ADDENDUM #2 TO P11.

The Sigma Particles, ($J = 1/2\hbar$).

P.G.Bass.

Version 1.1.2.
www.relativitydomains.com
March 2017

Abstract.

This Addendum provides details of the energy distribution of the quarks that make up all Sigma sub-atomic particles. Also presented are the energy translations that take place during their decay. This is augmented by further discussion of the decay process itself.

This is the second Addendum to P11, "Derivation of the Quark Energy Distributions and Decay Products of Baryonic Sub-Atomic Particles".

Contents.

1.0 Introduction.

There are nine Sigma particles with $J = 1/2\hbar$, as shown in the following brief table, with their quark complement.

Particle	Quarks
Σ^+	uus
Σ^0	uds
Σ^-	dds
Σ_c^+	udc
Σ_c^0	ddc
Σ_c^{++}	uuc
Σ_b^+	uub
Σ_b^-	ddb
Σ_b^0	udb

Table 1.1 - The Sigma Particles.

It will be shown that Σ^0, Σ_c^+ and Σ_b^0 are high confinement energy versions of Λ^0, Λ_c^+ and Λ_b^0 respectively, as they contain the same quark complement. As a consequence, the decay of the former to the latter, takes place without a quark flavour change and is a confinement energy only decay.
Unlike the Lambda particles, the Sigma particles only exhibit a total of 12 decay paths and of these it is only Σ^+ and Σ^- that exhibit more than one. However, the 12 decay paths involve a total of eight decay types of which seven are different from those exhibited by the Lambda particles. It is for these seven that full details are provided in this Addendum. The details to be shown are as follows.

(i) The Intrinsic Angular Momentum Configurations, (from the generalised tables provided in [3]).

(ii) The Quark Energy Distributions, (These are calculated from the basic theory in [3]).

(iii) The Decay Energy Translations, (These are calculated using the decay process described in [3], as augmented in [4] and, as necessary, by Section 3.1 in this Addendum).

Note that as in [3] and [4], only particles with $J = 1/2\hbar$ containing quarks with $J = \pm 1/2\hbar$ are considered in this Addendum.
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.

Finally, for a full appreciation of this paper, it is recommended that [3] and [4] 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 in P.
E_c	Indicates quark confinement energy.
E_k	Indicates kinetic energy.
$\rightarrow$	Indicates a particle decay.
$\Rightarrow$	Indicates a quark flavour change.

3.0 Initial Discussions.

3.1 The Interim Energy Distribution - A Further variation.

In [3] it was shown that the decay process of the example shown there only involved a single quark flavour change to one at a lower level, (down) i.e. d $\Rightarrow$ u. In [4] decays of the Lambda particles involved three types of quark flavour change, (i) a single change down, (ii) a double change down, and (iii) a double change, one down and one up, i.e. u $\Rightarrow$ d. In all of these the major quark to change flavour was the one possessing the greatest total energy. In this Addendum two further types appear, (i) a single change down, and (ii) a single change up, where in both cases the quark that changes flavour is not the highest total energy quark. The mechanism that triggers these events is discussed in Section 5.0.

3.2 Decay Distribution Patterns - Overall Summary.

This summary lists the primary decay products of the nine Sigma particles according to their intrinsic angular momentum configurations. Included are the branching fractions from [2], which have been augmented via inclusion of their minor decay products, to raise the overall branching fraction to 100% for each Sigma. Also included is indication of the seven decays for which full details are provided in Section 4.0.

P(1)	P(2)	P(3)	Branching Fraction, (%)	Full Details Provided
$\Sigma^+(1)$	$\Sigma^+(2)$			
$p^+(1)$	$p^+(2)$		51.57	
$n^0(1)$	$n^0(2)$		48.31	√
$\Lambda^0(2)$	$\Lambda^0(3)$		0.12	√
$\Sigma^0(1)$	$\Sigma^0(2)$	$\Sigma^0(3)$		
$\Lambda^0(1)$	$\Lambda^0(2)$	$\Lambda^0(3)$	100	√
$\Sigma^-(1)$	$\Sigma^-(2)$			
$n^0(1)$	$n^0(2)$		99.85	
$\Lambda^0(2)$	$\Lambda^0(3)$		0.15	√
$\Sigma_c^+(1)$	$\Sigma_c^+(2)$	$\Sigma_c^+(3)$		
$\Lambda_c^+(1)$	$\Lambda_c^+(2)$	$\Lambda_c^+(3)$	100	
$\Sigma_c^0(1)$	$\Sigma_c^0(2)$			
$\Lambda_c^+(2)$	$\Lambda_c^+(3)$		100	
$\Sigma_c^{++}(1)$	$\Sigma_c^{++}(2)$			
$\Lambda_c^+(2)$	$\Lambda_c^+(3)$		100	√

$\Sigma_b^+(1)$	$\Sigma_b^+(2)$			
$\Lambda_b^0(2)$	$\Lambda_b^0(3)$		100	√
$\Sigma_b^-(1)$	$\Sigma_b^-(2)$			
$\Lambda_b^0(2)$	$\Lambda_b^0(3)$		100	√
$\Sigma_b^0(1)$	$\Sigma_b^0(2)$	$\Sigma_b^0(3)$		
$\Lambda_b^0(1)$	$\Lambda_b^0(2)$	$\Lambda_b^0(3)$	100	

Table 3.1 - Overall Summary of Decay Configuration Patterns.

Note: In Table 3.1 the decay of Σ_b^0 is reported in [2] and [3] as unknown. This is discussed in Section 4.9.

3.3 Type of Decay.

The types of decay exhibited by all Sigma particles is shown in the table below. These types arise according to, in The Interim Energy Distribution Tables, the nature of the quark flavour change(s), and how the quark confinement energy varies.

Decay Type	Particle Decay	Interim Energy Distribution - Confinement Energy Sign			Quark Flavour Change	
		q_1	q_2	q_3	Down	Up
1	$\Sigma^+ \rightarrow p^+$	+ve	+ve	+ve	q_3	
11	$\rightarrow n^0$	−ve	+ve	+ve	q_3	q_2
7	$\rightarrow \Lambda^0$	+ve	+ve	+ve		q_2
8	$\Sigma^0 \rightarrow \Lambda^0$	+ve	+ve	+ve		
8	$\Sigma_c^+ \rightarrow \Lambda_c^+$	+ve	+ve	+ve		
1	$\Sigma^- \rightarrow n^0$	+ve	+ve	+ve	q_3	
1ϕ	$\rightarrow \Lambda^0$	+ve	+ve	+ve	q_2	
1ϕ	$\Sigma_c^0 \rightarrow \Lambda_c^+$	+ve	+ve	+ve	q_2	
9	$\Sigma_c^{++} \rightarrow \Lambda_c^+$	−ve	+ve	+ve		q_2
10	$\Sigma_b^+ \rightarrow \Lambda_b^0$	−ve	−ve	+ve		q_2
2ϕ	$\Sigma_b^- \rightarrow \Lambda_b^0$	−ve	−ve	+ve	q_2	
8*	$\Sigma_b^0 \rightarrow \Lambda_b^0$	+ve	+ve	+ve		

Table 3.2 - Types of Decay Exhibited by Sigma Particles.

Note that Decay Type 8 is a confinement energy only decay, there is no quark flavour change.

1ϕ This decay is classified as Type 1 but with q_2 changing flavour instead of q_3, (q_2 has less total energy than q_3).

2ϕ This decay is classified as Type 2 but with q_2 changing flavour instead of q_3.

* This decay is reported as unknown in [2] and [3] but because Σ_b^0 and Λ_b^0 have the same quark complement, (udb), it is expected that Σ_b^0 will decay to Λ_b^0 via Decay Type 8.

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

4.1 The Σ^+ Particle.

4.1.1. Intrinsic Angular Momentum Configuration.

The Σ^+ particle contains two identical quarks and can therefore exist in only two configurations.

Σ^+(#)	u_1	u_2	s_1	Decay Modes
1	↑	↓	↑	$\Sigma^+(s_1) \Rightarrow n^0(d_1)$ and $\Sigma^+(u_2) \Rightarrow n^0(d_2)$
2	↓	↑	↑	$\Sigma^+(s_1) \Rightarrow n^0(d_2)$ and $\Sigma^+(u_1) \Rightarrow n^0(d_1)$

Table 4.1 - Intrinsic Angular Momentum Configuration of Σ^+.

In Table 4.1 each arrow represents the direction of an intrinsic angular momentum of $J = 1/2\hbar$.

4.1.2. Energy Distribution Table.

This is determined from the basic theory in [3], is shown in the following table, and is applicable to both configurations in Table 4.1 above.

Energy	u_1	u_2	s_1	Total
Matter	2.40	2.40	100.00	104.80
Resonance	47.79	47.79	1.15	96.73
Confinement	22.62	22.62	942.61	987.85
Total	72.81	72.81	1043.76	1189.38

Table 4.2 - Energy Distribution for Σ^+.

4.1.3. **Decay Energy Translations.**

(i) Decay $\Sigma^+ \rightarrow n^0$, (Decay type 11).

The decay process here is identical to that described in [4], Section 3.1, (for decay Type 4), and is similar to Type 4 with the exception that in the Interim Energy Distribution Table the sign of the confinement energy for q_2 is positive instead of negative.

Energy	u_1	$\Sigma^+(u_2) \Rightarrow n^0(d_2)$	$\Sigma^+(s_1) \Rightarrow n^0(d_1)$	Total
Matter	2.40	4.75	4.75	11.90
Resonance	72.73	36.75	36.75	146.23
Confinement	-2.32	31.31	1002.26	1031.25
Total	72.81	72.81	1043.76	1189.38

Table 4.3 - Interim Enery Distribution for $\Sigma^+ \rightarrow n^0$.

The decay is completed by the following confinement energy translations.

$E_c(u_1)$ Increases via absorption from d_1 by 159.92 to 157.60, (the Neutron level).
$E_c(d_2)$ Increases via absorption from d_1 by 280.61 to 311.92, (the Neutron level).
$E_c(d_1)$ Therefore decreases by 440.53 to 561.73.

Finally, d_1 ejects 249,81 in the form of a π^+ Pion plus E_k to reduce to 311.92, the Neutron level. This completes the decay.

(i) Decay $\Sigma^+ \rightarrow \Lambda^0$, (Decay Type 7).

This decay is considered unusual in that it is not the quark with the highest total energy that changes flavour. The process is discussed in Section 5.0. The Interim Energy Distribution Table is as follows

Energy	u_1	$\Sigma^+(u_2) \Rightarrow \Lambda^0(d_1)$	s_1	Total
Matter	2.40	4.75	100.00	107.15
Resonance	62.47	31.56	1.50	95.53
Confinement	7.94	36.50	942.26	986.70
Total	72.81	72.81	1043.76	1189.38

Table 4.4 - Interim Energy Distribution for $\Sigma^+ \rightarrow \Lambda^0$.

The quark confinement energy translations are then

$E_c(u_1)$ Increases via absorption from s_1 by 12.51 to 20.45, (the Λ^0 level).
$E_c(d_1)$ Increases via absorption from s_1 by 3.97 to 40.47, (the Λ^0 level).
$E_c(s_1)$ Therefore decreases by 16.48 to 925.78.

Finally, s_1 ejects 73.70 as an $e^+ + \nu_e + E_k$ and reduces to 852.08, the Λ^0 level.

4.2 The Σ^0 Particle.

4.2.1. Intrinsic Angular Momentum Configuration.

This particle has the same quark complement as Λ^0 and therefore has the same Intrinsic Angular Momentum Configuration.

Σ^0(#)	u_1	d_1	s_1	Decay Mode
1	↑	↑	↓	$\Sigma^0 \rightarrow \Lambda^0$
2	↑	↓	↑	
3	↓	↑	↑	

Table 4.5 - Intrinsic Angular Momentum Configuration of Σ^0.

4.2.2. Energy Distribution table and Decay Energy Translations.

Energy	u_1	d_1	s_1	Total
Matter	2.4	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 4.6 - Energy Distribution for Σ^0.

Table 4.6 also represents the Interim Energy Distribution for the decay of Σ^0 to Λ^0 because with identical quark complements the matter and resonance energies are the same. The decay is therefore via confinement energy translation only, Decay Type 8. The confinement energy translations are as follows

$E_c(u_1)$ Decreases by 1.72 to 20.45, (the Λ^0 level).
$E_c(d_1)$ Decreases by 3.42 to 40.47, (the Λ^0 level).
$E_c(s_1)$ Decreases by 71.82 to 852.08, (the Λ^0 level).

The sum of the above reductions, 76.96, is then ejected as Gamma radiation.

4.3 The Σ^- Particle.

4.3.1. Intrinsic Angular Momentum Configuration.

This is similar to that for Σ^+

Σ^-(#)	d_1	d_2	s_1	Decay Modes
1	↑	↓	↑	$\Sigma^-(s_1) \Rightarrow n^0(u_1)$ or $\Sigma^-(d_1) \Rightarrow \Lambda^0(u_1)$
2	↓	↑	↑	$\Sigma^-(s_1) \Rightarrow n^0(u_1)$ or $\Sigma^-(d_2) \Rightarrow \Lambda^0(u_1)$

Table 4.7 - Intrinsic Angular Momentum of Σ^-.

4.3.2. Energy Distribution.

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 4.8 - Energy Distribution for Σ^-.

4.3.3. **Decay Energy Translations.**

(i) Decay $\Sigma^- \rightarrow \Lambda^0$, (Decay Type 1$\phi$).

The Interim Energy Distribution for this decay is as follows.

Energy	d_1	$\Sigma^-(d_2)\to\Lambda^0(u_1)$	s_1	Total
Matter	4.75	2.40	100.00	107.15
Resonance	31.56	62.47	1.50	95.53
Confinement	57.86	29.30	907.62	985.78
Total	94.17	94.17	1009.12	1197.46

Table 4.9 - Interim Energy Distribution for $\Sigma^-\to\Lambda^0$.

This decay only occurs with a branching fraction of 0.15%. For the other 99.85% it is s_1 that changes flavour to a u quark to realise $\Sigma^-\to n^0$ as a Type 1 decay. The process for this variation, $\Sigma^-\to\Lambda^0$, is discussed in Section 5.0.
The confinement energy translations are as follows.

$E_c(d_1)$ Decreases by 17.39 to 40.47, (the Λ^0 level).
$E_c(s_1)$ Decreases by 55.74 to 852.08, (the Λ^0 level).
$E_c(u_1)$ Therefore increases by 72.93 to 102.23.

Finally, u_1 ejects 81.75 as an $e^- + \overline{\nu}_e + E_k$ and reduces to 20.45, the Λ^0 level. This completes the decay.

4.4 The Σ_c^+ Particle.

4.4.1. Intrinsic Angular Momentum Configuration.

This particle has the same quark complement as Λ_c^+ and therefore has the same Intrinsic Angular Momentum Configuration.

Σ_c^+ (#)	u_1	d_1	c_1	Decay Mode
1	↑	↑	↓	$\Sigma_c^+\to\Lambda_c^+$
2	↑	↓	↑	
3	↓	↑	↑	

Table 4.10 - Intrinsic Angular Momentum Configuration for Σ_c^+.

4.4.2. Energy Distribution.

Energy	u_1	d_1	c_1	Total
Matter	2.40	4.75	1250	1257.15
Resonance	21.43	10.83	0.04	32.30
Confinement	2.22	4.40	1156.83	1163.45
Total	26.05	19.98	2406.87	2452.90

Table 4.11 - Energy Distribution of Σ_c^+.

4.4.3. Decay Energy Translations.

This particle decays to Λ_c^+ via Decay Type 8, a confinement energy only decay due to possessing the same quark complement.

4.5 The Σ_c^0 Particle.

4.5.1. Intrinsic Angular Momentum Configuration.

This is similar to that for Σ^-.

Σ_c^0 (#)	d_1	d_2	c_1	Decay Modes
1	↑	↓	↑	$\Sigma_c^0 (d_1) \Rightarrow \Lambda_c^+ (u_1)$
2	↓	↑	↑	$\Sigma_c^0 (d_1) \Rightarrow \Lambda_c^+ (u_1)$

Table 4.12 - Intrinsic Angular Momentum Configuration for Σ_c^0.

4.5.2. **Energy Distribution.**

Energy	d_1	d_2	c_1	Total
Matter	4.75	4.75	1250	1259.50
Resonance	16.23	16.23	0.06	32.52
Confinement	4.38	4.38	1152.95	1161.71
Total	25.36	25.36	2403.01	2453.73

Table 4.13 - Enegy Distribution of Σ_c^0.

4.5.3. **Decay Energy Translations.**

This particle decays to Λ_c^+ via Decay Type 1ϕ.

4.6 The Σ_c^{++} Particle.

4.6.1. Intrinsic Angular Momentum Configuration.

This is similar to those for Σ_c^0 and Σ^-.

Σ_c^{++} (#)	u_1	u_2	c_1	Decay Modes
1	↑	↓	↑	$\Sigma_c^{++} (u_2) \Rightarrow \Lambda_c^+ (d_1)$
2	↓	↑	↑	$\Sigma_c^{++} (u_2) \Rightarrow \Lambda_c^+ (d_1)$

Table 4.13 - Intrinsic Angular Momentum Configuration for Σ_c^{++}.

4.6.2. **Energy Distribution.**

Energy	u_1	u_2	c_1	Total
Matter	2.40	2.40	1250	1254.80
Resonance	15.99	15.99	0.03	32.01
Confinement	2.23	2.23	1162.71	1167.17
Total	20.62	20.62	2412.74	2453.98

Table 4.15 - Energy Distribution of Σ_c^{++}.

4.6.3. **Decay Energy Translations.**

This particle decays to Λ_c^+ via Decay Type 9 in which the only difference to Type 7 is that in the Interim Energy Distribution Table the sign of the confinement energy of q_1 is negative instead of positive.

Energy	u_1	$\Sigma_c^{++}(u_2) \Rightarrow \Lambda_c^+(d_1)$	c_1	Total
Matter	2.40	4.75	1250	1257.15
Resonance	21.43	10.83	0.04	32.30
Confinement	-3.21	5.04	1162.70	1164.53
Total	20.62	20.62	2412.74	2453.98

Table 4.16 - Interim Energy Distribution for $\Sigma_c^{++} \rightarrow \Lambda_c^+$.

The quark confinement energy translations are then

$E_c(u_1)$ Increases via absorption from c_1 by 5.11 to 1.9, (the Λ_c^+ level).

$E_c(c_1)$ Decreases by 171.36 to 991.34, (the Λ_c^+ level).

$E_c(d_1)$ Therefore increases by 166.25 to 171.29.

Finally, d_1 ejects 167.52 as a π^+ Pion + E_k and reduces to 3.77 the Λ_c^+ level.

4.7 The Σ_b^+ Particle.

4.7.1. Intrinsic Angular Momentum Configuration.

This is similar to those for Σ_c^0 etc.

Σ_b^+ (#)	u_1	u_2	b_1	Decay Modes
1	↑	↓	↑	$\Sigma_b^+(u_2) \Rightarrow \Lambda_c^+(d_1)$
2	↓	↑	↑	$\Sigma_b^+(u_2) \Rightarrow \Lambda_c^+(d_1)$

Table 4.17 - Intrinsic Angular Momentum Configuration for Σ_b^+.

4.7.2. **Energy Distribution.**

Energy	u_1	u_2	b_1	Total
Matter	2.40	2.40	4300	4304.80
Resonance	5.20	5.20	0.003	10.40
Confinement	0.83	0.83	1494.43	1496.09
Total	8.43	8.43	5794.43	5811.29

Table 4.18 - Energy Distribution for Σ_b^+

4.7.3. **Decay Energy Translations.**

This particle decays to Λ_b^0 via Decay Type 10 in which the only difference to Type 9 is that in the Interim Energy Distribution Table the sign of the confinement energy of q_2 is negative instead of positive.

Energy	u_1	$\Sigma_b^+(u_2) \Rightarrow \Lambda_b^0(d_1)$	b_1	Total
Matter	2.4	4.75	4300	4307.15
Resonance	58.74	29.68	0.033	88.45
Confinement	-52.71	-26.00	1494.40	1415.69
Total	8.43	8.43	5794.43	5811.29

Table 4.19 - Interim Energy Distribution for $\Sigma_b^+ \to \Lambda_b^0$.

The confinement energy translations are as follows

$E_c(u_1)$ Increases via absorption from b_1 by 53.39 to 0.68, (the Λ_b^0 level).
$E_c(b_1)$ Decreases by 272.63 to 1221.77, (the Λ_b^0 level).
$E_c(d_1)$ Therefore increases by 219.24 to 193.24.

Finally d_1 ejects 191.89 as a π^+ pion + E_k and reduces to 1.35, the Λ_b^0 level. This completes the decay.

In the Interim Energy Distribution Table the quark confinement energy of u_1 and $\Sigma_b^+(u_2) \Rightarrow \Lambda_b^0(d_1)$ are both negative indicating the confinement force between them has become repulsive. However, the particle at this stage is still held together by the excessive confinement force possessed by b_1. This is similar to the decay of Λ_c^+ to Λ^0 in [4], (see [4] Appendix A for supporting analysis).

4.8 The Σ_b^- Particle.

4.8.1. Intrinsic Angular Momentum Configuration.

This is similar to most other Sigma particles.

Σ_b^- (#)	d_2	d_1	b_1	Decay Modes
1	↑	↓	↑	$\Sigma_b^-(d_1) \Rightarrow \Lambda_b^0(u_1)$
2	↓	↑	↑	$\Sigma_b^-(d_1) \Rightarrow \Lambda_b^0(u_1)$

Table 4.20 - Intrinsic Angular Momentum Configuration for Σ_b^-.

4.8.2. Energy Distribution.

Energy	d_2	d_1	b_1	Total
Matter	4.75	4.75	4300	4309.50
Resonance	4.89	4.89	0.005	9.79
Confinement	1.65	1.65	1492.90	1496.20
Total	11.29	11.29	5792.91	5815.49

Table 4.21 - Energy Distribution for Σ_b^-.

4.8.3. Decay Energy Translations.

This particle decays to Λ_b^0 via Decay Type 2ϕ which is similar to Type 1ϕ except that in the Interim Energy Distribution Table the confinement energy of both q_1 and q_2 is negative instead of positive. This table is as follows

Energy	d_2	$\Sigma_b^-(d_1) \Rightarrow \Lambda_b^0(u_1)$	b_1	Total
Matter	4.75	2.40	4300	4307.15
Resonance	29.68	58.74	0.033	88.45
Confinement	-23.13	-49.84	1492.88	1419.91
Total	11.30	11.30	5792.91	5815.51

Table 4.22 - Interim Energy Distribution for $\Sigma_b^- \rightarrow \Lambda_b^0$.

The comments above with regard to the negative quark confinement energies of $\Sigma_b^-(d_1) \Rightarrow \Lambda_b^0(u_1)$ and d_2 equally apply here. The final confinement energy translations are as follows.

$E_c(u_1)$ Increases via absorption from b_1 by 50.52 to 0.68, (the Λ_b^0 level).

$E_c(d_2)$ Increases via absorption from b_1 by 24.48 to 1.35, (the Λ_b^0 level).

$E_c(b_1)$ Therefore decreases by 75.00 to 1414.88.

Finally, b_1 ejects 196.11 in the form of a π^- pion + E_k and reduces to 1221.77, the Λ_b^0 level. This completes the decay.

4.9 The Σ_b^0 Particle.

4.9.1. Intrinsic Angular Momentum Configuration.

This is identical to Λ_b^0.

Σ_b^0 (#)	u_1	d_1	b_1	Decay Modes
1	↑	↑	↓	$\Sigma_b^0 \to \Lambda_b^0$
2	↑	↓	↑	
3	↓	↑	↑	

Table 4.23 - Intrinsic Angular Momentum Configuration for Σ_b^0.

4.9.2. **Energy Distribution.**

Energy	u_1	d_1	b_1	Total
Matter	2.40	4.75	4300	4307.15
Resonance	58.74	29.68	0.033	88.45
Confinement	0.74	1.47	1334.00	1337.21
Total	61.88	35.90	5634.03	5732.81

Table 4.24 - Energy Distribution for Σ_b^0.

4.9.3. **Decay Energy Translations.**

The decay of this particle is reported as unknown in [1] and [2]. However, it has the same quark complement as Λ_b^0 and will therefore exhibit the same matter and resonance energies. It will therefore decay to Λ_b^0 via Decay Type 8 as per similar Sigma particles reviewed here.

5.0 Conclusions.

There are four aspects of this Addendum worthy of discussion. The first is that there are seven extra Decay Types identified, over and above those in [4]. Six of these are major in that they exhibit a single flavour change of q_2 rather than q_3, which contravenes the expectation that it is the highest total energy quark that will change flavour. This must represent a further variation of the decay process and is discussed below.

The second point to note is that the decay of all Sigma particles considered here are to low energy particle versions, i.e. as stated in [3], Λ^0, Λ_c^+ and Λ_b^0 are low confinement energy versions of Σ^0, Σ_c^+ and Σ_b^0 respectively. The decays to p^+ and n^0 may also be so categorised as they are low resonance energy versions of Δ^+ and Δ^0 respectively. The reason why the Sigma particles considered here decay so is at present unclear.

It is believed that the above feature is related to the third point, the lack of multiple decay paths. All but two of the Sigma particles here exhibit a single decay path, all to Lambda particles. The two with multiple decay paths are first Σ^+, decaying to p^+ and n^0 with roughly equal branching fractions near 50/50, and to Λ^0, but with only a 0.12% branching fraction. Secondly, Σ^- decays to n^0 and Λ^0, predominately the former at 99.85% leaving only 0.15% for the decay to Λ^0. Once again the reasons/mechanisms behind these features is not clear.

The final point of interest is the most important and is the decay process variation represented by Decay Types 1ϕ, 2ϕ, 7, 9, and 10. There are two variants, 1ϕ and 2ϕ, in which q_2 changes flavour to a lower level quark while 7, 9, and 10 involve q_2 changing flavour to a higher level quark.. There is however, a common feature in that Decay Types 1ϕ and 2ϕ apply to decaying particles that have a quark complement of (ddq_3), where q_3 is s, c and b respectively, while Decay Types 7, 9, and 10 apply to decaying particles with a quark complement of (uuq_3), where again q_3 is s, c and b respectively. This feature explains the direction of the flavour change of q_2, but what triggers its change rather than q_3 is again unclear.
With regard to the decay process itself, for the 1ϕ and 2ϕ Type decays, the process is as described in [3] except for the lower energy quark changing flavour and it is a question of how this is triggered. In the case of 7, 9, and 10, q_2 must gain matter energy before it can change flavour. Such a gain can only come from its own resonance/confinement energy or via an exchange of energy with q_3 as described in [4] Section 3.1. The further Addendums may help to clarify this.

Finally, it should be noted that these are interim conclusions which may be augmented/amended in the forthcoming further Addendums.

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.

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