Addendum to P12, (on Baryon Decay)

Analysis of All Possible Initial Quark Flavour Changes and the Existence of Multiple Decay Paths.

and

Reasons for the Non-Appearance of Potential Baryon Decay Paths that have Acceptable Decay Modes.

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Abstract.

This paper is in three parts. The first part details the decay paths of all Baryons, ($J = 1/2\hbar$ and $J = 3/2\hbar$), for all possible initial quark flavour changes. The presentation is in tabular form only but with explanatory notes. As such it represents the complete decay hierarchy of all Baryons.

The second part of the paper presents a detailed explanation of the manner in which a particle exhibits multiple decay paths for just the initial quark flavour change.

Also presented is an explanation for the non-appearance of decay paths that theoretically exhibit acceptable decay modes. The presentation is in enhanced tabular form.

Contents.

1.0 Introduction.

In [1], [2], [3], (plus six addenda), and [4], the attributes and decay characteristics were derived for all Baryons. However, with regards to the latter, the decay characteristics, these were only derived for one particular flavour change of the highest energy quark. To complete the picture, the first part of this paper presents the decay characteristics for all Baryons for all possible flavour changes of the highest energy quark. The presentation is in tabular form with explanatory notes. Thus while the energy dynamics of these decay paths are not included, for conciseness, they are identical in form to those shown in [3] et al and [4]. As such, although in tabular form, the presentation does show the complete decay hierarchy for all Baryons with $J = 1/2\hbar$ and $J = 3/2\hbar$ intrinsic momenta.

In the above references it was also shown that there are several Baryons that exhibit multiple decay paths for a single initial quark flavour change. It was suggested, but not pursued in these references, that this could be due to the kinetic energy possessed by the decaying particle attained at its creation. This is now examined in full detail in the second part of this addendum and shown to be the most likely cause.

Despite the above, there are still a great many potential decay paths for all Baryons that, according to [5] and [6], have never been observed. These decay paths all appear to exhibit acceptable decay modes. The third part of this paper presents an analytical discussion, based upon the energy levels of the particles in question, as to why these paths have never been observed. The presentation is again in tabular form, enhanced, and also with reference to an example in Appendix A.

2.0 The Decay Path Hierarchy of All Baryons.

There are four tables below showing the following.

Table 2.1 - The effect of single and multiple level quark flavour changes for Baryons with an intrinsic angular momentum of $J = 1/2\hbar$ and a known mass as stated in [5] and [6].

Table 2.2 - The effect of single and multiple level quark flavour changes for Baryons with an intrinsic angular momentum of $J = 1/2\hbar$ but for which the mass, according to [5] and [6], is unknown. However, the mass of these particles was determined in [1].

Table 2.3 - The effect of single and multiple level quark flavour changes for Baryons with an intrinsic angular momentum of $J = 3/2\hbar$ and a known mass as stated in [5] and [6].

Table 2.4 The effect of single and multiple level quark flavour changes for Baryons with an intrinsic angular momentum of $J = 3/2\hbar$ but for which the mass, according to [5] and [6], is unknown. However, the mass of these particles was determined in [1].

Note that in Tables 2.2 and 2.4, only the first decay path is shown. There may be extra decay paths for any particular quark flavour change as is exhibited by Λ_c^+ et al in Table 2.1 and discussed in Section 3.0.

Table 2.1 - Effect of Single and Multiple Level Quark Flavour Changes, (J = 1/2 hBar)

Particle	Quark q_3 Flavour Change Level.				Quarks q_2 and q_3 Flavour Change Level.				Comments
	1	2	3	4	1	2	3	4	
p^+									*See Note 1 Below*
n^0	p^+				N/A				*See Note 2 Below*
Λ^0	p^+	n^0							
Σ^+	Λ^0	N/A							*See Note 6 Below*
	n^0								
	p^+								
Σ^0	Λ^0	Λ^0							
Σ^-	N/A	Λ^0							*See Note 4 Below*
		n^0							
Ξ^0	Λ^0	Λ^0			n^0	X			*See Note 3 & 5 Below.*
	Σ^0	Σ^0							
	Σ^+	Σ^+							
Ξ^-	Ξ^0	Ξ^0			X	n^0			*See Note 3 & 5 Below.*
	Λ^0	Λ^0							
	Σ^-	Σ^-							
	Σ^0	Σ^0							
Λ^+_c	Σ^+	Σ^+	Σ^+						
	Λ^0	Λ^0	Λ^0						*See Note 5 Below* *Decay to Δ^{++} not shown*
	Σ^0	Σ^0	Σ^0						
	Σ^-	Σ^-	Σ^-						
	X	Ξ^0	Ξ^0						
	Ξ^-	Ξ^-	Ξ^-						
	X	n^0	n^0						
	X	p^+	p^+						
	X	X	Δ^{++}						
Σ^+_c	Λ^+_c	Λ^+_c	Λ^+_c						
Σ^0_c	Λ^+_c	Λ^+_c	Λ^+_c						
Σ^{++}_c	Λ^+_c	Λ^+_c	Λ^+c						
Ξ^+_c	Ω^-	Ω^-	Ω^-						
	Ξ^-	Ξ^-	Ξ^-						
	Ξ^0	Ξ^0	Ξ^0						
	Σ^0	Σ^0	Σ^0						
	Σ^-	Σ^-	Σ^-						
	Λ^0	Λ^0	Λ^0						
	Σ^+	Σ^+	Σ^+						
	X	p^+	p^+						*See Note 5 Below*

Table 2.1 - Effect of Single and Multiple Level Quark Flavour Changes, (J = 1/2 hBar), Continued.

$\Xi^0{}_c$	Ω^-	Ω^-	Ω^-						*See Note 5 Below*
	Ξ^-	Ξ^-	Ξ^-						
	X	p^+	p^+						
	Λ^0	Λ^0	Λ^0						
$\Xi^{+/}{}_c$	$\Xi^+{}_c$	$\Xi^+{}_c$	$\Xi^+{}_c$						
$\Xi^{0/}c$	$\Xi^0{}_c$	$\Xi^0{}_c$	$\Xi^0{}_c$						
$\Omega^0{}_c$	Ω^-	Ξ^0	Ξ^0						*See Note 7 Below*
		Ξ^-	Ξ^-						
		Σ^+	Σ^+						
$\Xi^+{}_{cc}$	**X**	p^+	p^+						*See Note 5 Below*
	Λ^+c	Λ^+c	$\Lambda^+{}_c$		Ξ^-	**X**	Ξ^-		
	Ξ^-	Ξ^-	X						
$\Lambda^0{}_b$	X	X	p^+	p^+					*See Note 5 Below*
	X	Λ^0	Λ^0	Λ^0					
	X	Λ^+c	Λ^+c	Λ^+c					
	X	X	$\Sigma^{++}{}_c$	$\Sigma^{++}{}_c$					
	$\Sigma^0{}_c$	$\Sigma^0{}_c$	$\Sigma^0{}_c$	$\Sigma^0{}_c$					
$\Xi^0{}_b$	**X**	**X**	p^+	p^+					*See Note 5 Below*
	X	**X**	$\Lambda^+{}_c$	$\Lambda^+{}_c$					
$\Xi^-{}_b$	X	Ξ^-	Ξ^-	Ξ^-					*See Note 5 Below*
$\Sigma^+{}_b$	X	$\Lambda^0{}_b$	$\Lambda^0{}_b$	$\Lambda^0{}_b$					*See Note 5 Below*
$\Sigma^-{}_b$	$\Lambda^0{}_b$	$\Lambda^0{}_b$	$\Lambda^0{}_b$	$\Lambda^0{}_b$					
$\Omega^-{}_b$	$\Omega^0{}_c$	Ω^-	$\Omega^0{}_c$	$\Omega^0{}_c$					

General Note	*The multiple decay paths for the same quark flavour change occur because trap levels are bypassed, See Section 3.0.*
General Note	*Decays to these paths, (Green) occur via a second quark flavour change.*
Note 1	*No flavour changes, particle stable.*
Note 2	*q_2 and q_3 cannot both change flavour down as this would produce a J = 3/2 hBar particle and there is insufficient particle energy to achieve this.*
Note 3	*Decay to this particle, (RED) has not been recorded.*
Note 4	*q_3 cannot change flavour down one level because this would create a J = 3/2hBar particle and there is insufficient particle energy to achieve this.*
Note 5	***X** - This decay path does not occur because the quark energy levels of the decayed particle are not in the range of the of the levels of the decaying particle between the first quark flavour change and full confinement energy re-balance, (See example in Appendix A).*
Note 6	*N/A - q_2 cannot change flavour down 1 or 2 levels, (as applicable), as this would produce a J = 3/2 hBar particle and there is insufficient/too much particle/quark energy to achieve this.*
Note 7	*The decay of $\Omega^0{}_c$ via $c_1 \Rightarrow s_1$ can only result in the decay to Ω^- as all three quarks are now s.*

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Table 2.2 - Decay of the Unknowns, (Only the First Decay Path is Shown, J = 1/2 hBar)

Particle	Quark q_3 Flavour Change Level.				Quarks q_2 and q_3 Flavour Change Level.				Comments
	1	2	3	4	1	2	3	4	
Ω^{+}_{cc}	Λ^{+}_{c}	Λ^{+}_{c}	Λ^{+}_{c}		X	X	Ξ^{+}_{c}		*See Note 1 Below*
Σ^{0}_{b}	Σ^{0}_{c}	Σ^{0}_{c}	Σ^{0}_{c}	Σ^{0}_{c}					
$\Xi^{0/}_{b}$	Ξ^{+}_{c}	Ξ^{0}_{b}	Ξ^{-}_{b}	Ξ^{-}_{b}					
$\Xi^{-/}_{b}$	Ω^{+}_{cc}	Ξ^{0}_{b}	Ω^{+}_{cc}	Ω^{+}_{cc}					
Ξ^{+}_{cb}	Σ^{0}_{b}	Σ^{0}_{b}	Σ^{0}_{b}	Ω^{+}_{cc}					
$\Xi^{+/}_{cb}$	Σ^{0}_{b}	Σ^{0}_{b}	Σ^{0}_{b}	Ω^{+}_{cc}					*This particle has identical energies to its un-dashed counterpart, (two decimal place level).*
Ξ^{0}_{cb}	Σ^{0}_{b}	Σ^{0}_{b}	Ω^{+}_{cc}	Ω^{+}_{cc}					
$\Xi^{0/}_{cb}$	Σ^{0}_{b}	Σ^{0}_{b}	Ω^{+}_{cc}	Ω^{+}_{cc}					*This particle has identical energies to its un-dashed counterpart, (two decimal place level).*
Ω^{0}_{cb}	Ξ^{0}_{cb}	Ξ^{0}_{cb}	Ξ^{0}_{cb}	Ξ^{0}_{cb}					
$\Omega^{0/}_{cb}$	Ξ^{0}_{cb}	Ξ^{0}_{cb}	Ξ^{0}_{cb}	Ξ^{0}_{cb}					*This particle has identical energies to its un-dashed counterpart, (two decimal place level).*
Ω^{+}_{ccb}	$\Xi^{+}cc$	$\Omega^{0}cb$	$\Xi^{+}cc$	$\Xi^{+}cc$					
Ξ^{0}_{bb}	Ω^{+}_{ccb}	Ω^{+}_{ccb}	Ω^{+}_{ccb}	Ω^{+}_{ccb}	Ξ^{++}_{cc}	X	Ω^{+}_{ccb}	Ω^{+}_{ccb}	*See Note 1 Below*
Ξ^{-}_{bb}	Ξ^{0}_{bb}	Ξ^{0}_{bb}	Ξ^{0}_{bb}	Ξ^{0}_{bb}	Ξ^{0}_{cb}	X	Ξ^{0}_{bb}	Ξ^{0}_{bb}	*See Note 1 Below*
Ω^{-}_{bb}	Ξ^{-}_{bb}	Ξ^{-}_{bb}	Ξ^{-}_{bb}	Ξ^{-}_{bb}	X	Ξ^{-}_{bb}	Ξ^{-}	Ξ^{-}	*See Note 1 Below*
Ω^{0}_{cbb}	Ω^{-}_{bb}	Ω^{-}_{bb}	Ω^{-}_{bb}	Ω^{-}_{bb}	Ω^{-}_{bb}	Ω^{-}_{bb}	Ω^{-}_{bb}	Ω^{-}_{bb}	

Note 1 ***X*** *- This decay path does not occur because the quark energy levels of the decayed particle are not in the range of the of the levels of the decaying particle between the first quark flavour change and full confinement energy re-balance, (See example in Appendix A).*

Table 2.3 - Effect of Single and Multiple Level Quark Flavour Changes, (J = 3/2 hBar).

Particle	Quark q_3 Flavour Change Level.				Quarks q_2 and q_3 Flavour Change Level.				Comments
	1	2	3	4	1	2	3	4	
Δ^{++}									*This particle decays to p^+ via a double flavour change up.*
Δ^{+}									*This particle decays to p^+ or n^0 via a single/double flavour change up. See Note 1 Below.*
Δ^{0}					N/A				*This particle decays to p^+ or n^0 via a single/double flavour change up. See Note 3 Below.*
Δ^{-}	n^0				n^0				
Σ^{+*}	Λ^0 Σ^0 Σ^+	Λ^0 Σ^0 Σ^+	Λ^0 Σ^0 Σ^+						
Σ^{0*}	Λ^0 Σ^0	Λ^0 Σ^0	Λ^0 Σ^0						
Σ^{-*}	Λ^0 Σ^-	Λ^0 Σ^-							
Ξ^{0*}	Ξ^0 Ξ^-	Ξ^0 Ξ^-	Ξ^0 Ξ^-		Ξ^0 Ξ^-	Ξ^0 Ξ^-			
Ω^{-}	Ξ^- Ξ^0	Ξ^- Ξ^0	Ξ^- Ξ^0		Λ^0	Λ^0			
Σc^{+*}	X	Λ^+_c	Λ^+_c						*See Note 2 Below*
Σc^{++*}	X	Λ^+_c	Λ^+_c						*See Note 2 Below*
Σc^{0*}	Λ^+_c	Λ^+_c	Λ^+_c						
Ξc^{+*}	Ξ^0_c	Ξ^0_c	Ξ^0_c						
Ξc^{0*}	Ξ^+_c	Ξ^+_c	Ξ^+_c						
Ωc^{0*}	Ω_c^0	Ω_c^0	Ω_c^0						
Σ_b^{+*}	X	Λ^0_b	Λ^0_b	Λ^0_b					*See Note 2 Below*
Σ_b^{-*}	X	Λ^0_b	Λ^0_b	Λ^0_b					*See Note 2 Below*
Ξ_b^{0*}	X	Ξ^-_b	Ξ^-_b	Ξ^-_b	Ξ^-_b				*See Note 2 Below*
Note 1	*This particle cannot decay via a single q_2 quark flavour change down as this would produce a J = 3/2 hBar particle and there is insufficient particle energy to achieve this.*								
Note 2	***X*** *- This decay path does not occur because the quark energy levels of the decayed particle are not in the range of the of the levels of the decaying particle between the first quark flavour change and full confinement energy re-balance, (See example in Appendix A).*								
Note 3	*q_2 and q_3 cannot both change flavour down 1 or 2 levels, (as applicable), as this would produce a J = 3/2 hBar particle and there is insufficient quark energy in q_2 to achieve this.*								

Table 2.4 - Decay of the Unknowns, (Only the First Decay Path is Shown, *J* = 3/2 hBar)

Particle	Quark q_3 Flavour Change Level.				Quarks q_2 and q_3 Flavour Change Level.				Comments
	1	2	3	4	1	2	3	4	
$\Xi^{*+}cc$	$\Lambda^{+}c$	$\Lambda^{+}c$	$\Lambda^{+}c$		$\Xi^{+}cc$	$\Xi^{+}cc$	$\Xi^{+}cc$		
$\Omega^{*+}cc$	$\Lambda^{+}c$	$\Lambda^{+}c$	$\Lambda^{+}c$		$\Omega^{+}cc$	$\Omega^{+}cc$	$\Omega^{+}cc$		
$\Omega^{++}ccc$	$\Omega^{*+}cc$	$\Omega^{*+}cc$	$\Omega^{*+}cc$		$\Omega^{*+}cc$	$\Omega^{*+}cc$	$\Omega^{*+}cc$		
$\Sigma^{*0}b$	Σ^{0}	Σ^{0}	Σ^{0}	Σ^{0}					
$\Xi^{*-}b$	$\Lambda^{0}b$	$\Lambda^{0}b$	$\Lambda^{0}b$	$\Lambda^{0}b$					
$\Omega^{*-}b$	$\Xi^{0}b$	$\Xi^{0}b$	$\Xi^{0}b$	$\Xi^{0}b$					
$\Xi^{*+}cb$	$\Xi^{0}b$	$\Xi^{0}b$	$\Xi^{0}b$	$\Xi^{0}b$					
$\Xi^{*0}cb$	$\Xi^{0/}b$	$\Xi^{0/}b$	$\Xi^{0/}b$	$\Xi^{0/}b$					
$\Omega^{*0}cb$	$\Omega^{0/}cb$	$\Omega^{0/}cb$	$\Omega^{0/}cb$	$\Omega^{0/}cb$					
$\Omega^{*+}ccb$	$\Omega^{+}ccb$	$\Omega^{+}ccb$	$\Omega^{+}ccb$	$\Omega^{+}ccb$					
$\Xi^{*0}bb$	$\Xi^{0}bb$	$\Xi^{0}bb$	$\Xi^{0}bb$	$\Xi^{0}bb$	X	X	$\Xi^{0}bb$	$\Xi^{0}bb$	*See Note 1 Below*
$\Xi^{*-}bb$	$\Xi^{-}bb$	$\Xi^{-}bb$	$\Xi^{-}bb$	$\Xi^{-}bb$	X	X	$\Xi^{-}bb$	$\Xi^{-}bb$	*See Note 1 Below*
$\Omega^{*-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	$\Omega^{-}bb$	
$\Omega^{*0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	
$\Omega^{-}bbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	$\Omega^{0}cbb$	
Note 1	***X*** *- This decay path does not occur because the quark energy levels of the decayed particle are not in the range of the of the levels of the decaying particle between the first quark flavour change and full confinement energy re-balance (See example in Appendix A).*								

3.0 A Discussion of the Cause of Multiple Decay Paths for a Single Quark Flavour Change.

Λ^+_c is used as the example for this analysis.

3.1 Λ^+_c Quark Energy Levels.

u_1	d_1	c_1
25.73	19.35	2241.38

q_3 decays confinement energy to q_1 and q_2 after the initial flavour change of q_3.

The following three Sub-Sections list the decay hierarchy energy levels of Λ^+_c ignoring all kinetic energy possessed by the particle prior to its initial quark flavour change. These energy levels are, for single decay levels, those at the final decay stage when the secondary particles are emitted. For the double decay levels, they are those just before the second quark flavour change. The yellow cells are the energy levels of the particle to which Λ^+_c could decay.

(i) Decay Hierarchy #1, ($c_1 \Rightarrow s_1$),

To	u_1	d_1	s_1	Decay Level	2nd Flavour Change
Σ^+	72.81	52.03	2161.62	Double	$d_1 \Rightarrow u_2$
Λ^0	85.32	76.79	2124.35	Single	None
Σ^0	87.04	80.20	2119.22	Single	None
Σ^-	94.10	94.17	2098.19	Double	$u_1 \Rightarrow d_2$
Ξ^-	109.98	125.59	2050.89	Double	$u_1 \Rightarrow s_2$

These are the energy levels reached by the decaying particle as confinement energy is decayed from s_1 to u_1 and d_1. The yellow cells are the energy levels of the particle to which Λ^+_c could decay.

u_1	d_1	s_1
111.54	128.69	2046.73

These would be the energy levels after the full re-balance of the decaying Λ^+_c.

(ii) Decay Hierarchy #2, ($c_1 \Rightarrow d_2$)

To	u_1	d_1	d_2	Decay Level	2nd Flavour Change
Ξ^0	117.81	125.97	2042.68	Double	$d_1 \Rightarrow s_2$
n^0	232.73	353.42	1700.31	Single	None

These are the energy levels reached by the decaying particle as confinement energy is decayed from d_2 to u_1 and d_1. The yellow cells are the energy levels of the particle to which Λ^+_c could decay.

u_1	d_1	d_2
504.38	891.04	891.04

These would be the energy levels after the full re-balance of the decaying Λ^+_c.

(iii) Decay Hierarchy #3, ($c_1 \Rightarrow u_2$)

To	u_1	d_1	u_2	Decay Level	2^{nd} Flavour Change
p^+	257.51	423.45	1605.70	Single	None
Δ^{++}	302.40	512.09	1471.97	Double	$d_1 \Rightarrow u_3$

These are the energy levels reached by the decaying particle as confinement energy is decayed from u_2 to u_1 and d_1.

u_1	d_1	u_2
596.32	1093.81	596.32
551.68	1071.26	663.52

These would be the energy levels after re-balance of the decaying Λ^+_c, towards p^+ and Δ^{++} respectively.

3.2 Discussion.

Decay hierarchy #3 is discussed first because the cause of these paths is not anomalous. In this case the two decay paths are determined by the amount of matter energy converted to resonance energy as c_1 changes flavour to u_2 in the initial flavour change. However, while this explains the two decay paths exhibited, what determines how much matter energy is converted to resonance is itself not clear.

In decay hierarchy #1, first note that in a single decay level there are two yellow highlighted energy levels of the decayed particle and these are always for the two quarks that have not changed flavour. This also applies to decay hierarchies #2 and 3. Where there is a double quark flavour change, there is only one highlighted energy cell.
The anomaly in this hierarchy is when s_1 is decaying confinement energy to u_1 and d_1, how/why is the first et al decay path bypassed. i.e. bypassing Σ^+ to decay to one of the other particles. As stated in an earlier paper, a possible reason was that when created Λ^+_c was endowed with a high level of kinetic energy, which as shown in [7] is stored as extra mass. Consequently, with particle mass being comprised of three types of energy, matter, resonance and confinement, it is necessary to decide in which form the kinetic energy is stored. Firstly, with the particle also being composed of three quarks, it would be expected that each of these would absorb some of the kinetic energy. Secondly, because confinement energy has been shown to be the only energy of the three to transmit between quarks, it is proposed that the kinetic energy is stored by all three quarks in the form of extra confinement energy. Accordingly, because confinement energy is retained by quarks in the ratio of their matter energy mass, it is concluded that this must be how the particles kinetic energy is stored.

Before proceeding it is also necessary to determine a suitable formula relating the particles kinetic energy to its velocity.

3.3 Determination of Particle Velocity from its Kinetic Energy.

In [7] it was shown that relativistic kinetic energy is given by

$$E_k = mc^2 - m_0c^2 \tag{3.1}$$

and it is easily shown that this leads directly to

$$v = c\left(1 - \frac{m_0^2}{m^2}\right)^{1/2} \tag{3.2}$$

where as in [1]

m is the energy mass of the particle
m_0 is the rest mass
c is the velocity of light.

3.4 Quark Energy Levels Incorporating Kinetic Energy.

With kinetic energy stored as a mass increase via an increase in quark confinement energy, then if the particles kinetic energy at creation is E_k, it will be distributed among the three quarks of Λ^+_c after the flavour change of c_1 to s_1 as

$$\frac{2.4}{107.15}E_k \text{ to } u_1; \quad \frac{4.75}{107.15}E_k \text{ to } d_1; \text{ and } \frac{100}{107.15}E_k \text{ to } s_1 \tag{3.3}$$

The total energy of each quark then becomes, from the (mini table in Section 3.1)

$$u_1 = 25.73 + \frac{2.4}{107.15}E_k$$

$$d_1 = 19.34 + \frac{4.75}{107.15}E_k \tag{3.4}$$

$$s_1 = 2241.38 + \frac{100}{107.15}E_k$$

The Dynamics of Decay Bypasses.

If Σ^+ is to be bypassed, then put the total energy of u_1, at the point of the initial quark flavour change, equal to 72.82, then from (3.4)

$$E_k = (72.82 - 25.73)\frac{107.15}{2.4} = 2102.37 \tag{3.5}$$

then the energy of d_1 is

$$d_1 = 19.34 + \frac{4.75}{107.15} x\ 2102.37 = 112.54 \tag{3.6}$$

and the energy of s_1 is

$$s_1 = 2241.38 + \frac{100}{107.15} x\ 2102.37 = 4203.46 \tag{3.7}$$

The total energy of the decaying particle is then

$$\Lambda_c^+ = 72.82 + 112.54 + 4203.46 = 4388.83 \tag{3.8}$$

So that finally, the creation velocity of Λ^+_c would have been, from (3.2)

$$v = c\left\{1 - \left(\frac{2286.46}{4388.83}\right)^2\right\}^{1/2} = 0.8536c \tag{3.9}$$

In this case, Λ^+_c would decay to Ξ^- as d_1 attains a total energy of 125.59 via decay of s_1 confinement energy.

The following table shows the Λ^+_c decay dynamics for the bypass of all particles.

Bypassed Particle	***E**$_k$*	**Energy Dynamics of the Bypass**					**Particle Decayed To**	**Quark Flavour Change**
		u_1	d_1	**s_1**	**Total**	**Creation Velocity of Λ^+_c**		
Σ^+	2107.37	72.82	112.54	4203.46	4388.83	0.8536*c*	Ξ^-	$d_1 = 125.59$
Ξ^-	2396.78	79.41	125.60	4478.26	4683.24	0.8727*c*	Λ^0	-
Λ^0	2660.89	85.33	137.3	4727.71	4947.35	0.8868*c*	Σ^0	-
Σ^0	2737.68	87.05	140.70	4796.38	5024.14	0.8904*c*	Σ^-	$u_1 \Rightarrow d_2$
Σ^-	3056.01	94.18	154.81	5093.47	5342.47	0.9038*c*	Ξ^0	$d_1 \Rightarrow s_2$
Ξ^0	4111.43	117.82	201.60	6078.45	6397.89	0.9555*c*	Full Re-Balance	-
Full Re-Balance	**4111.44+**	143.30+	283.62+	5970.97+	6397.90+	0.9555*c*+	-	$s_1 \Rightarrow d_2$ or u_2

Table 3.1 – Energy Decay Dynamics of Λ^+_c.

As shown, at full rebalance s_1, still being the highest energy quark, changes flavour to either d_2 or u_2 and enters enhanced versions of either hierarchies 2 or 3.

The above analysis applies to hierarchy #2, either normal as at 3.1(ii) or enhanced, and to all Baryons that exhibit multiple decay paths for an initial quark flavour change, (see Tables 2.1 and 2.3)

4.0 The Non-Appearance of Potential Decay Paths.

This part of the paper will only consider particles with an intrinsic angular momentum of $J = 1/2\hbar$. Particles with $J = 3/2\hbar$ all decay directly to those with $J = 1/2\hbar$ and there are sufficient quantities of potential decay paths in the former to adequately illustrate the reasons for the non-appearance of these paths. Similarly, only those particles for which a decay path has been experimentally observed as reported in [5] and [6] are considered here for the same reason as above. Note that an "acceptable" decay mode is one in which either one to two quark flavour changes exist to effect the decay.

Table 4.1 below presents a complete picture of the decay attributes of all $J = 1/2\hbar$ particles.

Baryon Decay Attributes. | Particle decay unknown. | J = 3/2hBar | Decay is by confinement energy decay only, no quark flavour change involved.

Particle	Mass	Quarks	p^+	n^0	Λ^0	Σ^+	Σ^0	Σ^-	Ξ^0	Ξ^-	Ω^-	Λ^+_c	Σ^+_c	Σ^0_c	Σ^{++}_c	Ξ^+_c	Ξ^0_c	$\Xi^{+/}_c$	$\Xi^{0/}_c$	Ω^0_c
			938.27	939.57	1,115.68	1,189.37	1,192.64	1,197.45	1,314.86	1,321.71	1,672.45	2,286.46	2,452.90	2,453.74	2,453.98	2,467.80	2,470.88	2,575.60	2,577.90	2,695.20
p^+	938.27	uud																		
n^0	939.57	udd	D																	
Λ^0	1,115.68	uds	D	D																
Σ^+	1,189.37	uus	D	D	D															
Σ^0	1,192.64	uds	♣	♣	D	♣														
Σ^-	1,197.45	dds	X	D	D	X														
Ξ^0	1,314.86	uss	X		D	D	D													
Ξ^-	1,321.71	dss		X	D	X	D	D	D											
Λ^+_c	2,286.46	udc	D	D	D	D	D	D	D	D	X									
Σ^+_c	2,452.90	udc	♣	♣	♣	♣	♣	♣	♣	♣	♣	D								
Σ^0_c	2,453.74	ddc	X			X			X		X	D								
Σ^{++}_c	2,453.98	uuc		X				X	X	X	X	D		X						
Ξ^+_c	2,467.80	usc	D	X	D	D	D	D	D	D	D			X	X					
Ξ^0_c	2,470.88	dsc	D		D	X			X	D	D	X	X		X					
$\Xi^{+/}_c$	2,575.60	usc	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	D	♣			
$\Xi^{0/}_c$	2,577.90	dsc	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	D	♣		
Ω^0_c	2,695.20	ssc	X	X		D		X	D	D	D	X	X	X	X	X		X		
Ξ^+_{cc}	3,518.90	dcc	D	X	X	X	X	X	X		X	D		X	X	X		X		X
Ξ^{++}_{cc}	3,650.73	ucc	X		X	X	X	X		X	X									
Ω^+_{cc}	3,752.22	scc	X	X	X		X		X	X		X	X	X	X					
Λ^0_b	5,619.40	udb	D		D	X			X	X	X	D		D	D					X
Σ^0_b	5,731.82	udb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
Ξ^0_b	5,787.80	usb	D	X				X		D	X	D		X	X					
Ξ^-_b	5,791.10	dsb	X			X			X	D		X	X		X	X		X		
Σ^+_b	5,811.30	uub		X	X		X	X	X	X	X			X		X	X	X	X	X
Σ^-_b	5,815.50	ddb	X		X	X	X		X	X	X				X	X		X		X
$\Xi^{0/}_b$	5,855.67	usb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
$\Xi^{-/}_b$	5,858.74	dsb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
Ω^-_b	6,071.00	ssb	X	X		X		X			D	X	X	X	X	X		X		D
Ξ^+_{cb}	7,487.11	ucb				X		X	X	X	X			X						X
$\Xi^{+/}_{cb}$	7,487.11	ucb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
Ξ^0_{cb}	7,490.72	dcb	X		X	X	X		X	X	X				X	X		X		
$\Xi^{0/}_{cb}$	7,490.72	dcb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
Ω^0_{cb}	7,638.11	scb	X	X	X	X	X		X		X	X	X	X	X					
$\Omega^{0/}_{cb}$	7,638.11	scb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣
Ω^+_{ccb}	9,586.36	ccb	X	X	X	X	X	X	X	X	X				X	X		X		X
Ξ^0_{bb}	13,381.23	ubb	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Ξ^-_{bb}	13,386.84	dbb	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X
Ω^-_{bb}	13,616.99	sbb	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Ω^0_{cbb}	16,669.09	cbb	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	

Nomenclature :-

X	**Not observed, (does not exhibit observed decay modes).**
D	**Observed decay.**
♣	**Not Observed, (confinement energy only decay).**
	Potential decay, (exhibits acceptable decay modes, but not observed).

Baryon Decay Attributes.

The Decay of Λ^{+}_{c} to Δ^{+} is not shown in this Chart.

Particle	Mass	Quarks	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}	$\Xi^{+/}_{cb}$	Ξ^{0}_{cb}	$\Xi^{0/}_{cb}$	Ω^{0}_{cb}	$\Omega^{0/}_{cb}$
			3,518.90	3,650.73	3,752.22	5,619.40	5,731.82	5,787.80	5,791.10	5,811.30	5,815.50	5,855.67	5,858.74	6,071.00	7,487.11	7,487.11	7,490.72	7,490.72	7,638.11	7,638.11
p^{+}	938.27	uud																		
n^{0}	939.57	udd																		
Λ^{0}	1,115.68	uds																		
Σ^{+}	1,189.37	uus																		
Σ^{0}	1,192.64	uds																		
Σ^{-}	1,197.45	dds																		
Ξ^{0}	1,314.86	uss																		
Ξ^{-}	1,321.71	dss																		
Λ^{+}_{c}	2,286.46	udc																		
Σ^{+}_{c}	2,452.90	udc																		
Σ^{0}_{c}	2,453.74	ddc																		
Σ^{++}_{c}	2,453.98	uuc																		
Ξ^{+}_{c}	2,467.80	usc																		
Ξ^{0}_{c}	2,470.88	dsc																		
$\Xi^{+/}_{c}$	2,575.60	usc																		
$\Xi^{0/}_{c}$	2,577.90	dsc																		
Ω^{0}_{c}	2,695.20	ssc																		
Ξ^{+}_{cc}	3,518.90	dcc																		
Ξ^{++}_{cc}	3,650.73	ucc	X																	
Ω^{+}_{cc}	3,752.22	scc		X																
Λ^{0}_{b}	5,619.40	udb	X	X	X															
Σ^{0}_{b}	5,731.82	udb	♣	♣	♣	D														
Ξ^{0}_{b}	5,787.80	usb	X		X															
Ξ^{-}_{b}	5,791.10	dsb		X		X	X													
Σ^{+}_{b}	5,811.30	uub	X	X	X	D		X	X											
Σ^{-}_{b}	5,815.50	ddb	X	X	X	D		X		X										
$\Xi^{0/}_{b}$	5,855.67	usb	♣	♣	♣	♣	♣	D	♣	♣	♣									
$\Xi^{-/}_{b}$	5,858.74	dsb	♣	♣	♣	♣	♣	♣	D	♣	♣	♣								
Ω^{-}_{b}	6,071.00	ssb	X	X		X	X	X		X	X	X								
Ξ^{+}_{cb}	7,487.11	ucb				X	X		X	X	X		X	X						
$\Xi^{+/}_{cb}$	7,487.11	ucb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	D					
Ξ^{0}_{cb}	7,490.72	dcb		X		X	X	X		X	X	X		X						
$\Xi^{0/}_{cb}$	7,490.72	dcb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	D			
Ω^{0}_{cb}	7,638.11	scb	X	X		X	X	X	X	X	X	X	X		X	X				
$\Omega^{0/}_{cb}$	7,638.11	scb	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	♣	D	
Ω^{+}_{ccb}	9,586.36	ccb				X	X	X	X	X	X	X	X	X	X	X	X	X		
Ξ^{0}_{bb}	13,381.23	ubb	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X
Ξ^{-}_{bb}	13,386.84	dbb		X	X	X	X	X		X		X			X	X				
Ω^{-}_{bb}	13,616.99	sbb	X	X		X	X			X	X				X	X	X	X	X	X
Ω^{0}_{cbb}	16,669.09	cbb	X	X	X	X	X	X	X	X	X	X	X	X						

Particle	Mass	Quarks	$\Omega^{+}{}_{ccb}$	$\Xi^{0}{}_{bb}$	$\Xi^{-}{}_{bb}$	$\Omega^{-}{}_{bb}$	$\Omega^{0}{}_{cbb}$
			9,586.36	13,381.23	13,386.84	13,616.99	16,669.09
p^{+}	938.27	uud					
n^{0}	939.57	udd					
Λ^{0}	1,115.68	uds					
Σ^{+}	1,189.37	uus					
Σ^{0}	1,192.64	uds					
Σ^{-}	1,197.45	dds					
Ξ^{0}	1,314.86	uss					
Ξ^{-}	1,321.71	dss					
$\Lambda^{+}{}_{c}$	2,286.46	udc					
$\Sigma^{+}{}_{c}$	2,452.90	udc					
$\Sigma^{0}{}_{c}$	2,453.74	ddc					
$\Sigma^{++}{}_{c}$	2,453.98	uuc					
$\Xi^{+}{}_{c}$	2,467.80	usc					
$\Xi^{0}{}_{c}$	2,470.88	dsc					
$\Xi^{+/}{}_{c}$	2,575.60	usc					
$\Xi^{0/}{}_{c}$	2,577.90	dsc					
$\Omega^{0}{}_{c}$	2,695.20	ssc					
$\Xi^{+}{}_{cc}$	3,518.90	dcc					
$\Xi^{++}{}_{cc}$	3,650.73	ucc					
$\Omega^{+}{}_{cc}$	3,752.22	scc					
$\Lambda^{0}{}_{b}$	5,619.40	udb					
$\Sigma^{0}{}_{b}$	5,731.82	udb					
$\Xi^{0}{}_{b}$	5,787.80	usb					
$\Xi^{-}{}_{b}$	5,791.10	dsb					
$\Sigma^{+}{}_{b}$	5,811.30	uub					
$\Sigma^{-}{}_{b}$	5,815.50	ddb					
$\Xi^{0/}{}_{b}$	5,855.67	usb					
$\Xi^{-/}{}_{b}$	5,858.74	dsb					
$\Omega^{-}{}_{b}$	6,071.00	ssb					
$\Xi^{+}{}_{cb}$	7,487.11	ucb					
$\Xi^{+/}{}_{cb}$	7,487.11	ucb					
$\Xi^{0}{}_{cb}$	7,490.72	dcb					
$\Xi^{0/}{}_{cb}$	7,490.72	dcb					
$\Omega^{0}{}_{cb}$	7,638.11	scb					
$\Omega^{0/}{}_{cb}$	7,638.11	scb					
$\Omega^{+}{}_{ccb}$	9,586.36	ccb					
$\Xi^{0}{}_{bb}$	13,381.23	ubb	X				
$\Xi^{-}{}_{bb}$	13,386.84	dbb					
$\Omega^{-}{}_{bb}$	13,616.99	sbb	X	X			
$\Omega^{0}{}_{cbb}$	16,669.09	cbb		X	X		

Table 4.2 below presents the various reasons for the non-appearance of the potential decay paths shown in Table 4.1 above. The reasons are all based upon an analysis of their decay energy dynamics.

Potential Decay	Initial Quark Flavour Change	Reason for Non- Appearance of The Decay Paths.	Notes
$\Sigma^- \to \Sigma^0$	$s_1 \Rightarrow u_1$	The energies of Σ^0 are not within the range of the re-balanced energies the decaying Σ^-.	1, 2
$\Xi^0 \to \Sigma^-$ $\to n^0$	$s_1 \Rightarrow d_1$	Ξ^0 decays to Λ^0 preferentially, (99.525%), via a single quark flavour change. Also to Σ^0 and Σ^+, (0.475% combined). Decay to Σ^- would need a second quark flavour change and while theoretically possible has not been observed probably due to a vanishingly small branching fraction. This also applies to the potential decay to n^0.	
$\Xi^- \to p^+$	$s_2 \Rightarrow u_1$ $s_2 \Rightarrow d_2$	Ξ^- decays to Λ^0 preferentially, (99.887%), via a single quark flavour change. Also to Σ^- and Σ^0, and to Ξ^0 via $d_1 \Rightarrow S_2$, (0.113% combined), Decay to p^+ would need $S_1 \Rightarrow u_2$ and the energy level of $p^+(u_2)$ is outside the range of S_1. This would require a double quark flavour change at the second change level and both S_1 and d_1 are not within the range of $p^+(u)$.	
$\Sigma^0 \to \Sigma^+$ $\to \Xi^-$ $\to \Sigma^0$ $\to \Lambda^0$ $\to n_0$	$c_1 \Rightarrow s_1$	With a total basic energy difference of only 0.85, the Σ^+ decay path is most likely bypassed due to the kinetic energy attained by Σ^0 at creation. At full rebalance the energy of s_1 is greater than that of the s quarks in Ξ^-, Σ^- Σ^0 and Λ^0 and greater than that of d in n^0. Also d_2 is less than $\Xi^-(s_1)$. d_1 can reach $\Xi^-(d_1)$, but s_1 reaches Λ^+_c (s_1) first (100% branching fraction)	
$\Sigma^{++}{}_c \to \Sigma^0$ $\to \Sigma^+{}_c$ $\to \Sigma^+$ $\to \Lambda^0$ $\to p^+$	$c_1 \Rightarrow s_1$	The energy difference to $\Sigma^+{}_c$ is only 1.08 so that this decay path is most likely bypassed due to the kinetic energy attained by $\Sigma^{++}{}_c$ at creation $\Sigma^{++}{}_c$. The potential decay to the other particles is prohibited because the energy levels of the applicable quarks in the other particles is beyond those of $\Sigma^{++}{}_c$ at full re-balance.	2
$\Xi^+{}_c \to \Sigma^+{}_c$ $\to \Lambda^+{}_c$	$c_1 \Rightarrow s_1$	The potential decay to $\Sigma^+{}_c$ is prohibited because its energies are beyond those of $\Xi^+{}_c$ at full re-balance. s_1 can attain $\Lambda^+{}_c(c_1)$ but because the confinement energy level of u_1 is so highly negative at the first quark flavour change, this decay path is probably bypassed by the ensuing high decay rates.	2
$\Xi^0{}_c \to \Xi^+{}_c$ $\to \Sigma^0{}_c$ $\to \Sigma^-$ $\to \Sigma^0$ $\to n_0$	$c_1 \Rightarrow s_2$	s_2 energy is less than the s energy in either $\Xi^+{}_c$ or $\Sigma^0{}_c$ The energies of Σ^0 and Σ^- are not within the range of the re-balanced energies of the decaying $\Xi^0{}_c$. s_1 can attain the energy level of $n^0(u_1)$. This decay path is therefore theoretically possible but is not recorded, (as with $c_1 \Rightarrow d_2$ and $c_1 \Rightarrow u_1$), because decays to Ω^-, Ξ^-, Λ^0 and p^+ take precedence.	2
$\Omega^0{}_c \to \Xi^{0/}{}_c$ $\to \Xi^0{}_c$ $\to \Sigma^0$ $\to \Lambda^0$	$c_1 \Rightarrow d_1$	The energies of $\Xi^{0/}{}_c$ are not within the range of the re-balanced energies of the decaying $\Omega^0{}_c$ The decays to $\Xi^0{}_c$, Σ^0 or Λ^0 seem theoretically possible but would require $d_1 \Rightarrow c_1$ plus s_1 or $s_2 \Rightarrow d_1$ at the second quark flavour change and this may not be a viable transition scenario.	2
$\Xi^+{}_{cc} \to \Xi^{0/}{}_c$ $\to \Xi^0{}_c$ $\to \Sigma^+{}_c$ $\to \Xi^-$	$c_1 \Rightarrow s_1$	The energies of $\Xi^{0/}{}_c$, $\Xi^0{}_c$, or $\Sigma^+{}_c$ are not within the range of the re-balanced energies of the decaying $\Xi^+{}_{cc}$. The re-balanced energy of d_1 is not within the range of $\Xi^-(d_1)$.	2
$\Lambda^0{}_b \to \Xi^{0/}{}_c$ $\to \Xi^0{}_c$ $\to \Xi^+{}_c$ $\to \Sigma^+{}_c$ $\to \Sigma^-$ $\to \Sigma^0$ $\to n_0$	$b_1 \Rightarrow c_1$	The energies of all potential decay particles are not within the range of the re-balanced energies of the decaying $\Lambda^0{}_b$.	2
$\Xi^0{}_b \to \Sigma^0{}_b$ $\to \Lambda^0{}_b$ $\to \Xi^{++}{}_{cc}$ $\to \Omega^0{}_c$ $\to \Xi^{0/}{}_c$ $\to \Xi^{+/}{}_c$ $\to \Xi^0{}_c$ $\to \Xi^+{}_c$ $\to \Sigma^+{}_c$ $\to \Xi^0$ $\to \Sigma^0$ $\to \Sigma^+$ $\to \Lambda^0$	$b_1 \Rightarrow c_1$	The energies of all potential decay particles are not within the range of the re-balanced energies of the decaying $\Xi^0{}_b$.	2

$\Xi^-_b \rightarrow \Xi^0_b$ $\rightarrow \Omega^+_{cc}$ $\rightarrow \Xi^+_{cc}$ $\rightarrow \Omega^0_c$ $\rightarrow \Xi^{0/}_c$ $\rightarrow \Xi^0_c$ $\rightarrow \Sigma^0_c$ $\rightarrow \Omega^-$ $\rightarrow \Sigma^-$ $\rightarrow \Sigma^0$ $\rightarrow \Lambda^0$ $\rightarrow n_0$	$b_1 \Rightarrow c_1$	The energies of all potential decay particles are not within the range of the re-balanced energies of the decaying Ξ^-_b.	2
$\Sigma^+_b \rightarrow \Sigma^0_b$ $\rightarrow \Sigma^{++}_c$ $\rightarrow \Sigma^+_c$ $\rightarrow \Lambda^+_c$ $\rightarrow \Sigma^+$ $\rightarrow p^+$	$b_1 \Rightarrow c_1$	Σ^0_b, Σ^{++}_c, Σ^+_c and Λ^+_c are all theoretically possible but are bypassed most likely due to the high kinetic energy attained by Σ^+_b at the point of its creation. The energies of Σ^+ p^+ and are not within the range of the re-balanced energies of the decaying Σ^+_b.	2
$\Sigma^-_b \rightarrow \Xi^-_b$ $\rightarrow \Sigma^0_b$ $\rightarrow \Xi^{0/}_c$ $\rightarrow \Xi^0_c$ $\rightarrow \Sigma^0_c$ $\rightarrow \Sigma^+_c$ $\rightarrow \Lambda^+_c$ $\rightarrow \Sigma^-$ $\rightarrow n_0$	$b_1 \Rightarrow c_1$	The energies of Ξ^-_b, $\Xi^{0/}_c$, Ξ^0_c, Σ^- and n_0 are not within the range of the re-balanced energies of the decaying Σ^+_b. Potential decay to Σ^0_b, Σ^0_c, Σ^+_c and Λ^+_c is theoretically possible but d_2 reaches $\Lambda^0_b(d_1)$ first.	2
$\Omega^-_b \rightarrow \Xi^-_b$ $\rightarrow \Omega^+_{cc}$ $\rightarrow \Xi^{0/}_c$ $\rightarrow \Xi^0_c$ $\rightarrow \Xi^-$ $\rightarrow \Xi^0$ $\rightarrow \Sigma^0$ $\rightarrow \Lambda^0$	$b_1 \Rightarrow c_1$	Theoretically possible but s_2 reaches $\Omega^0_c(s_2)$ first. For all other potential decays, their energies are not within the range of the re-balanced energies of the decaying Ω^-_b.	2

Table 4.2 – Reasons for the Non-Appearance of Potential Decay Paths.

Notes: 1 – The energy of u_1 should reach $\Lambda^0(s_1)$ before d_1 or d_2 reach $n^0(d)$ but this would require a second flavour change and therefore the decay to n^0 predominates, i.e a branching fraction of 99.848% to 0.152%.

2 – See explanatory analysis in Appendix A.

In the above table no account has been made for the kinetic energy of the decaying particle. Inclusion of this may accentuate some reasons and also remove those potential decay paths designated as theoretically possible.

5.0 Conclusions.

The decay hierarchies shown in Tables 2.1 to 2.4 are of course predicated upon the fact that they have been constructed without taking account of the linear momentum imparted to the decaying particle at the point of its creation. As such they can only be considered as a basic guide, because inclusion of the effects of initial kinetic energy may significantly affect the order of decay paths exhibited. This is exemplified by the decay regime of Λ^+_c as demonstrated in the second part of the paper. There it was shown that the initial kinetic energy of the particle results in a multiplicity of decay paths where its velocity at creation varied over the relatively small range of ~0.8536*c* to 0.9038*c*.
In the final part of the paper the reasons analysed have again been without consideration of the kinetic energy possessed by the decaying particle. Doing so may result in some variation of the results obtained. However, due to the range over which kinetic energy of any decaying particle may vary, analysis of same would require a major study in its own right. Such a study would be somewhat lengthy and difficult in that it may have to consider not only the kinetic energy of the decaying particle at its creation, but also the

effects of the kinetic energies of all particle decays leading up to it, right up the tree to the original particle initiating the decay cascade. Consequently, it would need to consider not only $J = 1/2\hbar$ particles, but also $J = 3/2\hbar$ particles, each with a range of kinetic energies, plus particles with higher resonance and confinement energies where these were involved in the process. Such a study, if considered worthwhile, would require extensive resources in the form of manpower and computing facilities.

Appendix A.

This Appendix illustrates one specific reason for the non-appearance of some decay paths.

Table A.1 - Energy Distribution of Σ^-

	Denominator	Energy	d_1	d_2	s_1	Total
Decaying Particle Energy Distribution Σ^-	2.0475	Matter	4.75	4.75	100.00	109.50
		Resonance	46.34	46.34	2.20	94.88
	1	Confinement	43.08	43.08	906.92	993.08
		Total	94.17	94.17	1009.12	1197.46

Table A.2 - Energy Distribution Immediately After 1st Quark Flavour Change

	Denominator	Energy	d_1	d_2	u_1	Total
Decayed Particle Interim Energy Distribution, (First Quark Flavour Change)	3.979166667	Matter	4.75	4.75	2.40	11.90
		Resonance	36.75	36.75	72.73	146.22
	2	Confinement	52.67	52.67	934.00	1039.34
		Total	94.17	94.17	1009.12	1197.46

Table A.3 - Energy Distribution After Re-Balance of Confinement Energy

	Denominator	Energy	d_1	d_2	u_1	Total
Decayed Particle Interim Energy Distribution, (Full Re-Balance of Confinement Energy)	3.979166667	Matter	4.75	4.75	2.40	11.90
		Resonance	36.75	36.75	72.73	146.22
	3	Confinement	414.86	414.86	209.61	1039.34
		Total	456.36	456.36	284.74	1197.46

Table A.4 - Energy Distribution of Σ^0

	Denominator	Energy	u_1	d_1	s_1	Total
Particle Energy Distribution Σ^0	1.529263158	Matter	2.40	4.75	100.00	107.15
		Resonance	62.47	31.56	1.50	95.53
	1	Confinement	22.17	43.89	923.90	989.96
		Total	87.04	80.20	1025.40	1192.64

Note: - the red font in Table A.2 indicates the values that change.

In Table A.2 immediately after the first quark flavour change, u_1 decays confinement energy to d_1 and d_2 and therefore starts to lose energy. u_1 cannot therefore exhibit the energy level of $\Sigma^0(s_1)$ as in Table A.4 at any time in the decay process. Similarly, d_1 and d_2 in Table A.2 gain confinement energy from u_1 and therefore increase. As they already possess a greater level of energy than $\Sigma^0(u_1)$ or (d_1) they can never exhibit the energy levels of these Σ^0 quarks. Hence Σ^- cannot possibly decay to Σ^0. The kinetic energy possessed by Σ^- at its creation would accentuate this. Note that Σ^- cannot decay via $s_1 \Rightarrow d_3$ as this would create a $J = 3/2\hbar$ particle and there is insufficient energy in Σ^- to achieve this.

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