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CONSERVATION OF BASIC MONOPOLES IN DECAY PROCESSES

by

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ABSTRACT

The conservation law of basic monopoles and other rules followed by these monopoles in the formation and decay processes of elementary particles are presented and discussed.

A new interpretation of the distinction between rapid decay process (commonly ascribed to strong interactions) and slow decay processes (commonly ascribed to weak interactions) is proposed.

1. Introduction

In a preceding paper (Barricelli, 1983) the configurations identifying the magnetic monopoles shaping various elementary particles and their organization have been described. A list of the magnetic monopoles involved and their main properties is presented in table 1. The configurations of various elementary particles are listed in table 2. The configurations are identified by fitting the calculated masses, electric charges and spins of the various particles to the observed ones.

All elementary particles and their magnetically charged components whose configurations are presented in tables 1 and 2 are interpreted as systems formed by various kinds of association of the three basic monopoles B^3, U_1, L^1, and their anti-particles B_3, U^1, L_1.

The purpose of this paper is to describe the way in which the basic monopoles of a decaying particle are distributed among the decay products and interpret some of the phenomena characteristic of these processes.

A few conservation laws play a fundamental role in all decay processes. One of them is the conservation of the three basic monopoles.

2. The B,U,L conservation law

According to this law the three basic monopoles are conserved in every decay process and every interaction process between elementary particles. This means that none of these monopoles can be created or destroyed except in the form of a "monopole-anti-monopole pair", namely a B^3B_3-pair, U^1U_1-pair or L^1L_1-pair. Decay processes not following this conservation law are apparently impossible in nature.

An array of decay processes interpreted on the basis of the B,U,L conservation law is listed in the tables 3A,B,C. The interpretation is made as follows. One compares the B,U,L composition of the decaying particle (for example $\mu^+=(B_3D^1L^1L^1)1$ which is composed by the basic monopoles $B_3B^3U_1L_1L^1L^1$, see table 2) with the composition of the decay products (for example $\nu_e=(D^1L_1)0$, $\nu^\mu=(B_3U^1L^1L^1)0$, $e^+=(U_1L^1)0$ which all together contain the basic monopoles $B^3U_1L_1L_1B_3U^1L^1L^1U_1L^1$). If there is a difference between the two sets of basic monopoles one may intro-

Table 1

Description of magnetic monopoles.*

Name	Symbol	Mass $M_o=1$	Electric charge $e=1$	Magnetic charge $g=1$	Strangeness	Charm	Spin $\hbar=1$	Configuration brief notation
Baric	B^3	9.000213	-1	-3	0	0	0	B
Light boson	L^1	1.000000	0	-1	0	0	0	L
u-quark	U_1	1.000213	1	1	0	0	1/2	U
d-quark	D_1	1.000000	0	1	0	0	1/2	(BUL)0
s-quark (compact)	S_1	1.079326	0	1	-1	0	1/2	((BU)0L)1
s-quark (split)	T_1	1.068	0	1	-1	0	1/2	--
c-quark (normal)	C_1	1.572278	1	1	0	1	1/2	((BS)2L)3
c-quark (I-version)	I_1	1.562069	1	1	0	1	1/2	((BT)2L)3

* The respective antiparticles B_3, L_1, U^1, D^1, S^1, T^1, C^1, I^1 have opposite magnetic and electric charges, and opposite strangeness and charm. Lower indexes identify positive magnetic charges; upper indexes identify negative ones.

Table 2

Configurations of elementary particles.

B A R Y O N S

Strangeness	Name and mass	Octett of spin 1/2 Configurations		Name and mass	Decuplett of spin 3/2 Configurations	
-3				Ω(1672)	((BT)1TT)5	
-2	Ξ(1321)	((BS)1DT)4	((BS)1UT)4	Ξ(1530)	((BD)1TT)5	((BU)1TT)5
-1	Σ(1190)	((BD)1DS)4	((BD)1US)4 etc.	Σ(1385)	((BD)1DT)5	((BD)1UT)5 etc.
0	n,p(938)	((BUD)4D)1	((BUD)4U)1	Δ(1232)	((BD)1DD)5	((BD)1UD)5 etc.
-1	Λ(1115)	((BUD)4S)1				
0	Λ_c(2260)	((BUD)4C)1	Charmed Lambda baryon of spin 1/2			

M E S O N S

Strangeness	Name and mass	Nonett of spin 0	Name and mass	Nonett of spin 1
0	η'(958)	((BL)0UT)4 ?	ϕ(1020)	(TT)3
0	η (549)	(ST)1	ω (783)	(ST)2
±1	$K^{\pm}$(494)	((BT)1(BU)0)1	$K'^{\pm}$(886)	((BT)1(BU)1)2
±1	K^{0}(498)	((BT)1(BD)0)1 ((BU)1TL)1	K'^{0}(892)	((BT)1(BD)1)2
0	$\pi^{\pm}$(140)	((BU)0(BD)0)1	$\rho^{\pm}$(770)	(((BD)1B)1U)2
0	π^{0}(135)	((BU)0(BU)0)1	ρ^{0}(770)	(((BU)1B)1U)2
		Charmed triplett of spin 0		**Charmed triplett of spin 1**
0	D^{0}(1863)	((BC)1(BU)1)1	D'^{0}(2006)	((BI)1(BU)1)2
0	$D^{\pm}$(1868)	((BC)1(BD)1)1	$D'^{\pm}$(2009)	((BI)1(BD)1)2
±1	$F^{\pm}$(2040)	((BC)1(BS)1)1	$F'^{\pm}$(2140)	((BI)1(BT)1)2
		Charm-anticharm of spin 0		**Charm-anticharm of spin 1**
0	η_c(2970)	(CC)1 ?	ψ (3095)	(CC)2

L E P T O N S

Name and mass	Configuration	El.charge	Strangeness	Charm
τ (1807)	(B(BL)0C)3	±1	0	±1
S^{0}	(B(BL)0S)2	0	±1	0
$\mu^{\pm}$ (106)	(B(BL)0U)1 or (BDLL)1	±1	0	0
μ^{0}	(B(BL)0D)1 or (BULL)1	0	0	0
ν_{μ}(0)	(BULL)0	0	0	0
e(0.511)	(UL)0	±1	0	0
ν_e(0)	(DL)0	0	0	0

duce the necessary number of pair formations and/or annihilations in order to bring agreement (if possible) between the two sets (in the above example the two pairs L^1L_1 and U^1U_1 are missing in the decaying particle in order to complete the list of basic monopoles appearing in the decay products. These two pairs are recorded in the table as pair formations). A simple way to make sure that the two sets can be converted to one another by pair formations and/or annihilations is to remove in both sets every pair which can be found. If the two sets become identic after the removal they will obviously be reducible into each other by simple pair formations and/or annihilations (in the above example both of the two sets are reduced to the same set U_1L^1 after such pair removal).

In many cases the notation FF is used in the tables 3A,B,C instead of BB,UU in a pair formation or annihilation. F_2 is an abbreviation, sometimes designated as heavy fermion, which stands for the (L-0) association $(B_3U^1)0$. For example the s-quark configuration is often expressed by (FL)1 instead of ((BU)0L)1, the d-quark configuration is often expressed by (FL)0 instead of (BUL)0, and the Π^0-mesons configuration by (FF)1 instead of ((BU)0(BU)0)1. Likewise can a pair (L-0) associations such as e^+e^- be used instead of the corresponding pairs of basic monopoles.

If a decay process is possible, the B,U,L conservation law requires that the set of basic monopoles in the decaying particle can be converted into the set of basic monopoles in the decay products by a few pair formations and/or annihilations. But this does not have to be the case if the considered decay process is faulty or impossible. For example one of two faulty decay processes we have found in the literature (Barricelli, 1978) is the process $K^+ \rightarrow \Pi^-e^+e^+$, conflicting with the rule that two positively charged leptons can not be produced by a meson decay without producing an equal number of neutrinos or negatively charged leptons. If we compare the B,U,L composition of the decaying particle $K^+=((B_3T^1)1(B^3U_1)0)1$, which is $B_3B^3U_1L_1B^3U_1$, with that of the decay products, $\Pi^-=(F_2U^1L^1)1$, $e^+=(U_1L^1)0$, $e^+=(U_1L^1)0$, namely $B_3U^1U^1L^1U_1L^1U_1L^1$, we find that they are not reducible into one another by pair formations and/or annihilations. In fact, after removing all pairs, the first set becomes $B^3U_1U_1L_1$ and the second one becomes a quite different set, namely $B_3L^1L^1L^1$.

Table 3A

Decay of elementary particles

Particle and Configuration	Mean life (sec)	Pairs formed	New associations	Annihilations	Decay products	% of decays
			LEPTONS			
$\mu^+ = (B_3 D^1 L^1 L^1)1$	2×10^{-6}	LL,UU	$(D^1 L_1)0, (B_3 U^1 L^1 L^1)0, (U_1 L^1)0$	--	$\nu_e = (DL)0,\ \bar{\nu}_\mu = (BULL)0,\ e^+ = (UL)0, (\gamma)$	100*
		--	$(B_3 D^1 L^1 L^1)0$	BB,LL	$e^+ = (UL)0,\ \gamma,\ (\gamma)$	10^{-3}
		UU	$(B_3 B^3 U_1 L^1)0, (U_1 L^1)0, (U^1 L_1)0$	BB	$e^+ = (UL)0,\ e^+ = (UL)0,\ e^- = (UL)0$	10^{-7}
$\tau^+ = (B^3 (B_3 L^1)0 C_1)3$	?	DD	$(B^3 (B_3 L^1)0 D_1)0, (B_3 F^1 L^1)1, (D^1 L_1)0$	BB	$\bar{\nu}_e = (DL)0,\ \mu^+ = (BFL)1,\ \nu_\sigma = (DL)0$	18
meaning $= (B^3 (B_3 L^1)0 ((B_3 S^1)2 L^1)3)3$		LL,UU	$(B_3 (B^3 L_1)0 D^1)0, (U_1 L^1)0, (B_3 U^1 L^1 L^1)0$	BB	$\nu_e = (DL)0,\ e^+ = (UL)0,\ \bar{\nu}_\mu = (BULL)0$	18
		UU	$(F^2 U_1 L_1)1, (B_3 U^1 L^1 L^1)0, (B^3 B_3)0$	BB	$\Pi^+ = (FUL)1,\ \bar{\nu}_\mu = (BULL)0$	10 ?
		UU	$(((B_3 D^1)1 B^3)1 U_1)2, (B_3 U^1 L^1 L^1)0$	--	$\rho^+ = (((BD)1B)1U)2,\ \bar{\nu}_\mu = (BULL)0$	20 ?
		UU, (nFF)	$((B_3 T^1)1 (B^3 U_1)0)1, (B_3 U^1 L^1 L^1)0, n(F^2 F_2)1$	--	$K^+ = ((BT)1(BU)0)1,\ \bar{\nu}_\mu = (BULL)0,\ n\Pi^\circ$	?
		UU, (nFF)	$(F^2 U_1 L_1)1, (B_3 U^1 L^1 L^1)0, (B^3 B_3)0, n(F^2 F_2)1$	BB	$\Pi^+ = (FUL)1,\ \bar{\nu}_\mu = (BULL)0,\ n\Pi^\circ$	?
			etc.			

* The identity of the two neutrinos is given only as an example, which applies in less than 25% of the cases (cfr. Tables of Particle Properties. April 1978).

Table 3B

Decay of elementary particles

Particle and Configuration	Mean life (sec)	Pairs formed	New associations	Annihilations	Decay products	% of decays
			MESONS			
$\Pi^+ = (F^2U_1L_1)1$	3×10^{-8}	LL	$(B_3F^2L^1)1, (F^2L_1L_1)0$	--	$\mu^+=(BFL)1,\ \nu_e=(FLL)0,\ (\gamma)$	100
$= ((B_3D^1)0(B^3U_1)0)1$		LL	$(U_1L^1)0, (D^1L_1)0$	BB	$e^+=(UL)0,\ \nu_e=(DL)0,\ (\gamma)$	10^{-2}
		LL,UU	$(U_1L^1)0, (D^1L_1)0, ((B_3U^1)0(B^3U_1)0)1$	--	$e^+=(UL)0,\ \nu_e=(DL)0,\ \Pi^0=(FF)1$	10^{-6}
		LL, e^+e^-	$(U_1L^1)0, (D^1L_1)0, e^+e^-$	BB	e^+, e^+, e^-, ν_e	10^{-6}
$\Pi^0 = (F^2F_2)1$	10^{-16}	--	$(F_2F^2)0$	FF	$\gamma, \gamma, (\gamma\ldots)$	99
		LL	$(U_1L^1)0, (U^1L_1)0, (B^3B_3)0$	BB	$e^+=(UL)0,\ e^-=(UL)0,\ (\gamma)$	1
$K^+ = ((B_3T^1)1F^2)1$	10^{-8}	LL	$(B_3F^2L^1)1, (B^3U_1L_1L_1)0$	--	$\mu^+=(BFL)1,\ \nu_\mu=(BULL)0,\ (\gamma)$	64
$= ((B_3T^1)1(B^3U_1)0)1$		FF	$((B_3D^1)0(B^3U_1)0)1, (F_2F^2)1$	--	$\Pi^+=((BD)0(BU)0)1,\ \Pi^0=(FF)1,\ (\gamma)$	21
		FF,UU,LL	$(F^2(B_3F^2)0L_1)1, (F^2U_1L_1)1, (F_2U^1L^1)1$	BB	$2\Pi^+=2(FUL)1,\ \Pi^-=(FUL)1,\ (\gamma)$	6
		2FF	$(F^2(B_3F^2)0L_1)1, (F^2F_2)1, (F^2F_2)1$	BB	$\Pi^+=(FUL)1,\ 2\Pi^0=2(FF)1$	2
		FF,LL	$(F^2F_2)1, (B_3F^2L^1)1, (F^2L_1L_1)0$	--	$\Pi^0=(FF)0,\ \mu^+=(BFL)1,\ \nu_e=(FLL)0,\ (\gamma)$	3
		UU,LL	$((B^3U_1)0(B_3U^1)0)1, (F^2L_1L_1)0, (U_1L^1)0$	--	$\Pi^0=(FF)0,\ \nu_e=(FLL)0,\ e^+=(UL)0,\ (\gamma)$	5
$K^0_S = ((B_3U^1)1T^1L^1)1$	10^{-10}	UU	$((B_3U^1)0U^1L^1)1, (F^2U_1L_1)1$	--	$\Pi^-=(FUL)1,\ \Pi^+=(FUL)1,\ (\gamma)$	69
		FF	$((B_3U^1)0F^2)1, (F^2F_2)1, (L^1L_1)0$	LL	$2\Pi^0=2(FF)1$	31
$K^0_L = ((B_3T^1)1U^1L^1)1$	5×10^{-8}	FF,UU	$((B_3U^1)0(B^3U_1)0)1, 2(F^2F_2)1, (L^1L_1)0$	LL	$3\Pi^0=3(FF)1$	21
$= ((B_3T^1)1(B^3D_1)0)1$		2UU	$((B_3U^1)0F^2)1, ((B^3U_1)0U_1L_1)1, (F_2U^1L^1)1$	--	$\Pi^0=(FF)1,\ \Pi^+=(FUL)1,\ \Pi^-=(FUL)1$	12
		UU,LL	$((B_3U^1)0U^1L^1)1, (B_3F^2L^1)1, ((B^3U_1)0L_1L_1)0$	--	$\Pi^-=(FUL)1,\ \mu^+=(BFL)1,\ \nu_e=(FLL)0$	27
		UU,LL	$(F^2U_1L_1)1, (U^1L_1)0, (B_3U^1L^1L^1)0, (B^3B_3)0$	BB	$\Pi^+=(FUL)1,\ e^-=(UL)0,\ \bar{\nu}_\mu=(BULL)0,\ (\gamma)$	40
Reversible transition		--	$((B_3D^1)0(B^3T_1)1)1$	--	K^0_L with opposite strangeness	~100

Table 3B(continued)

Particle and Configuration	Mean life (sec)	Pairs formed	New associations	Annihilations	Decay products	% of decays
$\eta = (S^1T_1)1$	10^{-18}	--	$(L^1L_1)0,(F^2F_2)0$ or $(F^2F_2)1$	LL,(FF)	γ, γ, (π°)	41
		2FF	$3(F^2F_2)1,(L^1L_1)0$	LL	$3\pi^\circ=3(FF)1$	30
		UU,FF	$(F^2U_1L_1)1,(F_2U^1L^1)1,(F^2F_2)1$	--	$\pi^+=(FUL)1$, $\pi^-=(FUL)1$, $\pi^\circ=(FF)1$,(γ)	24
		UU	$(F^2U_1L_1)1,(F_2U^1L^1)1$	--	$\pi^+=(FUL)1$, $\pi^-=(FUL)1$	5
$\eta' = ((B^3L_1)0U_1T_1)4$?	$>10^{-21}$	2FF	$(((B^3U_1)0L_1)1T_1)1,2(F^2F_2)1$	--	$\eta=(ST)1$, $2\pi^\circ=2(FF)1$	66
		BB	$(((B^3D_1)1B_1)1(B^3U_1L_1)0)2$	--	$\rho^\circ=(((BD)1B)1D)2$, γ	30
		--	$(((B^3U_1)0L_1)1T_1)2$	--	$\omega=(ST)2$, γ	2
		--	$((B^3U_1)0F_2)0,(L^1L_1)0$	FF,LL	γ, γ	2
$\rho^+ = (((B^3U_1)1B_3)1D^1)2$	10^{-23}	UU	$((B^3U_1)0(B_3U^1)0)1,(F^2U_1L_1)1$	--	$\pi^\circ=(FF)1$, $\pi^+=(FUL)1$	100
$K^{*\mp} = ((B^3T_1)1(B_3D^1)1)2$	10^{-23}	FF	$((B^3T_1)1(B_3D^1)0)1,(F^2F_2)1$	--	$K^\circ=((BT)1(BD)0)1$, $\pi^\circ=(FF)1$	100
$\omega = (S^1T_1)2$	10^{-22}	UU,FF	$(F^2U_1L_1)1,(F_2U^1L^1)1,(F\ F\ )1$	--	$\pi^+=(FUL)1$, $\pi^-=(FUL)1$, $\pi^\circ(FF)1$	90
		UU	$(F^3U_1L_1)1,(F_2U^1L^1)1$	--	$\pi^+=(FUL)1$, $\pi^-=(FUL)1$	1
		--	$(F^2F_2)1,(L^1L_1)0$	LL	$\pi^\circ=(FF)1$, γ	9
$\phi = (T^1T_1)3$	10^{-22}	BB,FF	$((B^3T_1)1F_2)1,((B_3T^1)1F^2)1$	--	$K^-=((BT)1F)1$, $K^+=((BT)1F)1$	48
		BB,LL,UU	$((B^3T_1)1U_1L_1)1,((B_3U^1)1T^1L^1)1$	--	$K^\circ_L=((BT)1UL)1$, $K^\circ_S=((BU)1TL)1$	35
		UU,FF	$(F^2U_1L_1)1,(F_2U^1L^1)1,(F^2F_2)1$	--	$\pi^+=(FUL)1$, $\pi^-=(FUL)1$, $\pi^\circ=(FF)1$	15
		--	$(S^1T_1)1$	--	$\eta=(ST)1$, γ	2
$D^{*\pm} = ((B^3I_1)1(B_3D^1)1)2$	10^{-21}	UU	$((B^3C_1)1(B_3U^1)1)1,(F^2U_1L_1)1$	--	$D^\circ=((BC)1(BU)1)1$, $\pi^+=(FUL)1$	68
		(FF)	$((B^3C_1)1(B_3D^1)1)1$, ($(F^2F_2)1$)	--	$D^+=((BC)1(BD)1)1$, ($\pi^\circ=(FF)1$), (γ)	32
$F^{*\pm} = ((B^3I_1)1(B_3T^1)1)2$	?	--	$((B^3C_1)1(B_3S^1)1)1$	--	$F^+=((BC)1(BS)1)1$, γ	100

<u>Table 3C</u>

<u>Decay of elementary particles</u>

Particle and Configuration	Mean life (sec)	Pairs formed	New associations	Annihilations	Decay products	% of decays
			BARYONS			
$n = ((B^3U_1D_1)4D_1)1$	918	UU,LL	$((B^3U_1D_1)4U_1)1, (U^1L_1)1, (D_1L^1)1$	--	$p = ((BUD)4U)1,\ e^- = (UL)0,\ \bar{\nu}_e = (DL)0$	100
$\Lambda = ((B^3U_1D_1)4S_1)1$	3×10^{-10}	UU	$((B^3U_1D_1)4U_1)1, (F_2U^1L^1)1$	--	$p = ((BUD)4U)1,\ \pi^- = (FUL)1,\ (\gamma)$	64
		FF	$((B^3U_1D_1)4D_1)1, (F_2F^2)1$	--	$n = ((BUD)4D)1,\ \pi^0 = (FF)1$	36
$\Sigma^+ = ((B^3U_1)1U_1S_1)4$	10^{-10}	FF	$((B^3U_1D_1)4U_1)1, (F_2F^2)1$	--	$p = ((BUD)4U)1,\ \pi^0 = (FF)1$	52
		FF,LL	$((B^3U_1D_1)4(F_2L^1)0)1, (F^2U_1L_1)1$	--	$n = ((BUD)4D)1,\ \pi^+ = (FUL)1,\ (\gamma)$	48
$\Sigma^0 = ((B^3D_1)1U_1S_1)4$	6×10^{-20}	(e^+e^-)	$((B^3U_1D_1)4S_1)1, (e^+e^-)$	--	$\Lambda = ((BUD)4S)1,\ \gamma,\ (e^+e^-)$	100
$\Sigma^- = ((B^3D_1)1D_1S_1)4$	10^{-10}	UU	$((B^3U_1D_1)4D_1)1, (F_2U^1L^1)1$	--	$n = ((BUD)4D)1,\ \pi^- = (FUL)1,\ (\gamma)$	100
$\Xi^0 = ((B^3S_1)1U_1T_1)4$	3×10^{-10}	FF	$((B^3U_1D_1)4S_1)1, (F^2F_2)1$	--	$\Lambda = ((BUD)4S)1,\ \pi^0 = (FF)1$	100
$\Xi^- = ((B^3S_1)1D_1T_1)4$	2×10^{-10}	UU	$((B^3U_1D_1)4S_1)1, (F_2U^1L^1)1$	--	$\Lambda = ((BUD)4S)1,\ \pi^- = (FUL)1$	100
$\Lambda_c = ((B^3U_1D_1)4C_1)1$	?	FF,2UU,LL	$((B^3U_1D_1)4S_1)1, 2(F^2U_1L_1)1, (F_2U^1L^1)1$	--	$\Lambda = ((BUD)4S)1,\ 2\pi^+ = 2(FUL)1,\ \pi^- = (FUL)1$	?
$\Delta^- = ((B^3D_1)1D_1D_1)5$	10^{-23}	UU	$((B^3U_1D_1)4D_1)1, (F_2U^1L^1)1$	--	$n = ((BUD)4D)1,\ \pi^- = (FUL)1$	100
$\Sigma^- = ((B^3D_1)1D_1T_1)5$	3×10^{-23}	UU	$((B^3U_1D_1)4S_1)1, (F_2U^1L^1)1$	--	$\Lambda = ((BUD)4S)1,\ \pi^- = (FUL)1$	88
		FF	$((B^3D_1)1D_1S_1)4, (F_2F^2)1$	--	$\Sigma^- = ((BD)1DS)4,\ \pi^0 = (FF)1$	12
$\Xi^- = ((B^3D_1)1T_1T_1)5$	10^{-22}	FF	$((B^3S_1)1D_1T_1)4, (F_2F^2)1$	--	$\Xi^- = ((BS)1DT)4,\ \pi^0 = (FF)1$	100
$\Omega^- = ((B^3T_1)1T_1T_1)5$	10^{-11}	FF	$((B^3S_1)1D_1T_1)4, (F_2F^2)1$	--	$\Xi^- = ((BS)1DT)4,\ \pi^0 = (FF)1$	?
		FF	$((B^3U_1D_1)4S_1)1, ((B^3T_1)1F_2)1$	--	$\Lambda = ((BUD)4S)1,\ K^- = ((BT)1F)1$	?

Similar inconsistencies could be found if the decaying particle or one of the decay products had been assigned a faulty configuration. The B,U,L test is a powerful tool as a means to detect errors in the assigned configurations as well as in decay and interaction processes.

3. Other rules and conservation laws

We may mention a few more conservation rules and/or implications of already known rules and experimental observations.

The forbidden annihilation rule. This rule applies only for baryons. If we look at the baryon decays in table 3C, we do not find a single annihilation. The same applies to all baryon decay processes we have analysed so far. This is a very surprising property of baryons which, we will see, may have important implications.

One may notice, however, that several baryon processes in table 3C lead to the formation of a particle (such as Π^0) or a pair of particles (suc as e^+e^-) which will or might be annihilated later on (by the process $\Pi^0 \rightarrow \gamma\gamma$ or $e^+e^- \rightarrow \gamma\gamma$). One may be tempted to consider this as a sort of "postponed" or "delayed" annihilation. In a sense it is. But look at what kind of monopoles are annihilated in this delayed process. The formation of $\Pi^0 = (FF)1$ is always preceded b; an FF-pair formation. Likewise e^+e^- appears only as the result of a pair formation. The net result of these delayed annihilations is never the elimination of monopoles included in the decaying baryon configuration. Only the excess monopoles created by pair-formation during the decay process can be included in a particle where they may be subject to subsequent annihilation.

In short: The net result of a baryon decay can not be the annihilation of monopoles included in the baryon, without creating the same monopoles by pair formation.

The implications of this rule seem to be strictly related to the conservation of baryon number, because if no decay can eliminate any monopole belonging to a baryon by (either immediate or delayed) annihilation, there will always be left a set of monopoles adequate for the formation of a baryon.

The forbidden magnetic charge rule. An other rule which seems to apply to all elementary particles is that no elementary particle carrying a magnetic monopole charge can be formed by any decay or interaction process known today. All elementary particles formed in any known process carry an equal number of positive and negative magnetic monopole charges and are magnetically neutral.

The limited free L rule. As already mentioned in the preceding paper (Barricelli, 1983) section 8, the light boson L is present as a free monopole only in leptons (see table 2) and other systems D=(BUL)0, S=((BU)oL)1, C=((BS)2L)3, (BL)0 etc. (see table 1 and 2) containing no more than one fermion . Mesons and baryons with respectively two or three fermions do not contain free L monopoles. In these particles L is found only as a member of a partial system D,S,C,(BL)0 etc. or a positional association containing no more than one fermion.

Limits of energy levels. The kinds of energy levels permitted in a system also depend on the number of fermions involved. The only systems in which the orbit of highest energy level can be an (L-0) orbit are leptons e=(UL)0, ν_e=(DL)0, ν_μ=(BULL)0 and other systems D=(BUL)0, (BU)0, (BD)0, (BL)0 containing no more than one fermion. Systems with two fermions (mesons) always involve at least one orbit of energy level (L-1) or higher. Systems with three fermions (barions) always involve an orbit with two positionally associated quarks at an energy level (L-4) or higher (see table 1 and 2).

Other rules are the exclusion principles presented in the preceding paper (Barricelli, 1983), section 6. We shall not enumerate all the well-known conservation laws which apply in elementary particle processes. But there must be other laws and rules which are still unidentified, because many configurations and many decaying processes which would not seem impossible or prohibited by any presently known law have never been observed. In some cases this might be due to experimental difficulties such as the difficulty to identify neutral leptons like the μ^0=(BULL)1 and S^0=(B(BL)0U)2 leptons (see table 2) predicted by our theory. In other cases the unfrequent occurence of a predicted decay or a predicted particle may be the explanation. But this will hardly explain all the cases.

Still unidentified association rules for systems of energy level (L-0) might be involved in the behaviour of different neutrinos.

The difference between the e-neutrino, with the assumed configuration (DL)0, and the Mu-neutrino with the assumed configuration (BULL)0, is not clear, since D=(BUL)0 and the primary monopoles included in the two configurations are therefore the same. The difference must probably depend on the way the four monopoles B,U,L,L are put together, in spite of the fact that the energy level is the same (L-0) in both neutrinos. The two neutrinos can, however, in some cases replace each other, as indicated for example by the unfrequent cases in which a myon decays directly into an electron and a photon, without producing an e-neutrino and a μ-anti-neutrino as is usually the case (see table 3A).

4. The decay probability and life time problem

In order to obtain quantitative estimates of decay probabilities and life times of elementary particles it would seem convenient to replace the Bohr and Sommerfeld quantization we have applied, by wave mechanical methods. We are planning to do that, and if we use the same kind of finite potential fields we have been using in our approach that may not require renormalization and related problems. Once this is done, conventional wave mechanical methods might be applied in the calculation of decay probabilities.

In the meantime we may attempt to anticipate some of the answers on the basis of the interpretations we have presented and the observations available.

The main problems we shall address are:

(1) Why (with one exception concerning Ω) the spin $^3/_2$ decuplet baryons and the spin 1 mesons are rapidly decaying particles with a very short life time of 10^{-21} to 10^{-23} seconds? (See table 3B and 3C).

(2) Why strangeness is conserved in these rapid decays, but not necessarily in the much slower decays of other particles commonly associated with weak interactions.

(3) Why leptons never appear in the rapid (life time around 10^{-22} sec.) decay processes except by the pair formations e^+e^- or $\mu^+\mu^-$, whereas they often appear in the slower (life time 10^{-10} or longer) decay processes?

Part of the answer, which we will propose as a preliminary suggestion pending further investigation of the problem, can be obtained by introducing a discrimination between permitted and prohibited jumps in the energy level of a system. Suppose the jumps from an (L-5) orbit to an (L-4) orbit converting a spin $^3/_2$ baryon into the corresponding (equal strangeness and charge) baryon of spin $^1/_2$ are permitted jumps taking a short time of say 10^{-22} to 10^{-23} sec. That would permit a rapid decay of most baryons of spin $^3/_2$ listed in the right side of table 2 for example by decay into the corresponding baryons of spin $^1/_2$ listed on the left side of table 2 (see table 3C about decays). Likewise if the jump from an (L-2) or (L-3) orbit to an (L-1) orbit converting a spin 1 meson to the right of table 2 into the corresponding spin 0 meson to the left of table 2 are permitted, that would give at least one rapid decay possibility, not necessarily the only one, for most spin 1 mesons (see table 3B about decays).

This would be part of the answer to question 1. In order to answer the questions 2 and 3 it will be sufficient to assume that all jumps to an energy level zero, leading to the formation of anyone of the (L-0) associations D=(FL)0 (d-quark), and the three (L-0) leptons e=(UL)0, ν_e=(DL)0 and ν_μ=(BULL)0, are "forbidden" jumps of a kind not completely impossible, but requiring a relatively long time of 10^{-10} sec. or more.* Any decay leading to the formation of one of these particles will be

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* There are two other (L-0) associations, namely F=(BU)0 and (BD)0=UL(posit.assoc.), which behave in a quite different way in baryons than in mesons. Any jump leading to the formation of one of these (L-0) associations between the Baric and one of the quarks in a baryon is completely forbidden by the baryon number conservation law. On the other hand the formation of the two (L-0) associations (BU)0 and (BD)0 is permitted, and causes no apparent delays, in such meson decay processes as for example the meson decay $\rho(770)\to\Pi\Pi$ or $K^*(892)\to K(498),\Pi$, see table 3B). Evidently not all jumps to an (L-0) level lead to a slow decay process. Apparently slow decays are found in those processes in which an L monopole becomes part of an (L-0) association starting from a configuration in which the same L was not beforehand part of an (L-0) association.

a slow decay requiring 10^{-10} sec. or longer. Moreover any particle decaying in a much shorter time than 10^{-10} sec. will not produce the (L-0) associations D, e, ν_e, ν_μ simply because there will not be sufficient time to produce these particles before a faster decay takes place. Such fast decaying particles will have no time to convert an S=(FL)1 into a D=(FL)0, and strangeness is therefore conserved, which is the answer to question 2. They will have no time to produce any of the leptons e, ν_e, ν_μ except by the pair formation e^+e^-. Moreover μ can not be produced without producing a neutrino or an e except by the pair formation $\mu^+\mu^-$. This is the answer to question 3.

The fact that Ω can not decay without loss of strangeness since there are no baryons of lower energy with the same strangeness-3 and there is not enough mass to produce a strange meson in the decay $\Omega(1672) \rightarrow \Xi(1321)$, explains why Ω-decay is slow (10^{-11} sec., see table 3C): Decay can not take place before one of the three s-quarks is converted into a d-quark by a jump to an (L-0) energy level.

The interpretation of slow decay modes not involving the formation of (L-0) particles or loss of strangeness and the quantitative estimate of decay probabilities must await the introduction of wave mechanical methods.

The success often obtained in the calculation of many decay probabilities is based on general principles not requiring a specification of the forces acting between the quarks as a function of their positions and reciprocal distances, and often using little or no information about the nature and properties of assumed vector particles. It may therefore be worth investigating whether many of these results could be extended to the magnetic quark model we have presented.

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