Hyperons - birth of the proton

Table of contents:

26.08.2009

Introduction

Hyperons amongst massive molecules are taking the special place on account of their properties. Having the half spin are baryons – so they have the odd number of biquarks, being born from massive mesons (with the integer spin) must so come into existence in pairs (two molecules from the family of hyperons). They are disintegrating in a special way: in a cascade slowly (with lifetime 10^{-10}[s]) losing the part of one's structure spitting out charge or neutral pions and sometimes photons raising part of the excess angular momentum. Then series of breakdowns are coming into existence having begun from the Ω hyperon one by one through hyperons: Ξ, (Σ^o), Λ, all the way to the N nucleon (p or n). This property of the cascade breakdown is pointing at the slow disintegration of the primal complete structure of the Ω hyperon, rather than as disintegrations of big mesons consisting very oftentimes in complete disintegrations of structures of fullerene onions and for being born kind of anew a few less massive structures creating new molecules. [1] and [2].

In this publication are presented models of the most well-known hyperons with many graphics showing presumable their structures and cascade breakdowns. Also a model of pre-proton is discussed – structure from biquarks who is an immediate state preceding the uprising ”mature” for character of the nucleon.

The entire publication is based on The Subquark Model "MSq” and constitutes its next part describing world of elementary particles built from subquark pairs forming the elementary particles of the Universe (virtual quanta, photons, gravitons, neutrinos, electrons, biquarks, etc.)[3].

Leszek Ampel

[1] Ampel Leszek, *Whether new particle Y(4140) is confirming the correctness of MSq?*, (2009), http://all-subquarks.pl/

[2] Ampel Leszek, *Fullerene structures of massive elementary particles. Is the Higgs boson needed for us?,* (2009), http://all-subquarks.pl/

[3] Ampel Leszek, *The Subquark Model of the structure of elementary particles,* (2009), http://all-subquarks.pl/ (publication - 150 pages in PDF format – available after registering)

1. Pre-protons – creation of baryon matter

The Model of proton in MSq[1] is a trigonal dipyramid. It has 2 internal biquarks additionally in centers of both pyramids. With secret of its extraordinary stability as well as all at the same time the problem in creating its image is feeling odd number of biquarks forming it, and more precisely ▲ ring – long-lasting triple bond containing three Δb_x biquarks connected with oneself giving total baryon charge +1e. Such a structure cannot alone come into existence, because biquarks can create only in pairs. Such two complementary structures can however come into existence – 2 ▲ rings from complementary Δb_x and Δb_y biquarks, who after splitting can create hard core of the proton and the antiproton.

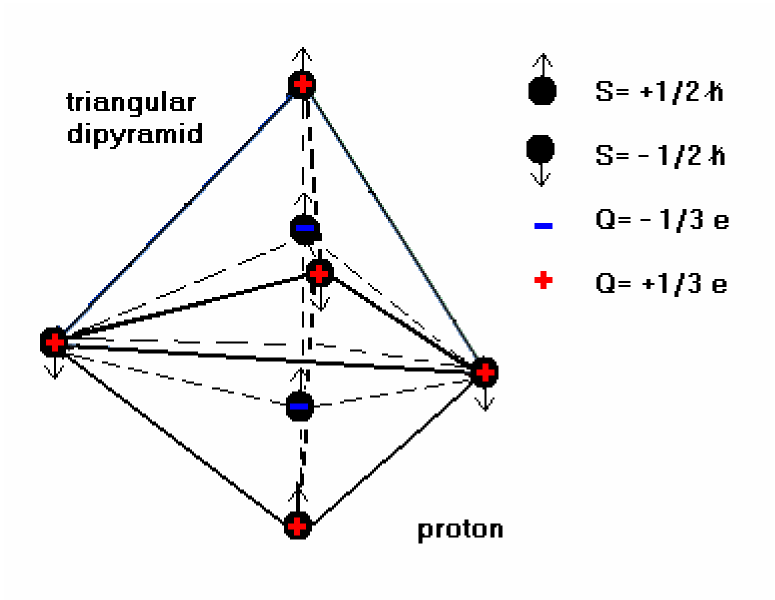


Fig.1.1 Structure of the proton compound of 7 biquarks

Pairs of proton–antiproton can presumably come into existence from being transformed two complementary pentagonal dipyramids in the process of the implosion (of outside breakdown of biquark fullerene of massive elementary particle: meson: B^+, B^o, $J/\psi(1S)$. Then the part of the energy of the breakdown is directed at the center of the disintegrating structure of molecule causing compression of its inner fullerene biquark layers and increasing the number of bonds amongst them.

[1] Ampel Leszek, *The Subquark Model of the structure of elementary particles,* (2009), http://all-subquarks.pl/ (publication - 150 pages in PDF format – available after registering).

Sides of fullerene onions always contain 12 pentagons in structures of massive particles. Smallest such fullerene is $^{30}\mathbf{f}_{20}$[2], which is build exclusively from 12 pentagons. Outside fullerene ($^{90}\mathbf{f}_{60}$) surrounding it and the internal biquark Platonic or Archimedean solid, for example: regular icosahedron ($^{30}f^{\Delta}12$), can provide for two biquarks being peaks with both pentagonal dipyramids:

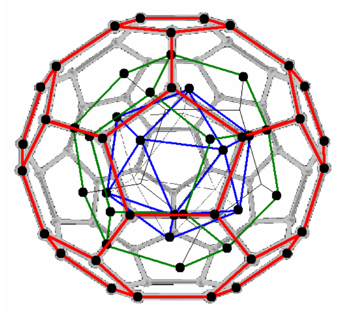


Fig.1.2 Onion: $^{90}\mathbf{f}_{60}$ @ $^{30}\mathbf{f}_{20}$ @ $^{30}\mathbf{f}^{\Delta}{}_{12}$
R = (4.90@2.75@1.86) [fm]
for a = r_{bb} = 1.9613 [fm] – length of bonds.

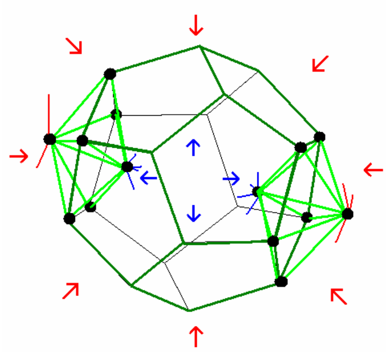


Fig.1.3 Forming of two complementary pentagonal dipyramids
on both sides of fullerene $^{30}\mathbf{f}_{20}$.

After the disintegration of external fullerene $^{90}\mathbf{f}_{60}$ in the course of the acting compression (implosion) a disintegration of fullerene $^{30}\mathbf{f}_{20}$ is coming to two parts and condensation bonds amongst staying biquarks. Two that come opposite pentagonal dipyramids (pre-protons) containing for 7 biquarks[3], are converting finally themselves into two proton structures – trigonal dipyramids[4] with two additional internal biquarks.

[2] For differentiate structures of biquark fullerenes from carbon fullerenes, for example C60 we will simply be calling them for example $^{90}\mathbf{f}_{60}$ or when are fullerenes about sides from an equilateral triangles then for example $^{30}\mathbf{f}^{\Delta}{}_{12}$. The left upper sign is giving the number of bonds in the fullerene (in the solid).

[3] Resemblance to the solid: http://mathworld.wolfram.com/PentagonalDipyramid.html

[4] Resemblance to the solid: http://mathworld.wolfram.com/TriangularDipyramid.html

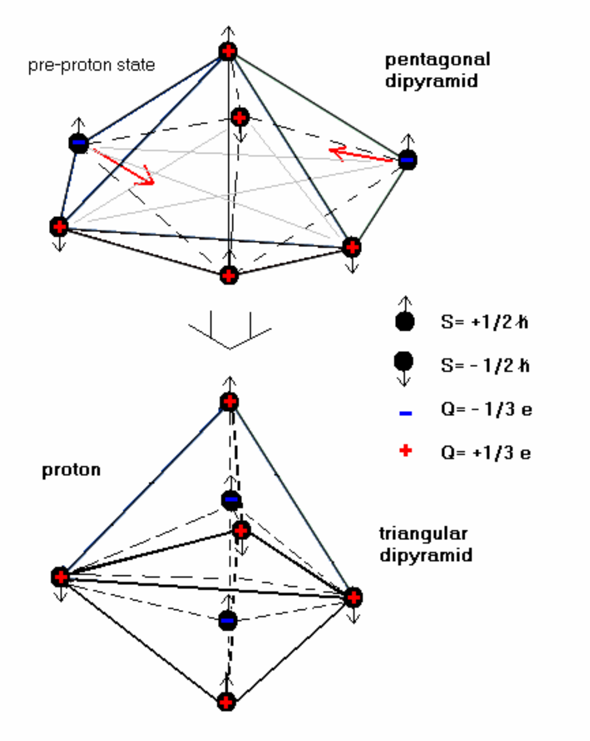


Fig.1.4 Fall in structure of the pre-proton to the final form.

So that such a transformation can occur, must be fulfilled conditions concerning quantum states of biquarks which created pair of proton – antiproton (spins, charges and their relative spreading of oneself) and the completeness of bonds amongst them.

All biquarks in these structures are connecting between themselves by 6 strong bonds B_a and B_s giving altogether: $12B_a + 9B_s = 938.272$ [MeV] (for: $B_a = 52.860395$ [MeV] and $B_s = 33.771919$ [MeV]).

Antiproton is a reflection of the proton in the C symmetry. It has 5 b_y and 2 b_x (3 b_y are creating the triple bond Δb_y).

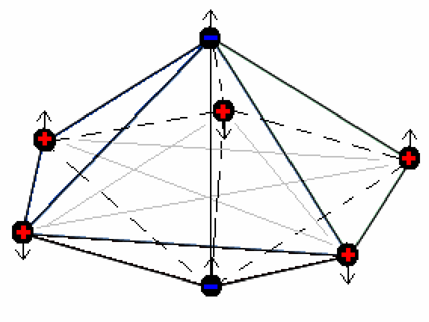


Fig.1.5 Different spreading biquarks in pre-proton favoring coming into existence of the neutron (probable catching of pair of virtual electron with the neutrino in the centre of structure)

The part of bonds in nucleons is a little bit shorter and longer than the direct stiff bond amongst biquarks (for length r_{bb} = 1.961 [fm]). But they are gluon bonds (especially asymmetrical bonds B_a amongst biquarks about opposite). Majority of remaining biquarks of coming from breakdowns of external and internal fullerene structures can be built in these gluons. Gluon bonds are describe more precisely in the chapter "Gluons" in the part: „*B. Detailed model – Subquark structure of matter*".

Two variants of the most probable layouts of directions of biquark spins creating the structure of the pre-proton are introduced below:

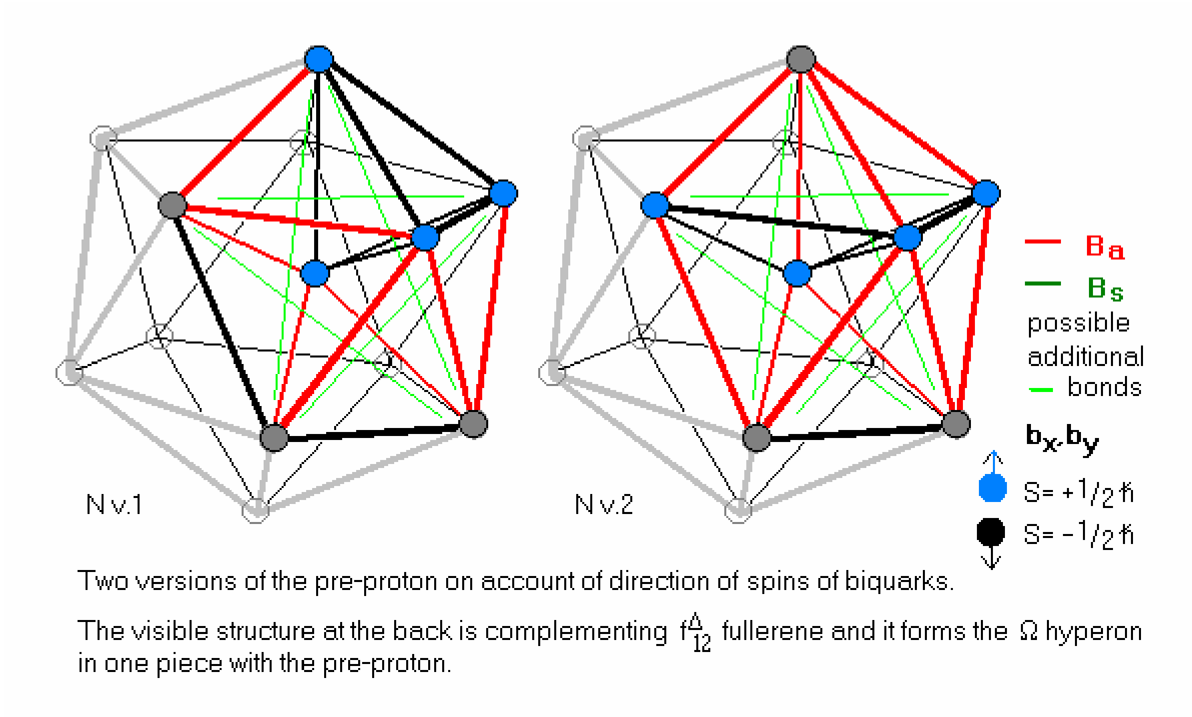


Fig.1.6 Two variants of the pre-proton on account of direction of spins of biquarks.
The visible structure at the back is complementing the solid of fullerene $^{30}\mathbf{f}^{\Delta}_{12}$, who including the pre-proton is creating hyperon Ω.

Creating pre-protons from structures of fullerenes about triangular sides $^{30}\mathbf{f}^{\Delta}_{12}$ is rather more probable than the creation of fullerenes about pentagonal sides $^{30}\mathbf{f}_{20}$ (Fig.1.3). Two structures of such fullerenes (Ω or their fragments: Ξ, Σ, Λ, Δ) must however come into existence from one greater (meson) structure, who after tearing will divide biquarks of one of biquark pairs, so that both structures have the odd number of biquarks. Otherwise lighter mesons will come into existence (about integer spins) which in the process of next breakdowns leptons and quanta of the energy (virtual and real) will create.

2. Structure of the Ω hyperon

From hyperons a Ω hyperon is most massive. In the process of the cascade breakdowns are coming into existence one by one hyperons: Ξ, (Σ^o), Λ, all the way to the creation of the nucleon N (proton or neutron). In the process of each of breakdowns additionally charge or neutral pions are coming into existence (sometimes kaons, additional photons and leptons)[5].

Hyperon Ω is the $^{30}\mathbf{f}^{\Lambda}{}_{12}$ fullerene with the internal unpaired biquark built in, who is connected with 6 neighbors (creating the structure of pre-proton). Inside the structure of pre-proton in hyperon Ω not all diagonal bonds must be present (5 bonds - diagonals marked on green on Fig.1.6); all of they will be formed after its decay.

We must distinguish two variants of the structure of pre-proton in this hyperon depending on spreading spins of biquarks situated on the hoop of the solid (Fig.1.6).

Since directions of spins of biquarks connected with oneself and their decomposition have gigantic meaning to mass of the particle (number of symmetrical and asymmetrical bonds), so we must analyze these two variants individually trying this way to select remaining 6 biquarks complementing fulleren $^{30}\mathbf{f}^{\Lambda}{}_{12}$ so that all quantum numbers being characteristic of hyperon Ω are fulfilled (for example.: spin = $^1/_2$ ђ and $^3/_2$ ђ; baryon numbers of the hyperon and the proton are in accordance with themselves – charges of biquarks are appointing them; negative electric charge in this hyperon must create minimum two lepton electron-neutrino structures at the moment not discussed on account of their small contribution to creating integral mass).

With additional criteria (empirical) of selection of spreading biquarks on the surface of fullerene are:

- principle of the approximate number of asymmetrical bonds B_a to symmetrical B_s with the possibly small difference amongst B_a and B_s - criterion of the stability of the particle (long lifetime),
- minimum of the energy creating integral mass of the particle at fulfilling the above condition, that is if for example the particle has 30 biquark bonds, it if a decomposition of bonds B_a,B_s (15,15) exists - it will be more probable than the more energy decomposition (16,14).

[5] C. Amsler *et al.* (Particle Data Group), Physics Letters **B667**, 1 (2008) and 2009 partial update for the 2010 edition. Cut-off date for this update was January 15, 2009, http://pdg.lbl.gov/2009/listings/contents_listings.html

Amongst many possible of spreading biquarks in the structure of hyperon, below is introduced a few the most probable from them for both variants of pre-proton with spins $^1/_2$ ħ and $^3/_2$ ħ.

Variant 1 Pre-proton in the configuration: N (8,8) + diagonal bonds (4,1)

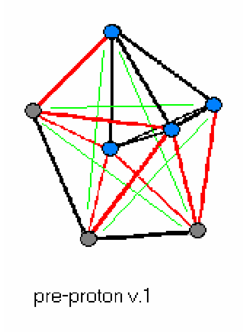


Fig.2.1 Variant v.1 of pre-proton

For the summary spin **S** = $^1/_2$ **ħ** the variant v.1 has one interested layout:

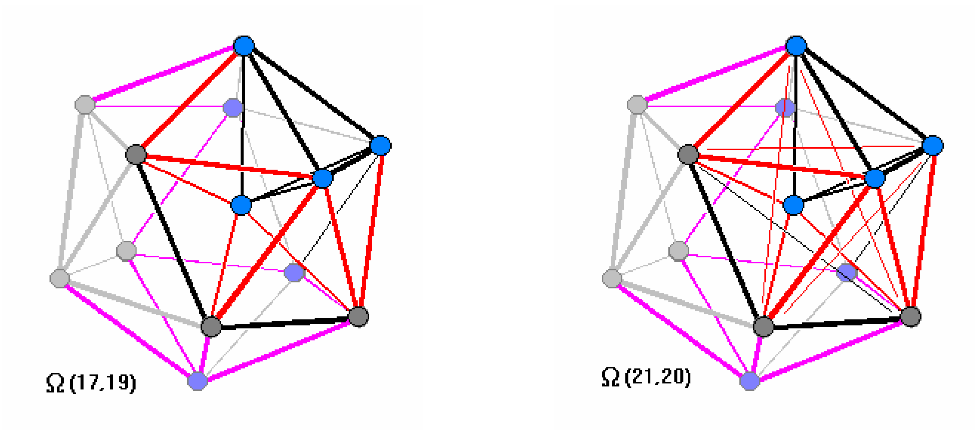


Fig.2.2 Variant v.1 „min" without diagonal internal bonds giving essentially $17B_a + 19B_s$ and „max" with all 5 diagonal bonds $21B_a + 20B_s$

For the better visualization of spreading biquarks in the solid, bonds between them and cascade breakdowns to less massive hyperons we will be presenting such structures in the distorted, but clearer way, for example:

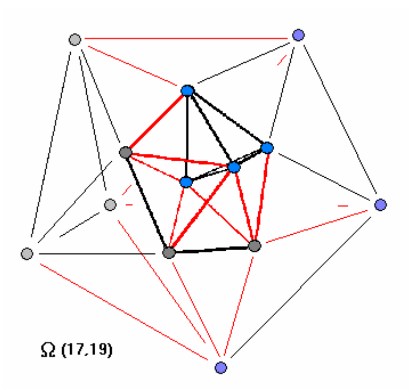


Fig.2.3 Graph of hyperon Ω in the variant v.$1_{1/2}$

If we will do the simple assumption, that any number of appearing of internal diagonal bonds in the structure of pre-proton in the hyperon Ω can be equally probable, we can calculate the mean energy of bonds for this variant (arithmetic mean amongst value "max" and "min").

$$\text{v.}1_{\text{min}} = 17B_a + 19B_s = 1540.29 \text{ [MeV]}$$

$$\text{v.}1_{\text{max}} = 21B_a + 20B_s = 1785.51 \text{ [MeV]}$$

$$\mathbf{v.1_{1/2\ \acute{s}r} = 1662.90\ [MeV]}$$

For the summary spin **S =** $^{3}/_{2}$ **ђ** the v.1 variant has two complementary layouts:

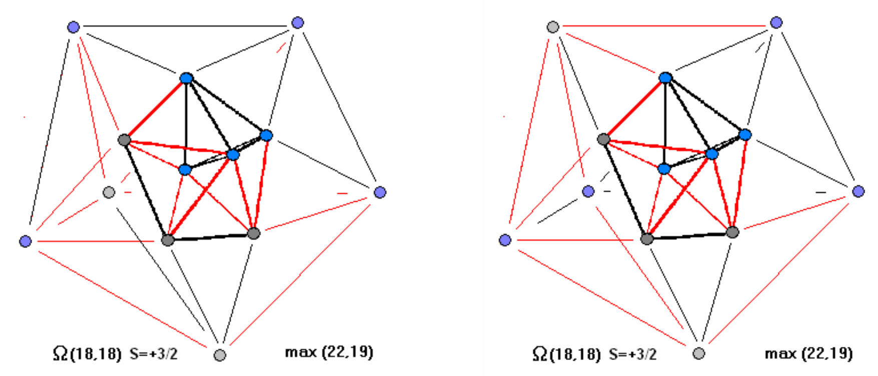


Fig.2.4 Graphs of hyperon Ω in the variant v.$1_{3/2}$

$$\text{v.}1_{\text{min}} = 18B_a + 18B_s = 1559.38 \text{ [MeV]}$$
$$\text{v.}1_{\text{max}} = 22B_a + 19B_s = 1804.60 \text{ [MeV]}$$

$$\mathbf{v.1_{3/2\ \acute{s}r} = 1681.99\ [MeV]}$$

Variant 2 Pre-proton in the configuration: N (10,6) + diagonal bonds (2,3)

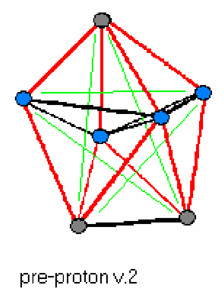


Fig.2.5 Variant v.2 of pre-proton

For the summary spin **S =** $^{1}/_{2}\,\hbar$ variant v.2 has three interested layouts.

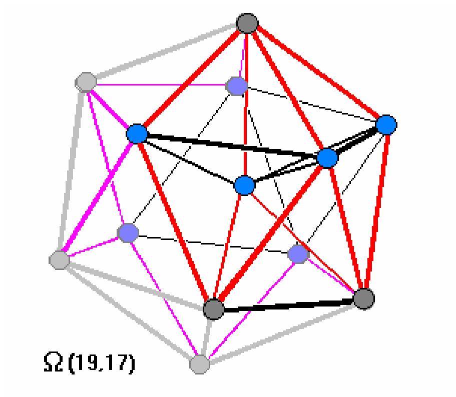


Fig.2.6 Variant v.2 „min"
– one thing from 3 layouts (19,17)

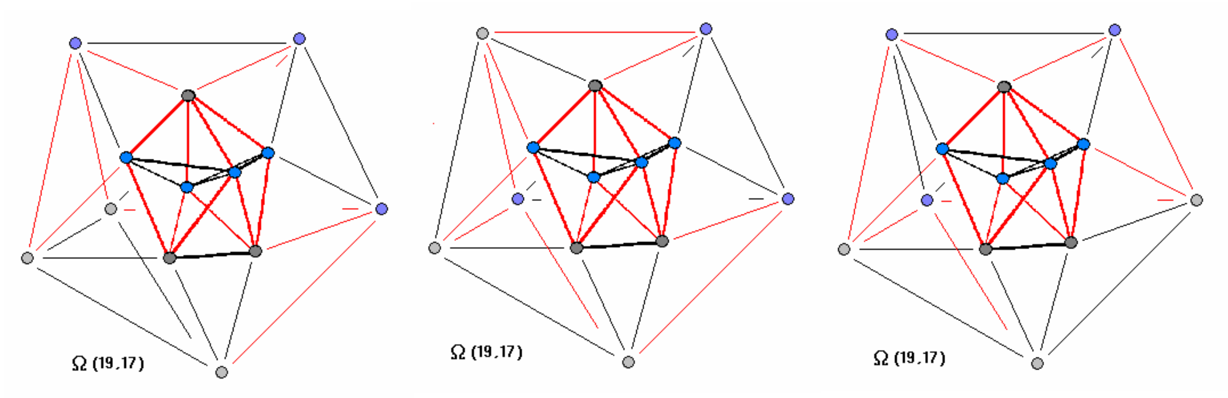


Fig.2.7 Graphs of 3 layouts of biquarks (19,17) for the v.2 variant with the spin S = $^{1}/_{2}\,\hbar$

$$\mathrm{v.2}_{\mathrm{min}} = 19B_a + 17B_s = 1578.47\ [\mathrm{MeV}]$$
$$\mathrm{v.2}_{\mathrm{max}} = 21B_a + 20B_s = 1785.51\ [\mathrm{MeV}]$$

$$\mathbf{v.2_{1/2\ śr} = 1681.99\ [MeV]}$$

For the summary spin **S =** $^{3}/_{2}\,\hbar$ variant v.2 has layout:

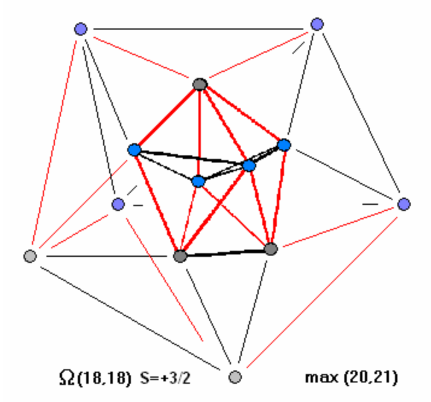


Fig.2.8 Graph of hyperon Ω in the variant $\mathrm{v.2}_{3/2}$

$$\mathrm{v.2}_{\mathrm{min}} = 18B_a + 18B_s = 1559.38\ [\mathrm{MeV}]$$
$$\mathrm{v.2}_{\mathrm{max}} = 20B_a + 21B_s = 1766.42\ [\mathrm{MeV}]$$

$$\mathbf{v.2_{3/2\ śr} = 1662.90\ [MeV]}$$

In order to appoint average mass of hyperon Ω let us accept the simplest assumption, that both variants of this hyperon are equally probable for both states of spin. So let us enumerate the arithmetic mean value of mass for these cases:

S = $^1/_2$ ħ

$$v.1_{1/2\ śr} = 1662.90\ [MeV]$$
$$v.2_{1/2\ śr} = 1681.99\ [MeV]$$

mean value is equal: $\mathbf{m_{\Omega śr} = 1672.44\ [MeV]}$

S = $^3/_2$ ħ

$$v.1_{3/2\ śr} = 1681.99\ [MeV]$$
$$v.2_{3/2\ śr} = 1662.90\ [MeV]$$

mean value is equal: $\mathbf{m_{\Omega śr} = 1672.44\ [MeV]}$

How we can see for both states of spin we have the same value of mass exactly, and at accurate calculations for:

$B_a = 52.860395$ [MeV]

$B_s = 33.771919$ [MeV]

$$\mathbf{m_{\Omega śr} = 1672.44417\ [MeV]}$$

Value of this mass exactly agrees with value of mass: 1672.45 (29) [MeV] presented by sources:

C. Amsler *et al.* (Particle Data Group), Physics Letters **B667**, 1 (2008) and 2009 partial update for the 2010 edition. Cut-off date for this update was January 15, 2009, http://pdg.lbl.gov/2009/listings/contents_listings.html

We should however emphasize that the above the enumerated average mass according to the MSq model can slightly be lowered from the account for not taking masses of lepton bonds into consideration which are certainly appearing in the structure of hyperons.

3. Cascade decays of hyperons Ω, Ξ, Σ, Λ

In the process of the cascade disintegration of the Ω hyperon one by one hyperons are coming into existence: Ξ, (Σ^o), Λ, all the way to the nucleon N (proton or neutron). From analysis of masses of these hyperons, of their spins and of accepted fullerene structure of the Ω hyperon it results that the process of the disintegration of fullerene $^{30}\mathbf{f}^{\Lambda}{}_{12}$ to N is proceeding with stages. Most oftentimes in the process of consecutive breakdowns are breaking away from it for two bonded biquarks with a few cracking gluon bonds and with lepton structures (with virtual electrons connected with neutrinos) altogether forming charged or neutral pions. The lifetime of next hyperons is tied together with time of disintegration of a few bonds causing the detachment of pairs of biquarks (to the power 10^{-10}[s]).

Below on graphs are shown consecutive phases of breakdowns of hyperons in the sequence: Ω => Ξ + Π

Ξ => Λ + Π

Λ => N + Π

for one of accepted earlier variants of the Ω hyperon:

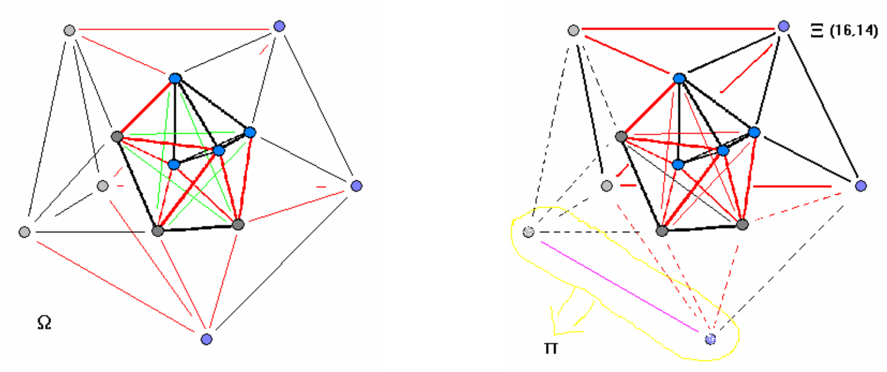


Fig.3.1 Graph of hyperon Ω in the variant v.$1_{1/2}$ and its decay into hiperon Ξ(16,14)

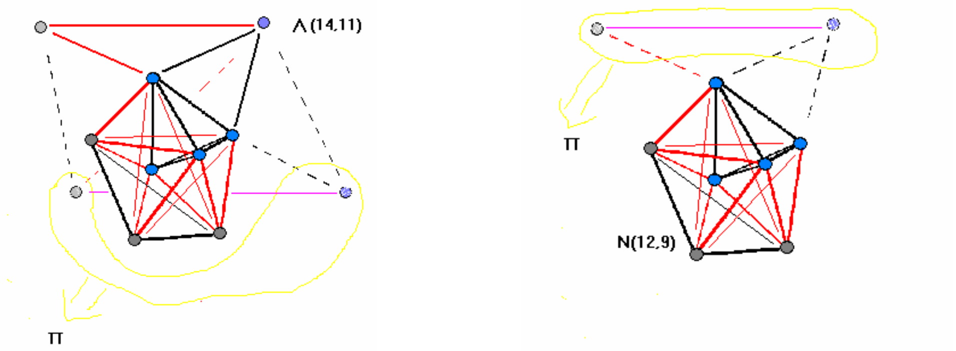


Fig.3.2 Graphs of consecutive decays into Λ(14,11) and into N(12,9).

Also breakdowns exist to photons carrying the excess angular momentum, for example: decay of hyperon Σ^o into $\gamma\Lambda$. This decay isn't conducting for taking away biquark pair with the part of bonds from lattice points of the structure of fullerene, but it relies in being transformed of single gluon bond B_a with emission of the photon to the symmetrical B_s bond. The number of lattice points in the torn structure of fullerene remains permanent, but one biquark with the opposite spin from the gluon is turning up at one of them. Former biquark of this lattice point with the second biquark from the gluon (spins with compatible direction) is undergoing the annihilation to the photon and the γ_g quantum. (or to the pair electron-positron in the case of catching the additional γ_g quantum).

Below is presented pattern of the gluon bond B_a and its breakdown into B_s. The gluon is marked with blue edge. The "clean" asymmetrical B_a bond and the gluon bond of this type have the same value of the binding energy (the same masses):

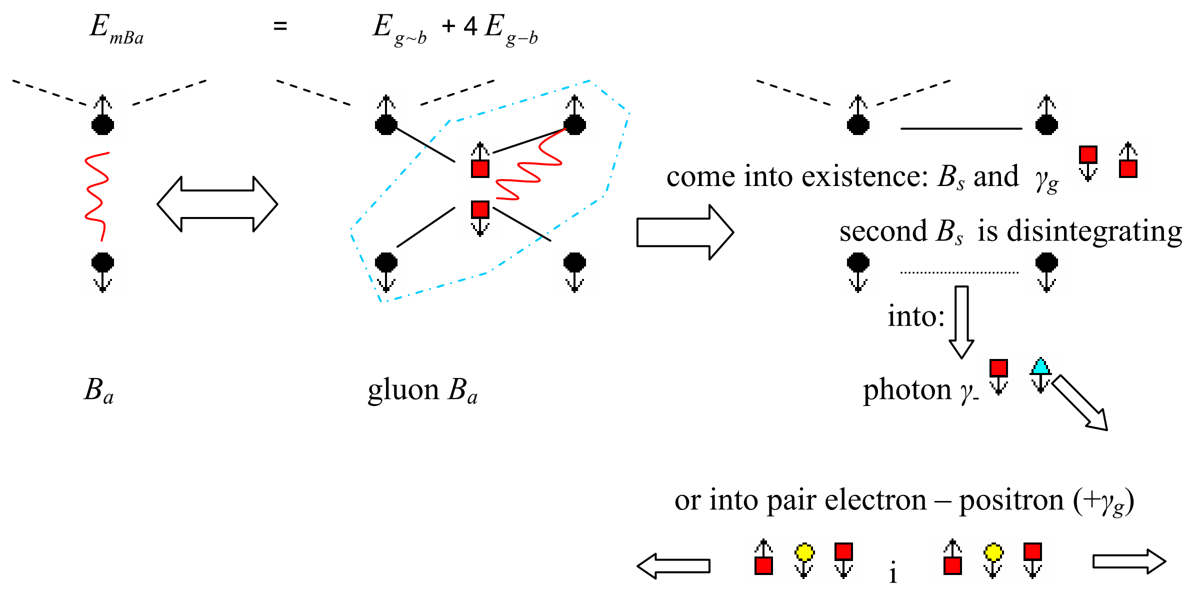


Fig.3.3 Scheme of the decay of the asymmetrical gluon bond B_a to symmetrical B_s with emission of photon or pair electron-positron.

We will trace such a decay on the series of breakdowns considering the hyperon Σ^o:

$\Omega \Rightarrow \Xi + \Pi$

$\Xi \Rightarrow \Sigma^o + \gamma$

$\Sigma^o \Rightarrow \Lambda + \gamma$

$\Lambda \Rightarrow N + \Pi$

The first decay of the Ω hyperon into Ξ and the last decay of the Λ hyperon into N are proceeding identically as higher. However hyperon Ξ is breaking down into Σ^o with emission of the γ quantum, rather than at once into Λ. Σ^o is also breaking down into Λ with emission of the photon. It looks, that Σ^o is an unsuccessful attempt of the Ξ decay (kind of uncompleted).

Slow transformation of the gluon bond B_a into B_s. Fast disintegration of the single bond B_a.

=> =>

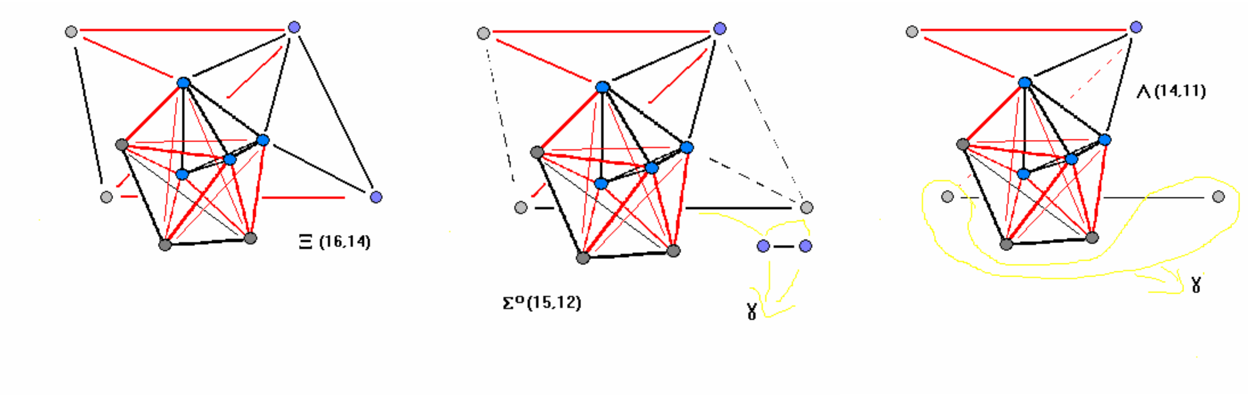
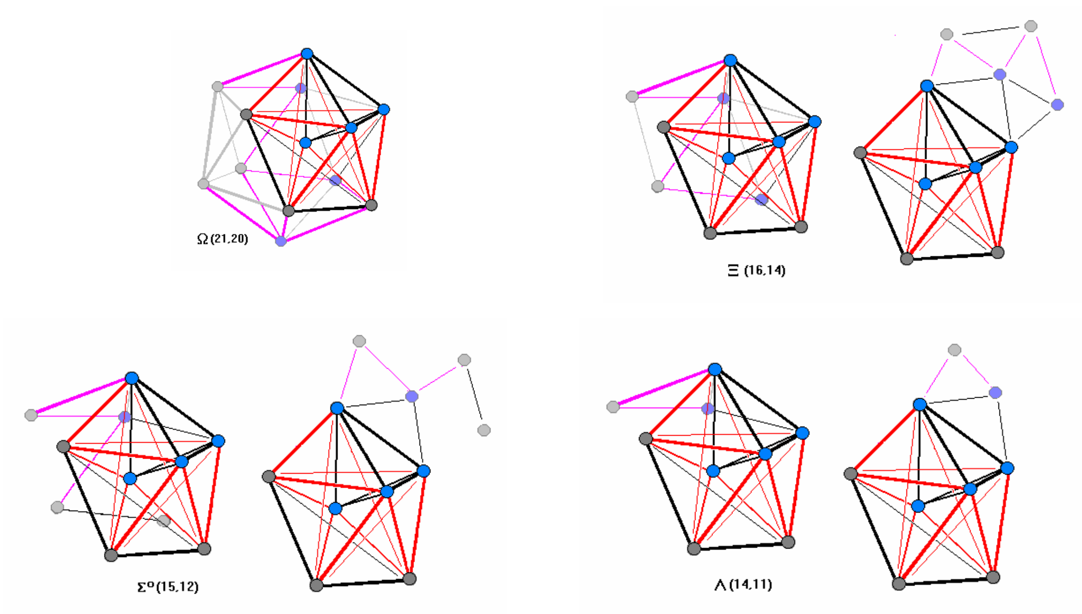


Fig.3.3 Graphs of consecutive breakdowns Ξ(16,14), into Σ°(15,12) and into Λ(14,11).

From the short lifetime of hyperon Σ° (to the power 10^{-20}[s]) results, that single bond B_a (at the back structures of pre-proton) very much quickly is undergoing tearing and freeing pair of biquarks about compatible spins, which is disintegrating to the photon.

Discussed hyperons are introduced below in forms of three-dimensional models.



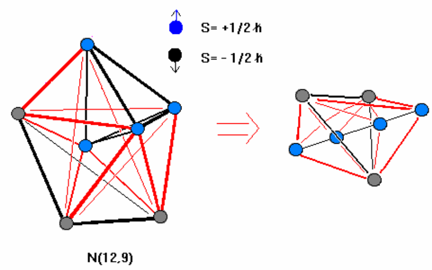


Fig.3.4 Models of hyperons: Ω, Ξ, Σ°, Λ, N

4. Remaining hyperons

The structure of hiperons Σ^+ and Σ^- must differ compared with Σ^o. It is involved with the very different time of the disintegration of these particles. Σ^+ and Σ^- have the lifetime comparable to the slow disintegration of hyperons: Ω, Ξ and Λ. They are breaking down almost always into N nucleons and pions, and they are rising from Ξ hyperons with emission of photon or pair electron-neutrino.

From analysis of their creation, breakdowns and masses results, that they should apart from the pre-proton structure (12,9) to contain additionally (3,3) or (2,4) asymmetrical and symmetrical biquark bonds. Number of biquarks in knots of fullerene should be identical as in hiperonie Ξ.

Below are presented two models of these particles.

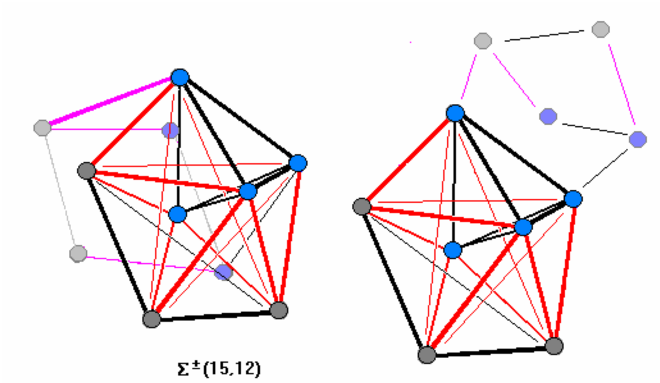


Fig.4.1 Model of hyperon Σ^+ and $\Sigma^-(15,12)$ with mass m_Σ = 1198.17 [MeV]

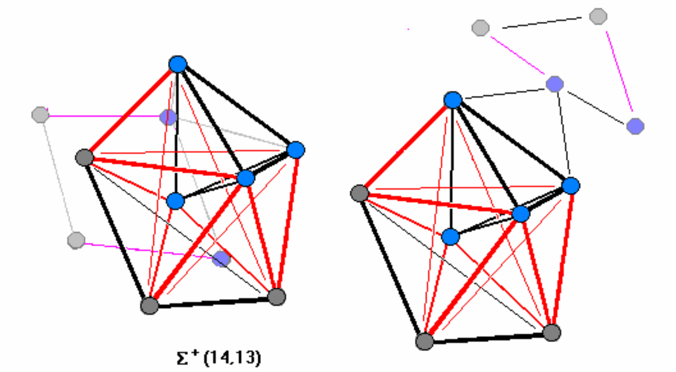


Fig.4.2 Model of hyperon $\Sigma^+(14,13)$ with mass m_Σ = 1179.08 [MeV]

Hyperons delta constitute the independent group (1232): Δ^-, Δ^o, Δ^+, Δ^{++} with spin $S = {}^3/_2\, ħ$.

From analysis of their creation results, that they don't participate in cascade higher described breakdowns – there are no Δ breakdowns to less massive hyperons Σ and Λ. Because they decay exclusively into nucleons and pions (and probably into photons carrying the excess angular momentum), so they must have the hard core compound of the pre-proton or proton structure and a few additional biquark bonds (3,4).

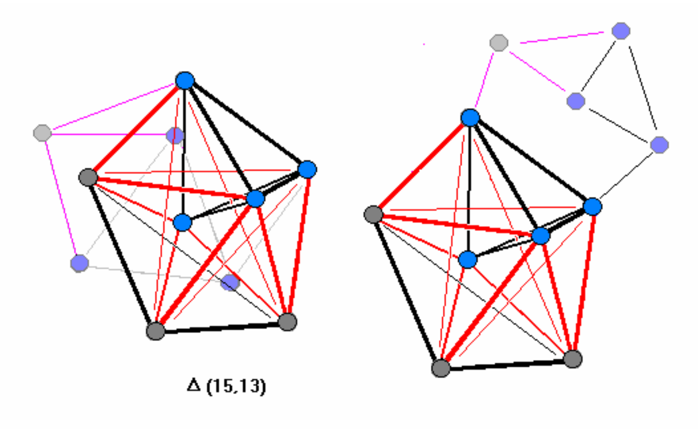


Fig.4.3 Model of hyperon Δ (15,13) with mass m_Δ = 1231.94 [MeV]

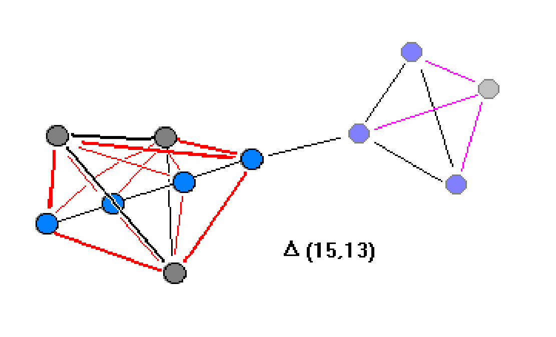


Fig.4.4 Model of hyperon Δ (15,13) in the different variant
(the structure of the N nucleon connected with the solid of the regular tetrahedron $^6f^\Delta{}_4$)

5. More massive baryons - examples

Below are presented models of baryon Λ_c. We can see the difference in their structure in the relationship to hyperons. This time pre-proton with a few diagonal bonds or the nucleon is surrounded with complete structure of fullerene $^{30}\mathbf{f}_{20}$. A Λ_c breakdown is a disintegration of bonds of fullerene. The part from them will produce kaon and/or a few pions. The part of the energy directed at the middle can with the pre-proton create the structure of one of hadrons (hyperons) or N.

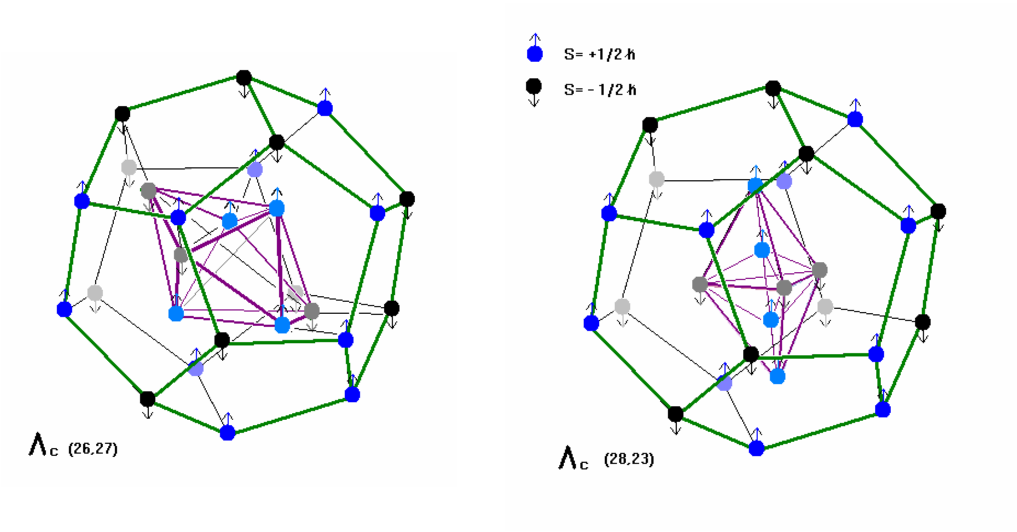


Fig.5.1 Models of baryon Λ_c (26,27) and (28,23)

More massive Λ_b baryon is presumably the proton N structure inside fullerene $^{105}\mathbf{f}_{70}$ or the Ω structure inside fullerene $^{90}\mathbf{f}_{60}$.

6. *The table of masses of hyperons and families of baryons Λ*

Table 6.1 of masses of hyperons and families of baryons Λ
(not taken into consideration lepton bonds with virtual electrons, neutrinos and particles *g*)

particle	**exsp.mass**[6] [MeV]	**structure according to MSq**	**model mass** [MeV]	**sum of biquark bonds B_a, B_s** {umber of biquarks}	**Δ m** [MeV]	**radius R** [fm]
N	938.2720	triangular dipyramid	938.2720	12,9 {7}		1.13 / 1.60
Δ^-, Δ^o, Δ^+, Δ^{++}	~1232	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1231.94	15,13 {11}	0.1	~1.86
Λ	1115.683 (6)	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1107.13 1126.22 1111.54 1130.63	12,14 {9} 13,13 {9} 14,11 {9} 15,10 {9}	8.6 -10.5 4.2 -14.9	~1.86
Σ^o	1192.642 (24)	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1198.17 1193.76 1179.08	15,12 {11} 13,15 {11} 14,13 {11}	-5.5 -1.1 13.6	~1.86
Σ^-	1197.45 (4)	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1183.49 1198.17 1193.76	16,10 {11} 15,12 {11} 13,15 (11)	14.0 -0.7 3.7	~1.86
Σ^+	1189.37 (7)	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1179.08 1183.49 1193.76 1198.17	14,13 {11} 16,10 {11} 13,15 {11} 15,12 {11}	10.3 5.9 -4.4 -8.8	~1.86
Ξ^o	1314.86 (20)	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1314.17 1318.57	14,17 {11} 16,14 {11}	0.7 -3.7	~1.86
Ξ^-	1321.71 (7)	fragment of ${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1314.17 1318.57	14,17 {11} 16,14 {11}	7.5 3.1	~1.86
Ω^- S=1/2	1672.45 (29)	${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1662.90 1681.99 **1672.44**	~19,19.5 {13} ~20.18.5 {13} **~19.5,19 {13}**	 0.1	1.86
Ω^- S=3/2	1672.45 (29)	${}^{30}\mathbf{f}^{\Lambda}{}_{12}$ + pre-**N**	1681.99 1662.90 **1672.44**	~20.18.5 {13} ~19,19.5 {13} **~19.5,19 {13}**	 0.1	1.86
Λ_c	2286.46 (14)	${}^{30}\mathbf{f}_{20}$ @ pre-**N** ${}^{30}\mathbf{f}_{20}$ @ **N** + (0,1)	2286.21 2290.62	~26,27 {27} 28,24 {27}	0.3 -4.2	2.75
Λ_b	5620.2 (1.6)	${}^{105}\mathbf{f}_{70}$ @ **N** + (0,2) ${}^{90}\mathbf{f}_{60}$ @ ${}^{30}\mathbf{f}^{\Delta}{}_{12}$ + pre-**N**	5620.82	68,60 {77} ~68,60 {73}	-0.6	4.90 / 5.10 4.90

(for: B_a = 52.860395 [MeV] and B_s =33.771919 [MeV])

[6] C. Amsler *et al.* (Particle Data Group), Physics Letters **B667**, 1 (2008) and 2009 partial update for the 2010 edition. Cut-off date for this update was January 15, 2009, http://pdg.lbl.gov/2009/listings/contents_listings.html