ADDENDUMS #6, 7 and 8 to P11.

THE SIGMA*, Xi*, OMEGA^{-} AND OMEGA* PARTICLES.

P.G.Bass.

www.relativitydomains.com

Version 1.0.0
March 2018

ABSTRACT.

This sixth et al Addendum to P11 provides details of the energy distribution of the quarks that make up all Sigma*, Xi*, Omega^{-} and Omega* sub-atomic particles with an intrinsic angular momentum of $J = 3/2\hbar$. Also presented are the energy translations that take place during their decay.

In addition the fundamental reason why all Baryons, other than the Proton, experience decay is also discussed.

This is the final Addendum to "Derivation of the Quark Energy Distribution and Decay Products of Baryonic Sub-Atomic Particles".

CONTENTS.

1.0 Introduction.

These three Addendum's to P11, #6, 7, 8, have been combined into one paper because the decay characteristics exhibited by most of the 15 particles involved have already been discussed in the five Addendums provided to date. The 15 particles considered have an intrinsic angular momentum of $J = 3/2\hbar$, and are listed in the following brief table together with their quark complement and their relationship to particles with the same quark complement, but with an intrinsic angular momentum of $J = 1/2\hbar$

Particle.	Quark Complement	Relationship to $J = 1/2\hbar$ Particles	
Σ^{+*}	uus	High Resonance Energy Version of :	Σ^{+}
Σ^{0*}	uds	↓	Σ^{0}
Σ^{-*}	dds	↓	Σ^{-}
Σ_c^{+*}	udc	↓	Σ_c^{+}
Σ_c^{++*}	uuc	↓	Σ_c^{++}
Σ_c^{0*}	ddc	↓	Σ^{0}_c
Σ_b^{+*}	uub	↓	Σ^{+}_b
Σ_b^{-*}	ddb	↓	Σ^{-}_b
Ξ^{0*}	uss	↓	Ξ^{0}
Ξ^{-*}	dss	↓	Ξ^{-}
Ξ_c^{+*}	usc	↓	Ξ^{+}_c
Ξ_c^{0*}	dsc	↓	Ξ^{0}_c
Ξ_b^{0*}	usb	↓	Ξ^{0}_b
Ω^{-}	sss	———	
Ω_c^{0*}	ssc	High Resonance Energy Version of :	Ω^{0}_c

Table 1.1 – Sigma*, Xi*, Omega^{-} and Omega* Particle Details.

Only two of the above particles exhibit uniquely new decay types to those shown in [3], [4], [5], [6], [7] and [8] and it is for these two, $\Sigma_c^{0}*$ and $\Sigma_c^{++}*$ that the following decay details are shown.

(i) The Intrinsic Angular Momentum Configuration Tables, (from the generalised tables in [3]).
(ii) The Quark Energy Distributions.
(iii) The Decay Energy Translations.

The energy distributions for all the other 13 particles are provided in Appendix A.

Also included in this Addendum is a detailed discussion of the primary reason why, and how, all Baryons, apart from the Proton, initiate a process of decay.

Note that in this Addendum, only particles with intrinsic angular momentum of $J = 3/2\hbar$, containing quarks with $J = 3/2\hbar$ and $J = \pm 1/2\hbar$ are considered.

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

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

2.0 Nomenclature.

In this Addendum the following nomenclature will be used.

P	Indicates any Baryon.
P(#)	Indicates the type of intrinsic angular momentum configuration of P.
$q_{\#}$	Indicates the #th quark of P.
E_c	Indicates quark confinement energy.
E_k	Indicates kinetic energy.
→	Indicates a particle decay.
⇒	Indicates a quark flavour change.

3.0 Initial Discussions.

3.1 Intrinsic Angular Momentum Configurations.

These are tabulated in detail here to simplify the decay distribution pattern presentation in Section 3.2 below.

Particle Intrinsic Angular Momentum Configuration.	Quark Angular Momentum		
	q_1	q_2	q_3
P(1)	$3/2\hbar$	$+1/2\hbar$	$-1/2\hbar$
P(2)	$3/2\hbar$	$-1/2\hbar$	$+1/2\hbar$
P(3)	$+1/2\hbar$	$3/2\hbar$	$-1/2\hbar$
P(4)	$-1/2\hbar$	$3/2\hbar$	$+1/2\hbar$
P(5)	$+1/2\hbar$	$-1/2\hbar$	$3/2\hbar$
P(6)	$-1/2\hbar$	$+1/2\hbar$	$3/2\hbar$

Table 3.1 – Intrinsic Angular Momentum Configurations for $J = 3/2\hbar$ Baryons.

This table is for use in conjunction with Table 3.2 below.

3.2 Decay Distribution Patterns – Overall Summary.

This summary lists the decay products of the 15 particles considered here in relation to their respective intrinsic angular momentum configurations. Included are the branching fractions from [2]. Also included is indication of the the decays for which full details are provided in Section 4.0 below. This table should be read in conjunction with Table 3.1 above.

P(1)	**P(2)**	**P(3)**	**P(4)**	**P(5)**	**P(6)**	**Branching Fraction %**	**Full Details Provided**	**Notes**
$\Sigma^{+*}(1)$	$\Sigma^{+*}(2)$	$\Sigma^{+*}(3)$	$\Sigma^{+*}(4)$	$\Sigma^{+*}(5)$	$\Sigma^{+*}(6)$			
$\Lambda^0(1)$	$\Lambda^0(2)$	$\Lambda^0(1)$	$\Lambda^0(3)$	$\Lambda^0(2)$	$\Lambda^0(3)$	87.00		
$\Sigma^0(1)$	$\Sigma^0(2)$	$\Sigma^0(1)$	$\Sigma^0(3)$	$\Sigma^0(2)$	$\Sigma^0(3)$	11.70		
	$\Sigma^+(1)$		$\Sigma^+(2)$	$\Sigma^+(1)$	$\Sigma^+(2)$	1.30*		*, 1
$\Sigma^{0*}(1)$	$\Sigma^{0*}(2)$	$\Sigma^{0*}(3)$	$\Sigma^{0*}(4)$	$\Sigma^{0*}(5)$	$\Sigma^{0*}(6)$			
$\Lambda^0(1)$	$\Lambda^0(2)$	$\Lambda^0(1)$	$\Lambda^0(3)$	$\Lambda^0(2)$	$\Lambda^0(3)$	87.00		
$\Sigma^0(1)$	$\Sigma^0(2)$	$\Sigma^0(1)$	$\Sigma^0(3)$	$\Sigma^0(2)$	$\Sigma^0(3)$	11.70		
	$\Sigma^+(1)$		$\Sigma^+(2)$	$\Sigma^+(1)$	$\Sigma^+(2)$	1.30*		*, 1

P(1)	**P(2)**	**P(3)**	**P(4)**	**P(5)**	**P(6)**	**Branching Fraction %**	**Full Details Provided**	**Notes**
$\Sigma^{-*}(1)$	$\Sigma^{-*}(2)$	$\Sigma^{-*}(3)$	$\Sigma^{-*}(4)$	$\Sigma^{-*}(5)$	$\Sigma^{-*}(6)$			
$\Lambda^0(1)$	$\Lambda^0(2)$	$\Lambda^0(1)$	$\Lambda^0(3)$	$\Lambda^0(2)$	$\Lambda^0(3)$	87.00		
$\Sigma^0(1)$	$\Sigma^0(2)$	$\Sigma^0(1)$	$\Sigma^0(3)$	$\Sigma^0(2)$	$\Sigma^0(3)$	11.70		
	$\Sigma^-(1)$		$\Sigma^-(2)$	$\Sigma^-(1)$	$\Sigma^-(2)$	1.30*		*, 1
$\Sigma_c{}^{+}*(1)$	$\Sigma_c{}^{+}*(1)$	$\Sigma_c{}^{+}*(1)$	$\Sigma_c{}^{+}*(1)$	$\Sigma_c{}^{+}*(1)$	$\Sigma_c{}^{+}*(1)$			
$\Lambda_c{}^{+}(1)$	$\Lambda_c{}^{+}(2)$	$\Lambda_c{}^{+}(1)$	$\Lambda_c{}^{+}(3)$	$\Lambda_c{}^{+}(2)$	$\Lambda_c{}^{+}(3)$	100		
$\Sigma_c{}^{++}*(1)$	$\Sigma_c{}^{++}*(2)$	$\Sigma_c{}^{++}*(3)$	$\Sigma_c{}^{++}*(4)$	$\Sigma_c{}^{++}*(5)$	$\Sigma_c{}^{++}*(6)$			
$\Lambda_c{}^{+}(1)$	$\Lambda_c{}^{+}(2)$	$\Lambda_c{}^{+}(1)$	$\Lambda_c{}^{+}(3)$	$\Lambda_c{}^{+}(2)$	$\Lambda_c{}^{+}(3)$	100	√	
$\Sigma_c{}^{0}*(1)$	$\Sigma_c{}^{0}*(2)$	$\Sigma_c{}^{0}*(3)$	$\Sigma_c{}^{0}*(4)$	$\Sigma_c{}^{0}*(5)$	$\Sigma_c{}^{0}*(6)$			
$\Lambda_c{}^{+}(1)$	$\Lambda_c{}^{+}(2)$	$\Lambda_c{}^{+}(1)$	$\Lambda_c{}^{+}(3)$	$\Lambda_c{}^{+}(2)$	$\Lambda_c{}^{+}(3)$	100	√	
$\Sigma_b{}^{+}*(1)$	$\Sigma_b{}^{+}*(2)$	$\Sigma_b{}^{+}*(3)$	$\Sigma_b{}^{+}*(4)$	$\Sigma_b{}^{+}*(5)$	$\Sigma_b{}^{+}*(6)$			
$\Lambda^0{}_b(1)$	$\Lambda^0{}_b(2)$	$\Lambda^0{}_b(1)$	$\Lambda^0{}_b(3)$	$\Lambda^0{}_b(2)$	$\Lambda^0{}_b(3)$	100		
$\Sigma_b{}^{-}*(1)$	$\Sigma_b{}^{-}*(2)$	$\Sigma_b{}^{-}*(3)$	$\Sigma_b{}^{-}*(4)$	$\Sigma_b{}^{-}*(5)$	$\Sigma_b{}^{-}*(6)$			
$\Lambda^0{}_b(1)$	$\Lambda^0{}_b(2)$	$\Lambda^0{}_b(1)$	$\Lambda^0{}_b(3)$	$\Lambda^0{}_b(2)$	$\Lambda^0{}_b(3)$	100		
$\Xi^{0*}(1)$	$\Xi^{0*}(2)$	$\Xi^{0*}(3)$	$\Xi^{0*}(4)$	$\Xi^{0*}(5)$	$\Xi^{0*}(6)$			
$\Xi^0(1)$	$\Xi^0(2)$	$\Xi^0(1)$		$\Xi^0(2)$		100		2, 3
$\Xi^-(1)$	$\Xi^-(2)$	$\Xi^-(1)$		$\Xi^-(2)$				3
$\Xi^{-*}(1)$	$\Xi^{-*}(2)$	$\Xi^{-*}(3)$	$\Xi^{-*}(4)$	$\Xi^{-*}(5)$	$\Xi^{-*}(6)$			
$\Xi^0(1)$	$\Xi^0(2)$	$\Xi^0(1)$		$\Xi^0(2)$		100		2, 3
$\Xi^-(1)$	$\Xi^-(1)$	$\Xi^-(1)$		$\Xi^-(1)$				3
$\Sigma_c{}^{+}*(1)$	$\Sigma_c{}^{+}*(2)$	$\Sigma_c{}^{+}*(3)$	$\Sigma_c{}^{+}*(4)$	$\Sigma_c{}^{+}*(5)$	$\Sigma_c{}^{+}*(6)$			
$\Sigma^0{}_c(1)$	$\Sigma^0{}_c(2)$	$\Sigma^0{}_c(1)$	$\Sigma^0{}_c(3)$	$\Sigma^0{}_c(2)$	$\Sigma^0{}_c(3)$	Seen		
$\Sigma_c{}^{0}*(1)$	$\Sigma_c{}^{0}*(2)$	$\Sigma_c{}^{0}*(3)$	$\Sigma_c{}^{0}*(4)$	$\Sigma_c{}^{0}*(5)$	$\Sigma_c{}^{0}*(6)$			
$\Sigma_c{}^{+}(1)$	$\Sigma_c{}^{+}(2)$	$\Sigma_c{}^{+}(1)$	$\Sigma_c{}^{+}(3)$	$\Sigma_c{}^{+}(2)$	$\Sigma_c{}^{+}(3)$	Seen		
$\Xi_b{}^{0*}(1)$	$\Xi_b{}^{0*}(2)$	$\Xi_b{}^{0*}(3)$	$\Xi_b{}^{0*}(4)$	$\Xi_b{}^{0*}(5)$	$\Xi_b{}^{0*}(6)$			
$\Xi^-{}_b(1)$	$\Xi^-{}_b(2)$	$\Xi^-{}_b(1)$	$\Xi^-{}_b(3)$	$\Xi^-{}_b(2)$	$\Xi^-{}_b(3)$	Seen		
$\Omega^-(1)$	$\Omega^-(2)$	$\Omega^-(3)$	$\Omega^-(4)$	$\Omega^-(5)$	$\Omega^-(6)$			
$\Lambda^0(1)$	$\Lambda^0(2)$	$\Lambda^0(1)$	$\Lambda^0(3)$	$\Lambda^0(2)$	$\Lambda^0(3)$	67.8		
$\Xi^0(1)$	$\Xi^0(2)$	$\Xi^0(1)$		$\Xi^0(2)$		23.6		1
$\Xi^-(1)$	$\Xi^-(2)$	$\Xi^-(1)$		$\Xi^-(2)$		8.6		1
$\Omega_c{}^{0*}(1)$	$\Omega_c{}^{0*}(2)$	$\Omega_c{}^{0*}(3)$	$\Omega_c{}^{0*}(4)$	$\Omega_c{}^{0*}(5)$	$\Omega_c{}^{0*}(6)$			
	$\Omega^0{}_c(1)$		$\Omega^0{}_c(2)$	$\Omega^0{}_c(1)$	$\Omega^0{}_c(2)$	100		1

Table 3.2 – Overall Summary of Decay Configuration Patterns.

The above table of decay distribution patterns has been constructed via a comparison of the intrinsic angular momentum configurations of the respective decaying and decayed particle. The following notes apply.

* - This branching fraction is not quoted in [2] but is assumed because the sum of all branching fractions must total 100.0%.

1 - Where there is a gap in the table, i.e. at $\Sigma^{+*}(1)$ etc it is because these decays cannot occur because of intrinsic angular momentum conflicts between the decaying and the decayed particle.

2 - The branching fractions of $\Xi^{0*}\rightarrow\Xi^0$ and $\Xi^{-*}\rightarrow\Xi^0$ are quoted in [2] at 100.0%. However, both decaying particles also decay to Ξ^- but with unquoted branching fractions. Thus the decay to Ξ^0 must be less than 100% with the balance attributable to Ξ^-.

3 - Configurations $\Xi^{0*}(4)$, $\Xi^{0*}(6)$, $\Xi^{-*}(4)$ and $\Xi^{-*}(6)$ do not exhibit a decay product of the type shown in Table 3.2 because of intrinsic angular momentum conflicts. Consequently, either these configurations are never created, or they decay to other particles via an s quark flavour change that has not yet been seen experimentally.

3.3 Types of Decay.

The following table lists the types of decay exhibited by the particles considered here for all intrinsic angular momentum configurations.

Particle Decay	**Quark with $J = 3/2\hbar$**	**Interim Energy Distribution – Confinement Energy Sign.**			**Quark Flavour Change**		**Decay Type**	**Notes**
		q_1	q_2	q_3	Down	Up		
$\Sigma^{+*}\rightarrow\Lambda^0$ $\rightarrow\Sigma^0$	u_1	+ve	+ve	+ve		u_2	7	
	u_2	-ve	+ve	+ve			9	
	s_1	+ve	+ve	+ve			7	
$\Sigma^{+*}\rightarrow\Sigma^+$	Any	+ve	+ve	+ve			6	1
$\Sigma^{0*}\rightarrow\Lambda^0$ $\rightarrow\Sigma^0$	Any	+ve	+ve	+ve			6	1
$\Sigma^{0*}\rightarrow\Sigma^+$	Any	+ve	+ve	+ve	d_1		1ϕ	
$\Sigma^{-*}\rightarrow\Lambda^0$ $\rightarrow\Sigma^0$	Any	+ve	+ve	+ve	d_1		1ϕ	
$\Sigma^{-*}\rightarrow\Sigma^-$	Any	+ve	+ve	+ve			6	1
$\Sigma_c{}^{+}{*}\rightarrow\Lambda_c{}^+$	u_1	+ve	-ve	+ve			14	1
	d_1	-ve	+ve	+ve			16	1
	c_1	+ve	+ve	+ve			6	1
$\Sigma_c{}^{++}{*}\rightarrow\Lambda_c{}^+$	u_1	+ve	-ve	+ve		u_2	22	
	u_2	-ve	+ve	+ve			9	
	c_1	+ve	+ve	+ve			1ϕ	
$\Sigma_c{}^{0}{*}\rightarrow\Lambda_c{}^+$	d_1	+ve	+ve	+ve	d_1		21	
	d_2	-ve	+ve	+ve			19	
	c_1	+ve	+ve	+ve			21	
$\Sigma_b{}^{+}{*}\rightarrow\Lambda_b{}^0$	Any	-ve	-ve	+ve		u_1	10	
$\Sigma_b{}^{-}{*}\rightarrow\Lambda_b{}^0$	Any	-ve	-ve	+ve	d_2		2ϕ	
$\Xi^{0*}\rightarrow\Xi^0$	Any	+ve	+ve	+ve			6	1
$\rightarrow\Xi^-$	Any	+ve	+ve	+ve		u_1	20	
$\Xi^{-*}\rightarrow\Xi^-$	Any	+ve	+ve	+ve			6	1
$\rightarrow\Xi^0$	Any	+ve	+ve	+ve	d_1		21	
$\Xi_c{}^{+*}\rightarrow\Xi^0{}_c$	Any	+ve	+ve	+ve		u_1	20	
$\Xi_c{}^{0*}\rightarrow\Xi_c{}^+$	Any	+ve	+ve	+ve	d_1		21	
$\Omega^-\rightarrow\Lambda^0$	Any	+ve	+ve	+ve	s_1, s_2		12	
$\rightarrow\Xi^0$	Any	+ve	+ve	+ve	s_1		1	
$\rightarrow\Xi^-$	Any	+ve	+ve	+ve	s_1		1	
$\Omega_c{}^{0*}\rightarrow\Omega_c{}^0$	Any	+ve	+ve	+ve			6	1

Table 3.3 – Types of Decay for all Sigma*, Xi*, Omega$^-$ and Omega* Particles.

Notes: 1 These are all "resonance energy only" decays.

There are six new decay types appearing in Table 3.3, they are:

(i) Decay Type 14 - Similar to Decay Type 6 with the exception that in the interim energy distribution, the sign of the confinement energy of q_2 is –ve instead of +ve.

(ii) Decay Type 16 - Similar to Decay Type 6 with the exception that in the interim energy distribution, the sign of the confinement energy of q_1 is –ve instead of +ve.

(iii) Decay Type 19 – Details shown below for Σ_c^0*(3&4) $\rightarrow\Lambda_c^+$(1&2).

(iv) Decay Type 20 – Similar to Decay Type 7 with the exception that the quark changing flavour up one level is q_1 instead of q_2 or q_3.

(v) Decay Type 21 - Similar to Decay Types 1 and 1ϕ with the exception that the quark changing flavour down one level is q_1 instead of q_2 or q_3.

(vi) Decay Type 22 - Details shown below for Σ_c^{++}*(1&2) $\rightarrow\Lambda_c^+$(1&2).

Finally, as this is the final Addendum detailing pertinent attributes and decay characteristics of all Baryons, as analysed by the methodology employed, and for which the mass is known, [1] and [2], a complete listing of all decay types identified to date is shown in Appendix B.

4.0 Intrinsic Angular Momentum Configuration Tables, Energy Distribution Tables and Decay Energy Translations.

4.1 The Σ_c^{0*} Particle.

4.1.1 Intrinsic Angular Momentum Configurations.

The six intrinsic angular momentum configurations of this particle all decay to Λ_c^+ via the same decay mode $d_1 \Rightarrow u_1$, but by two different decay types, 19 and 21 as shown in Table 3.3 above. Only the configurations resulting in Decay Type 19 are shown here.

Σ_c^0*(#)	d_1	d_2	c_1	Decay Modes
3	↑1/2	↑3/2	↓1/2	$\Sigma_c^{0*}(d_1) \Rightarrow \Lambda_c^+ (u_1)$
4	↓1/2	↑3/2	↑1/2	

Table 4.1 – Intrinsic Angular Momentum Configurations for Σ_c^0*(3 & 4)

In Table 4.1 each arrow indicates the direction of intrinsic angular momentum. Configurations Σ_c^0*(1 & 2) are obtained by exchanging the values of d_1 and d_2. Configurations Σ_c^0*(5 & 6) are shown in Appendix A. These two latter configurations decay via Type 21.

4.1.2 Energy Distribution Table.

The energy distribution table for the intrinsic angular momentum configurations considered here is

Energy	**d_1**	**d_2**	**c_1**	**Total**
Matter	4.75	4.75	1250	1259.5
Resonance	9.76	87.8	0.04	97.60
Confinement	4.38	4.38	1152.95	1161.71
Total	18.89	96.93	2402.99	2518.81

Table 4.2 – Energy Distribution Table for Σ_c^{0}*(3 & 4).

Note that in Table 4.2 it is quark d_2 that carries the intrinsic angular momentum of $J = 3/2\hbar$. The other two quarks carry an intrinsic angular momentum of $J = \pm 1/2\hbar$ respectively.

4.1.3 Decay Energy Translations.

The decay energy translation table for the decay $\Sigma_c^{0}* \rightarrow \Lambda_c^{+}$ for the above intrinsic angular momentum configurations and energy distribution table is as follows, (Decay Type 19).

Energy	**$d_1 \Rightarrow u_1$**	**d_2**	**c_1**	**Total**
Matter	2.40	4.75	1250	1257.15
Resonance	21.43	10.83	0.04	32.3
Confinement	-4.94	81.35	1152.95	1229.56
Total	18.89	96.93	2402.99	2518.81

Table 4.3 – Interim Energy Distribution for Σ_c^{0*}(3&4) $\rightarrow \Lambda_c^{+}$(1&3).

The decay is completed by the following energy translations.

(i) $E_c(u_1)$ increases by 6.84 via absorption from d_2 and c_1 to reach 1.90, (the Λ_c^{+} level).

(ii) $E_c(d_2)$ decreases to 3.77, (the Λ_c^{+} level).

(iii) $E_c(c_1)$ decreases to 991.34, (the Λ_c^{+} level).

(iv) Via (i), (ii) and (iii), d_2 and c_1 eject a total of 232.35 in the form of negatively charged secondary particles plus kinetic energy.

4.2 The Σ_c^{++*} Particle.

4.2.1 Intrinsic Angular Momentum Configurations.

The intrinsic angular momentum configurations for Σ_c^{++*}(1&2) are shown in the following table.

Σ_c^{0}*(#)	**d_1**	**d_2**	**c_1**	**Decay Modes**
1	↑3/2	↑1/2	↓1/2	$\Sigma_c^{++*}(u_2) \Rightarrow \Lambda_c^{+}(d_1)$
2	↑3/2	↓1/2	↑1/2	

Table 4.4 – Intrinsic Angular Momentum Configurations for Σ_c^{++}*(1 & 2)

Note that similar comments to those under Table 4.1 also apply here.

4.2.2 Energy Distribution Table.

Energy	u₁	u₂	c₁	Total
Matter	2.4	2.4	1250	1254.80
Resonance	86.41	9.6	0.02	96.03
Confinement	2.23	2.23	1162.71	1167.17
Total	91.04	14.23	2412.72	2518.00

Table 4.5 – Energy Distribution Table for Σ_c^{++}*(1 & 2).

Note that in Table 4.5 it is quark u_1 that carries the intrinsic angular momentum of $J = 3/2\hbar$. The other two quarks carry an intrinsic angular momentum of $J = \pm 1/2\hbar$ respectively.

4.2.3 Decay Energy Translations.

The decay energy translation table for the decay $\Sigma_c^{++}* \rightarrow \Lambda_c^+$ for the above intrinsic angular momentum configurations and energy distribution table is as follows, (Decay Type 22).

Energy	u₁	$u_2 \Rightarrow d_1$	c₁	Total
Matter	2.4	4.75	1250	1257.15
Resonance	21.43	10.83	0.04	32.30
Confinement	67.21	-1.35	1162.69	1228.55
Total	91.04	14.23	2412.72	2518.00

Table 4.6 – Interim Energy Distribution Table for Σ_c^{++}*(1 & 2) $\rightarrow \Lambda_c^+$(1&2).

The decay is completed by the following energy translations.

(v) $E_c(u_1)$ and $E_c(c_1)$ decay 5.12 to d_1 which increases to 3.77, (the Λ_c^+ level).
(vi) $E_c(u_1)$ decreases to 1.90, (the Λ_c^+ level).
(vii) $E_c(c_1)$ decreases to 991.34, (the Λ_c^+ level).
(viii) Via (i), (ii) and (iii), u_1 and c_1 eject a total of 231.54 in the form of positively charged secondary particles plus kinetic energy.

4.0 The Initial Cause of Baryonic Particle Decay.

It is of course well known that all Baryons except the Proton decay. In fact it is quite easy to show that all Baryons decay down to the Proton through a series of hierarchical decay paths. One example is shown in Appendix C for the decay of Λ_c^+.

The whole process can be somewhat likened to the decay of the Electron in the Hydrogen atom after it has been subjected to radiative excitation. The excitation raises the Electron to some orbital in a high orbit shell which, after the excitation is removed, cascades back down to the ground state via the emission of energy in the form of quantum levels of Gamma radiation. This decay occurs simply because its total energy in the high orbit shell is greater than when it is in the ground state. The decay path can be via single or multiple orbit shell jumps.

The scenario is considerably more complex in the decay of Baryons because there are three elementary particles involved in the process, the three quarks, and three forms of active energy present, matter, resonance and confinement to make up their total energy. In the case of the Electron in the Hydrogen atom there is only one elementary particle involved, the Electron itself, and only one form of energy involved in the process, the quantum energy level of its orbital. Nevertheless, the overall process is considered sufficiently similar such that the Proton may be regarded as the "ground state" of all Baryons and the trigger that initiates their decay down towards the Proton is simply the excess total energy that they possess above that of the Proton. Also, in a similar manner to the decay of the Electron, Baryon decay can be either directly to the Proton via a single jump or through multiple jumps as shown in Appendix C for Λ_c^+. However, because quarks are elementary particles they cannot simply expel energy to initiate the decay, they can only change form, i.e. "change flavour", to a lower energy level quark. The quark that performs this initial flavour change down to initiate the decay is always the quark that possesses the highest total energy. However, this scenario does not apply to decays that do not involve a quark flavour change, viz "confinement energy only" decays, i.e. as for $\Sigma^0 \rightarrow \Lambda^0$, as has been shown in [7].

6.0 Conclusions.

The decay of the particles considered here, although portraying two new unique decay types, are merely variations on what has been presented in earlier Addendums and, consequently, there is only one point regarding decay types that warrants further discussion. As shown in Table 1.1, of the 15 particles reviewed here, 14 are high resonance energy version of their $J = 1/2\hbar$ counterparts. However, there are only six of these that decay via a resonance energy only decay. The reason for this is the detailed decay process that such particles experience, which will be discussed in a future paper.

The main matter requiring further review is that of the implications of the initial cause of Baryon decay as discussed in the previous Section. While such a cause has been presented based upon the precedent represented by the decay of the Electron in the Hydrogen atom, it is by no means adequate to represent the complete process.

The manner in which the decay of Baryons has been presented in [3], [4], [5], [6], [7], [8] and this Addendum, has been 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 via the emission of secondary particles, or Gamma radiation, together with kinetic energy. To fully describe the overall total process, what is now required are complete details of the events that take place between these two energy distributions. Also essential are the triggers that cause these events, and how and why they have the effects that they do. A detailed analysis of the information generated in [3], [4], [5], [6], [7], [8] and this Addendum has now enabled that task to be completed, and this will form the subject et al of the next paper.

Appendix A

Energy Distribution Tables for All Particle Configurations Not Covered in the Main Text.

Quark Energy Distributions.

Particle	Energy	u_1*	u_2	s_1	Total
Σ^{+*}	Matter	2.40	2.40	100	104.80
	Resonance	260.59	28.96	0.69	290.14
	Confinement	22.62	22.62	942.61	987.86
	Total	285.61	53.98	1043.31	1382.80
	Energy	**u_1**	**u_2**	**s_1***	**Total**
	Matter	2.40	2.40	100	104.80
	Resonance	130.93	130.93	28.28	290.14
	Confinement	22.62	22.62	942.61	987.86
	Total	155.95	255.95	1070.89	1382.80
	Energy	**u_1***	**d_1**	**s_1**	**Total**
Σ^{0*}	Matter	2.40	4.74	100	107.15
	Resonance	270.67	15.20	0.72	286.59
	Confinement	22.17	43.89	923.90	989.96
	Total	295.24	63.84	1024.62	1383.70
	Energy	**u_1**	**d_1***	**s_1**	**Total**
	Matter	2.40	4.74	100	107.15
	Resonance	51.44	233.92	1.28	286.59
	Confinement	22.17	43.89	923.90	989.96
	Total	76.01	282.56	1025.13	1383.70
	Energy	**u_1**	**d_1**	**s_1***	**Total**
	Matter	2.40	4.74	100	107.15
	Resonance	166.50	84.13	35.96	286.59
	Confinement	22.17	43.89	923.90	989.96
	Total	191.07	132.77	1059.86	1383.70
	Energy	**d_1***	**d_1**	**s_1**	**Total**
Σ^{-*}	Matter	4.75	4.75	100	109.50
	Resonance	254.95	28.33	1.35	284.63
	Confinement	43.08	43.08	906.92	993.08
	Total	302.78	76.16	1008.24	1387.21
	Energy	**d_1**	**d_1**	**s_1***	**Total**
	Matter	4.75	4.75	100	109.50
	Resonance	117.25	117.25	50.13	284.63
	Confinement	43.08	43.08	906.92	993.08
	Total	165.08	165.08	1057.05	1387.21

Quark Energy Distributions.

Particle	Energy	u_1*	d_1	c_1	Total
Σ_c^{+*}	Matter	2.40	4.75	1250	1257.15
	Resonance	91.73	5.15	0.02	96.90
	Confinement	2.22	4.40	1156.83	1163.45
	Total	96.35	14.30	2406.85	2517.50
	Energy	**u_1**	**d_1***	**c_1**	**Total**
	Matter	2.40	4.75	1250	1257.15
	Resonance	17.46	79.40	0.03	96.90
	Confinement	2.22	4.40	1156.83	1163.45
	Total	22.08	88.45	2406.87	2517.50
	Energy	**u_1**	**d_1**	**c_1***	**Total**
	Matter	2.40	4.75	1250	1257.15
	Resonance	63.64	32.16	1.10	96.90
	Confinement	2.22	4.40	1156.83	1163.45
	Total	68.26	41.31	2407.93	2517.50
	Energy	**u_1**	**u_2**	**c_1***	**Total**
Σ_c^{++*}	Matter	2.40	2.40	1250	1254.80
	Resonance	47.60	47.60	0.83	96.03
	Confinement	2.23	2.23	1162.71	1167.17
	Total	52.23	52.23	2413.54	2518.40
	Energy	**d_1**	**d_2**	**c_1***	**Total**
Σ_c^{0*}	Matter	4.75	4.75	1250	1259.50
	Resonance	47.97	47.97	1.65	97.59
	Confinement	4.38	4.38	1152.95	1161.71
	Total	57.10	57.10	2404.60	2518.80
	Energy	**u_1***	**u_2**	**b_1**	**Total**
Σ_b^{+*}	Matter	2.40	2.40	4300	44304.80
	Resonance	28.09	3.12	0.002	31.202
	Confinement	0.83	0.83	1494.43	1496.10
	Total	31.20	6.35	5794.43	5832.10
	Energy	**u_1**	**u_2**	**b_1***	**Total**
	Matter	2.40	2.40	4300	44304.80
	Resonance	15.56	15.56	0.09	31.202
	Confinement	0.83	0.83	1494.43	1496.10
	Total	18.79	18.79	5794.52	5832.10

Appendix A

Energy Distribution Tables for All Particle Configurations Not Covered in the Main Text.

Quark Energy Distributions.

Particle	Energy	d_1^*	d_1	b_1	Total
Σ_b^{-*}	Matter	4.75	4.75	4300	4309.50
	Resonance	26.46	2.94	0.003	29.403
	Confinement	1.65	1.65	1492.90	1496.20
	Total	32.86	9.34	5792.90	5835.10
	Energy	d_1	d_1	b_1^*	Total
	Matter	4.75	4.75	4300	4309.50
	Resonance	14.63	14.63	0.143	29.403
	Confinement	1.65	1.65	1492.90	1496.20
	Total	21.03	21.03	5793.04	5835.10
	Energy	u_1^*	s_1	s_2	Total
Ξ^{0*}	Matter	2.40	100	100	202.40
	Resonance	323.69	0.87	0.87	325.43
	Confinement	11.91	493.04	493.04	1003.99
	Total	338.00	596.91	596.91	1531.82
	Energy	u_1	s_1^*	s_2	Total
	Matter	2.40	100	100	202.40
	Resonance	262.43	56.68	6.32	325.43
	Confinement	11.91	493.04	493.04	1003.99
	Total	276.74	652.72	602.36	1531.82
	Energy	d_1^*	s_1	s_2	Total
Ξ^{-*}	Matter	4.75	100	100	204.75
	Resonance	316.59	1.67	1.67	319.93
	Confinement	23.44	493.44	493.44	1010.32
	Total	344.78	595.11	595.11	1535.00
	Energy	d_1	s_1^*	s_2	Total
	Matter	4.75	100	100	204.75
	Resonance	216.90	92.73	10.30	319.93
	Confinement	23.44	493.44	493.44	1010.32
	Total	245.09	686.17	603.74	1535.00
	Energy	u_1^*	s_1	c_1	Total
Ξ_c^{+*}	Matter	2.40	100	1250	1352.40
	Resonance	266.38	0.71	0.06	267.15
	Confinement	1.82	75.89	948.64	1026.35
	Total	270.60	176.60	2199.06	2645.90

Quark Energy Distributions.

Particle	Energy	u_1	s_1^*	c_1	Total
Ξ_c^{+*}	Matter	2.40	100	1250	1352.40
	Resonance	219.35	47.38	0.42	267.15
	Confinement	1.82	75.89	948.64	1026.35
	Total	223.57	223.27	2198.70	2645.90
	Energy	u_1	s_1	c_1^*	Total
	Matter	2.40	100	1250	1352.40
	Resonance	256.56	6.16	4.43	267.15
	Confinement	1.82	75.89	948.64	1026.35
	Total	260.78	182.05	2203.07	2645.90
	Energy	d_1^*	s_1	c_1	Total
Ξ_c^{0*}	Matter	4.75	100	1250	1354.75
	Resonance	212.82	1.12	0.09	214.03
	Confinement	3.79	79.75	996.93	1080.47
	Total	221.36	180.87	2247.02	2649.25
	Energy	d_1	s_1^*	c_1	Total
	Matter	4.75	100	1250	1354.75
	Resonance	149.54	63.93	0.57	214.03
	Confinement	3.79	79.75	996.93	1080.47
	Total	158.08	243.68	2247.50	2649.25
	Energy	d_1	s_1	c_1^*	Total
	Matter	4.75	100	1250	1354.75
	Resonance	197.86	9.40	6.77	214.03
	Confinement	3.79	79.75	996.93	1080.47
	Total	206.40	189.15	2253.68	2649.25
	Energy	u_1^*	s_1	b_1	Total
Ξ_b^{0*}	Matter	2.40	100	4300	4402.40
	Resonance	235.91	0.63	0.01	236.55
	Confinement	0.71	29.68	1276.16	1306.55
	Total	239.02	130.31	5576.17	5945.50
	Energy	u_1	s_1^*	b_1	Total
	Matter	2.40	100	4300	4402.40
	Resonance	194.44	42.00	0.11	236.55
	Confinement	0.71	29.68	1276.16	1306.55
	Total	197.55	171.68	5576.27	5945.50

Appendix A

Energy Distribution Tables for All Particle Configurations Not Covered in the Main Text.

Quark Energy Distributions.

Particle	**Energy**	**u_1**	**s_1**	**b_1***	**Total**
Ξ_b^{0*}	**Matter**	2.40	100	4300	4402.40
	Resonance	229.88	5.52	1.15	236.55
	Confinement	0.71	29.68	1276.16	1306.55
	Total	232.99	135.20	5577.31	5945.50
	Energy	**s_1***	**s_2**	**s_3**	**Total**
Ω^-	**Matter**	100	100	100	300
	Resonance	238.73	26.53	26.53	291.79
	Confinement	360.22	360.22	360.22	1080.86
	Total	698.95	486.75	486.75	1672.45
	Energy	**s_1***	**s_2**	**c_1**	**Total**
Ω_c^{0*}	**Matter**	100	100	1250	1450
	Resonance	94.69	10.52	0.84	106.05
	Confinement	83.44	83.44	1042.97	1209.85
	Total	278.13	193.96	2293.82	2765.90
	Energy	**s_1**	**s_2**	**c_1***	**Total**
	Matter	100	100	1250	1450
	Resonance	38.98	38.98	28.07	106.05
	Confinement	83.44	83.44	1042.97	1209.85
	Total	222.43	222.43	2321.05	2765.90

The intrinsic angular momentum tables for all of the above energy distributions are as per Table 3.1.

Note that here * indicates the quark with $J = 3/2\hbar$.

In the above tables only two energy distributions are shown when two quarks are identical because the particle energy distributions associated with each such quark configuration will be the same.

The decay energy translations for the distributions in this Appendix can be deduced from the basic theory in [3].

Appendix B

List of Decay Types in P11 and all Eight Addendums to P11.

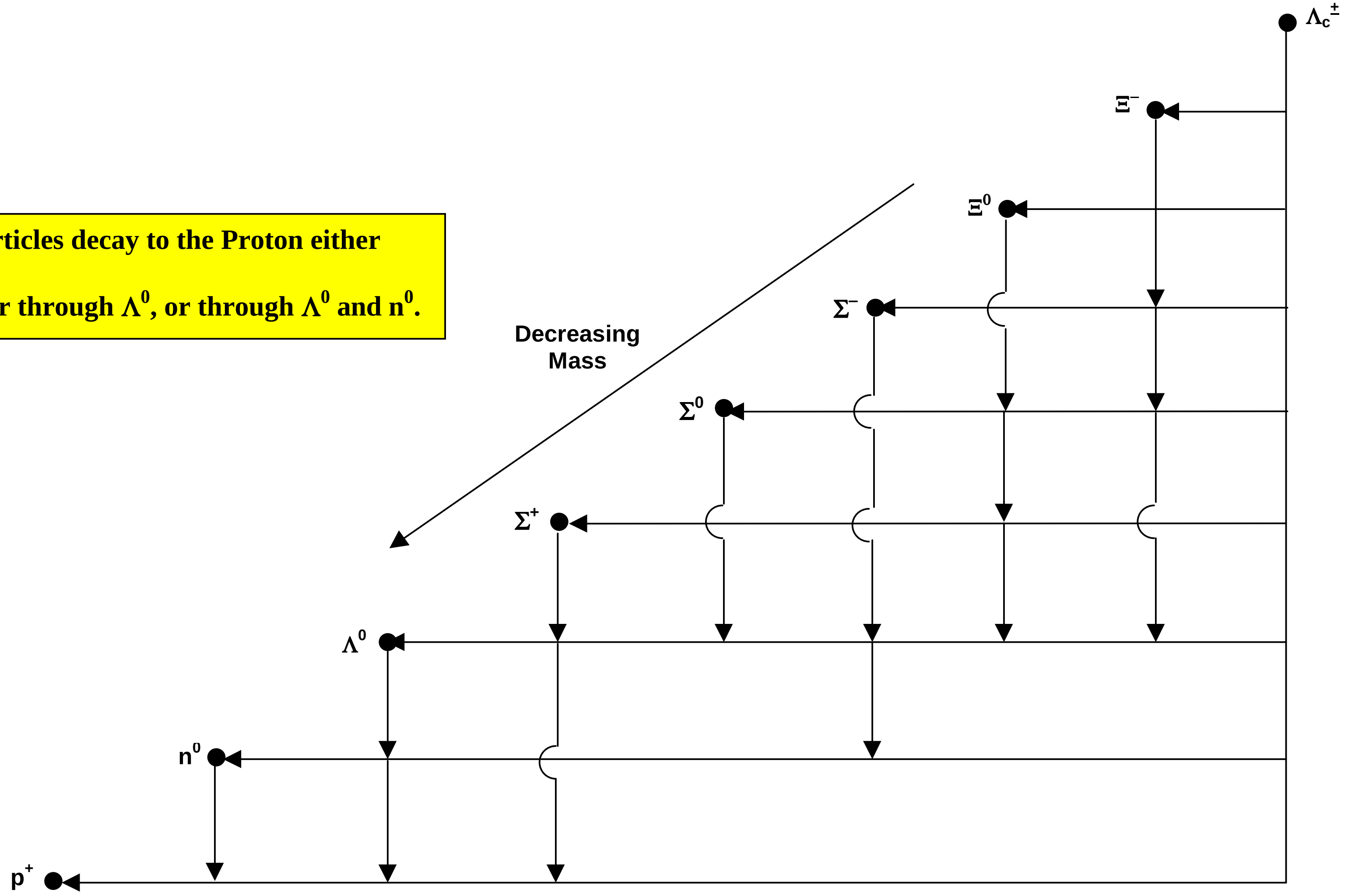
These decay types are based upon the interim energy distribution for the decaying particle assuming that all quark flavour changes take place "instantly" and simultaneously, i.e. as in Tables 4.3 and 4.6. However, note that the complete decay scenario to be presented in the next paper will result in a modification and consolidation of all decay types shown here.

Decay Type Number.	**Quark Flavour Change.**		**Interim Energy Distribution – Confinement Energy Sign.**		
	Down	**Up**	**q_1**	**q_2**	**q_3**
1	**q_3**		+ve	+ve	+ve
1ϕ	**q_2**		+ve	+ve	+ve
2	**q_3**		-ve	-ve	+ve
2ϕ	**q_2**		-ve	-ve	+ve
3	**q_3 and q_2**		-ve	-ve	+ve
4	**q_3**	**q_2**	-ve	-ve	+ve
5	**q_3**	**q_1**	+ve	+ve	+ve
6	**Resonance Energy Only Decay**		+ve	+ve	+ve
7		**q_2 or q_3**	+ve	+ve	+ve
8	**Confinement Energy Only Decay**		+ve	+ve	+ve
9		**q_2**	-ve	+ve	+ve
10		**q_1 or q_2**	-ve	-ve	+ve
11	**q_3**	**q_1 or q_2**	-ve	+ve	+ve
12	**q_3 and q_2**		+ve	+ve	+ve
13	**q_3**	**q_1**	-ve,($J = 3/2\hbar$)	+ve	+ve
14	**Resonance Energy Only Decay**		-ve	-ve	+ve
15	**q_3**		+ve	+ve	+ve,($J = 3/2\hbar$)
16	**Resonance Energy Only Decay**		-ve	+ve	+ve
17	**q_3**		-ve	+ve	+ve
19	**q_1**		-ve	+ve	+ve
20		**q_1**	+ve	+ve	+ve
21	**q_1**		+ve	+ve	+ve
22		**q_2**	+ve	-ve	+ve

Appendix C.

Decay Hierarchy of the Λ_c^+ Particle.

All particles decay to the Proton either directly, or through Λ^0, or through Λ^0 and n^0.



REFERENCES.

[1] Wikipedia, *List of Baryons,* en.wikipedia.org.

[2] Particle Data Group, *Particle Listings*, pdg.lbl.gov.

[3] P.G.Bass, *Derivation of Quark Energy Distributions and Decay Products of Baryonic Sub-Atomic Particles, (P11),*www.relativitydomains.com.

[4] P.G.Bass, *Addendum #1 to P11, The Lambda Particles,* www.relativitydomains.com.

[5] P.G.Bass, *Addendum #2 to P11, The Sigma Particles,* www.relativitydomains.com.

[6] P.G.Bass, *Addendum #3 to P11, The Xi Particles,* www.relativitydomains.com.

[7] P.G.Bass, *Addendum #4 to P11, The Omega Particles,* www.relativitydomains.com.

[8] P.G.Bass, *Addendum #5 to P11, The Delta Particles,* www.relativitydomains.com.

[9] P.G.Bass, *The Distribution of Energy Within Baryonic Sub-Atomic Particles,* www.relativitydomains.com.

[10] P.G.Bass, *Derivation of Empirical Laws for the Mass of Baryonic Sub-Atomic Particles,* www.relativitydomains.com.