as in our case $q_F << p_\Lambda$ one can use the tabular data on cross sections for the target at rest [15]. The yield for a model of a ^{12}C nucleus of a cylindrical form of D_C both diameter and height is

$$N_{\Lambda\Sigma} = \frac{\sigma_{\Lambda\Sigma}^T}{\sigma_{\Lambda p}^T} \mathrm{e}^{-l\left(3n_C\sigma_{\Lambda C} + 8n_p\sigma_{\Lambda p}^T + \frac{M}{P_\Lambda c\tau_\Lambda}\right)} \times \tag{2}$$

$$\times\, (1 - \mathrm{e}^{-n\sigma_{\Lambda p}^T D_C}) \frac{d^2 N_\Lambda^m}{dp_\Lambda d\Omega_\Lambda} \cdot \sin\Theta_\Lambda^m \cdot 3(\Delta p_\Lambda^m) \cdot 3\Delta(\Delta\Theta_\Lambda^m) \cdot 3(\Delta\varphi_\Lambda^m).$$

Here $l = 12.83$ cm is the range of the V^0, $n_C = 1.8 \cdot 10^{22}$ cm^{-3}, $n_p = 4.8 \cdot 10^{22}$ cm^{-3} — the ^{12}C and ^{1}H densities in propane, $\sigma_{\Lambda\Sigma}^T(1271) = (4.4 \pm 2.2)$ mb [15], $\sigma_{\Lambda p}^T = 34$ mb [15] $\sigma_{\Lambda C}^T = 236$ mb —

the total cross sections, $D_C = 5.48\cdot 10^{-13}$ cm, $1.3\cdot 10^{38}$ cm^{-3} — the nuclear matter density. The measured parameters are labelled by the letter m. Finally we have $P(26.56)\cdot N_{\Lambda\Sigma}(26.56) = 9.010^{-8}$ and $P(79.68)\cdot N_{\Lambda\Sigma}(79.68) = 6.3\cdot 10^{-7}$.

Not being content with this we have considered the same reaction induced by a Λ, emitted this time from an unknown interaction vertex. In this case we do not know the Λ momentum 3-vector. Therefore both in the first and the second steps we have (1V—1C)-fits. Again the full two-step fit has failed with χ^2(2V—2C) = 204.0, though the second step fit of the hypothesis $\Sigma^- \to n + \pi^-$ once more had been successful with χ^2(1V—1C) = 0.54, C.L. = 46.0% thereby confirming again that the kinked track of the V^0 observed belongs to a Σ^--hyperon.

Thus the above analysis demonstrates that the $\Lambda\Sigma$ conversion of a Λ emitted either from the interaction vertex P_r or from an unknown one on a neutron either Fermi-moving or at rest fails to imitate the event observed. Six reactions $\Lambda + n \to p + \Sigma^- + \pi^0$ with π^0 and n momenta parallel or antiparallel to the Λ momentum, or n at rest, failed to fit the event also.

(ii) After we have convinced ourselves that the kinked track of the V^0 belongs to a Σ^- hyperon, the following trivial possibility of imitation had been tried: the V^0 particle observed in reality had been created in $n + n \to p + \Sigma^- + K^0 + (m\pi^0)$, $m = 0, 1, 2, \ldots$ interaction, by a fast neutron, which could result in a proton- or a secondary hadron-nucleus collision. Unfortunately no kinematical analysis is feasible in this case. The estimate of the differential cross section of this reaction in the frame of the OBE-model for the topology of our event leads to a yield of $6\cdot 10^{-7}$ events on 100K photographs. Therefore this possibiluty also should be rejected.

It is pertinent to discuss here the assertion of Dr Imai in his answer to a question at PANIC 12 [16] on the possibility of imitating event $H(2218) \to p + \Sigma^-, \Sigma^- \to n + \pi^-$ [10] by intranuclear conversion $\Lambda + n_F \to p + \Sigma^-, \Sigma^- \to n + \pi^-$ on a Fermi-moving target neutron of 40 MeV/c momentum.

Let us remind that the fit of the $\Lambda\Sigma$ conversion on a target neutron at rest proceeded in two steps. In the first one the hypothesis on $\Lambda + n \to p + \Sigma^-$ conversion fails to fit the event with χ^2(1V—2C) = 11.14 and C.L. = 0.39% (the Λ and Σ^- momenta are unmeasurable)

Table 6. The same as in Table 5, for the event, reported in [10]

	$\tilde{H} \to p + \Sigma^-$,	$\Sigma^- \to n + \pi^-$	$\Lambda + n \to p + \Sigma^-$	$\Sigma^- \to n + \pi^-$
	Measured	Fitted	Measured	Fitted
$p_{\Sigma^-}^{\perp}$	200.8 ± 4.4	204.3 ± 4.4	206.6 ± 6.3	201.9 ± 4.0
$p_p^{\perp}$	202.4 ± 4.4	203.8 ± 4.4	202.4 ± 4.4	201.6 ± 6.1
η	6.7 ± 6.7	2.6 ± 4.4	6.6 ± 6.7	0.9 ± 6.7

demonstrating thereby that the V^0 observed was not created in the above binary reaction and particularly that the neutral particle is not a Λ-hyperon. In the second step the hypothesis on a weak decay fits well the event with $\chi^2(1V\text{—}1C) = 0.476$ and C.L. = 48.0% proving thereby that the negative kinked track of the V^0 is due to the weak decay of a Σ^--hyperon. The total hypothesis on $\Lambda + n \to p + \Sigma^-, \Sigma^- \to n + \pi^-$ now should be rejected with $\chi^2(2V\text{—}3C) = 11.53$, C.L. = 0.82% (the 11-th reaction in Table 1 of the article [10]). Again, in order to reveal the Fermi-motion of the presumed neutral target, the transversal p_{Σ^-}- and -momenta both for the $\Lambda\Sigma$ conversion reaction and the H-decay hypotheses using both the measured or fitted parameters as well as the non-coplanarity angle η have been calculated (Table 6). Let us note that $p_{\Sigma^-}^{\perp}$ in the first and third columns were calculated using the fitted p_{Σ^-} (p_{Σ^-} is unmeasurable) and the sin of the corresponding measured angles. It is clear that both the η and $\Delta p^{\perp} = p_{\Sigma^-}^{\perp} - p_p^{\perp}$ are compatible with zero. Again, the (2V—3C) kinematical fits of the hypotheses on $\Lambda\Sigma$ conversion on Fermi-moving neutron with the momenta either parallel or antiparallel to the incident Λ momentum, were unsuccessful. Nevertheless let us identify the maximal components of the p_Λ momentum in the (p, Σ^-)-plane $\Delta p^{\perp} = (4.30 \pm 7.70)$ MeV/c and along the normal to it $\Delta p^N = p \sin\eta = (6.00 \pm 6.00)$ MeV/c ($p_\Lambda = (900.10 \pm 18.10)$ MeV/c being the fitted Λ momentum for the $\Lambda\Sigma$ conversion hypothesis) with the respective components of the target neutron momentum. Thus, suppose $q_F = \sqrt{(\Delta p^{\perp})^2 + (\Delta p^N)^2} = (7.35 \pm 10.25)$ MeV/c. The probability of meeting a neutron of 7.35 MeV/c momentum within the $q_F = 7.4$MeV/c momentum interval in a ^{12}C nucleus, according to the formula (1) is $P(7.35) = 1.8 \cdot 10^{-2}$. The corresponding $\Lambda\Sigma$ conversion yield is $N_{\Lambda\Sigma}=1.2\cdot 10^{-5}$. Here $l=10.0$ cm, $\sigma^{T}_{\Lambda\Sigma}=7.85$ [15], $\sigma^{T}_{\Lambda\Sigma}(900)=$ $=34$ mb, $\frac{d^2N^m_\Lambda}{dp_\Lambda d\Omega_\Lambda}=0.22$ $(\mathrm{MeV/c})^{-1}\cdot\mathrm{rad}^{-2}$, $\Delta p^m_\Lambda=18.1$ MeV/c, $\Delta\theta^m_\Lambda=$ $=8.66$ mrd, $\Delta\varphi^m_\Lambda=1.42$ mrd, $\sin\theta^m_\Lambda=0.2852$. Finally $P(900)=$ $=P(7.35)\cdot N_{\Lambda\Sigma}=2.16\cdot 10^{-7}$. For $q_F=40$ MeV/c, $\Delta q_F=40$ MeV/c, $P(40)=$ $=0.182$ and $P(900)=P(40)\cdot N_{\Lambda\Sigma}=2.18\cdot 10^{-6}$. Thus even the ellegal identification of the nonsignificant Λ momentum disbalance with the assumed target neutron Fermi momentum $q_F=(7.35\pm 10.25)$ or 40 MeV/c [16] leads to negligibly small probability of the ΛΣ conversion. The refinements of the nuclear model would not change much this result if only the use of the differential cross section of the ΛΣ conversion, corresponding to the topology of our event, which is unfortunately unknown, instead of the only known total cross section of the $\Lambda+p\to p+\Sigma^0$ [10], would certainly cover these changes. Again, the ^{12}C nucleus recoiled as a whole would form in propane a 0.2 cm long track which would be quite reliably detected. Any of the lighter fragments of a ^{12}C nucleus would produce longer tracks, i.e. we have an independent proof that the kink of the negative track does not result in the reactions 1—4 of Table 1 [10].

Thus the hypothesis on ΛΣ conversion on a Fermi-moving neutron of a 40 MeV/c momentum [16] is completely baseless.

Returning to the event found in February 1991 we are forced to interpret it as the weak decay of a stable neutral dibaryon $\tilde{H}\to p+\Sigma^-$, $\Sigma^-\to n+\pi^-$ of a mass $M_{\tilde{H}}=(2408.9\pm 11.2)$ MeV/c^2, exceeding the ΛΛ, ΞN, ΛΣ and ΣΣ strong decay thresholds. Perhaps we have succedeed in observing a representative of the neutral component of the charge triplet $I=1$, $J=0^+$, $\{f\}=\{10^*\}$ stable dibaryon of the mass $M_{\tilde{H}}\approx 2370$ MeV/c^2 predicted by Callan — Klebanov — Kunz — Mulders soliton Skyrme-like model [8]. From this point of view it would be very important to find its positively and negatively charged partners. Experimentally one has to search for weak decays $\tilde{H}^+\to\Lambda+p$, $\Lambda+p+\pi^++\pi^-$, etc., and $\tilde{H}^-\to\Lambda+p+\pi^-+\pi^-$. This program is easily feasible by means of bubble chamber technique and we have started the search for the $\tilde{H}^\pm$ weak decays among the events of the appropriate topologies.

It should be stressed that the bubble chamber technique is well suited for the reliable detection and analysis of weak decays of stable dibaryons and multibaryonic hadrons which quite often have to look out as branching out combinations of V^0 and $V^{\pm}$ events. Three examples of such objects have been reported in [9,10,12]. Moreover, it is possible to estimate the mean life-time for weak decays due to wide momentum interval of detectable dibaryons. But simultaneously this technique permits one to detect and analyse quite reliably also the events of the intranuclear conversion of these exotic hadrons into hyperons. Two events found in n^{12}C (7 GeV/c) and p^{12}C (10 GeV/c) exposures have been well fitted by the reaction $H + p \rightarrow 2\Lambda + p$ [17,18].

2. This method permitted us to identify an event as a candidate for the $A(S = -3)$ dibaryon. As a result of the triple scan of 260K photographs an event has been found which can be interpreted as due to intranuclear conversion of a A-dibaryon. A 10 GeV/c beam proton produces a six-prong star and three lambdas. The most «dangerous» background able to imitate this event is the possible creation of all these lambdas in an intranuclear cascade process. Unfortunately a precise and refined estimate of its probability is impossible today because of the absence of suitable algorithms. Instead, the pessimistic, overestimated background of this sort is $5 \cdot 10^{-2}$ events on 260K photographs. The measured total cross sections for the Λ production in p^{12}C collisions at 10 GeV/c is $\sigma_{\Lambda}(p^{12}\mathrm{C}) = 5$ mb, and the total cross section for the Λ production in πN collisions at $0.9 < p_{\pi} < 10.0$ GeV/c is $\sigma(\pi N) \cong 1$ mb. Now we have supposed that the most energetic Λ is created in p^{12}C collisions with cross section $0.1\sigma_{\Lambda}(p^{12}C) = 0.5$ mb, the two slower lambdas being created in πN intranuclear collisions with $0.1\sigma_{\Lambda}(\pi N) = 0.1$ mb cross section at $n = 1.3 \cdot 10^{38}\,\mathrm{cm}^{-3}$ nucleon density on $r = 1.5R(^{12}\mathrm{C}) = 4.12$ fm path length each. The coefficient 0.1 accounts for the momentum and angular distributions of lambdas. Of a series of intranuclear cascade processes, successfully fitting our event ($\chi^2(4V\text{—}9C) = 9.19$, C.L. = 42.0%) were only the following ones $,A^{\substack{0\\-}} + \begin{pmatrix} p \\ n \end{pmatrix} \rightarrow 3\Lambda + \begin{pmatrix} \pi^+ \\ \pi^- \end{pmatrix}$ with the best-fit mass averaged $M_A = (2480.2 \pm 32.5)\ \mathrm{MeV}/c^2$. For the fixed predicted masses [13] one has: 1. $\chi^2(4V\text{—}10C) = 10.0$, C.L. = 44.0% for the Spherical Bag Model and 2. $\chi^2(4\mathrm{V}\text{—}10\mathrm{C}) = 18.0$, C.L. = 5.5% for the Potential Model [19]. In both cases χ^2 were averaged over these two reactions.

There is no need to stress the extreme importance of the search for the stable di- and multibaryonic hadrons. One of the most difficult parts of this problem seems to be the copious production of these hadrons. Most probably it could be ensured in low-energy Ω^-, Ξ^--nucleus interactions by sending an intensive hyperon beam of inevitably high momentum after an intensive beam of relativistic ions, the adjustable momentum per nucleon of which is always lower than the hyperon beam momentum.

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