The Complete Energy Translations in the Detailed Decay Process of Baryonic Sub-Atomic Particles.

[4]

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Abstract.

This is the final paper on the characteristics and decay processes of those Baryonic sub-atomic particles for which a decay product is known. The whole decay process is described in terms of the total energy translations that take place during the complete process together with a full description of the trigger mechanisms that cause each event to occur.

Contents.

1.0 Introduction.

In the final Addendum to P11, (#6), [9], it was stated that all previous papers in this series, [3], [4], [5], [6], [7], [8] and [9], described the decay of Baryons via firstly, the energy distribution of a particle effectively at the point of its creation, and secondly, the interim energy distribution at the point at which it transforms to the decayed particle. Consequently, to fully describe the overall process, what is now required are complete details of the events that take place between these two energy distributions, together with a description of the trigger mechanisms that cause these events.

It is the purpose of this paper to provide these details.

The manner in which this will be done is firstly to identify the criteria specific to the decay process, which also effectively identifies the event triggers mentioned above. Secondly, the detailed decay process itself will be described by means of a number of specific examples for each unique decay group.
There are also a number of ancillary tasks pertinent to the presentation which are itemised as follows.

(i) The final analysis resulting in this paper has enabled a modification and consolidation of all Decay Types. A complete correlation of the Decay Types used in this paper with those in all previous papers is the subject of Appendix A.
(ii) One of the most important decay criteria that will be listed below is the energy ratios, both resonance and confinement, between quarks in all Baryons. The empirical data that identified this criteria is the subject of Appendix B.
(iii) The completion of the analysis resulting in this paper has also enabled the identification of full details of the decay characteristics of all Baryons for which a decay product is known. Appendix C summarises this data for all $J = 1/2\hbar$ Particles and Appendix D for all $J = 3/2\hbar$ Particles.
(iv) Finally, to complete the overall picture, Appendix E presents a compendium of Baryon particle decay statistics as determined in this series of papers.

Note that as in all previous papers, only those particles with intrinsic angular momenta of $J = 1/2\hbar$ and $J = 3/2\hbar$ are considered here.

Also note that energy will be represented as equivalent mass via the units MeV/c^2, which, for concisement, will be assumed and therefore omitted in the text.

Finally, for a full appreciation of this paper, it is recommended that [3] and at least one of [4] or [5] be read first.

2.0 Nomenclature.

In this paper the following nomenclature will be used.

- $q_\#$ Indicates the #th quark in any Baryon.
- $\rightarrow$ Indicates a particle decay.
- $\Rightarrow$ Indicates a quark flavour change.

3.0 Initial Discussions.

3.1 The Criteria Specific to the Decay Process.

In [3] a small list of decay rules were discussed. These rules were generic only and while perfectly valid were insufficient in themselves to control or explain how the detailed decay process is manifested. To do this requires extensive additional criteria and these are listed and briefly discussed below.

Criteria #1. Quark energy is interchangeable, i.e. matter, resonance and confinement energy can, when triggered, convert freely from one to another on the same quark. Confinement energy is the only energy that can interchange between quarks, or be ejected, because it is the binding energy that holds the quarks together in the Baryon.

Criteria #2. The ratio of the energy content of all quarks within a Baryon is (i) for confinement energy, proportional to the ratio of quark mass. In addition, in any decay the transference of confinement energy between quarks will also adhere to this ratio. (ii) For resonance energy it is proportional to the inverse ratio of quark mass. It is the second part of this criteria, i.e. (ii), that takes precedence because resonance energy conversion to/from matter/confinement energy, is confined to each quark as stated in Criteria #1.

Criteria #3. During the decay process a quark will redistribute its internal resonance energy to that of a quark in a lower energy particle if its total energy content becomes equal to that of the quark in the lower energy particle.

Criteria #4. To initiate a particle decay it is always the quark(s) with the highest total energy that makes the initial flavour change to a lower energy quark(s).

Criteria #5. A quark cannot change flavour to one with the opposite direction of intrinsic angular momentum.

Criteria #6. A quark can change up flavours if its total energy content becomes equal to that of the higher level quark, or if forced to do so as a result of other quarks readjusting resonance energy in accordance with Criteria #3 and #2(ii).

Criteria #7. A simultaneous double quark flavour change can take place from two identical quarks that possess the highest total energy in the decaying particle, to two quarks that are also identical in the decayed particle. This only occurs to initiate a particle decay as in Criteria #4.

Criteria #8. A quark that has changed any number of flavours to initiate a particle decay can be forced to reverse that change as a result of it, or a second quark, re-balancing its total energy as in Criteria #3. This reversal is forced via the decaying particle maintaining conformance to Criteria #2.

Criteria #9. For the particles considered here, a confinement energy only decay, i.e. with no quark flavour change, is only exhibited by particles possessing three different quarks. However, it is known that most if not all Baryons can possess higher levels of resonance energy, greater than that applicable to an intrinsic angular momentum of $J = 3/2\hbar$ and it is believed that these particles may also possess higher levels of confinement energy.

The above decay criteria are the only ones necessary to dictate the decay process of all Baryons considered in this series of papers. It is also to be noted that the following sub-set of them also act as triggers mechanisms to initiate the various events that take place during the decay process - Criteria # - 3,4,6,7.

All of the above will be fully illustrated in the examples presented in Section 4.

3.2 Modification and Consolidation of Decay Types.

In [3] to [6] a total of 24 decay types were identified. These arose because the results presented in those references were curtailed in that the energy distribution patterns shown were firstly that at the point of creation of the decaying particle, and secondly that at the point of energy ejection, i.e. the final interim energy distribution. This resulted in the ejected energy being emitted from just one quark. In the much more detailed process presented here it is shown that ejected energy can be emitted by one, two or all three quarks, depending on the level of intrinsic angular momentum of the decaying particle. However, the matter of which mode of final energy ejection is the more likely, is discussed in Section 6.
The final analysis here results in a slightly different decay type regime in which some of the earlier decay types no longer appear and which thereby enables a consolidation. The new decay type listing is shown below in Table 3.1. The decay type numbers have been re-allocated to permit easier grouping. A composite list of the previous and new types is shown in Appendix A.

Decay Type Number	Quark Flavour Change		Interim Energy Distribution – Sign of Confinement Energy		
	Down	**Up**	**q_1**	**q_2**	**q_3**
1	**q_3**		+	**+**	**+**
2	**q_3**		+	+	**+** ($J = 3/2\hbar$)
3	**q_3**		**-**	+	+
4	**q_3**		**-**	**-**	+
5	**$q_{1/2}$**		+	+	+
6	**$q_{1/2}$**		**-**	+	+
7	**q_3, $q_{1/2}$**		+	+	+
8	**q_3, $q_{1/2}$**		-	+	+
9	**q_3**	**$q_{1/2}$**	+	+	+
10	**q_3**	**$q_{1/2}$**	**-**	+	+
11	**q_3**	**$q_{1/2}$**	**-** ($J = 3/2\hbar$)	+	+
12		**$q_{1/2}$**	+	+	+
13		**$q_{1/2}$**	**-**	+	+
14	Confinement Energy Only Decay.		+	+	+

Extra Decay Types for $J = 3/2\hbar$.

Decay Type Number	Quark Flavour Change		Interim Energy Distribution – Sign of Confinement Energy		
	Down	**Up**	**q_1**	**q_2**	**q_3**
15	Resonance Energy Only Decay		+	+	+
16	Resonance Energy Only Decay		**-**	+	+
17		**q_3**	+	+	+

Table 3.1 – Modified and Consolidated Decay Types.

Note in Table 3.1 $q_{1/2}$ means q_1 or q_2.

The following brief table now shows the consolidation of the above decay types into Groups.

Group	Decay Types
1	1 to 4
2	5 and 6
3	7
4	9 to 11
5	12,13 and 17
6	14
7	15 and 16

Table 3.2 – Decay Type Groups.

It is for these seven decay type groups that the detailed examples are presented below.

4.0 Detailed Examples of Specific Decay Type Groups for $J = 1/2\hbar$ Particles.

To enable a full appreciation of the decay process, the events that take place are shown below in consecutive order. It is however believed the process is one in which all events, apart from confinement energy quark to quark translations, occur virtually simultaneously. Also, to precisely illustrate the manner in which events are triggered, the description in the examples is presented by particular reference to each applicable decay criteria. Finally, to relate the following example processes to the energy distributions of the decayed particle, [4] to [6] may be referred to for details of these distributions.

4.1 Decay Type Group 1 – (Single Quark Flavour Change q_3 Down), Example Σ^+ to p^+.

Starting with the energy distribution of Σ^+.

Energy	u_1	u_2	s_1	Total
Matter	2.40	2.40	100.00	104.80
Resonance	47.79	47.79	1.15	96.72
Confinement	22.62	22.62	942.61	987.86
Total	72.81	72.81	1043.76	1189.38

Table 4.1 – Energy Distribution of Σ^+.

This is the energy distribution essentially at the point of its creation.

Decay Criteria #4 – The quark with the highest total energy is s_1 which in accordance with Decay Criteria #4 changes down one level to a d. The initial decay path is therefore to p^+.

Decay Criteria #2(ii) – This immediately unbalances the resonance energy ratios which therefore re-adjust by u_1 and u_2 converting confinement energy to resonance and by $s_1 \Rightarrow d_1$ converting some matter energy to resonance, the balance converting to confinement. The interim energy distribution at this point has then become as per Table 4.2 below.

Energy	u_1	u_2	d_1	Total
Matter	2.40	2.40	4.75	9.55
Resonance	58.62	58.62	29.62	146.87
Confinement	11.78	11.78	1009.39	1032.96
Total	72.81	72.81	1043.76	1189.38

Table 4.2 – Interim Energy Distribution After the Quark Flavour Change $s_1 \Rightarrow d_1$.

Decay Criteria 2(i) – The quark flavour change $s_1 \Rightarrow d_1$ and subsequent re-balancing of the resonance energy ratios has unbalanced the confinement energy ratios. These now start to re-balance by d_1 transferring confinement energy to u_1 and u_2.

Decay Criteria #3 – However, as this process continues, the following interim energy distribution is reached.

Energy	u_1	u_2	d_1	Total
Matter	2.40	2.40	4.75	9.55
Resonance	58.62	58.62	29.62	146.87
Confinement	196.49	196.49	639.97	1032.96
Total	257.51	257.51	674.34	1189.38

Table 4.3 – Interim Energy Distribution at the Point of Energy Ejection.

In this configuration both u_1 and u_2 have acquired the total energy of the u quarks in the Proton and the decay is completed by d_1 ejecting 251.10 of confinement energy and thereby falling to the Proton level of 388.88.

4.2 Decay Type Group 2, (Single Flavour Change of q_1 or q_2 Down), Example Σ^- to Λ^0.

Once again starting with the energy distribution of Σ^-.

Energy	d_1	d_2	s_1	Total
Matter	4.75	4.75	100.00	109.50
Resonance	46.34	46.34	2.20	94.88
Confinement	43.08	43.08	906.92	993.08
Total	94.17	94.17	1009.12	1197.46

Table 4.4 – Energy Distribution of Σ^-.

Decay Criteria #4. – The highest energy quark is s_1 which changes flavour down two levels to a u. The initial decay path is therefore towards n^0.

Decay Criteria 2(ii). – This unbalances the resonance energy ratios which re-balance by d_1 and d_2 converting resonance energy to confinement and $s_1 \Rightarrow u_1$ converting some matter energy to resonance, the balance converting to confinement. The first interim energy distribution has thereby become

Energy	d_1	d_2	u_1	Total
Matter	4.75	4.75	2.40	11.90
Resonance	36.75	36.75	72.73	146.22
Confinement	52.67	52.67	934.00	1039.34
Total	94.17	94.17	1009.12	1197.46

Table 4.5 – First Interim Energy Distribution After the Quark Flavour Change $s_1 \Rightarrow u_1$.

Decay Criteria 2(i) – The quark flavour change $s_1 \Rightarrow u_1$ and the subsequent re-balancing of the resonance energy ratios has unbalanced the confinement energy ratios. These now start to re-balance by u_1 transferring confinement energy to d_1 and d_2.

Decay Criteria #3 – During this process the following point would be reached.

Energy	d_1	d_2	u_1	Total
Matter	4.75	4.75	2.40	11.90
Resonance	36.75	36.75	72.73	146.22
Confinement	80.44	80.44	878.45	1039.34
Total	121.94	121.94	953.58	1197.46

Table 4.6 – Interim Energy Distribution During Rebalancing of Confinement Energy.

At this point the total energy of u_1 has dropped to the same value as s_1 in Λ^0.

Decay Criteria #8 – Consequently, in accordance with decay criteria #8, u_1 changes flavour back up two levels to an s again.

Decay Criteria #3 – This again unbalances the resonance energy ratios which re-balance by firstly $u_1 \Rightarrow s_1$ converting both resonance and confinement energy to matter, to obtain the energy distribution of s_1 in Λ^0.

Decay Criteria #6 – The re-balancing of resonance energy can now only be completed by either d_1 or d_2 changing flavour down one level to a u, and converting matter and confinement energy to resonance energy. The interim energy distribution has thus become.

Energy	u_1	d_1	s_1	Total
Matter	2.40	4.75	100.00	107.15
Resonance	62.47	31.56	1.50	95.53
Confinement	57.07	85.63	852.08	994.78
Total	121.94	121.94	953.58	1197.46

Table 4.7 – Interim Energy Distribution After the Second Quark Flavour Change $d_1 \Rightarrow u_1$.

All quarks now have the resonance energy levels of Λ^0 and s_1 has the confinement energy level of Λ^0. However, the confinement energy ratio between u_1 and d_1 is still unbalanced so that a small amount of confinement energy flows from u_1 to d_1 to correct this and realise the final interim energy distribution as

Energy	u_1	d_1	s_1	Total
Matter	2.40	4.75	100.00	107.15
Resonance	62.47	31.56	1.50	95.53
Confinement	47.90	94.80	852.08	994.78
Total	112.77	131.11	953.58	1197.46

Table 4.8 – Final Interim Energy Distribution.

The decay is completed by u_1 ejecting confinement energy 27.45 and d_1 ejecting confinement energy 54.32 for a total of 81.78, thereby both falling to the confinement energy levels of Λ^0.
It is to be noted that the branching fraction for this decay is only 0.15%, the balance being to n^0.
Also note that the ratio of energy ejected by u_1 and d_1 conform to decay criteria #2(i).

4.3 Decay Type Group 3, (Two Consequtive Quark Flavour Changes, q_1 or q_2, and q_3 Down), Example $\Xi_c^+ \rightarrow p^+$.

The energy distribution of Ξ_c^+ is

Energy	u1	s1	c1	Total
Matter	2.40	100.00	1250.00	1352.40
Resonance	34.26	0.82	0.07	35.15
Confinement	1.92	79.88	998.46	1080.25
Total	38.58	180.70	2248.52	2467.80

Table 4.9 – Energy Distribution of Ξ_c^+.

Dceay Criteria #4 – In this decay c_1 changes flavour down three levels to a u. The initial decay path is therefore towards Σ^+.

Decay Criteria #2(ii) – so that after re-balancing the resonance energy ratios, the first interim energy distribution becomes

Energy	u1	s1	d2	Total
Matter	2.40	100.00	4.75	107.15
Resonance	95.61	2.29	48.31	146.22
Confinement	-59.44	78.40	2195.46	2214.43
Total	38.58	180.70	2248.52	2467.80

Table 4.10 – First Interim Energy Distribution After the Quark Flavour Change $c_1 \Rightarrow u_2$.

Decay Criteria #2(i) – During re-balancing of the confinement energy ratios the following point would be reached.

Energy	u1	s1	d2	Total
Matter	2.40	100.00	4.75	107.15
Resonance	95.61	2.29	48.31	146.22
Confinement	7.70	320.96	1885.77	2214.43
Total	105.72	423.25	1938.83	2467.80

Table 4.11 – Interim Energy Distribution During the Re-Balancing of Confinement Energy Ratios.

Decay Criteria #6 – Here s_1 has acquired the total energy level of d_1 in p^+ and changes flavour down one level to a d.

Decay Criteria #3 – and re-arranges its energy levels to that in p^+.

Decay Criteria #2(ii) – This then forces u_1 and u_2 to re-arrange their resonance energies to those of u_1 and u_2 in p^+. The interim energy distribution has therefore become

Energy	u1	d1	u2	Total
Matter	2.40	4.75	2.40	9.55
Resonance	58.62	29.62	58.62	146.87
Confinement	-3.11	388.88	1925.61	2311.38
Total	57.92	423.25	1986.63	2467.80

Table 4.12 – Interim Energy Distribution After the Second Quark Flavour Change.

Decay Criteria #2(i) – The re-balancing of confinement energy continues to realise the final interim energy distribution

Energy	u1	d1	u2	Total
Matter	2.40	4.75	2.40	9.55
Resonance	58.62	29.62	58.62	146.87
Confinement	196.49	388.88	1726.01	2311.38
Total	257.51	423.25	1787.04	2467.80

Table 4.13 – Final Interim Energy Distribution After the Re-Balancing of Confinement Energy Ratios.

The decay is completed by u_2 ejecting 1529.52 of confinement energy to fall to the p^+ level of 196.49.

4.4 Decay Type Group 4, (Two Consequetive Quark Flavour Changes, q_3 Down and q_1 or q_2 Up), Example $\Xi_b^0 \to \Xi^-$.

The energy distribution of Ξ_b^0 is

Energy	u_1	s_1	b_1	Total
Matter	2.40	100.00	4300.00	4402.40
Resonance	76.96	1.85	0.04	78.85
Confinement	0.71	29.68	1276.16	1306.55
Total	80.07	131.53	5576.20	5787.80

Table 4.14 – Energy Distribution of Ξ_b^0.

Decay Criteria #4 – In this decay b_1 initially changes flavour down two levels to an s. The initial decay path is therefore to Ξ^0.

Decay Criteria #2(ii) – After re-balancing of the resonance energy ratios, the interim energy distribution has become

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	103.50	2.48	2.48	108.47
Confinement	-25.83	29.04	5473.72	5476.93
Total	80.07	131.53	5576.20	5787.80

Table 4.15 – Interim Energy Distribution After the First Quark Flavour Change $b_1 \Rightarrow s_1$.

Decay Criteria #2(i) – During re-balancing of the confinement energy ratios, the following point would be reached

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	103.50	2.48	2.48	108.47
Confinement	-14.63	495.59	4995.98	5476.93
Total	91.27	598.07	5098.46	5787.80

Table 4.16 – Interim Energy Distribution During Re-Balancing of the Confinement Energy Ratios.

Decay Criteria #3 – At this point the total energy acquired by s_1 has reached the level of s_1 in Ξ^-. s_1 accordingly re-distributes its total energy to that of s_1 in Ξ^-.

Decay Criteria #2(ii) – which forces s_2 to adjust its resonance energy to that of s_2 in Ξ^-.

Decay Criteria #6 and #2(ii) – u_1 is therefore forced to change flavour up one level to a d and adjust its resonance energy to that of d_1 in Ξ^-. The interim energy distribution has become

Energy	d_1	s_1	s_2	Total
Matter	4.75	100.00	100.00	204.75
Resonance	97.40	4.63	4.63	106.65
Confinement	-10.88	493.44	4993.83	5476.40
Total	91.27	598.07	5098.46	5787.80

Table 4.17 – Interim Energy Disribution After the Second Quark Flavour Change $u_1 \Rightarrow d_1$.

Decay Criteria #2(i) – The re-balancing of confinement energy ratios continues until it reaches the point

Energy	d_1	s_1	s_2	Total
Matter	4.75	100.00	100.00	204.75
Resonance	97.40	4.63	4.63	106.65
Confinement	23.44	493.44	4959.51	5476.40
Total	125.59	598.07	5064.14	5787.80

Table 4.18 – Final Interim Energy Distribution After Re-Balancing of the Confinement Energy Ratios.

The decay is completed by s_2 ejecting 4466.08 to fall to the confinement energy level of s_2 in Ξ^-.

4.5 Decay Type Group 5, (A Single Quark Flavour Change, q_1 or q_2 Up), Example $\Sigma_b^+ \rightarrow \Lambda_b^0$.

The energy distribution of Σ_b^+ is

Energy	u_1	u_2	b_1	Total
Matter	2.40	2.40	4300.00	4304.80
Resonance	5.20	5.20	< 0.00	10.40
Confinement	0.83	0.83	1494.43	1496.10
Total	8.43	8.43	5794.43	5811.30

Table 4.19 –Energy Distribution of Σ_b^+.

Decay Criteria #4 – For this decay b_1 initially changes flavour down two levels to an s. The initial decay path is therefore towards Σ^+.

Decay Criteria #2(ii) – After re-balancing of the resonance energy ratios, the interim energy distribution becomes

Energy	u1	u2	s1	Total
Matter	2.40	2.40	100.00	104.80
Resonance	47.79	47.79	1.15	96.72
Confinement	-41.75	-41.75	5693.29	5609.78
Total	8.43	8.43	5794.43	5811.30

Table 4.20 – Interim Energy Distribution After the First Quark Flavour Change $b_1 \Rightarrow s_1$.

Decay Criteria #2(i) – As confinement energy re-balancing proceeds, the following point will be reached.

Energy	u1	u2	s1	Total
Matter	2.40	2.40	100.00	104.80
Resonance	47.79	47.79	1.15	96.72
Confinement	-14.41	-14.41	5638.59	5609.78
Total	35.78	35.78	5739.74	5811.30

Table 4.21 – Interim Energy Distribution During Re-Balancing of the Confinement Energy Ratios.

Decay Criteria #3 and #2(ii) – At this point both u_1 and u_2 have acquired the total energy levels of d_1 in Λ_b^0. Therefore u_1, (or u_2), changes flavour up one level to a d and re-adjusts its resonance energy level to that of d_1 in Λ_b^0.

Decay Criteria #8 and #2(ii) – Therefore s_1 reverses its earlier flavour change and reverts to a b and adjusts its resonance energy level accordingly. The interim energy distribution has thereby become

Energy	u_1	d_1	b_1	Total
Matter	2.40	4.75	4300.00	4307.15
Resonance	58.74	29.68	0.03	88.45
Confinement	-25.36	1.35	1439.71	1415.70
Total	35.78	35.78	5739.74	5811.30

Table 4.22 – Interim Energy Distribution After the Second Quark Flavour Change $u_2 \Rightarrow d_1$.

Decay Criteria #2(i) – The re-balancing of the confinement energy ratios then continues to produce the final interim energy distribution thus

Energy	u_1	d_1	b_1	Total
Matter	2.40	4.75	4300.00	4307.15
Resonance	58.74	29.68	0.03	88.45
Confinement	0.68	1.35	1413.67	1415.70
Total	61.82	35.78	5713.70	5811.30

Table 4.23 – Final Interim Energy Distribution After Re-Balancing of the Confinement Energy Ratios.

The decay is completed by b_1 ejecting 191.90 of confinement energy to fall to 1221.77 the level of b_1 in Λ_b^0.

4.6 Decay Type Group 6, (Confinement Energy Only Decay, No Quark Flavour Change), Example $\Sigma^0 \rightarrow \Lambda^0$.

The energy distribution of Σ^0 is

Energy	u_1	d_1	s_1	Total
Matter	2.40	4.75	100.00	107.15
Resonance	62.47	31.56	1.50	95.53
Confinement	22.17	43.89	923.90	989.96
Total	87.04	80.20	1025.40	1192.64

Table 4.24 – Energy Distribution of Σ^0.

In Addendum #2 to [3], this decay was described as a confinement energy only decay. While the final outcome conforms to that description, the process by which it gets there must comply with the decay criteria of Section 3.1.

Decay Criteria # 4 – Accordingly, to initiate the decay, quark s_1 changes down one level to a d. The initial decay path is therefore towards n^0.

Decay Criteria #2(ii) – After re-balancing of the resonance energy ratios, the first interim energy distribution becomes

Energy	u_1	d_1	d_2	Total
Matter	2.40	4.75	4.75	11.90
Resonance	72.73	36.75	36.75	146.22
Confinement	11.91	38.70	983.90	1034.52
Total	87.04	80.20	1025.40	1192.64

Table 4.25 – Interim Energy Distribution After the First Quark Flavour Change $s_1 \Rightarrow d_2$.

Decay Criteria #2(i) – As the confinement energy ratios re-balance, the following point will be reached

Energy	u_1	d_1	d_2	Total
Matter	2.40	4.75	4.75	11.90
Resonance	72.73	36.75	36.75	146.22
Confinement	36.02	86.41	912.08	1034.52
Total	111.15	127.91	953.58	1192.64

Table 4.26 – Interim Energy Distribution During Re-Balancing of the Confinement Energy Ratios.

At this point the total energy of d_2 has fallen to the level of s_1 in Λ^0

Decay Criteria #8 – therefore d_2 changes flavour back to an s and

Decay Criteria #2(ii) – re-distributes its energy to that of s_1 in Λ^0. Consequently both u_1 and d_1 re-distribute resonance energy to achieve the same levels as u_1 and d_1 in Λ^0. The interim energy distribution has become

Energy	u_1	d_1	s_1	Total
Matter	2.40	4.75	100.00	107.15
Resonance	62.47	31.56	1.50	95.53
Confinement	46.28	91.60	852.08	989.96
Total	111.15	127.91	953.58	1192.64

Table 4.27 – Interim Energy Distribution After the Second Quark Flavour Change $d_2 \Rightarrow s_1$.

Note that the quark complement and resonance energy distribution has now returned to that of Σ^0 but with a different confinement and total quark energy level distribution. The decay is completed with u_1 ejecting 25.83 of confinement energy and d_1 ejecting 51.12 of confinement energy for a total of 76.95. Note that in the final interim energy distribution, because both matter and resonance energy levels are the same as that in Σ^0 it is only original confinement energy that has been ejected. Again note that the ratio of confinement energy that has been ejected by u_1 and d_1 conforms to decay criteria #2(i).

5.0 Detailed Examples of Decay Type Groups for $J = 3/2\hbar$ Particles.

5.1 Decay Type Group 7, (Resonance Energy Only Decay, No Quark Flavour Change), Example $\Xi^{0*} \rightarrow \Xi^0$.

The energy distribution of Ξ^{0*} is, (with u_1 possessing the enhanced resonance energy).

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	323.69	0.86	0.86	325.42
Confinement	11.91	496.04	496.04	1003.99
Total	338.00	596.91	596.91	1531.81

Table 5.1 – Energy Distribution of Ξ^{0*}.

From Table 5.1 it is clear that at the point of its creation the resonance energy ratios of Ξ^{0*} contradict the Decay Criteria #2(ii).

Decay Criteria #2(ii) – Consequently, the first event in this decay is for the resonance energy ratios to be re-balanced by u_1 converting resonance energy to confinement to produce the first interim energy distribution thus, (this step does not apply to particles with three identical quarks),

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	35.97	0.86	0.86	37.69
Confinement	299.63	496.04	496.04	1291.72
Total	338.00	596.91	596.91	1531.81

Table 5.2 – Interim Energy Distribution After Re-Balance of the Resonance Energy Ratios.

Decay Criteria 2(i) – This has unbalanced the confinement energy ratios which therefore re-balance in accordance with Decay Criteria 2(i) to produce

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	35.97	0.86	0.863	37.69
Confinement	15.32	638.20	638.20	1291.72
Total	53.68	739.06	739.06	1531.81

Table 5.3 – Interim Energy Distribution After Re-Balance of the Confinement Energy Ratios.

Decay Criteria #4 – Both s quarks have the same maximum total energy and therefore either one or both could change flavour to initiate the decay. In this example let s_2 change flavour down one level to a d.

Decay Criteria 2(ii) – After resonance energy ratios are again re-balanced the interim energy distribution has become

Energy	u_1	s_1	d_1	Total
Matter	2.40	100.00	4.75	107.15
Resonance	62.47	1.50	31.56	95.53
Confinement	-11.19	637.56	702.75	1329.13
Total	53.68	739.06	739.06	1531.81

Table 5.4 – Interim Energy Distribution After the First Quark Flavour Change $s_2 \Rightarrow d_1$.

Decay Criteria #2(i) – As the confinement energy ratios are again re-balanced, the following point will be reached

Energy	u_1	s_1	d_1	Total
Matter	2.40	100.00	4.75	107.15
Resonance	62.47	1.50	31.56	95.53
Confinement	-7.89	774.80	562.22	1329.13
Total	56.98	876.30	598.53	1531.81

Table 5.5 – Interim Energy Distribution During Re-Balancing of the Confinement Energy Ratios.

At this point the total energy of d_1 has reached that of s_2 in Ξ^0

Decay Criteria #8 – therefore d_1 changes up one level to an s again and

Decay Criteria #2(ii) – re-distributes its total energy to that of s_2 in Ξ^0. This forces both u_1 and s_1 to do the same via conversion from confinement energy to result in the following interim energy distribution

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	103.50	2.48	2.48	108.47
Confinement	-48.93	773.82	496.05	1220.94
Total	56.98	876.30	598.53	1531.81

Table 5.6 – Interim Energy Distribution After the Second Quark Flavour Change $d_1 \Rightarrow s_2$.

Once again the confinement energy ratios have become un-balanced and are re-balanced by confinement energy transferring from s_1 to u_1 to produce the final interim energy distribution thus

Energy	u_1	s_1	s_2	Total
Matter	2.40	100.00	100.00	202.40
Resonance	103.50	2.48	2.48	108.47
Confinement	11.91	712.99	496.05	1220.94
Total	117.81	815.47	598.53	1531.81

Table 5.6 – Final Interim Energy Distribution After Confinement Energy ratios Are Re-Balanced.

The decay is completed by s_1 ejecting 216.93 of confinement energy to fall to the Ξ^0 level of 496.05. Note that although this has been described as a resonance energy only decay, the energy that has been ejected is confinement energy in accordance with Decay Criteria #1. However, also note that the quark complement of Ξ^{0*} and Ξ^0 are identical, and the resonance energy difference between Ξ^{0*} and Ξ^0 is equal to the value of ejected energy showing that the ejected energy is in fact resonance energy after conversion to confinement, thus effectively confirming the description.

6.0 Discussion of the Possible Energy Ejection Regimes.

In Section 3.2 it was stated that the energy ejected at the final point of the decay was shown in Addendums 1 to 6 of [3] to be from just one quark, but the final analysis here also allowed the ejection to be emitted from one, two (and possibly) all three quarks. As an example consider the decay of $\Xi_c^+ \rightarrow p^+$. This showed the final interim energy distribution as

Energy	u_1	d_1	u_2	Total
Matter	2.40	4.75	2.40	9.55
Resonance	58.62	29.62	58.62	146.87
Confinement	196.49	388.88	1669.27	2254.63
Total	257.51	423.25	1730.29	2411.05

Table 6.1 – Final Interim Energy Distribution of $\Xi_c^+ \rightarrow p^+$.

This assumed that the final confinement energy ratio re-balance to be effected by u_2 transferring confinement energy to u_1 only, because d_1 already possessed the correct level for p^+. However, this assumption could be invalid and u_2 could during the confinement energy re-balance transfer energy to both u_1 and d_1. In that case the final interim energy distribution would have been

Energy	u_1	d_1	u_1	Total
Matter	2.40	4.75	2.40	9.55
Resonance	58.62	29.62	58.62	146.87
Confinement	566.61	1121.41	566.61	2254.63
Total	627.63	1155.78	627.63	2411.05

Table 6.2 – Alternative Final Interim Energy Distribution of $\Xi_c^+ \rightarrow p^+$.

In this case the confinement energy ejected would be made up of 370.12 from u_1, 732.53 from d_1 and 370.12 from u_2 for the total of 1472.77, suggesting three possible secondary decay products. The decay products involving p^+ are $p2K_s^0$, $pK^-\pi^+$ and $p\overline{K}^*(892)^0$. Thus the first two secondary decay products contain two particles while the third just one. The significant point here is that the third secondary product, $\overline{K}^*(892)^0$ has a higher mass than that ejected by any single quark in Table 6.2. It is therefore considered that in this case it is more likely that the ejected energy is emitted by just one quark, as shown in the main text, which then splits into the secondary decay products. The feature that dictates which overall secondary product(s) emerges is not known but could be related to the initial kinetic energy possessed by the decaying particle.

7.0 Conclusions

The method that has been described here, has provided a completely satisfactory explanation for the process by which the Baryons in the examples shown decay. In fact it can be shown that all Baryons for which the decay products are known decay exactly according to this regime. This in itself provides adequate justification for the identification of the Decay Criteria cited in Section 3.
However, in providing the examples here, and determining the exact decay process of all other Baryons by this method, there are still two tasks which remain to be investigated.

The first is that in the initial quark flavour change, where there is more than one possibility, (Λ^0 et al), all possible flavour changes of the highest energy quark(s) need to be examined. This will enable the complete decay hierarchy for all Baryons to be determined in terms of energy levels and translations.

Secondly, according to [1] and [2], there are some 32 Baryons, some of each with intrinsic angular momenta of $J = 1/2\hbar$ and $J = 3/2\hbar$, for which the decay products are unknown. In [3], [10] and [11], the mass, the overall energy distribution and the individual energy distribution for each quark, in these unknowns was derived. This data, using the decay regime of this paper, can now permit their exact decay products to be determined.

These two final tasks will be added to this paper as Addendums.

Finally, it is of course obvious that the decay process that has been described here has not invoked the use of the Boson mediating particles as predicted by the Standard Model. Such particles are not necessary in the regime described here, and in any case it is believed that their purported presence in the Baryon decay process represents a serious energy anomaly.

APPENDIX A.

Correlation of Decay Types – Old to New.

Decay Types		Quark Flavour Change		Interim Energy Distribution – Sign of Confinement Energy		
Old	New	Down	Up	q_1	q_2	q_3
1	1	q_3		+	+	+
1ϕ	5	$q_{1/2}$		+	+	+
2	4	q_3		-	-	+
2ϕ		q_2		-	-	+
3		q_3, $q_{1/2}$		-	-	+
4		q_3	q_2	-	-	+
5	9	q_3	q_1	+	+	+
6	15	Resonance Energy Only		+	+	+
7			$q_{3/2}$	+	+	+
8	14	Confinement Energy Only		+	+	+
9	13		$q_{1/2}$	-	+	+
10			$q_{1/2}$	-	-	+
11	10	q_3	$q_{1/2}$	-	+	+
12	7	q_3, $q_{1/2}$		+	+	+
13	11	q_3	$q_{1/2}$	- ($J = 3/2\hbar$)	+	+
14		Resonance Energy Only		+	-	+
15	2	q_3		+	+	+ ($J = 3/2\hbar$)
16	16	Resonance Energy Only		-	+	+
17	3	q_3		-	+	+
18	Not Allocated					
19	6	$q_{1/2}$		-	+	+
20	12		$q_{1/2}$	+	+	+
21	5	$q_{1/2}$		+	+	+
22			$q_{1/2}$	+	-	+
	8	q_3, $q_{1/2}$		-	+	+
	17		q_3	+	+	+

Table A1 – Correlation of Decay Types.

Appendix B

Confinement and Resonance Energy Ratios Analysis.

This Appendix shows how the Decay Criteria #2 was determined from the quark energy variations that take place during particle decay.

A1 Confinement Energy Variations.

Decay Path	Confinement Energy Variations				
	u	d	s	c	b
$\Sigma^0 \to \Lambda^0$	-1.72	-3.42	-71.82		
$\Sigma_c^+ \to \Lambda_c^+$	-0.32	-0.63		-165.49	
$\Xi_c^+ \to \Xi_c^+$	-0.19		-7.97	-99.64	
$\Xi_c^{0/} \to \Xi_c^0$		-0.38	-7.90	-98.73	
$\Sigma_b^0 \to \Lambda_b^0$	-0.06	-0.12			-112.73

Table A1 – Confinement Energy Variations During Particle Decay.

Now from Table A1 calculate the ratio of confinement energy variations between quarks.

Decay Path	Ratio of Confinement Energy Variations Between Quarks.									
	d/u	s/d	s/u	c/s	c/d	c/u	b/c	b/s	b/d	b/u
$\Sigma^0 \to \Lambda^0$	1.988	21.000	41.756							
$\Sigma_c^+ \to \Lambda_c^+$	1.969				262.683	517.156				
$\Xi_c^+ \to \Xi_c^+$			42.000	12.486		524.421				
$\Xi_c^{0/} \to \Xi_c^0$		20.789		12.497	259.816					
$\Sigma_b^0 \to \Lambda_b^0$	2.00								935.250	1870.500
Average	1.986	20.895	41.878	12.492	261.250	520.789			935.250	1870.500
Mass Ratio	1.979	21.053	41.667	12.500	263.158	520.833	3.44	43.0	905.263	1791.667

Table A2 - Ratio of Confinement Energy Variations Between Quarks.

This was the initial data that identified these ratios and while the data is sparse and the ratios become less exact for the higher mass ratios, they were considered sufficiently accurate to be used as a criteria. Not only have they now been confirmed by all other decays, as can be seen in the examples in the main text, but it is also seen that the confinement energy ratios between quarks also conform to these values.

The decays of the dashed Xi particles was assumed because of identical quark complement to their non-dashed counterparts.

A2 Resonance Energy Variations.

Decay Path	Resonance Energy Variations				
	u	d	s	c	b
$n^0 \to p^0$	-14.10	-7.13			
$\Lambda^0 \to p^+$	-3.84	-1.94			
$\Lambda^0 \to n^0$	+10.26	+5.19			
$\Xi^0 \to \Lambda^0$	-41.03		-0.98		
$\Xi^- \to \Lambda^0$		-65.84	-3.13		
$\Lambda_c^+ \to p^+$	+37.2	+18.79			
$\Sigma_c^0 \to \Lambda_c^+$		-5.40		-0.02	
$\Sigma_c^{++} \to \Lambda_c^+$	+5.44			+0.01	
$\Xi_c^+ \to \Xi^0$	+16.70		+0.04		
$\Xi_c^0 \to \Xi^-$		+12.56	+0.60		
$\Xi_{cc}^+ \to \Lambda_c^+$		-32.09		-0.12	
$\Lambda_b^0 \to \Lambda_c^+$	-37.31	-18.35			
$\Xi_b^- \to \Xi^-$		+21.65	+1.03		
$\Sigma_b^+ \to \Lambda_b^0$	+53.54				+0.03
$\Sigma_b^- \to \Lambda_b^0$		+24.79			+0.028

Table A3 – Resonance Energy Variations During Particle Decay.

Now from Table A3 calculate the ratio of resonance energy variations between quarks.

Decay Path	Ratio of Resonance Energy Losses Between Quarks.									
	d/u	**s/d**	**s/u**	**c/s**	**c/d**	**c/u**	**b/c**	**b/s**	**b/d**	**b/u**
$\mathbf{n^0 \rightarrow p^0}$	**0.506**									
$\mathbf{\Lambda^0 \rightarrow p^+}$	**0.505**									
$\mathbf{\Lambda^0 \rightarrow n^0}$	**0.506**									
$\mathbf{\Xi^0 \rightarrow \Lambda^0}$			**0.024**							
$\mathbf{\Xi^- \rightarrow \Lambda^0}$		**0.048**								
$\Lambda_c^+ \rightarrow \mathbf{p^+}$	**0.505**									
$\Sigma_c^0 \rightarrow \Lambda_c^+$					**0.004**					
$\Sigma_c^{++} \rightarrow \Lambda_c^+$						**0.002**				
$\Xi_c^+ \rightarrow \Xi^0$			**0.024**							
$\Xi_c^0 \rightarrow \Xi^-$		**0.048**			**0.004**					
$\Xi_{cc}^+ \rightarrow \Lambda_c^+$					**0.004**					
$\Lambda_b^0 \rightarrow \Lambda_c^+$	**0.505**									
$\Xi_b^- \rightarrow \Xi^-$		**0.048**								
$\Sigma_b^+ \rightarrow \Lambda_b^0$										**0.0006**
$\Sigma_b^- \rightarrow \Lambda_b^0$									**0.001**	
Average	**0.505**	**0.048**	**0.024**		**0.004**	**0.002**			**0.001**	**0.0006**
Inverse Mass Ratio	**0.505**	**0.048**	**0.024**	**0.080**	**0.004**	**0.002**	**0.291**	**0.023**	**0.001**	**0.0006**

Table B2 - Ratio of Resonance Energy Losses Between Quarks.

Note that in the first table both quarks experience the same direction of energy variations.

The above ratios also apply to the levels of resonance energy possessed by all quarks in all Baryons.

Appendix C.

Summarised Details of the Decay Characteristics of All $J = 1/2\hbar$ Particles.

Particle Decay	Decay Type	Interim Energy Distribution – Confinement Energy Sign			Quark Flavour Change	
		q_1	q_2	q_3	Down	Up
$n^0 \to p^+$	1	+ve	+ve	+ve	q_3	
$\Lambda^0 \to p^+$	1	+ve	+ve	+ve	q_3	
$\to n^0$	1	+ve	+ve	+ve	q_3	
$\Lambda_c^+ \to p^+$	4	-ve	-ve	+ve	q_3	
$\to n^0$	4	-ve	-ve	+ve	q_3	
$\to \Lambda^0$	4	-ve	-ve	+ve	q_3	
$\to \Sigma^0$	4	-ve	-ve	+ve	q_3	
$\to \Sigma^+$	7	+ve	+ve	+ve	q_3, $q_{1/2}$	
$\to \Sigma^-$	9	+ve	+ve	+ve	q_3	$q_{1/2}$
$\to \Xi^0$	9	+ve	+ve	+ve	q_3	$q_{1/2}$
$\to \Xi^-$	10	-ve	+ve	+ve	q_3	$q_{1/2}$
$\Lambda_b^0 \to p^+$	1	+ve	+ve	+ve	q_3	
$\to \Lambda^0$	4	-ve	-ve	+ve	q_3	
$\to \Lambda_c^+$	1	+ve	+ve	+ve	q_3	
$\to \Sigma_c^{++}$	7	+ve	+ve	+ve	q_3, $q_{1/2}$	
$\to \Sigma_c^0$	9	+ve	+ve	+ve	q_3	$q_{1/2}$
$\Sigma^+ \to p^+$	1	+ve	+ve	+ve	q_3	
$\to n^0$	9	+ve	+ve	+ve	q_3	$q_{1/2}$
$\to \Lambda^0$	12	+ve	+ve	+ve		$q_{1/2}$
$\Sigma^0 \to \Lambda^0$	14	+ve	+ve	+ve		
$\Sigma_c^+ \to \Lambda_c^+$	14	+ve	+ve	+ve		
$\Sigma^- \to n^0$	1	+ve	+ve	+ve	q_3	
$\to \Lambda^0$	5	+ve	+ve	+ve	$q_{1/2}$	
$\Sigma_c^0 \to \Lambda_c^+$	5	+ve	+ve	+ve	$q_{1/2}$	
$\Sigma_c^{++} \to \Lambda_c^+$	12	+ve	+ve	+ve		$q_{1/2}$
$\Sigma_b^+ \to \Lambda_b^0$	13	-ve	+ve	+ve		$q_{1/2}$
$\Sigma_b^- \to \Lambda_b^0$	6	-ve	+ve	+ve	$q_{1/2}$	
$\Sigma_b^0 \to \Lambda_b^0$	14*	+ve	+ve	+ve		
$\Xi^0 \to \Lambda^0$	1	+ve	+ve	+ve	q_3	
$\to \Sigma^0$	1	+ve	+ve	+ve	q_3	
$\to \Sigma^+$	1	+ve	+ve	+ve	q_3	
$\Xi^- \to \Lambda^0$	1	+ve	+ve	+ve	q_3	
$\to \Xi^0$	5	+ve	+ve	+ve	$q_{1/2}$	
$\to \Sigma^0$	1	+ve	+ve	+ve	q_3	
$\to \Sigma^-$	1	+ve	+ve	+ve	q_3	
$\Xi_c^+ \to p^+$	8	-ve	+ve	+ve	q_3, $q_{1/2}$	

Particle Decay	Decay Type	Interim Energy Distribution – Confinement Energy Sign			Quark Flavour Change	
		q_1	**q_2**	**q_3**	**Down**	**Up**
$\Xi_c^+ \to \Lambda^0$	1	+ve	+ve	+ve	**q_3**	
$\to \Sigma^+$	1	+ve	+ve	+ve	**q_3**	
$\to \Sigma^0$	1	+ve	+ve	+ve	**q_3**	
$\to \Sigma^-$	9	+ve	+ve	+ve	**q_3**	**$q_{1/2}$**
$\to \Xi^0$	3	-ve	+ve	+ve	**q_3**	
$\to \Xi^-$	10	-ve	+ve	+ve	**q_3**	**$q_{1/2}$**
$\to \Omega^-$	11	-ve (J = 3/2$\hbar$)	+ve	+ve	**q_3**	**$q_{1/2}$**
$\Xi_c^0 \to p^+$	7	+ve	+ve	+ve	**q_3, $q_{1/2}$**	
$\to \Lambda^0$	1	+ve	+ve	+ve	**q_3**	
$\to \Xi^-$	3	-ve	+ve	+ve	**q_3**	
$\to \Omega^-$	11	-ve (J = 3/2$\hbar$)	+ve	+ve	**q_3**	**$q_{1/2}$**
$\Xi_{cc}^+ \to p^+$	7	+ve	+ve	+ve	**q_3, $q_{1/2}$**	
$\to \Lambda_c^+$	1	+ve	+ve	+ve	**q_3**	
$\to \Xi^-$	8	-ve	+ve	+ve	**q_3, $q_{1/2}$**	
$\Xi_b^0 \to p^+$	7	+ve	+ve	+ve	**q_3, $q_{1/2}$**	
$\Xi_b^0 \to \Lambda_c^+$	7	+ve	+ve	+ve	**q_3 & $q_{1/2}$**	
$\Xi_b^0 \to \Xi^-$	9	+ve	+ve	+ve	**q_3**	**$q_{1/2}$**
$\Xi_b^- \to \Xi^-$	3	-ve	+ve	+ve	**q_3**	
$\Omega_c^0 \to \Sigma^+$	7	+ve	+ve	+ve	**q_3, $q_{1/2}$**	
$\to \Omega^-$	2	+ve	+ve	+ve (J = 3/2$\hbar$)	**q_3**	
$\to \Xi^0$	1	+ve	+ve	+ve	**q_3**	
$\to \Xi^-$	1	+ve	+ve	+ve	**q_3**	
$\Omega_b^- \to \Omega^-$	2	+ve	+ve	+ve (J = 3/2$\hbar$)	**q_3**	

<u>Table C1 - Summarised Details of the Decay Characteristics of All J = 1/2$\hbar$ Particles.</u>

- \- Assumed because of identical quark complement.

The confinement energy sign is that in the interim energy distribution for the first or second quark flavour change as applicable.

Appendix D.

Summarised Details of the Decay Characteristics of All $J = 3/2\hbar$ Particles.

Particle Decay	Decay Type		
	q_1	**q_2**	**q_3**
$\Delta^{++} \rightarrow p^{+}$	17	17	17
$\Delta^{+} \rightarrow p^{+}$	15	15	15
$\rightarrow n^{0}$	12	12	12
$\Delta^{0} \rightarrow p^{+}$	1	1	1
$\rightarrow n^{0}$	15	15	15
$\Delta^{-} \rightarrow n^{0}$	1	1	1
$\Sigma^{+*} \rightarrow \Lambda^{0}$	12	12	12
$\rightarrow \Sigma^{0}$	12	12	12
$\rightarrow \Sigma^{+}$	15	15	15
$\Sigma^{0*} \rightarrow \Lambda^{0}$	15	15	15
$\rightarrow \Sigma^{0}$	15	15	15
$\rightarrow \Sigma^{+}$	5	5	5
$\Sigma^{-*} \rightarrow \Lambda^{0}$	5	5	5
$\rightarrow \Sigma^{0}$	5	5	5
$\rightarrow \Sigma^{-}$	15	15	15
$\Sigma_{c}^{+*} \rightarrow \Lambda_{c}^{+}$	15	15	15
$\Sigma_{c}^{++*} \rightarrow \Lambda_{c}^{+}$	12	12	12
$\Sigma_{c}^{0*} \rightarrow \Lambda_{c}^{+}$	5	5	5
$\Sigma_{b}^{-*} \rightarrow \Lambda_{b}^{0}$	5	5	5
$\Sigma_{b}^{+*} \rightarrow \Lambda_{b}^{0}$	12	12	12
$\Xi^{0*} \rightarrow \Xi^{0}$	16	15	15
$\rightarrow \Xi^{-}$	13	13	13
$\Xi^{-*} \rightarrow \Xi^{0}$	6	6	6
$\rightarrow \Xi^{-}$	16	16	16
$\Xi_{c}^{+*} \rightarrow \Xi_{c}^{0}$	12	12	12
$\Xi_{c}^{0*} \rightarrow \Xi_{c}^{+}$	5	5	5
$\Xi_{b}^{0*} \rightarrow \Xi_{b}^{-}$	12	12	12
$\Omega^{-} \rightarrow \Lambda^{0}$	7	7	7
$\rightarrow \Xi^{0}$	1	1	1
$\rightarrow \Xi^{-}$	1	1	1
$\Omega_{c}^{0*} \rightarrow \Omega_{c}^{0}$	15	15	15

Table D1 - Summarised Details of the Decay Characteristics of All $J = 3/2\hbar$ Particles.

The q_1, q_2, q_3 columns are for which quark has the high resonance energy.

See the Table 3.1 for the confinement energy signs.

Appendix E.

Particle Decay Statistics.

E1 Frequency of Decay Types by Decaying Particle.

Decay Type	Decaying Particle	Total
1	$n^0, \Lambda^0, \Sigma^+, \Lambda_b^0, \Sigma^-, \Xi^0, \Xi^-, \Xi_c^+, \Xi_c^0, \Omega_c^0, \Xi_{cc}^+, \Delta^0, \Delta^-, \Omega^-$	**14**
2	Ω_c^0, Ω_b^-	**2**
3	$\Xi_c^+, \Xi_b^-, \Xi_c^0,$	**3**
4	Λ_c^+, Λ_b^0	**2**
5	$\Sigma^-, \Xi^-, \Sigma^{0*}, \Sigma^{-*}, \Sigma_c^0, \Sigma_b^{-*}, \Xi^{-*}, \Xi_c^{0*}$	**8**
6	Σ_b^-, Ξ^{-*}	**2**
7	$\Lambda_b^0, \Xi_c^0, \Xi_{cc}^+, \Xi_b^0, \Omega_c^0, \Omega^-, \Lambda_c^+$	**7**
8	Ξ_{cc}^+, Ξ_c^+	**2**
9	$\Lambda_c^+, \Lambda_b^0, \Sigma^+, \Xi_c^+, \Xi_b^0$	**5**
10	Ξ_c^+, Λ_c^+	**2**
11	Ξ_c^+, Ξ_c^0	**2**
12	$\Sigma^+, \Sigma^{+*}, \Xi_b^{0*}, \Delta^+, \Sigma_c^{++*}, \Sigma_b^{+*}, \Xi_c^{+*}, \Sigma_c^{++}$	**8**
13	$\Sigma_b^+, \Xi^{0*}, \Xi_c^{+*}$	**3**
14	Σ^0, Σ_c^+	**2**
15	$\Delta^+, \Delta^0, \Sigma^{+*}, \Sigma^{0*}, \Sigma^{-*}, \Xi^{0*}, \Omega_c^{0*}, \Sigma_c^{+*}, \Xi^{-*}$	**9**
16	$\Xi^{0*}, \Xi^{-*}, \Sigma_c^{+*}$	**3**
17	Δ^{++}	**1**
	Total	**75**
Unknown	$\Xi_{cc}^{++}, \Omega_{cc}^+, \Xi_{cb}^+, \Xi_{cb}^0, \Omega_{cb}^0, \Omega_{ccb}^+, \Xi_{bb}^0, \Xi_{bb}^-, \Omega_{bb}^-, \Omega_{cbb}^0$ $\Sigma_b^{0*}, \Xi_{cc}^{++*}, \Xi_{cc}^{+*}, \Xi_b^{-*}, \Xi_{bb}^{0*}, \Xi_{bb}^{-*}, \Xi_{cb}^{+*}, \Xi_{cb}^{0*}, \Omega_b^{-*}, \Omega_{cc}^{+*}, \Omega_{cb}^{0*}, \Omega_{bb}^{-*}, \Omega_{ccc}^+, \Omega_{ccb}^{+*}, \Omega_{cbb}^{0*}, \Omega_{bbb}^-$	**26**
Assumed at 14	$\Sigma_b^0, \Xi_b^{0/}, \Xi_b^{-/}, \Xi_{cb}^{+/}, \Omega_{cb}^{0/}, \Xi_{cb}^{0/}$	**6**

Table E1 - Frequency of Decay Types by Decaying Particle.

The final six particles are assumed at Decay Type 14 because their quark complement is identical to their non-dashed and non-starred counterparts, (Σ_b^0 is assumed to decay to Λ_b^0)

E2 Decay Type in Order of Interim Energy Distribution – Confinement Energy Sign.

Decay Type	**Interim Energy Distribution – Confinement Energy Sign.**		
	q_1	**q_2**	**q_3**
1, 2, 5, 7, 9, 12, 14, 15, 17	+ve	+ve	+ve
3, 6, 10, 11, 13, 16, 8	-ve	+ve	+ve
4	-ve	-ve	+ve

Table E2 – Confinement Energy Sign Distribution.

E3 Matrix of Energy Levels for all Baryons.

Quark	Particle															
Matrix of Quark Energy Levels for $J = 1/2\hbar$																
	p^+	n^0	Λ^0	Σ^+	Σ^0	Σ^-	Ξ^0	Ξ^-	Λ^+_c	Σ^+_c	Σ^0_c	Σ^{++}_c	Ξ^+_c	Ξ^0_c	$\Xi^{+/}_c$	$\Xi^{0/}_c$
u	**257.51**	232.73	85.32	**72.81**	87.04		117.81		25.73	26.05		**20.62**	38.58		38.77	
d	423.26	**353.42**	76.79		80.20	**94.17**		125.59	19.35	19.97	**25.36**			42.48		42.85
s			953.58	1043.76	1025.40	1009.12	**598.52**	**598.07**					180.7	181.36	188.67	189.26
c									2241.38	2406.87	2403.01	2412.74	2248.52	2247.04	2348.16	2345.78
b																
Total	**938.28**	**939.57**	**1115.69**	**1189.38**	**1192.64**	**1197.46**	**1314.85**	**1321.73**	**2286.46**	**2452.89**	**2453.73**	**2453.98**	**2467.80**	**2470.89**	**2575.60**	**2577.89**

Quark	Particle															
	Ω^0_c	Ξ^{++}_{cc}	Ξ^+_{cc}	Ω^+_{cc}	Λ^0_b	Σ^0_b	Ξ^0_b	Ξ^-_b	Σ^+_b	Σ^-_b	$\Xi^{0/}_b$	$\Xi^{-/}_b$	Ω^-_b	Ξ^+_{cb}	Ξ^0_{cb}	$\Xi^{+/}_{cb}$
u		46.56			61.82	61.88	80.07		**8.43**		80.15			79.26		79.33
d			49.77		35.78	35.90		81.91		**11.30**		82.06			82.32	
s	**200.43**			179.20			131.53	133.27			134.76	142.48	**136.68**			
c	2294.33	**1802.08**	**1801.70**	**1786.51**										1668.54	1668.77	1701.80
b					5521.80	5634.03	5576.20	5575.93	5794.43	5792.91	5715.37	5713.71	5797.66	5739.31	5739.65	5853.72
Total	**2695.19**	**3650.72**	**3653.17**	**3752.22**	**5619.40**	**5731.81**	**5787.80**	**5791.11**	**5811.29**	**5815.51**	**5930.28**	**5938.25**	**6071.02**	**7487.11**	**7490.74**	**7634.85**

Quark	Particle							
	Ω^0_{cb}	$\Xi^{0/}_{cb}$	$\Omega^{0/}_{cb}$	Ω^+_{ccb}	Ξ^0_{bb}	Ξ^-_{bb}	Ω^-_{bb}	Ω^0_{cbb}
u					377.88			
d		82.45				381.46		
s	206.54		209.01				526.88	
c	1677.91	1701.97	1708.67	**1800.11**				2447.69
b	5753.66	5853.87	5859.48	5986.15	**6501.67**	**6502.70**	**6545.05**	**7110.70**
Total	**7638.11**	**7638.29**	**7777.16**	**9586.37**	**13381.22**	**13386.86**	**13616.98**	**16669.09**

Bold = 2 Off.

Decay Products Reported as Unknown

Table E3 - Matrix of Quark Energy Levels for $J = 1/2\hbar$

Matrix of Quark Confinement Energy Levels for $J = 1/2$,																
Quark	**Particle**															
	p^+	n^0	Λ^0	Σ^+	Σ^0	Σ^-	Ξ^0	Ξ^-	Λ^+_c	Σ^+_c	Σ^0_c	Σ^{++}_c	Ξ^+_c	Ξ^0_c	$\Xi^{+/}_c$	$\Xi^{0/}_c$
u	**196.49**	157.60	20.45	**22.62**	22.17		11.91		1.90	2.22		**2.23**	1.92		2.11	
d	388.88	**311.92**	40.47		43.89	**43.08**		23.44	3.77	4.40	**4.38**			3.79		4.16
s			852.08	942.61	923.90	906.92	**496.04**	**493.44**					79.88	79.75	87.85	87.65
c									991.34	1156.83	1152.95	1162.71	998.46	996.91	1098.09	1095.65
b																
Total	**781.86**	**781.44**	**913.00**	**987.85**	**989.96**	**993.08**	**1003.99**	**1010.32**	**997.01**	**1163.45**	**1161.71**	**1167.17**	**1080.25**	**1080.45**	**1188.05**	**1187.47**

Quark	**Particle**															
	Ω^0_c	Ξ^{++}_{cc}	Ξ^+_{cc}	Ω^+_{cc}	Λ^0_b	Σ^0_b	Ξ^0_b	Ξ^-_b	Σ^+_b	Σ^-_b	$\Xi^{0/}_b$	$\Xi^{-/}_b$	Ω^-_b	Ξ^+_{cb}	Ξ^0_{cb}	$\Xi^{+/}_{cb}$
u		1.06			0.68	0.74	0.71		**0.83**		0.79			0.80		0.87
d			2.10		1.35	1.47		1.41		**1.65**		1.56			1.59	
s	**83.44**			42.69			29.68	29.67			32.91	32.88	**34.83**			
c	1042.97	**552.00**	**551.53**	**533.59**										418.39	418.48	451.65
b					1221.77	1334.00	1276.16	1275.85	1494.43	1492.90	1415.33	1413.63	1497.61	1439.27	1439.56	1553.68
Total	**1209.85**	**1105.06**	**1105.16**	**1109.87**	**1223.80**	**1336.21**	**1306.55**	**1306.93**	**1496.09**	**1496.20**	**1449.03**	**1448.07**	**1567.27**	**1858.46**	**1859.63**	**2006.20**

Quark	**Particle**							
	Ω^0_{cb}	$\Xi^{0/}_{cb}$	$\Omega^{0/}_{cb}$	Ω^+_{ccb}	Ξ^0_{bb}	Ξ^-_{bb}	Ω^-_{bb}	Ω^0_{cbb}
u					1.23			
d		1.72				2.43		
s	33.77		36.23				52.01	
c	422.08	451.68	452.85	**484.63**				781.93
b	1451.97	1553.79	1557.79	1667.1	**2201.47**	**2202.28**	**2236.34**	**2689.84**
Total	**1907.82**	**2007.19**	**2046.87**	**2636.36**	**4404.17**	**4406.99**	**4524.69**	**6161.61**

Bold = 2 Off.

Decay Products Reported as Unknown

Table E4 - Matrix of Quark Confinement Energy Levels for $J = 1/2\hbar$,

Matrix of Quark Energy Levels for $J = 3/2\hbar$

Quark	Particle															
	Δ^{++}	Δ^{+}	Δ^{+}	Δ^{0}	Δ^{0}	Δ^{-}	Σ^{+*}	Σ^{+*}	Σ^{0*}	Σ^{0*}	Σ^{0*}	Σ^{-*}	Σ^{-*}	Ξ^{0*}	Ξ^{0*}	Ξ^{-*}
u	**302.40** **627.21**	**576.36** 240.83	**266.18**	554.38	232.48		285.61 53.97	**155.96**	295.25	76.01	166.50			337.98	**276.74**	
d		414.82	699.64	**338.81**	646.24 353.29	**306.04** **619.92**			63.83	282.55	132.76	302.78 76.16	**165.08**			344.79
s							1043.31	1070.90	1024.62	1025.14	1059.87	1008.27	1057.05	**596.91**	602.34 **652.72**	**595.11**
c																
b																
Total	**1232.01**	**1232.00**	**1232.00**	**1232.00**	**1232.00**	**1232.00**	**1382.80**	**1382.80**	**1383.70**	**1383.70**	**1383.70**	**1387.21**	**1387.21**	**1531.82**	**1531.82**	**1535.00**

Quark	Particle															
	Ξ^{-*}	Ω^{-}	Σ_c^{+*}	Σ_c^{+*}	Σ_c^{+*}	Σ_c^{++*}	Σ_c^{++*}	Σ_c^{0*}	Σ_c^{0*}	Ξ_c^{+*}	Ξ_c^{+*}	Ξ_c^{+*}	Ξ_c^{0*}	Ξ_c^{0*}	Ξ_c^{0*}	Ωc^{0*}
u			96.35	22.08	68.26	91.04 14.23	**52.24**			270.60	223.57	260.78				Ω_c^{0*}
d	245.10		14.30	88.45	41.30			96.93 18.89	**57.11**				221.36	158.07	206.40	
s	603.74 **686.17**	**486.75** **698.95**								176.60	223.27	182.05	1080.88	243.68	189.15	
c			2406.85	2406.87	2407.93	**2412.72**	2413.53	2402.98	2404.59	2198.70	2199.06	2203.07	2247.02	2247.50	2253.69	278.13 193.16
b																2293.82
Total	**1535.00**	**1672.45**	**2517.50**	**2517.50**	**2517.50**	**2518.00**	**2518.00**	**2518.80**	**2518.80**	**2645.90**	**2645.90**	**2645.90**	**2649.25**	**2649.25**	**2649.25**	**2765.90**

Quark	Particle															
	Ω_c^{0*}	Ξ_{cc}^{++*}	Ξ_{cc}^{++*}	Ξ_{cc}^{+*}	Ξ_{cc}^{+*}	Ω_{cc}^{+*}	Ω_{cc}^{+*}	Ω_{ccc}^{++*}	Σ_b^{0*}	Σ_b^{0*}	Σ_b^{0*}	Σ_b^{+*}	Σ_b^{+*}	Σ_b^{-*}	Σ_b^{-*}	Ξ_b^{0*}
u		133.21	130.82						254.33	50.92	178.79	31.31 6.35	**18.80**			239.02
d				136.49	131.85				20.23	223.62	94.90			32.86 9.34	**21.03**	
s	**222.43**					267.54	213.28									130.31
c	2321.05	**1802.03**	1804.20 1802.24	**1801.59**	1805.81 1802.01	**1784.70**	1834.41 1789.23	1827.19 **1644.85**								
b									5545.70	5545.73	5546.58	5794.43	5794.51	5792.90	5793.05	5576.17
Total	**2765.90**	**3737.27**	**3737.27**	**3739.66**	**3739.66**	**3836.93**	**3836.93**	**5116.89**	**5820.27**	**5820.27**	**5820.27**	**5832.10**	**5832.10**	**5835.10**	**5835.10**	**5945.50**

Matrix of Quark Energy Levels for $J = 3/2\hbar$

Quark	Particle															
	Ξ_b^{0*}	Ξ_b^{0*}	Ξ_b^{-*}	Ξ_b^{-*}	Ξ_b^{-*}	Ω_b^{-*}	Ω_b^{-*}	Ξ_{cb}^{+*}	Ξ_{cb}^{+*}	Ξ_{cb}^{+*}	Ξ_{cb}^{0*}	Ξ_{cb}^{0*}	Ξ_{cb}^{0*}	Ω_{cb}^{0*}	Ω_{cb}^{0*}	Ω_{cb}^{0*}
u	197.55	232.99						231.89	227.94	230.38						
d			243.16	172.68	231.23						235.26	227.57	232.28			
s	171.68	135.20	130.92	200.97	140.37	144.89 135.95	**139.90**							371.90	271.94	320.59
c								1668.44	1672.27	1668.83	1668.57	1676.04	1669.34	1674.20	1771.57	1687.03
b	5576.27	5577.31	5575.87	5576.33	5578.09	5797.64	5798.68	5739.28	5739.39	5740.41	5739.81	5739.81	5741.81	5752.58	5755.18	5791.07
Total	**5945.50**	**5945.50**	**5949.95**	**5949.95**	**5949.95**	**6078.47**	**6078.47**	**7639.61**	**7639.61**	**7639.61**	**7643.41**	**7643.41**	**7643.41**	**7798.69**	**7798.69**	**7798.69**

Quark	Particle										
	Ω_{ccb}^{+*}	Ω_{ccb}^{+*}	Ξ_{bb}^{0*}	Ξ_{bb}^{0*}	Ξ_{bb}^{-*}	Ξ_{bb}^{-*}	Ω_{bb}^{-*}	Ω_{bb}^{-*}	Ω_{cbb}^{0*}	Ω_{cbb}^{0*}	Ω_{bbb}^{-*}
u			1127.50	1121.40							
d					1132.21	1120.19					
s							**1322.89**	1106.88			
c	2128.18 1778.35	**1832.11**							3884.68	2306.42	
b	5979.82	6222.15	**6501.54**	6507.08 6502.09	**6602.42**	6513.14 6503.51	**6539.36**	6736.19 6558.54	**7049.68**	7707.99 7069.63	**12490.16** **9843.78**
Total	**9886.36**	**9886.36**	**14130.57**	**14130.57**	**14137.04**	**14137.04**	**14401.61**	**14401.61**	**17984.05**	**17984.05**	**32177.71**

Bold = 2 Off.
The Numbers in Blue Indicate the Quark with the High Resonance Energy. Similar Tables Exist When the Other Two Quarks Possess the Higher Resonance Energy
Decay Products Reported as Unknown

Matrix of Quark Energy Levels for $J = 3/2\hbar$					
Quark	Particle				
	Δ^{++}	Δ^{-}	Ω^{-}	Ω_{ccc}^{+++}	Ω_{bbb}^{-*}
u	259.39				
d		262.06			
s			360.22		
c				372.06	
b					5212.98
Total	778.17	786.18	1080.66	1116.18	15638.94

Red = 3 Off.	
	Decay Products Reported as Unknown

Table E5 - Matrix of Quark Energy Levels for $J = 3/2\hbar$

The Quark Confinement Energy Levels for the $J = 3/2\hbar$ particles is as per the $J = 1/2\hbar$ particles.

Tables E3 and E5 were used to determine which level a quark's total energy level was reached when conformance to Decay Criteria #3 & 6 was established during the decay process.

E4 Charge Variations

J = 1/2ℏ

Charge Variation	Total	%
+2	1	1.69
+1	16	27.12
0	20	33.90
-1	16	27.12
-2	6	10.17
Total	59	100.00

J = 3/2ℏ

Charge Variation	Total	%
+2	0	0
+1	10	32.26
0	11	35.48
-1	10	32.26
-2	0	0
Total	31	100.00

Table E6 – Summary of Charge Variations.

It appears that both of these distributions exhibit "very" approximate Gaussian characteristics.

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