The Quantum Chromodynamics Theory Of Pentaquarks

Based on a generalized particle diagram of baryons and anti-baryons which, in turn, is based on symmetry principles, this theory predicts the existence of: (a) strange pentaquarks containing one, two, three and four strange quarks, (b) strange pentaquarks with zero total strangeness, such as the $(\bar{u}\,\bar{u}\,\bar{u}\,\bar{s}\,s)$ *and* $(u\,u\,u\,s\,\bar{s})$ *pentaquarks, (c) a relatively large number of pentaquarks containing neither strange nor anti-strange quarks (also zero total strangeness) and (d) "bottom-top charmed" pentaquarks, such as the* $(t\,c\,u\,b\,\bar{b})$ *pentaquark. The theory, of course, also predicts the anti-pentaquarks corresponding to all predicted pentaquarks. More importantly, this theory predicts the existence of the* $(u\ u\ d\ c\ \bar{c})$ *pentaquark. This remarkable prediction was confirmed on July 14th, 2015 by CERN researchers with the discovery of a particle of composition:* $(u\ u\ d\ c\ \bar{c})$ *with a significance of more than 9 standard deviations. This makes the discovery as solid as scientists would like it to be. However, there are doubts on whether the discovered particle is a strongly bound state of five quarks (known as pentaquark) or a loosely bound state of a baryon,* $(u\ u\ d)$ *, and a meson,* $(c\ \bar{c})$ *(baryomesonic molecule). Although the foundations of this theory are mostly finalised, the details are still incomplete (there are points in the diagram that I shall complete in future versions). Therefore there are other pentaquarks that are not explicitly shown at the present time. However, when completed, the theory will show all the pentaquarks there exist in nature.*

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January 17st, 2016 (v1) - February 18th 2016 (v8)

Keywords: *mirror symmetry, parity, P symmetry, charge conjugation, C symmetry, time reversal, T symmetry, CP symmetry, CPT symmetry, PC+ symmetry, Q symmetry, quantum electrodynamics, quantum chromodynamics, quark, antiquark, up quark, down quark, strange quark, charm quark, bottom quark, top quark, pentaquark, quadruply strange pentaquark, triply strange pentaquark, doubly strange pentaquark, singly strange pentaquark, non-strange pentaquark, quadruply bottom pentaquark, colour charge, anticolour, anticolour charge, strangeness, charmness, bottomness, topness, fermion, hadron, baryon, meson, boson, photon, gluon, Pauli exclusion principle, force carrier, omega-minus particle, matter-antimatter way, MAW, LHC.*

Contents

1. Introduction

Quantum Chromodynamics (QCD) [1, 2, 3, 4] is a quantum mechanical description of the strong nuclear force. The strong force is mediated by gluons [4, 5] which are spin $1\hbar$ bosons (spin is quoted in units of reduced Plank's constant: $\hbar = h/2\pi$). Gluons act on quarks only (only quarks feel the strong force). Colour charge is a property of quarks (and gluons) which is a kind of electric charge (but of a totally different nature) associated with the strong nuclear interactions. There are three distinct types of colour charge: red, green and blue. It is very important to keep in mind that every quark carries a colour charge, while every antiquark carries an anticolour charge (antired, antigreen or antiblue). However colour charge has nothing to do with the real colour of things. The reason, this quark property, is called colour is because it behaves like colour: all known hadrons (baryons and mesons) are "colourless", meaning they are colour neutral particles. Baryons, which are made of three quarks, are "colourless" because each quark has a different colour. Mesons, which are made of a quark and an antiquark, are "colourless" because antiquarks carry anticolour. Thus, a meson with a blue quark and a antiblue quark is a colour neutral particle.

An important point to observe is that the Pauli exclusion principle leads to the existence of colour. This principle may be expressed as follows

Pauli Exclusion Principle
In a system made of identical fermions, no two fermions can have the same set of quantum numbers.

The existence of colour was inferred from the omega-minus particle or Ω^- baryon because it seemed to challenge the above principle. This particle, which was discovered in 1964, is made up of three strange quarks (*s* quarks). Because quarks are fermions, they cannot exist with identical quantum numbers, or in other words, they cannot exist in identical quantum states. So that, the Ω^- particle needed a new quantum number to be able to satisfy the Pauli exclusion principle. Thus, physicists proposed the existence of a new quantum number which was called colour. Having a particle with a red strange quark, a green strange quark and a blue strange quark solved the problem: the Ω^- baryon had all its quarks in different quantum states. So that the property called colour was the one that distinguished each of the quarks of the Ω^- particle when all the other quantum numbers are identical.

Like the electric charge, colour charge is a conserved quantity. Thus, QCD introduced a new conservation law: the conservation of "colour charge". Both quarks and gluons carry colour charge. In contrast, photons which are the mediators or carriers of the electromagnetic force, do not carry electric charge. This is a very important difference between Quantum Electrodynamics (QED) [6] and QCD. Another property of gluons is that they can interact with other gluons. The theory presented here is, in certain way, an extension of the QCD developed independently by Murray Gell-Mann and George Zweig in 1964. Gell-Mann read a James Joyce's novel entitled Finnegan's Wake, which contains the sentence "three quarks for Muster Mark", from where the word quark was taken and introduced into physics. Gell-Mann predicted the existence of the omega-minus particle from a particle diagram known as the baryon decuplet. This diagram is shown in FIGURE 1 (see also page 25 of reference [2]). The baryon decuplet contains 10 baryons [4, 7, 8], (shown as blue spheres) which are arranged in a symmetric pattern forming an inverted equilateral triangle. This famous decuplet is also shown on the right hand side of FIGURE 2 through 9. However, in these figures, the baryon decuplet has a slightly different arrangement: they are arranged along a right-angled triangle. This will allow us to use a slightly longer horizontal axis representing the electric charge of the particles (from -2 to +2) rather than the isospin. This, in turn, will allow us to add an “antimaterial mirror image” of the 10 baryons so that we can extend the symmetry of the physical system to include not only baryons and antibaryons but also the elusive pentaquarks and their antiparticles.

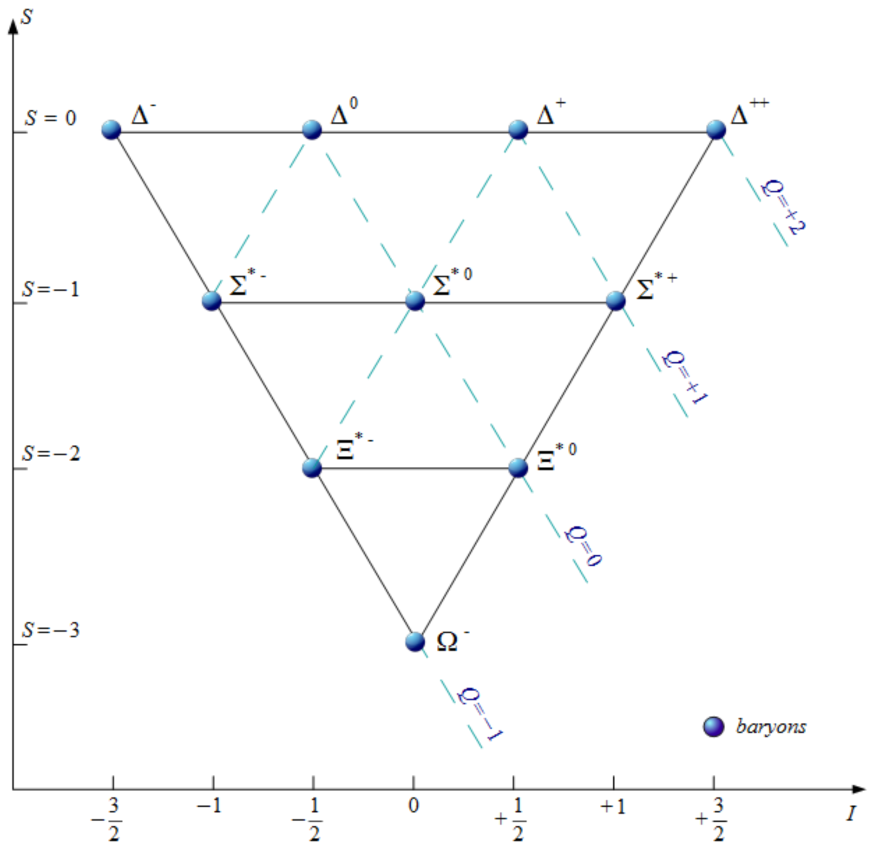

FIGURE 1: ***The Baryon decuplet***. *The diagram shows 10 baryons:* Δ^-, Δ^0, Δ^+, Δ^{++}, Σ^{*-}, Σ^{*0}, Σ^{*+}, Ξ^{*-}, Ξ^{*0} *and* Ω^-. *The vertical axis represents the strangeness, S, of the particles while the horizontal axis, I, the isospin. The diagonal lines shown in cyan are lines of equal electric charge. The particles whose names include an asterisk are exited states of the corresponding particles:* Σ^-, Σ^0, Σ^+, Ξ^-, Ξ^0.

Although this theory is intended for experts, it is, from a mathematical point of view, very simple, so that, it is also suitable for those readers with basic knowledge of quarks and equations. Appendix 1 contains the nomenclature and acronyms used throughout this paper. The expert may skip section 2 as it contains the basic properties of quarks and antiquarks.

2. Summary of the Properties of Quarks and Antiquarks

Before going into details of the theory, I would like to provide a brief overview of the properties of quarks and anti-quarks for non-experts. The following two tables aim to provide this overview. TABLE 1 is a summary of the properties of quarks while TABLE

2 is a summary of the properties of anti-quarks. I shall define the elementary charge, e, as a negative quantity: $e = -1.602\ 176\ 6208 \times 10^{-19} C$, approximately. Thus the charge of the proton is $|e|$ and that of the electron is e.

QUARKS PROPERTIES (see note 1)							
QUARK NAME	SYMBOL	ELECTRIC CHARGE (times $\|e\|$)	SPIN	STRANGENESS	CHARMNESS	BOTTOMNESS	TOPNESS
up	u	$+\frac{2}{3}$	$\frac{1}{2}$	0	0	0	0
down	d	$-\frac{1}{3}$	$\frac{1}{2}$	0	0	0	0
strange	s	$-\frac{1}{3}$	$\frac{1}{2}$	-1	0	0	0
charm	c	$+\frac{2}{3}$	$\frac{1}{2}$	0	$+1$	0	0
bottom	b	$-\frac{1}{3}$	$\frac{1}{2}$	0	0	-1	0
top	t	$+\frac{2}{3}$	$\frac{1}{2}$	0	0	0	$+1$

TABLE 1: *Properties of quarks. The isospin and the isospin z-componet are not shown.*

ANTIQUARKS PROPERTIES (see note 1)							
QUARK NAME	SYMBOL	ELECTRIC CHARGE (times $\|e\|$)	SPIN	STRANGENESS	CHARMNESS	BOTTOMNESS	TOPNESS
Anti-up	$\bar{u}$	$-\frac{2}{3}$	$\frac{1}{2}$	0	0	0	0
Anti-down	$\bar{d}$	$+\frac{1}{3}$	$\frac{1}{2}$	0	0	0	0
Anti-strange	$\bar{s}$	$+\frac{1}{3}$	$\frac{1}{2}$	$+1$	0	0	0
Anti-charm	$\bar{c}$	$-\frac{2}{3}$	$\frac{1}{2}$	0	-1	0	0
Anti-bottom	$\bar{b}$	$+\frac{1}{3}$	$\frac{1}{2}$	0	0	$+1$	0
Anti-top	$\bar{t}$	$-\frac{2}{3}$	$\frac{1}{2}$	0	0	0	-1

TABLE 2: *Properties of antiquarks. The isospin and the isospin z-componet are not shown because are not used by this theory.*

3. The Incomplete Matter-Antimatter Way

The existence of pentaquarks was first postulated by three Russian physicists: Polyakov, Diakonov and Petrov in 1997. In this formulation and using a different approach, I have hypothesized the existence of a wide spectrum of pentaquarks. My approach is based on a new diagram that I call **the matter-antimatter way** (MAW). In this article we shall explore this diagram in detail starting with **the incomplete matter-antimatter way** (see FIGURE 2) which is, as the name suggests, an incomplete version of **the matter antimatter way** (see FIGURE 9). The first thing we notice is that the diagram of FIGURE 2 is symmetrical about the vertical axis, which is called: the symmetry axis (the symmetry axis has no arrows and is shown in red). We also observe that the diagram may be considered as made up of two different diagrams:

(a) the **particles side** or **material side** (on the right hand size of the symmetry axis), and
(b) the **antiparticles side** or **anti-material side** (on the left hand side of the symmetry axis).

On the particles side we have 10 baryons, known as the baryon decuplet. This is the original decuplet discovered by Murray Gell-Mann. This decuplet is shown as blue circles. On the antiparticles side we have the anti-baryon decuplet containing the 10 corresponding anti-baryons. These anti-baryons are shown as red circles. The antiparticles side of the diagram can be obtained simply by placing a mirror along the symmetry axis (with the reflecting side facing the material side) and replacing the reflection of the particles by their corresponding antiparticles. Thus, our mirror is a kind of "magical mirror" because in addition to reflecting images (this is called parity or P symmetry) it has to do additional tasks that normal mirrors don't do. Firstly, it must also be able to replace the reflected particles by their corresponding antiparticles (this is called charge conjugation or C symmetry - see note 2). This means that the direction of the Q axis for antiparticles must point in the same direction to that of particles (according to the way axes are shown in FIGURE 2, the reflection of the Q axis in a normal reflected image will point in the opposite direction to that of the original or real Q axis). Secondly, it must reverse the direction of time so that if a particle moves forward in time, then its reflected image must be moving backward in time (this is called time reversal or T symmetry). Thirdly, it must change the strangeness of particles by the corresponding strangeness of antiparticles. This means that the direction of the S axis for antiparticles must point in the opposite direction to that of particles. This is **strangeness reversal**.

In summary, we have changed the direction of the reflected Q and S axes so that the Q axis for antiparticles will point in the same direction than that for particles, and the S axis for antiparticles will point in the opposite direction than that for particles. So, all in all, the operations our "magical mirror" must perform are:

(1) Parity operation (P symmetry).
(2) Charge conjugation (C symmetry),
(3) Time reversal (T symmetry),

These operations are called ***CPT* symmetry** (strangeness reversal is included into the C operation – see note 2). However, the name CPT symmetry is inappropriate because antiparticles have opposite properties to that of particles, and this includes opposite flow of time. In other words, antiparticles will always exhibit time reversal and charge conjugation simultaneously. Therefore, you cannot separate charge conjugation from time reversal because is conceptually wrong (see note 2). Thus, in order to solve this conceptual problem I shall use the acronym: ***PC*+ symmetry** instead of *CPT* symmetry. Where *P* indicates a parity operation (Operation 1) and *C*+ indicates all the reversal operations to be performed to convert particles into antiparticles. These include

C+ operation/ transformation (C plus symmetry)	Electrical charge reversal (*Q* symmetry) (Operation 2), Time reversal (*T* symmetry) (Operation 3), Strangeness reversal (Operation 4), Charmness reversal (Operation 5), Bottomness reversal (Operation 6), Topness reversal (Operation 7), Baryon number reversal (Operation 8), Lepton number reversal (Operation 9), etc.

Thus our “magical mirror” has to perform the following operations or transformations:

<table>
<tr><td rowspan="2">CPT
operation/
transformation
(CPT symmetry)</td><td>P operation</td><td>Parity (Operation 1),</td></tr>
<tr><td>C+ operation/
transformation
(C plus symmetry)</td><td>Electrical charge reversal (Q symmetry) (Operation 2),
Time reversal (T symmetry) (Operation 3),
Strangeness reversal (Operation 4),
Charmness reversal (Operation 5),
Bottomness reversal (Operation 6),
Topness reversal (Operation 7),
Baryon number reversal (Operation 8),
Lepton number reversal (Operation 9),
etc.</td></tr>
</table>

It is worthwhile to remark that the *Q* operation involves electrical charge reversal only. Let's now return to FIGURE 2. Because I have introduced two modifications to the “baryon decuplet”, this decuplet turns out to be a special case of the incomplete matter-antimatter way shown on FIGURE 2. The first modification is that (a) the isospin axis has been replaced by an axis representing the electric charge of particles. This modification changes the layout of the 10 baryons. Thus, instead of having 10 baryons arranged in an equilateral triangle, they are now arranged in a right-angled triangle (see the blue circles on the particles side of FIGURE 2). I must clarify that the electric charge axis, *Q*, may be drawn diagonally on the original baryon decuplet diagram. This is shown in page 25 of reference [2]. The second modification is (b) the addition of the “magical mirror image” (*PC*+ symmetry) of the 10 baryons represented by the right-angled triangle on the left hand side of the symmetry axis (see the red circles on the antiparticles side of FIGURE 2). The figure also shows 5 pairs of empty circles drawn on the symmetry axis. Despite the fact that every pair of empty circles overlap, they are shown as partially overlapped so that one can distinguish each pair. Each pair contains two points or empty circles. The fully visible empty circle correspond to particles (on the matter side) while the circle behind it, corresponds to antiparticles (on the antimatter side). Later when I describe the general theory of pentaquarks, I shall show these circles side by side and I shall also change the colours of some circles (see FIGURE 9). The reason is that the general theory requires a more meticulous diagram than that of FIGURE 2. But as for now, figures 2 through 8 will be good enough. The 5 fully visible points or empty circles are denoted, from the lower vertex up the page of FIGURE 2, with the letters *V, W, X, Y, Z,* respectively; and the 5 partially visible points or empty circles are denoted, in the same order, with the primed letters *V', W', X', Y', Z',* respectively. These 10 points are located on the symmetry axis. The coordinates of these 10 points are shown on TABLE 3. We have to keep in mind that these coordinates (as the coordinates of all the points shown on FIGURE 8) are fundamental to this theory.

QS COORDINATE SYSTEM	POINT	POINT COORDINATES	MEANING (The expert may leave out this column)
MATTER For particles. Right hand side coordinate system)	V (lower vertex)	$(-2,-4)$	$Q=-2$ and $S=-4$
	W (lower middle point)	$(-2,-3)$	$Q=-2$ and $S=-3$
	X (middle point)	$(-2,-2)$	$Q=-2$ and $S=-2$
	Y (upper middle point)	$(-2,-1)$	$Q=-2$ and $S=-1$
	Z (base point)	$(-2,\ 0)$	$Q=-2$ and $S=\ 0$
ANTIMATTER (For antiparticles. Left hand side coordinate system)	V' (lower vertex)	$(+2,+4)$	$Q=+2$ and $S=+4$
	W' (lower middle point)	$(+2,+3)$	$Q=+2$ and $S=+3$
	X' (middle point)	$(+2,+2)$	$Q=+2$ and $S=+2$
	Y' (upper middle point)	$(+2,+1)$	$Q=+2$ and $S=+1$
	Z' (base point)	$(+2,\ 0)$	$Q=+2$ and $S=\ 0$

TABLE 3: *Coordinates of the of points the triangle of FIGURE 2 (incomplete matter-antimatter way). These points are marked with empty circles.*

The main idea behind this formulation is that every pair of empty circles (every pair of non-primed and primed points) of FIGURE 2 represents a set of particles and antiparticles. In fact, in the next sections, and based on the values of electric charge and strangeness given in TABLE 3, I shall find: (a) the exact nature of the particles and antiparticles (pentaquarks and antipentaquarks) of each pair of empty circles, and (b) the exact number of particles and antiparticles (pentaquarks and antipentaquarks) contained in every pair of empty circles. But this is not the full story. The full story is that in every blue circle, red circle and empty circle of FIGURE 2 there exist pentaquarks. This is shown in FIGURE 9 of section 7. FIGURE 9 shows all the points in which pentaquarks/antipentaquarks exist. It is important to note that I have changed the colour code of the particles/antiparticles to be able to easily differentiate baryons from pentaquarks and anti-baryons from antipentaquarks. But, as for now, let us concentrate on FIGURE 2.

(see next page)

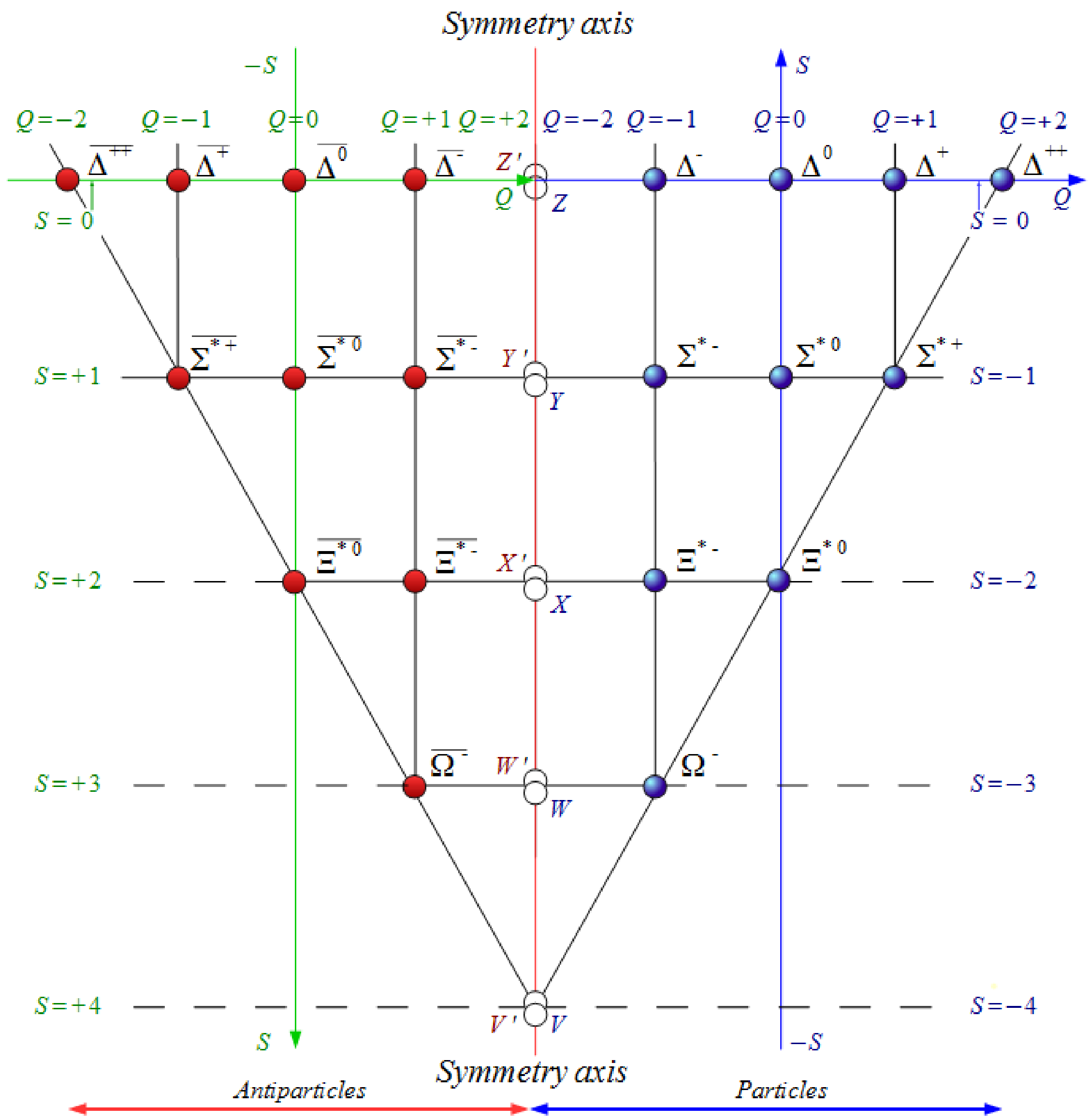

FIGURE 2: ***The Incomplete Matter-Antimatter Way:*** *a pattern of 10 baryons (blue circles), 10 anti-baryons (red circles) and 5 pairs of empty circles drawn on the symmetry axis. Despite the fact that every pair of empty circles overlap, they are shown as partially overlapped so that one can distinguish each pair. It is important to observe that two QS coordinate systems have been used. One QS coordinate system is for particles while the other one is for their antiparticles. Thus, one of the horizontal Q axes represents the electric charge of particles while the other one represents the electric charge of antiparticles. It is important to observe that Q=-2 belongs to the particles' Q axis while Q=+2 belongs to the antiparticles' Q axis (see TABLE 3 for the rest of the points). One of the vertical S axis represents the strangeness of particles while the other vertical S axis represents the strangeness of antiparticles. The isospin property of the particles and antiparticles is not used in this formulation, therefore is not shown. The composition of all the particles and antiparticles shown in this diagram are given in Appendix 1. The particles whose names include an asterisk:* Σ^{*-} , Σ^{*0} , Σ^{*+} , Ξ^{*-} , Ξ^{*0} *are exited states of the corresponding particles:* Σ^{-} , Σ^{0} , Σ^{+} , Ξ^{-} , Ξ^{0} .

In addition to the diagram of FIFURE 2 the main diagrams of this formulation are:

(1) **The matter-antimatter way along the symmetry axis.** This diagram includes all the pentaquarks and antipentaquarks there exist on the empty points along the symmetry axis. This diagram is shown in FIGURE 8.

(2) **The complete matter-antimatter way** or simply **the matter-antimatter way.** This diagram includes all the pentaquarks and antipentaquarks there exist in nature. This is the most complete diagram of this theory. This diagram is shown in FIGURE 9.

Now, let us explore the diagram of FIGURE 2 in more detail. An innovative feature of this diagram is that contains two *QS* coordinate systems which acts like a Cartesian coordinate system (*Q* instead of *x* and *S* instead of *y*). One *QS* coordinate system is for particles (shown in blue) while the other one is for their antiparticles (shown in red). Thus, one of the horizontal *Q* axes represents the electric charge of particles while the other one represents the electric charge of antiparticles. Similarly, one of the vertical *S* axis represents the strangeness of particles (+*S* points up the page) while the other vertical *S* axis represents the strangeness of antiparticles (+*S* points down the page).

It is important to observe that *Q*=-2 belongs to the particles' *Q* axis while *Q*=+2 belongs to the antiparticles' *Q* axis. Thus the points (-2, 0) and (+2,0) are *QS* points that overlap. In this theory, I propose that that there exist pentaquarks on the non-primed points: *V*, *W*, *X*, *Y* and *Z*; and antipentaquarks on the primed points: *V'*, *W'*, *X'*, *Y'* and *Z'* of the diagram.

If pentaquarks were not real, no particles would occupy the empty circles. This would contradict the belief that the universe is based on symmetry. (by the way, the Standard Model has been built on symmetry principles as well). Symmetry principles dictate the form of the laws of physics.

4. Analysis Along the Straight Lines $Q=-2$ and $Q'=+2$ (Symmetry Axis)

4.1 Analysis of Quadruply Strange Pentaquarks: Point $V(-2,-4)$ and $V'(+2,+4)$

Despite the fact I predicted the existence of quadruply strange pentaquarks in another article [9], I decided to include a similar analysis here because of three reasons. The first reason is completeness. The second reason is that the explanations of this section are more detailed. The third reason relates to graphics. The figure included in this section (FIGURE 2) is an improved version of the corresponding figure that appears in the previous article. While naive pentaquark diagrams are not included in this article, they are included in the Quantum Chromodynamics Theory of Quadruply Strange Pentaquarks.

4.1.1 Point $V(-2,-4)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue on the right hand side of FIGURE 2. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -2 ($Q=-2$) (meaning $-2e$, where *e* is the absolute value of the elementary charge).

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -4 ($S=-4$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), the only way a particle can have a strangeness of -4 is if 4 of the constituents of this particle were 4 strange quarks.

Taking into account these two conditions and the fact that each strange quark carries an electric charge of $-1/3$, the **electric charge equation** for this particle will be

$$Q = 4\,q_s + q \tag{4.1.1}$$

Where

Q = total electric charge of the unknown particle (-2)
q_s = electric charge of the strange quark ($-1/3$)
q = electric charge of another quark (different from an *s* quark) so that the total charge of the unknown particle is -2 . This quark will be called the fifth quark.

We solve equation (4.1.1) for *q*. This gives

$$q = Q - 4\,q_s \tag{4.1.2}$$

Then, the value of the electric charge, *q,* of the fifth quark should be

$$q = -2 - \left(-\frac{4}{3}\right) = -2 + \frac{4}{3} = -\frac{2}{3} \tag{4.1.3}$$

Looking at TABLE 2 of section 2 (antiquark properties) we see that there are only three antiquarks that have an electric charge equal to $-2/3$. These antiquarks are:

(i) the antiup quark, $\bar{u}$,
(ii) the anticharm quark, $\bar{c}$, and
(iii) the antitop quark, $\bar{t}$,

Because equation (4.1.2) is satisfied by three antiquarks, equation (4.1.1) must be written as three different equations

$$Q = 4\,q_s + q_{\bar{u}} \tag{4.1.4}$$
$$Q = 4\,q_s + q_{\bar{c}} \tag{4.1.5}$$
$$Q = 4\,q_s + q_{\bar{t}} \tag{4.1.6}$$

Where

$q_{\bar{u}}$ = electric charge of the antiup quark = $-2/3$
$q_{\bar{c}}$ = electric charge of the anticharm quark = $-2/3$
$q_{\bar{t}}$ = electric charge of the antitop quark = $-2/3$

But having three different electric charge equations means that we must also have three different particles and, in addition, these particles must be pentaquarks. Thus we write

Pentaquark $P_{4s\bar{u}}$ $(s\,s\,s\,s\,\bar{u})$ (4.1.7)

Pentaquark $P_{4s\bar{c}}$ $(s\,s\,s\,s\,\bar{c})$ (4.1.8)

Pentaquark $P_{4s\bar{t}}$ $(s\,s\,s\,s\,\bar{t})$ (4.1.9)

4.1.2 Point $V'(+2,+4)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for antiparticles which is shown in green colour on the left hand side of FIGURE 2. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (antipentaquark) must satisfy is that its electric charge should be equal to +2 (Q = +2) (meaning +2*e*, where *e* is the absolute value of the elementary charge).

(b) The second condition the unknown particle (antipentaquark) must satisfy is that its strangeness should be equal to +4 (S = +4). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property for anti-strange quarks is +1 (see TABLE 2 of section 2), the only way a particle can have a strangeness of +4 is if 4 of the constituents of this particle were 4 anti-strange quarks.

Taking into consideration these two conditions and the fact that each anti-strange quark carries an electric charge of $+1/3$, the electric charge equation for these particles should be

$$Q = 4\,q_{\bar{s}} + q_5 \qquad (4.1.10)$$

Where

Q = total electric charge of the unknown particle ($+2$)
$q_{\bar{s}}$ = electric charge of the anti-strange quark ($+1/3$)
q_5 = electric charge of another quark (different from a anti-strange quark) so that the total charge of the unknown particle is $+2$. This quark will be called the fifth quark.

We solve equation (4.1.11) for *q*. This gives

$$q_5 = Q - 4\,q_{\bar{s}} \qquad (4.1.11)$$

Then, the value of the electric charge, *q,* of the fifth quark should be

$$q_5 = +2 - \left(+\frac{4}{3}\right) = +2 - \frac{4}{3} = +\frac{2}{3} \qquad (4.1.12)$$

If we look at TABLE 1 of section 2 (quark properties) we shall see that there are only three quarks that have an electric charge equal to $+2/3$. These quarks are

(i) the up quark, u ,
(ii) the charm quark, c , and
(iii) the top quark, t

Because equation (4.1.11) is satisfied by three antiquarks, equation (4.1.10) must be written as three different equations

$$Q = 4\, q_{\bar{s}} + q_u \qquad (4.1.13)$$
$$Q = 4\, q_{\bar{s}} + q_c \qquad (4.1.14)$$
$$Q = 4\, q_{\bar{s}} + q_t \qquad (4.1.15)$$

Where

$q_u =$ electric charge of the up quark = $+2/3$
$q_c =$ electric charge of the charm quark = $+2/3$
$q_t =$ electric charge of the top quark = $+2/3$

But having three different electric charge equations means that we must also have three different particles and, in addition, these particles must be pentaquarks (or antipentaquarks). Thus we write

antipentaquark $P_{4\bar{s}u}$ $\qquad \bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,u$ (4.1.16)

antipentaquark $P_{4\bar{s}c}$ $\qquad \bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,c$ (4.1.17)

antipentaquark $P_{4\bar{s}t}$ $\qquad \bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,t$ (4.1.18)

Thus based on the allowed electric charge and strangeness we have found the nature of the unknown particles. TABLE 4 summarizes the properties of the quadruply strange pentaquarks.

(see next page)

	PREDICTED PARTICLE (symbol)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $|e|$)	STRANGENESS
PARTICLES WITH 4 STRANGE QUARKS	$P_{4s\bar{u}}$	$(s\,s\,s\,s\,\bar{u})$	-2	-4
	$P_{4s\bar{c}}$	$(s\,s\,s\,s\,\bar{c})$	-2	-4
	$P_{4s\bar{t}}$	$(s\,s\,s\,s\,\bar{t})$	-2	-4
ANTI-PARTICLES WITH 4 STRANGE QUARKS	$P_{4\bar{s}u}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,u)$	$+2$	$+4$
	$P_{4\bar{s}c}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,c)$	$+2$	$+4$
	$P_{4\bar{s}t}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,t)$	$+2$	$+4$

TABLE 4: *Some of the properties of the quadruply strange pentaquarks.*

4.1.3 Brief Analysis of the Colour Charge and Spin

Analysis for Particles

Because all known baryons and mesons are colourless, meaning they are neutral in terms of colour charge, the predicted pentaquarks should also be colourless. Also because of the Pauli exclusion principle there shouldn't be two quarks of the same type with all the same quantum numbers. This means that the two strange quarks of identical colour (because there are 4 strange quarks and because there are only three flavours of the colour charge, there must be two strange quarks of the same colour) should have opposite spins (one with spin up and the other one with spin down). For example the following pentaquark should be allowed by nature

$$s_R^{up}\; s_G^{up}\; s_B^{up}\; s_R^{down}\; \overline{u_R}^{up} \tag{4.2.1}$$

It is worthwhile to observe that the anti-quark up could have spin up or down. Because the antiquark up is antired, the combination $s_R^{down}\, \overline{u_R}^{up}$ will be colourless. Also the combination $s_R^{up}\, s_G^{up}\, s_B^{up}$ will be colourless. This means that the entire pentaquark will be colourless. As an additional example, the following pentaquarks should be allowed

$$s_R^{down}\; s_G^{down}\; s_B^{down}\; s_R^{up}\; \overline{u_R}^{up} \tag{4.2.2}$$

$$s_R^{up}\; s_G^{up}\; s_B^{down}\; s_R^{down}\; \overline{u_R}^{up} \tag{4.2.3}$$

etc.

The interested reader could find more allowed combinations.

Analysis for Antiparticles

Carrying out a similar analysis we find that

$$\overline{s_B}^{up}\; \overline{s_G}^{up}\; \overline{s_B}^{up}\; \overline{s_R}^{down}\; u_R^{up} \tag{4.2.4}$$

Because this theory predicts that point V should contain 3 pentaquarks and that point V' should contain another 3 pentaquarks (remember that V and V' overlap), we may replace the visible empty circle of the lower vertex of FIGURE 2 by a blue circle representing the 3 new pentaquarks ($(s\,s\,s\,s\,\bar{u})$, $(s\,s\,s\,s\,\bar{c})$, $(s\,s\,s\,s\,\bar{t})$, and the partially visible empty circle of that figure by and a red circle representing the 3 new antipentaquarks ($\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,u$, $\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,c$, $\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,t$). This is done in FIGURE 3.

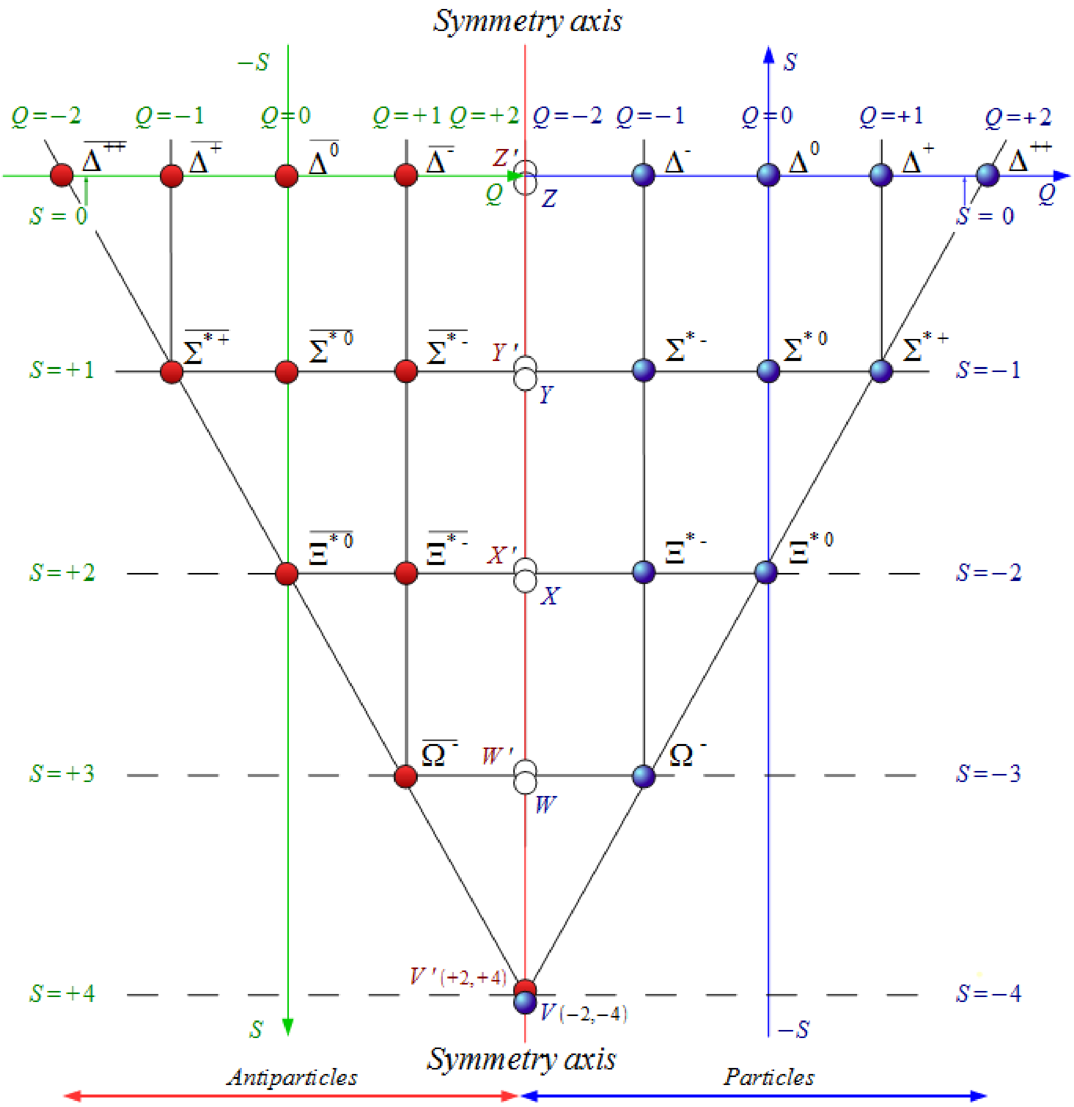

FIGURE 3: *The Incomplete Matter-Antimatter Way (including pentaquark level |4|): a pattern of 10 baryons (blue circles), 10 anti-baryons (red circles), 3 pentaquanks (blue circle at point V) and 3 antipentaquarks (red circle at point V').*

4.2 Analysis of Triply Strange Pentaquarks: Points $W(-2,-3)$ and $W'(+2,+3)$

4.2.1 Point $W(-2,-3)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 2. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -2 ($Q=-2$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -3 ($S=-3$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), the only way a particle can have a strangeness of -3 is if 3 of the constituents of this particle were 3 strange quarks.

Taking into account these two conditions and the fact that each strange quark carries an electric charge of $-1/3$, the electric charge equation for this particle should be

$$Q=3q_s+q_4+q_5 \tag{5.1.1}$$

Where

Q = total electric charge of the unknown particle (-2)
q_s = electric charge of the strange quark ($-1/3$)
q_5 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the fifth quark.
q_4 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the forth quark.

We solve equation (5.1.1) for q_4+q_5 . This gives

$$q_4+q_5=Q-3q_s \tag{5.1.2}$$

Then, the value of the combined electric charge, q_4+q_5 , of the forth and fifth quarks should be

$$q_4+q_5=-2-3\times\left(-\frac{1}{3}\right)=-2+1=-1 \tag{5.1.3}$$

Therefore, the pentaquark must have the forth and the fifth quarks so that the addition of their electrical charges to be equal to -1 and, because of condition (b), none of these two quarks must be *s* quarks.

Looking at TABLE 2 of section 2 (antiquark properties) we see that

(i) the forth quark must be a *d* quark or a *b* quark, and
(ii) the fifth quark must be a $\bar{u}$ quark, a $\bar{c}$ quark or a $\bar{t}$ quark

These constrains will give us the following 6 pentaquarks

Pentaquark $P_{3sd\bar{u}}$: $(s\,s\,s\,d\,\bar{u})$

Pentaquark $P_{3sd\bar{c}}$: $(s\,s\,s\,d\,\bar{c})$

Pentaquark $P_{3sd\bar{t}}$: $(s\,s\,s\,d\,\bar{t})$

Pentaquark $P_{3sb\bar{u}}$: $(s\,s\,s\,b\,\bar{u})$

Pentaquark $P_{3sb\bar{c}}$: $(s\,s\,s\,b\,\bar{c})$

Pentaquark $P_{3sb\bar{t}}$: $(s\,s\,s\,b\,\bar{t})$

4.2.2 Point $W'(+2,+3)$: Analysis of the Electric Charge and Strangeness

A similar analysis shows that point *W'* should contain the following 6 antipentaquarks

Antipentaquark $P_{3\bar{s}\bar{d}u}$: $(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,u)$

Antipentaquark $\bar{P}_{3\bar{s}\bar{d}c}$: $(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,c)$

Antipentaquark $\bar{P}_{4\bar{s}t}$: $(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,t)$

Antipentaquark $\bar{P}_{3\bar{s}\bar{b}u}$: $(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,u)$

Antipentaquark $\bar{P}_{3\bar{s}\bar{b}c}$: $(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,c)$

Antipentaquark $\bar{P}_{3\bar{s}\bar{b}t}$: $(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,t)$

Because this theory predicts that point *W* should contain 6 pentaquarks and that point *W'* should also contain 6 pentaquarks (remember that *W* and *W'* overlap), we may replace the visible empty circle of point *W* of FIGURE 2 by a blue circle representing the 6 new pentaquarks; and the partially visible empty circle of point *W'*, by and a red circle representing the 6 new antipentaquarks. This is done in FIGURE 4. TABLE 5 summarizes the properties of the triply strange pentaquarks.

(see next page)

	PREDICTED PARTICLE (symbol)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
PARTICLES WITH 3 STRANGE QUARKS	$P_{3sd\bar{u}}$	$(s\,s\,s\,d\,\bar{u})$	-2	-3
	$P_{3sd\bar{c}}$	$(s\,s\,s\,d\,\bar{c})$	-2	-3
	$P_{3sd\bar{t}}$	$(s\,s\,s\,d\,\bar{t})$	-2	-3
	$P_{3sb\bar{u}}$	$(s\,s\,s\,b\,\bar{u})$	-2	-3
	$P_{3sb\bar{c}}$	$(s\,s\,s\,b\,\bar{c})$	-2	-3
	$P_{3sb\bar{t}}$	$(s\,s\,s\,b\,\bar{t})$	-2	-3
ANTI-PARTICLES WITH 3 ANTI-STRANGE QUARKS	$P_{3\bar{s}\bar{d}u}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,u)$	$+2$	$+3$
	$P_{3\bar{s}\bar{d}c}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,c)$	$+2$	$+3$
	$P_{3\bar{s}\bar{d}t}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,t)$	$+2$	$+3$
	$P_{3\bar{s}\bar{b}u}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,u)$	$+2$	$+3$
	$P_{3\bar{s}\bar{b}c}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,c)$	$+2$	$+3$
	$P_{3\bar{s}\bar{b}t}$	$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,t)$	$+2$	$+3$

TABLE 5: *Some of the properties of the triply strange pentaquarks.*

(see next page)

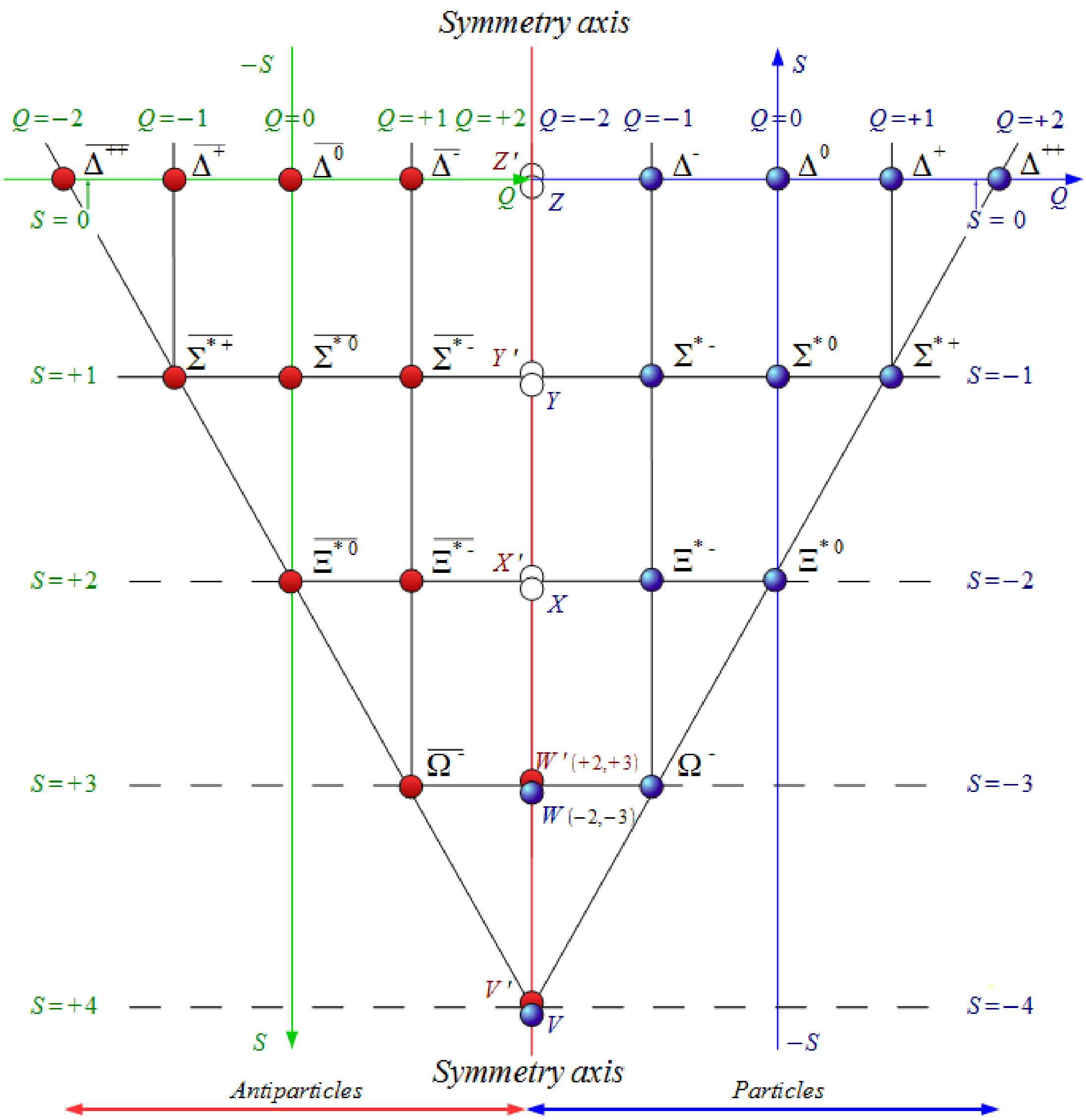

FIGURE 4: *The Incomplete Matter-Antimatter Way (including pentaquark levels* |*3*| and |*4*|)*: a pattern of 10 baryons (blue circles), 10 anti-baryons (red circles), 3 pentaquanks (blue circle at point V), 3 antipentaquarks (red circle at point V'), 6 pentaquanks (represented by a blue circle drawn at point W), 6 antipentaquarks (represented by a red circle drawn at point W').*

4.3 Analysis of Doubly Strange Pentaquarks: Points $X(-2,-2)$ and $X'(+2,+2)$

4.3.1 Point $X(-2,-2)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 2. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -2 ($Q=-2$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -2 ($S=-2$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), the only way a particle can have a strangeness of -2 is if 2 of the constituents of this particle were 2 strange quarks.

Taking into account these two conditions and the fact that each strange quark carries an electric charge of $-1/3$, the electric charge equation for this particle should be

$$Q=2q_s+q_3+q_4+q_5 \tag{6.1.1}$$

Where

$Q =$ total electric charge of the unknown particle (-2)
$q_s =$ electric charge of the strange quark ($-1/3$)
$q_5 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the fifth quark.
$q_4 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the forth quark.
$q_3 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the third quark.

We solve equation (5.1.1) for $q_3+q_4+q_5$. This gives

$$q_3+q_4+q_5=Q-2q_s \tag{6.1.2}$$

Then, the value of the combined electric charge, $q_3+q_4+q_5$ of the third, forth and fifth quarks should be

$$q_3+q_4+q_5=-2-2\times\left(-\frac{1}{3}\right)=-2+\frac{2}{3}=-\frac{4}{3} \tag{6.1.3}$$

Therefore, the addition of the electrical charge of the third, forth and the fifth quarks must be to be equal to $-4/3$ and, because of condition (b), none of these two quarks must be *s* quarks. Looking at TABLE 1 (quark properties) and TABLE 2 (antiquark properties) of section 2 we see that the only way that 3 quarks can yield an electrical charge of $-4/3$

is if two of the 3 quarks have an electric charge of $-1/3$, and the other quark an electric charge of $-2/3$ so that the total charge of these 3 quarks is $-1/3-1/3-2/3=-4/3$

These constrains will give us the following 9 pentaquarks

Pentaquark $P_{2s2d\bar{u}}$ $(s\,s\,d\,d\,\bar{u})$

Pentaquark $P_{2s2d\bar{c}}$ $(s\,s\,d\,d\,\bar{c})$

Pentaquark $P_{2s2d\bar{t}}$ $(s\,s\,d\,d\,\bar{t})$

Pentaquark $P_{2s\,d\,b\,\overline{u}}$: $(s\,s\,d\,b\,\overline{u})$

Pentaquark $P_{2s\,d\,b\,\overline{c}}$: $(s\,s\,d\,b\,\overline{c})$

Pentaquark $P_{2s\,d\,b\,\overline{t}}$: $(s\,s\,d\,b\,\overline{t})$

Pentaquark $P_{2s\,2b\,\overline{u}}$: $(s\,s\,b\,b\,\overline{u})$

Pentaquark $P_{2s\,2b\,\overline{c}}$: $(s\,s\,b\,b\,\overline{c})$

Pentaquark $P_{2s\,2b\,\overline{t}}$: $(s\,s\,b\,b\,\overline{t})$

4.3.2 Point $X'(+2,+2)$: Analysis of the Electric Charge and Strangeness

A similar analysis shows that point *W'* should contain the following 9 antipentaquarks

Antipentaquark $P_{2\overline{s}\,2\overline{d}\,u}$: $(\overline{s}\,\overline{s}\,\overline{d}\,\overline{d}\,u)$

Antipentaquark $P_{2\overline{s}\,2\overline{d}\,c}$: $(\overline{s}\,\overline{s}\,\overline{d}\,\overline{d}\,c)$

Antipentaquark $P_{2\overline{s}\,2\overline{d}\,t}$: $(\overline{s}\,\overline{s}\,\overline{d}\,\overline{d}\,t)$

Antipentaquark $P_{2\overline{s}\,\overline{d}\,\overline{b}\,u}$: $(\overline{s}\,\overline{s}\,\overline{d}\,\overline{b}\,u)$

Antipentaquark $P_{2\overline{s}\,\overline{d}\,\overline{b}\,c}$: $(\overline{s}\,\overline{s}\,\overline{d}\,\overline{b}\,c)$

Antipentaquark $P_{2\overline{s}\,\overline{d}\,\overline{b}\,t}$: $(\overline{s}\,\overline{s}\,\overline{d}\,\overline{b}\,t)$

Antipentaquark $P_{2\overline{s}\,2\overline{b}\,u}$: $(\overline{s}\,\overline{s}\,\overline{b}\,\overline{b}\,u)$

Antipentaquark $P_{2\overline{s}\,2\overline{b}\,c}$: $(\overline{s}\,\overline{s}\,\overline{b}\,\overline{b}\,c)$

Antipentaquark $P_{2\overline{s}\,2\overline{b}\,t}$: $(\overline{s}\,\overline{s}\,\overline{b}\,\overline{b}\,t)$

Because this theory predicts that point *X* should contain 9 pentaquarks and that point *X'* should also contain 9 pentaquarks (remember that *X* and *X'* overlap), we may replace the visible empty circle of point *X* of FIGURE 2 by a blue circle representing the 9 new pentaquarks; and the partially visible empty circle of point *X'*, by and a red circle representing the 9 new antipentaquarks. This is done in FIGURE 5.

(see next page)

TABLE 6 summarizes the properties of the doubly strange pentaquarks.

	PREDICTED PARTICLE (symbol)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
PARTICLES WITH 2 STRANGE QUARKS	$P_{2s\,2d\,\bar{u}}$	$(s\,s\,d\,d\,\bar{u})$	-2	-2
	$P_{2s\,2d\,\bar{c}}$	$(s\,s\,d\,d\,\bar{c})$	-2	-2
	$P_{2s\,2d\,\bar{t}}$	$(s\,s\,d\,d\,\bar{t})$	-2	-2
	$P_{2s\,d\,b\,\bar{u}}$	$(s\,s\,d\,b\,\bar{u})$	-2	-2
	$P_{2s\,d\,b\,\bar{c}}$	$(s\,s\,d\,b\,\bar{c})$	-2	-2
	$P_{2s\,d\,b\,\bar{t}}$	$(s\,s\,d\,b\,\bar{t})$	-2	-2
	$P_{2s\,2b\,\bar{u}}$	$(s\,s\,b\,b\,\bar{u})$	-2	-2
	$P_{2s\,2b\,\bar{c}}$	$(s\,s\,b\,b\,\bar{c})$	-2	-2
	$P_{2s\,2b\,\bar{t}}$	$(s\,s\,b\,b\,\bar{t})$	-2	-2
ANTI-PARTICLES WITH 2 ANTI-STRANGE QUARKS	$P_{2\bar{s}\,2\bar{d}\,u}$	$(\bar{s}\,\bar{s}\,\bar{d}\,\bar{d}\,u)$	$+2$	$+2$
	$P_{2\bar{s}\,2\bar{d}\,c}$	$(\bar{s}\,\bar{s}\,\bar{d}\,\bar{d}\,c)$	$+2$	$+2$
	$P_{2\bar{s}\,2\bar{d}\,t}$	$(\bar{s}\,\bar{s}\,\bar{d}\,\bar{d}\,t)$	$+2$	$+2$
	$P_{2\bar{s}\,\bar{d}\,\bar{b}\,u}$	$(\bar{s}\,\bar{s}\,\bar{d}\,\bar{b}\,u)$	$+2$	$+2$
	$P_{2\bar{s}\,\bar{d}\,\bar{b}\,c}$	$(\bar{s}\,\bar{s}\,\bar{d}\,\bar{b}\,c)$	$+2$	$+2$
	$P_{2\bar{s}\,\bar{d}\,\bar{b}\,t}$	$(\bar{s}\,\bar{s}\,\bar{d}\,\bar{b}\,t)$	$+2$	$+2$
	$P_{2\bar{s}\,2\bar{b}\,u}$	$(\bar{s}\,\bar{s}\,\bar{b}\,\bar{b}\,u)$	$+2$	$+2$
	$P_{2\bar{s}\,2\bar{b}\,c}$	$(\bar{s}\,\bar{s}\,\bar{b}\,\bar{b}\,c)$	$+2$	$+2$
	$P_{2\bar{s}\,2\bar{b}\,t}$	$(\bar{s}\,\bar{s}\,\bar{b}\,\bar{b}\,t)$	$+2$	$+2$

TABLE 6: *Some of the properties of the doubly strange pentaquarks.*

(see next page)

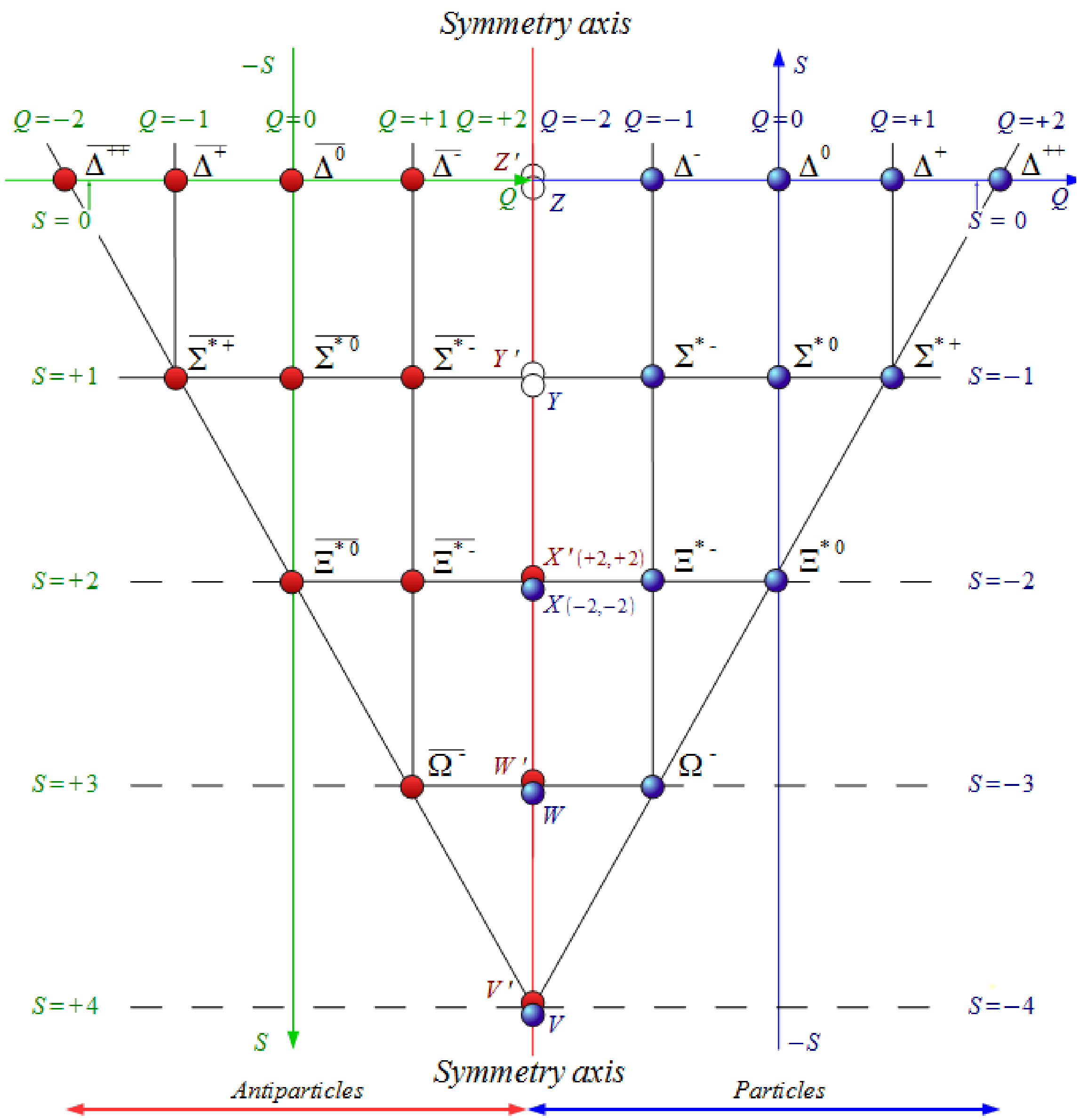

FIGURE 5: *The Incomplete Matter-Antimatter Way (including pentaquark levels* |*2*|, |*3*| and |*4*|)*: a pattern of 10 baryons (blue circles), 10 anti-baryons (red circles), 3 pentaquanks (blue circle at point V), 3 antipentaquarks (red circle at point V'), 6 pentaquanks (represented by a blue circle drawn at point W), 6 antipentaquarks (represented by a red circle drawn at point W'), 9 pentaquanks (represented by a blue circle drawn at point X) and 9 antipentaquarks (represented by a red circle drawn at point X').*

4.4 Analysis of Singly Strange Pentaquarks: Points $Y(-2,-1)$ and $Y'(+2,+1)$

4.4.1 Point $Y(-2,-1)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 1. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -2 ($Q=-2$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -1 ($S=-1$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), the only way a particle can have a strangeness of -1 is if one of the constituents of this particle is a strange quark.

Taking into account these two conditions and the fact that each strange quark carries an electric charge of $-1/3$, the electric charge equation for these particles should be

$$Q=q_s+q_2+q_3+q_4+q_5 \quad (7.1.1)$$

Where

$Q=$ total electric charge of the unknown particle (-2)
$q_s=$ electric charge of the strange quark ($-1/3$)
$q_5=$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the fifth quark.
$q_4=$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the forth quark.
$q_3=$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the third quark.
$q_2=$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the second quark.

We solve equation (7.1.1) for $q_2+q_3+q_4+q_5$. This gives

$$q_2+q_3+q_4+q_5=Q-q_s \quad (7.1.2)$$

Then, the value of the combined electric charge, $q_2+q_3+q_4+q_5$, of the second, third, forth and fifth quarks should be

$$q_2+q_3+q_4+q_5=-2-\left(-\frac{1}{3}\right)=-2+\frac{1}{3}=-\frac{5}{3} \quad (7.1.3)$$

Therefore, the addition of the electrical charge of the second, third, forth and the fifth quarks must be to be equal to $-5/3$ and, because of condition (b), none of these four quarks must be *s* quarks. Looking at TABLE 1 (quark properties) and TABLE 2 (antiquark properties) of section 2 we see that the only way that 4 quarks (an additional *s* quark will complete the pentaquark) can yield an electrical charge of $-5/3$ is if one of the 4 quarks has an electric charge of $-2/3$ (which is the charge of either an $\bar{u}$ quark, or a $\bar{c}$ quark or a $\bar{t}$ quark) and the other 3 quarks have a charge of $-1/3$ each (which is the charge of either a *d* quark or a *b* quark). Thus, a combinations of these types of 4 quarks will produce an electric charge of

$$q_2+q_3+q_4+q_5=-\frac{2}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}=-\frac{5}{3} \quad (7.1.4)$$

Thus, these conditions yield the following 12 pentaquarks

Pentaquark $P_{s3d\bar{u}}$: $(s\,d\,d\,d\,\bar{u})$

Pentaquark $P_{s2db\bar{u}}$: $(s\,d\,d\,b\,\bar{u})$

Pentaquark $P_{sd2b\bar{u}}$: $(s\,d\,b\,b\,\bar{u})$

Pentaquark $P_{s3b\bar{u}}$: $(s\,b\,b\,b\,\bar{u})$

Pentaquark $P_{s3d\bar{c}}$: $(s\,d\,d\,d\,\bar{c})$

Pentaquark $P_{s2db\bar{c}}$: $(s\,d\,d\,b\,\bar{c})$

Pentaquark $P_{sd2b\bar{c}}$: $(s\,d\,b\,b\,\bar{c})$

Pentaquark $P_{s3b\bar{c}}$: $(s\,b\,b\,b\,\bar{c})$

Pentaquark $P_{s3d\bar{t}}$: $(s\,d\,d\,d\,\bar{t})$

Pentaquark $P_{s2db\bar{t}}$: $(s\,d\,d\,b\,\bar{t})$

Pentaquark $P_{sd2b\bar{t}}$: $(s\,d\,b\,b\,\bar{t})$

Pentaquark $P_{s3b\bar{t}}$: $(s\,b\,b\,b\,\bar{t})$

4.4.2 Point $Y'(+2, +1)$: Analysis of the Electric Charge and Strangeness

A similar analysis shows that point Y' should contain the following 12 antipentaquarks

Antipentaquark $\bar{P}_{\bar{s}3\bar{d}u}$: $(\bar{s}\,\bar{d}\,\bar{d}\,\bar{d}\,u)$

Antipentaquark $\bar{P}_{\bar{s}2\bar{d}\bar{b}u}$: $(\bar{s}\,\bar{d}\,\bar{d}\,\bar{b}\,u)$

Antipentaquark $\bar{P}_{\bar{s}\bar{d}2\bar{b}u}$: $(\bar{s}\,\bar{d}\,\bar{b}\,\bar{b}\,u)$

Antipentaquark $\bar{P}_{\bar{s}3\bar{b}u}$: $(\bar{s}\,\bar{b}\,\bar{b}\,\bar{b}\,u)$

Antipentaquark $\bar{P}_{\bar{s}3\bar{d}c}$: $(\bar{s}\,\bar{d}\,\bar{d}\,\bar{d}\,c)$

Antipentaquark $\bar{P}_{\bar{s}2\bar{d}\bar{b}c}$: $(\bar{s}\,\bar{d}\,\bar{d}\,\bar{b}\,c)$

Antipentaquark $\bar{P}_{\bar{s}\bar{d}2\bar{b}c}$: $(\bar{s}\,\bar{d}\,\bar{b}\,\bar{b}\,c)$

Antipentaquark $\bar{P}_{\bar{s}3\bar{b}c}$: $(\bar{s}\,\bar{b}\,\bar{b}\,\bar{b}\,c)$

Antipentaquark $\bar{P}_{\bar{s}3\bar{d}t}$: $(\bar{s}\,\bar{d}\,\bar{d}\,\bar{d}\,t)$

Antipentaquark $\bar{P}_{\bar{s}2\bar{d}\bar{b}t}$: $(\bar{s}\,\bar{d}\,\bar{d}\,\bar{b}\,t)$

Antipentaquark $\bar{P}_{\bar{s}\bar{d}2\bar{b}t}$: $(\bar{s}\,\bar{d}\,\bar{b}\,\bar{b}\,t)$

Antipentaquark $\bar{P}_{\bar{s}3\bar{b}t}$: $(\bar{s}\,\bar{b}\,\bar{b}\,\bar{b}\,t)$

Because this theory predicts that point Y should contain 12 pentaquarks and that point Y' should also contain 12 pentaquarks (remember that Y and Y' overlap), we may replace the visible empty circle of point Y of FIGURE 2 by a blue circle representing the 12 new pentaquarks; and the partially visible empty circle of point Y', by and a red circle representing the 12 new antipentaquarks. This is done in FIGURE 6. TABLE 7 summarizes the properties of the singly strange pentaquarks.

	PREDICTED PARTICLE (symbol)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
PARTICLES WITH 1 STRANGE QUARK	$P_{s3d\bar{u}}$	$(s\,d\,d\,d\,\bar{u})$	-2	-1
	$P_{s2db\bar{u}}$	$(s\,d\,d\,b\,\bar{u})$	-2	-1
	$P_{sd2b\bar{u}}$	$(s\,d\,b\,b\,\bar{u})$	-2	-1
	$P_{s3b\bar{u}}$	$(s\,b\,b\,b\,\bar{u})$	-2	-1
	$P_{s3d\bar{c}}$	$(s\,d\,d\,d\,\bar{c})$	-2	-1
	$P_{s2db\bar{c}}$	$(s\,d\,d\,b\,\bar{c})$	-2	-1
	$P_{sd2b\bar{c}}$	$(s\,d\,b\,b\,\bar{c})$	-2	-1
	$P_{s3b\bar{c}}$	$(s\,b\,b\,b\,\bar{c})$	-2	-1
	$P_{s3d\bar{t}}$	$(s\,d\,d\,d\,\bar{t})$	-2	-1
	$P_{s2db\bar{t}}$	$(s\,d\,d\,b\,\bar{t})$	-2	-1
	$P_{sd2b\bar{t}}$	$(s\,d\,b\,b\,\bar{t})$	-2	-1
	$P_{s3b\bar{t}}$	$(s\,b\,b\,b\,\bar{t})$	-2	-1
ANTI-PARTICLES WITH 1 ANTI-STRANGE QUARK	$\bar{P}_{\bar{s}3\bar{d}u}$	$(\bar{s}\,\bar{d}\,\bar{d}\,\bar{d}\,u)$	$+2$	$+1$
	$\bar{P}_{\bar{s}2\bar{d}\bar{b}u}$	$(\bar{s}\,\bar{d}\,\bar{d}\,\bar{b}\,u)$	$+2$	$+1$
	$\bar{P}_{\bar{s}\bar{d}2\bar{b}u}$	$(\bar{s}\,\bar{d}\,\bar{b}\,\bar{b}\,u)$	$+2$	$+1$
	$\bar{P}_{\bar{s}3\bar{b}u}$	$(\bar{s}\,\bar{b}\,\bar{b}\,\bar{b}\,u)$	$+2$	$+1$
	$\bar{P}_{\bar{s}3\bar{d}c}$	$(\bar{s}\,\bar{d}\,\bar{d}\,\bar{d}\,c)$	$+2$	$+1$
	$\bar{P}_{\bar{s}2\bar{d}\bar{b}c}$	$(\bar{s}\,\bar{d}\,\bar{d}\,\bar{b}\,c)$	$+2$	$+1$
	$\bar{P}_{\bar{s}\bar{d}2\bar{b}c}$	$(\bar{s}\,\bar{d}\,\bar{b}\,\bar{b}\,c)$	$+2$	$+1$
	$\bar{P}_{\bar{s}3\bar{b}c}$	$(\bar{s}\,\bar{b}\,\bar{b}\,\bar{b}\,c)$	$+2$	$+1$
	$\bar{P}_{\bar{s}3\bar{d}t}$	$(\bar{s}\,\bar{d}\,\bar{d}\,\bar{d}\,t)$	$+2$	$+1$
	$\bar{P}_{\bar{s}2\bar{d}\bar{b}t}$	$(\bar{s}\,\bar{d}\,\bar{d}\,\bar{b}\,t)$	$+2$	$+1$
	$\bar{P}_{\bar{s}\bar{d}2\bar{b}t}$	$(\bar{s}\,\bar{d}\,\bar{b}\,\bar{b}\,t)$	$+2$	$+1$
	$\bar{P}_{\bar{s}3\bar{b}t}$	$(\bar{s}\,\bar{b}\,\bar{b}\,\bar{b}\,t)$	$+2$	$+1$

TABLE 7: *Some of the properties of the singly strange pentaquarks.*

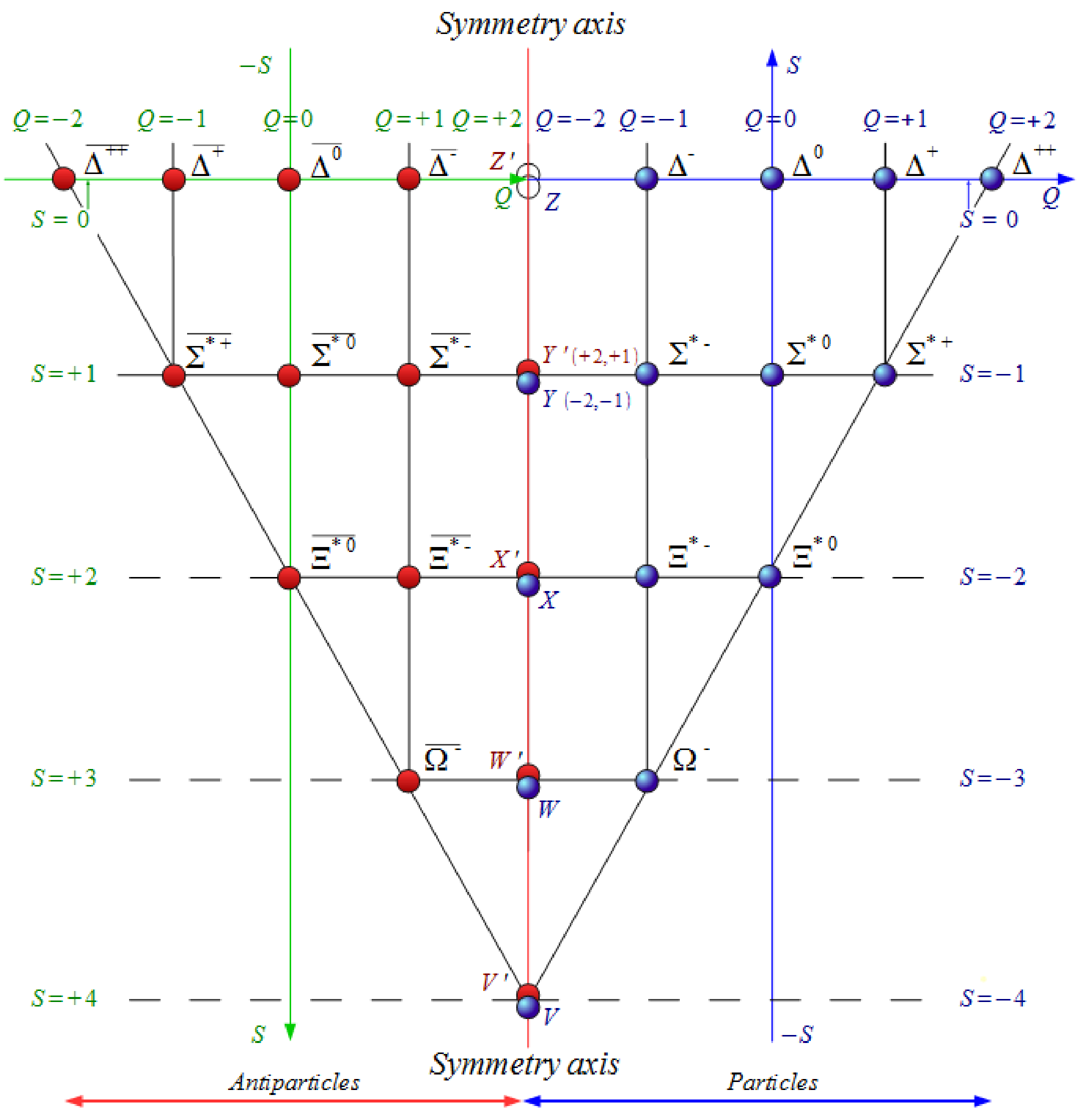

FIGURE 6: *The Incomplete Matter-Antimatter Way (including pentaquark levels |1|, |2|, |3| and |4|): a pattern of 10 baryons (blue circles that are not over the symmetry axis), 10 anti-baryons (red circles that are not over the symmetry axis), 3 quadruply strange pentaquanks (represented by a blue circle at point V over the symmetry axis), 3 quadruply strange antipentaquarks (represented by a red circle at point V' over the symmetry axis), 6 triply strange pentaquanks (represented by a blue circle drawn at point W over the symmetry axis), 6 triply strange antipentaquarks (represented by a red circle drawn at point W' over the symmetry axis), 9 doubly strange pentaquanks (represented by a blue circle drawn at point X over the symmetry axis), 9 doubly strange antipentaquarks (represented by a red circle drawn at point X' over the symmetry axis), 12 singly strange pentaquanks (represented by a blue circle drawn at point Y over the symmetry axis), 12 singly strange antipentaquarks (represented by a red circle drawn at point Y' over the symmetry axis).*

4.5 Analysis of Non-Strange Pentaquarks: Points $Z(-2,\ 0)$ and $Z'(+2,\ 0)$

4.5.1 Point $Z(-2,\ 0)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles and for antiparticles. The *QS* coordinate system for particles is shown in blue colour on the right hand side of FIGURE 2. The *QS* coordinate system for antiparticles is shown in green colour on the left hand side of FIGURE 2. Note that the point $Z(-2,0)$ is on the symmetry axis while the point $Z_{-2}{}'(-2,0)$ is one of the vertices of the diagram. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle must satisfy is that its electric charge should be equal to -2 ($Q=-2$)

(b) The second condition the unknown particle must satisfy is that its strangeness should be equal to 0 ($S=0$). In other words, this condition means that the unknown particle (pentaquark) can not contain any strange quarks.

Taking into account these two conditions and the fact that each strange quark carries an electric charge of $-1/3$, the electric charge equation for this particle should be

$$Q=q_1+q_2+q_3+q_4+q_5 \quad (8.1.1)$$

Where

$Q =$ total electric charge of the unknown particle (-2)
$q_5 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the fifth quark.
$q_4 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the forth quark.
$q_3 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the third quark.
$q_2 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the second quark.
$q_1 =$ electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the first quark.

The electric charge equation is

$$Q=q_1+q_2+q_3+q_4+q_5=-2 \quad (8.1.1)$$

Because this the addition of the electrical charge of the 5 quarks must be -2 , we shall consider the following three cases

Case 1: particles
The electric charge in this case is

$$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{2}{3}=-\frac{6}{3}=-2$$

Because of the quark composition we predict that this case will generate pentaquarks.

Case 1

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{2}{3}$
Quarks that satisfy the electric charge condition (the s quark has been left out because the total strangeness of the pentaquark must be 0)	$d \quad d \quad d \quad d \quad \bar{u}$ $b \quad b \quad b \quad b \quad \bar{c}$ $\bar{t}$

Combining these quarks we get the following 15 pentaquarks

Z CASE 1 **pentaquarks**				
	PREDICTED PARTICLE (symbol)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
1	Pentaquark $P_{4d\bar{u}}$	$(d\,d\,d\,d\,\bar{u})$	-2	0
2	Pentaquark $P_{3db\bar{u}}$	$(d\,d\,d\,b\,\bar{u})$	-2	0
3	Pentaquark $P_{2d2b\bar{u}}$	$(d\,d\,b\,b\,\bar{u})$	-2	0
4	Pentaquark $P_{d3b\bar{u}}$	$(d\,b\,b\,b\,\bar{u})$	-2	0
5	Pentaquark $P_{4b\bar{u}}$	$(b\,b\,b\,b\,\bar{u})$	-2	0
6	Pentaquark $P_{4d\bar{c}}$	$(d\,d\,d\,d\,\bar{c})$	-2	0
7	Pentaquark $P_{3db\bar{c}}$	$(d\,d\,d\,b\,\bar{c})$	-2	0
8	Pentaquark $P_{2d2b\bar{c}}$	$(d\,d\,b\,b\,\bar{c})$	-2	0
9	Pentaquark $P_{d3b\bar{c}}$	$(d\,b\,b\,b\,\bar{c})$	-2	0
10	Pentaquark $P_{4b\bar{c}}$	$(b\,b\,b\,b\,\bar{c})$	-2	0
11	Pentaquark $P_{4d\bar{t}}$	$(d\,d\,d\,d\,\bar{t})$	-2	0
12	Pentaquark $P_{3db\bar{t}}$	$(d\,d\,d\,b\,\bar{t})$	-2	0
13	Pentaquark $P_{2d2b\bar{t}}$	$(d\,d\,b\,b\,\bar{t})$	-2	0
14	Pentaquark $P_{d3b\bar{t}}$	$(d\,b\,b\,b\,\bar{t})$	-2	0
15	Pentaquark $P_{4b\bar{t}}$	$(b\,b\,b\,b\,\bar{t})$	-2	0

TABLE 8: *Non-strange pentaquarks*

4.5.2 Point $Z'(+2,\ 0)$: Analysis of the Electric Charge and Strangeness

Case 1: antiparticles
The electric charge in this case is

Case 1

Electric charge condition	$+\frac{1}{3}+\frac{1}{3}+\frac{1}{3}+\frac{1}{3}+\frac{2}{3}$
Quarks that satisfy the electric charge condition	$\bar{d}\ \bar{d}\ \bar{d}\ \bar{d}\ u$ $\bar{b}\ \bar{b}\ \bar{b}\ \bar{b}\ c$ t

Z' CASE 1 **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(\bar{d}\bar{d}\bar{d}\bar{d}u)$	$+2$	0
$(\bar{d}\bar{d}\bar{d}\bar{d}c)$	$+2$	0
$(\bar{d}\bar{d}\bar{d}\bar{d}t)$	$+2$	0
$(\bar{d}\bar{d}\bar{d}\bar{b}u)$	$+2$	0
$(\bar{d}\bar{d}\bar{d}\bar{b}c)$	$+2$	0
$(\bar{d}\bar{d}\bar{d}\bar{b}t)$	$+2$	0
$(\bar{d}\bar{d}\bar{b}\bar{b}u)$	$+2$	0
$(\bar{d}\bar{d}\bar{b}\bar{b}c)$	$+2$	0
$(\bar{d}\bar{d}\bar{b}\bar{b}t)$	$+2$	0
$(\bar{d}\bar{b}\bar{b}\bar{b}u)$	$+2$	0
$(\bar{d}\bar{b}\bar{b}\bar{b}c)$	$+2$	0
$(\bar{d}\bar{b}\bar{b}\bar{b}t)$	$+2$	0
$(\bar{b}\bar{b}\bar{b}\bar{b}u)$	$+2$	0
$(\bar{b}\bar{b}\bar{b}\bar{b}c)$	$+2$	0
$(\bar{b}\bar{b}\bar{b}\bar{b}t)$	$+2$	0

TABLE 9: *Some of the properties of the particles predicted by this theory at point* Z' *according to case 1.*

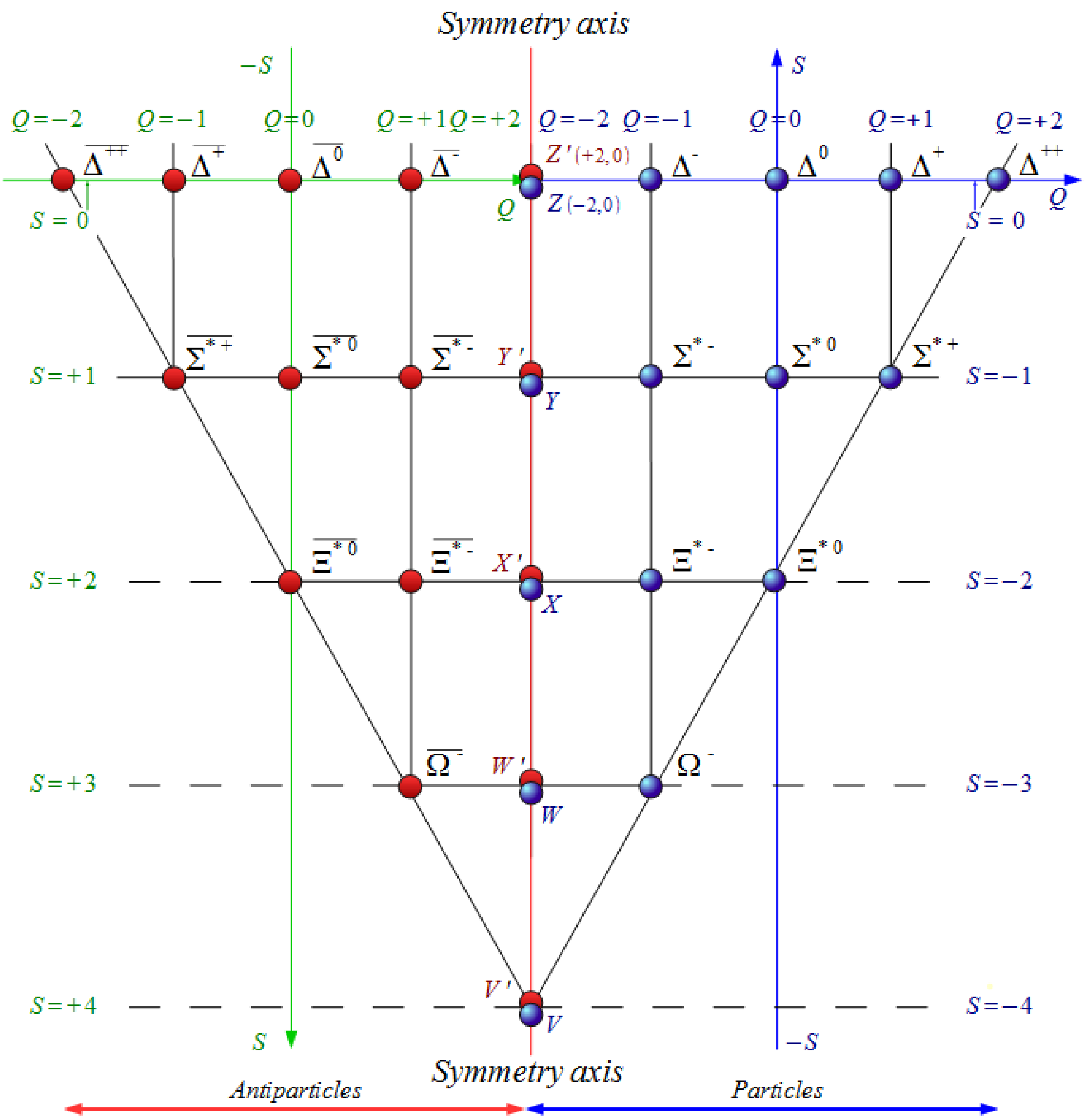

FIGURE 7: *The Matter-Antimatter Way showing pentaquarks on the symmetry axis (including non-strange pentaquarks).*

5. The Matter-Antimatter Way Along the Symmetry Axis

The diagram shown on FIGURE 7 is the complete matter-antimatter way along the symmetry axis. It is worthwhile to observe that the number of non-strange pentaquarks and antipentaquarks on points Z and Z', respectively, have been omitted in order to avoid cluttering the picture. Thus, the diagram of FIGURE 7 reflects the strange pentaquark and strange antipentaquark pattern of the triangle.

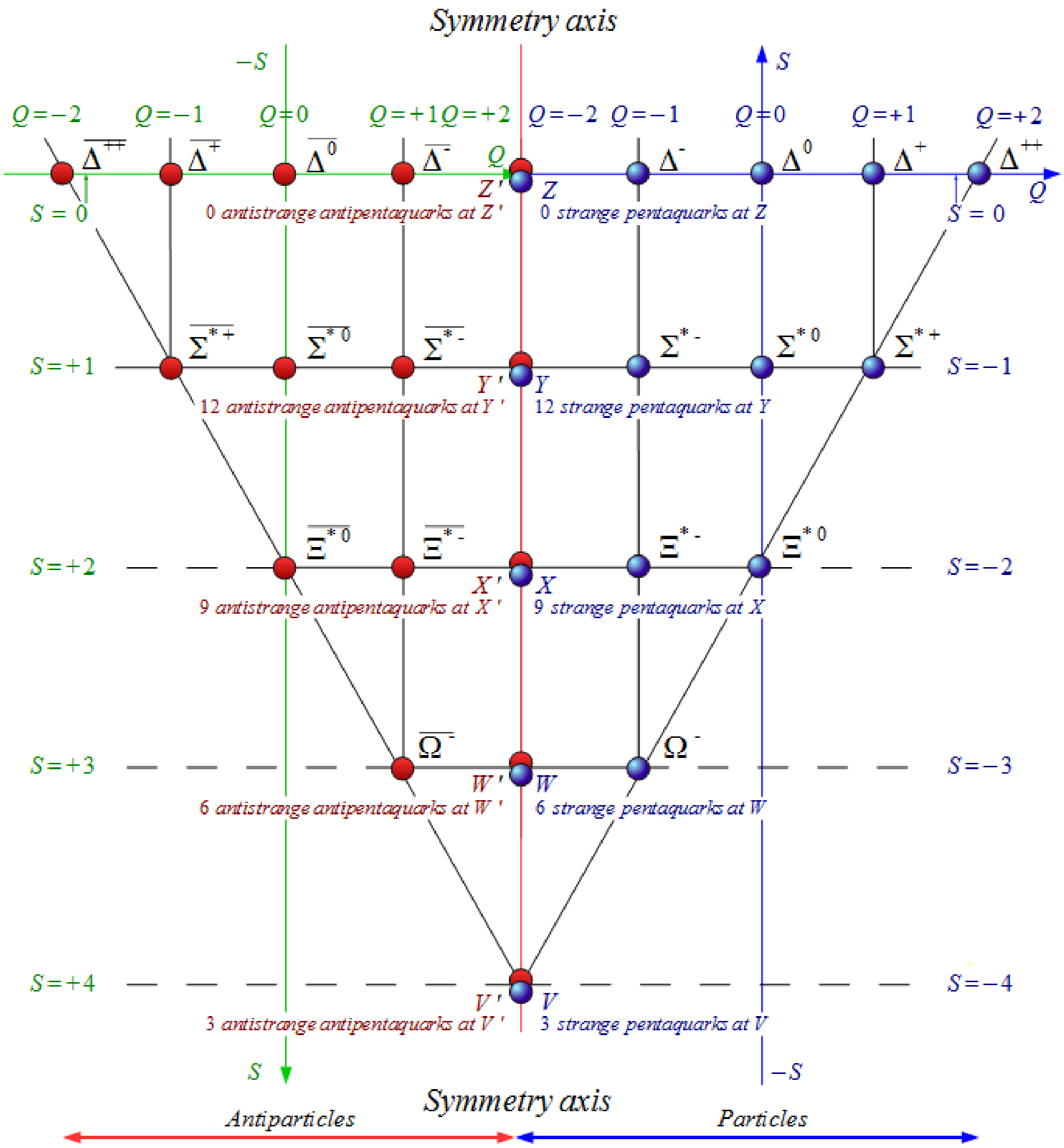

FIGURE 8: *The Complete Matter-Antimatter Way along the symmetry axis. The numbers of non-strange pentaquarks and non-strange antipentaquarks have been omitted to avoid cluttering the diagram. It is important to observe that pentaquarks on the Q axes can contain an* $s\bar{s}$ *pair of strange quark/anti-strange quark and still satisfy the condition of total zero strangeness.*

This diagram is complete along the symmetry axis because there are no empty circles on this axis. However this diagram does not represents the full story. The full story is the general case represented by the diagram of FIGURE 9. The general case, which will be analysed in section 11 onwards, will include the points of intersection of all electric charge levels with all the strangeness levels on both the matter and the anti-matter side. This means that, so far, we have only found pentaquarks/anti-pentaquarks in each and every labelled point on the symmetry axis of FIGURE 2 (these are the 10 points specified in TABLE 3, section 3).

6. Do Pentaquarks, Which Contain Quark-Antiquark Pairs of the Same Flavour, Exit?

Some of the pentaquarks predicted by this theory contain quarks and anti-quarks of the same flavour. For example

Example 1) the $(u\,\bar{u}\,\bar{u}\,\bar{u}\,\bar{u})$ antipentaquark contains the $(u\,\bar{u})$ pair
Example 2) the $(u\,u\,d\,d\,\bar{d})$ pentaquark contains the $(d\,\bar{d})$ pair
Example 3) the $(c\,\bar{c}\,\bar{c}\,\bar{c}\,\bar{t})$ antipentaquark contains the $(c\,\bar{c})$ pair
Example 4) the $(t\,\bar{t}\,\bar{t}\,\bar{t}\,\bar{t})$ antipentaquark contains the $(t\,\bar{t})$ pair

It is reasonable to ask: do pentaquarks which contain quark/antiquark pairs of the same flavour, like the ones shown in the above examples, really exit? To answer this question let's have a look at the neutral pi meson, which physicists have denoted with the symbol π^0 . According to quantum mechanics, the π^0 meson is a particle made up by a superposition of two compositions:

1) $(u\,\bar{u})$ and
2) $(d\,\bar{d})$

These two compositions can be found in two different configurations:

$$\text{(configuration 1)} \quad \pi^0 = \frac{(u\,\bar{u} + d\,\bar{d})}{\sqrt{2}}$$

and

$$\text{(configuration 2)} \quad \pi^0 = \frac{(u\,\bar{u} - d\,\bar{d})}{\sqrt{2}}$$

By the way, the composition of the π^0 meson indicates that this meson is its own antiparticle (there is no distinction between the particle and the antiparticle, they are the same entity). Because of its composition, the lifetime of the π^0 meson is about $0.83\times10^{-16}\,S$ which is much shorter than the lifetimes of the π^+ and π^- mesons, which is about $2.6\times10^{-8}\,S$.

Let us consider configuration 1. If we were able to measure the composition of this particle by measuring the electric charge of its constituents, which of the two states would we observe? The answer is that we would observe 50% of the time the $(u\,\bar{u})$ state and the other 50% of the time the $(d\,\bar{d})$ state. (believe it or not we would obtain the same result with configuration 2).

Because the π^0 is real, and because it is made up of a superposition of two quark/antiquark pairs of the same flavour ($u\,\bar{u}$ and $d\,\bar{d}$), then it seems that pentaquarks which contain this type of pairs should be real as well. Therefore, I postulate that these pentaquarks also exist. What's more, according to the symmetry principles exposed in this formulation, they have to exist (see references [10, 11, 12]). But one may ask: what about their lifetimes? Their lifetimes must be extremely short, much shorter than that of the pentaquarks that do not contain quark/antiquark pairs of the same flavour.

7. The Complete Matter-Antimatter Way

The diagram shown on FIGURE 9 is the complete matter-antimatter way. It includes not only pentaquarks on the symmetry axis but also pentaquarks in each and every labelled point of the diagram.

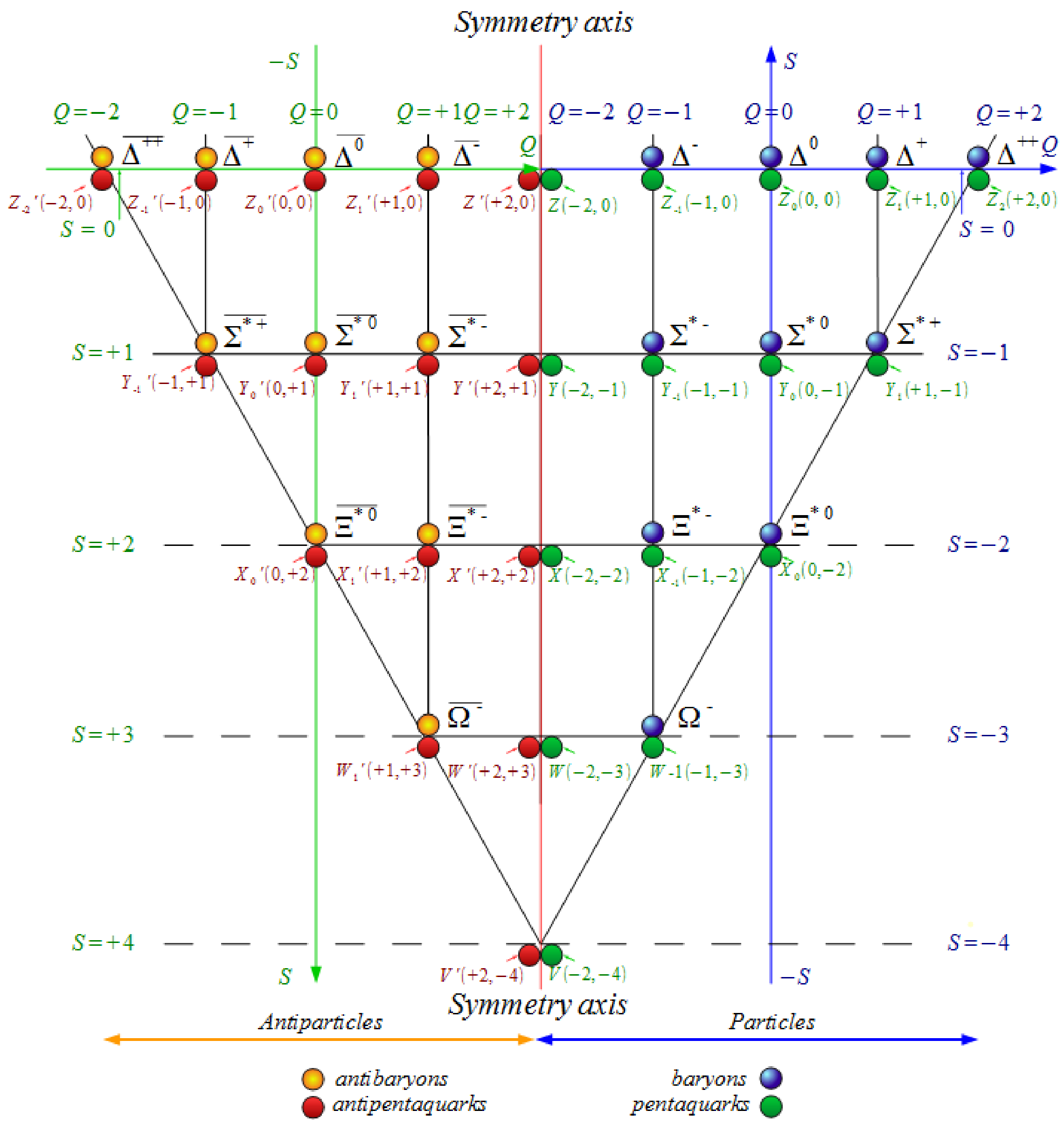

FIGURE 9: ***The Complete Matter-Antimatter Way*** *(or* ***Matter-Antimatter Way****). This theory predicts the existence of pentaquarks in each labelled point of the diagram. Each green circle represents a set of pentaquarks while each red circle represents the corresponding set of anti-pentaquarks. The blue circles represent the baryon decuplet while the orange-yellow circles represent the corresponding anti-baryon decuplet. In order to differentiate baryons from pentaquarks and anti-baryons from anti-pentaquarks some colours of the particles/antiparticles have been changed, with respect to the previous 7 diagrams.*

In this version of this article I shall analyse the point Z_1 on the particles side. However, the reader should keep in mind that the same type of analysis can be extended to all other points of the diagram that have not been already analysed (Z_{-2}' , Z_{-1}' , Z_0' , Z_1' , Z_{-1} , Z_0 , Y_{-1}' , Y_0' , Y_1' , Y_{-1} , Y_0 , Y_1 , X_0' , X_1' , X_{-1} , X_0 , W_1' , W_{-1}). The point Z_1 has not been chosen at random. Z_1 has been chosen because on July 14th, 2015 CERN's Large Hadron Collider discovered a pentaquark which is located exactly at this point. The composition of this pentaquark is: $(c\,u\,u\,d\,\bar{c})$ or expressed it in a more familiar way: $(u\,u\,d\,c\,\bar{c})$ (the order of the quarks is not important). The existence of this observed pentaquark is one of the main predictions of this theory.

8. Analysis Along the Straight Lines $Q=-1$ and $Q'=+1$

8.1 Analysis of Points $W_{-1}(-1,-3)$ and $W_1{}'(+1,+3)$

8.1.1 Point $W_{-1}(-1,-3)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -1 ($Q=-1$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -3 ($S=-3$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), there are two ways of satisfying this condition

b1) Three of the constituents of this particle are strange quarks and the other two constituents are not strange quarks.

b2) Four of the constituents of this particle are strange quarks and the other constituent is an anti-strange quark. Thus we have the following case

Case 1: particles

The electric charge in this case is

$$\left(-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}\right)-\frac{1}{3}+\frac{1}{3}=-\frac{3}{3}=-1$$

Case 1

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition. We shall consider the pair $s\,\bar{s}$ separately (there is only one particle).	$s\ \ s\ \ s\ \ d\ \ \bar{d}$ $d\ \ \bar{b}$ $s\ \ \bar{s}$

W_{-1} CASE 1 **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(s\,s\,s\,d\,\bar{d})$	-1	-3
$(s\,s\,s\,d\,\bar{b})$	-1	-3
$(s\,s\,s\,b\,\bar{d})$	-1	-3
$(s\,s\,s\,b\,\bar{b})$	-1	-3
$(s\,s\,s\,s\,\bar{s})$	-1	-3

TABLE 10: *Some of the properties of the pentaquarks predicted at point* W_{-1} *according to case 1.*

8.1.2 Point $W_1'(+1,+3)$: Analysis of the Electric Charge and Strangeness

Similarly we found the following antiparticles

W_1' CASE 1 **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,d)$	$+1$	$+3$
$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{d}\,b)$	$+1$	$+3$
$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,d)$	$+1$	$+3$
$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{b}\,b)$	$+1$	$+3$
$(\bar{s}\,\bar{s}\,\bar{s}\,\bar{s}\,s)$	$+1$	$+3$

TABLE 11: *Some of the properties of the antipentaquarks predicted at point* W_1' *according to case 1.*

8.2 Analysis of Points $X_{-1}(-1,-2)$ and $X_1'(+1,+2)$

8.2.1 Point $X_{-1}(-1,-2)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -1 ($Q=-1$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -2 ($S=-2$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), there are two ways of satisfying this condition:

Case 1: particles

The electric charge in this case is

$$\left(-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}\right)-\frac{1}{3}+\frac{1}{3}=-\frac{3}{3}=-1$$

There are two possibilities

Case 1a
The pentaquark must contain 2 strange quarks. The third, fourth and fifth quarks can be neither strange nor anti-strange quarks.

Case 1b
The pentaquark must contain 3 strange quarks and one anti-strange quark. The fifth quark can be neither a strange nor an anti-strange quark.

Case 1a

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad d \quad \bar{d}$ $s \quad s \quad s \quad s \quad \bar{s}$ $b \quad b \quad b \quad b \quad \bar{b}$
Because two of the quarks must be *s* quarks, we don't have to consider, for example, neither the *d* and *b* quarks of the 3rd and 4th columns nor the s quark of columns 1 and 2. Finally we don't consider the anti-strange quark of column 3.	$d \quad d \quad \quad \quad \bar{d}$ $\quad \quad s \quad s$ $b \quad b \quad \quad \quad \bar{b}$

X_{-1} CASE 1a **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,d\,s\,s\,\bar{d})$	-1	-2
$(d\,d\,s\,s\,\bar{d})$	-1	-2
$(d\,b\,s\,s\,\bar{d})$	-1	-2
$(d\,b\,s\,s\,\bar{b})$	-1	-2
$(b\,b\,s\,s\,\bar{d})$	-1	-2
$(b\,b\,s\,s\,\bar{b})$	-1	-2

TABLE 12: *Some of the properties of the pentaquarks predicted at point* X_{-1} *according to case 1a.*

Case 1b

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad d \quad \bar{d}$ $s \quad s \quad s \quad s \quad \bar{s}$ $b \quad b \quad b \quad b \quad \bar{b}$
Because the pentaquark must contain 3 strange quarks and one anti-strange quark, the possibilities are reduced to the following	d $\quad s \quad s \quad s \quad \bar{s}$ b

X_{-1} CASE 1b **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,s\,s\,s\,\bar{s})$	-1	-2
$(b\,s\,s\,s\,\bar{s})$	-1	-2

TABLE 13: *Some of the properties of the pentaquarks predicted at point* X_{-1} *according to case 1b.*

8.2.2 Point $X_1'(+1,+2)$: Analysis of the Electric Charge and Strangeness

Similarly we found the following antiparticles

X_1' CASE 1a **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
$(\bar{d}\bar{d}\bar{s}\bar{s}d)$	$+1$	$+2$
$(\bar{d}\bar{d}\bar{s}\bar{s}d)$	$+1$	$+2$
$(\bar{d}\bar{b}\bar{s}\bar{s}d)$	$+1$	$+2$
$(\bar{d}\bar{b}\bar{s}\bar{s}b)$	$+1$	$+2$
$(\bar{b}\bar{b}\bar{s}\bar{s}d)$	$+1$	$+2$
$(\bar{b}\bar{b}\bar{s}\bar{s}b)$	$+1$	$+2$

TABLE 14: *Some of the properties of the antipentaquarks predicted at point* X_1' *according to case 1a.*

X_1' CASE 1b **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
$(\bar{d}\bar{s}\bar{s}\bar{s}s)$	-1	$+2$
$(\bar{b}\bar{s}\bar{s}\bar{s}s)$	$+1$	$+2$

TABLE 15: *Some of the properties of the antipentaquarks predicted at point* X_1' *according to case 1b.*

8.3 Analysis of Points $Y_{-1}(-1,-1)$ and $Y_1'(+1,+1)$

8.3.1 Point $Y_{-1}(-1,-1)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -1 ($Q=-1$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -1 ($S=-1$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), there are two ways of satisfying this condition:

Case 1: particles

The electric charge in this case is

$$\left(-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}\right)-\frac{1}{3}+\frac{1}{3}=-\frac{3}{3}=-1$$

There are two possibilities

Case 1a
The pentaquark must contain only one strange quark and no anti-strange quarks.

Case 1b
The pentaquark must contain 2 strange quarks and 1 anti-strange quark only.

Case 2: particles

The electric charge in this case is

$$\left(-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3}=-\frac{3}{3}=-1$$

Case 1a

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad d \quad \bar{d}$ $s \quad s \quad s \quad s \quad \bar{s}$ $b \quad b \quad b \quad b \quad \bar{b}$
The possibilities reduce to	$d \quad d \quad d \quad \quad \bar{d}$ s $b \quad b \quad b \quad \quad \bar{b}$

(see next page)

Y_{-1} CASE 1a **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,d\,d\,s\,\bar{d})$	-1	-1
$(d\,d\,d\,s\,\bar{b})$	-1	-1
$(d\,d\,b\,s\,\bar{d})$	-1	-1
$(d\,d\,b\,s\,\bar{b})$	-1	-1
$(d\,b\,b\,s\,\bar{d})$	-1	-1
$(d\,b\,b\,s\,\bar{b})$	-1	-1
$(b\,b\,b\,s\,\bar{d})$	-1	-1
$(b\,b\,b\,s\,\bar{b})$	-1	-1

TABLE 16: *Some of the properties of the pentaquarks predicted at point* Y_{-1} *according to case 1a.*

Case 1b

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad d \quad \bar{d}$ $s \quad s \quad s \quad s \quad \bar{s}$ $b \quad b \quad b \quad b \quad \bar{b}$
The possibilities reduce to the following	$d \quad d$ $s \quad s \quad \bar{s}$ $b \quad b$

Y_{-1} CASE 1b **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,d\,s\,s\,\overline{s})$	-1	-1
$(d\,b\,s\,s\,\overline{s})$	-1	-1
$(b\,b\,s\,s\,\overline{s})$	-1	-1

TABLE 17: *Some of the properties of the pentaquarks predicted at point* Y_{-1} *according to case 1b.*

Case 2

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{2}{3}-\frac{2}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad u \quad \overline{u}$ $s \quad s \quad s \quad c \quad \overline{c}$ $b \quad b \quad b \quad t \quad \overline{t}$
The possibilities reduce to the following	$d \quad d \quad \quad u \quad \overline{u}$ $s \quad c \quad \overline{c}$

(see next page)

Y_{-1} CASE 2 **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,d\,s\,u\,\bar{u})$	-1	-1
$(d\,d\,s\,u\,\bar{c})$	-1	-1
$(d\,d\,s\,u\,\bar{t})$	-1	-1
$(d\,d\,s\,c\,\bar{u})$	-1	-1
$(d\,d\,s\,c\,\bar{c})$	-1	-1
$(d\,d\,s\,c\,\bar{t})$	-1	-1
$(d\,d\,s\,t\,\bar{u})$	-1	-1
$(d\,d\,s\,t\,\bar{c})$	-1	-1
$(d\,d\,s\,t\,\bar{t})$	-1	-1
$(d\,b\,s\,u\,\bar{u})$	-1	-1
$(d\,d\,s\,u\,\bar{c})$	-1	-1
$(d\,b\,s\,u\,\bar{t})$	-1	-1
$(d\,b\,s\,c\,\bar{u})$	-1	-1
$(d\,b\,s\,c\,\bar{c})$	-1	-1
$(d\,b\,s\,c\,\bar{t})$	-1	-1
$(d\,b\,s\,t\,\bar{u})$	-1	-1
$(d\,b\,s\,t\,\bar{c})$	-1	-1
$(d\,b\,s\,t\,\bar{t})$	-1	-1
$(b\,b\,s\,u\,\bar{u})$	-1	-1
$(b\,b\,s\,u\,\bar{c})$	-1	-1
$(b\,b\,s\,u\,\bar{t})$	-1	-1
$(d\,b\,s\,c\,\bar{u})$	-1	-1
$(b\,b\,s\,c\,\bar{c})$	-1	-1
$(b\,b\,s\,c\,\bar{t})$	-1	-1
$(b\,b\,s\,t\,\bar{u})$	-1	-1
$(b\,b\,s\,t\,\bar{c})$	-1	-1
$(b\,b\,s\,t\,\bar{t})$	-1	-1

TABLE 18: *Some of the properties of the pentaquarks predicted at point* Y_{-1} *according to case 2.*

8.3.2 Point $Y_1'(+1,+1)$: Analysis of the Electric Charge and Strangeness

Similarly we found the following antiparticles

Y_1' CASE 1a **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{s}\,d)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{s}\,b)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{b}\,\bar{s}\,d)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{b}\,\bar{s}\,b)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{b}\,\bar{s}\,d)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{b}\,\bar{s}\,b)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{b}\,\bar{s}\,d)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{b}\,\bar{s}\,b)$	$+1$	$+1$

TABLE 19: *Some of the properties of the antipentaquarks predicted at point* Y_1' *according to case 1a.*

Y_1' CASE 1b **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{s}\,s)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{s}\,s)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{s}\,s)$	$+1$	$+1$

TABLE 20: *Some of the properties of the antipentaquarks predicted at point* Y_1' *according to case 1b.*

$Y_1{}'$ CASE 2 **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{u}\,u)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{u}\,c)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{u}\,t)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{c}\,u)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{c}\,c)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{c}\,t)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{t}\,u)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{t}\,c)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{t}\,t)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{u}\,u)$	$+1$	$+1$
$(\bar{d}\,\bar{d}\,\bar{s}\,\bar{u}\,c)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{u}\,t)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{c}\,u)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{c}\,c)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{c}\,t)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{t}\,u)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{t}\,c)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{t}\,t)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{u}\,u)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{u}\,c)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{u}\,t)$	$+1$	$+1$
$(\bar{d}\,\bar{b}\,\bar{s}\,\bar{c}\,u)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{c}\,c)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{c}\,t)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{t}\,u)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{t}\,c)$	$+1$	$+1$
$(\bar{b}\,\bar{b}\,\bar{s}\,\bar{t}\,t)$	$+1$	$+1$

TABLE 21: *Some of the properties of the antipentaquarks predicted at point* $Y_1{}'$ *according to case 2.*

8.4 Analysis of Points $Z_{-1}(-1,0)$ and $Z_1'(+1,0)$

8.4.1 Point $Z_1'(+1,0)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to -1 ($Q=-1$)

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to 0 ($S=0$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is -1 (see TABLE 1 of section 2), there are two ways of satisfying this condition:

Case 1: particles

The electric charge in this case is

$$\left(-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}\right)-\frac{1}{3}+\frac{1}{3}=-\frac{3}{3}=-1$$

There are two possibilities

Case 1a
The pentaquark must contain no strange quark and no anti-strange quarks.

Case 1b
The pentaquark must contain a quark pair made of a strange quark and an anti-strange quark $(s\,\bar{s})$. The rest three quarks must be neither strange nor anti-strange quarks.

Case 2: particles

The electric charge in this case is

$$\left(-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3}=-\frac{3}{3}=-1$$

Case 1a

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition. In this case The pentaquark cannot contain neither strange nor no anti-strange quarks.	$d \quad d \quad d \quad d \quad \bar{d}$ $b \quad b \quad b \quad b \quad \bar{b}$

Z_{-1} CASE 1a **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,d\,d\,d\,\bar{d})$	-1	0
$(d\,d\,d\,d\,\bar{b})$	-1	0
$(d\,d\,d\,d\,\bar{d})$	-1	0
$(d\,d\,d\,b\,\bar{b})$	-1	0
$(d\,d\,b\,b\,\bar{d})$	-1	0
$(d\,d\,b\,b\,\bar{b})$	-1	0
$(d\,b\,b\,b\,\bar{d})$	-1	0
$(d\,b\,b\,b\,\bar{b})$	-1	0
$(b\,b\,b\,b\,\bar{d})$	-1	0
$(b\,b\,b\,b\,\bar{b})$	-1	0

TABLE 22: *Some of the properties of the pentaquarks predicted at point* Z_{-1} *according to case 1a.*

Case 1b

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad s \quad \bar{s}$ $b \quad b \quad b \quad s \quad \bar{s}$

Z_{-1} CASE 1b **pentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
$(d\,d\,d\,s\,\bar{s})$	-1	0
$(d\,d\,b\,s\,\bar{s})$	-1	0
$(d\,b\,b\,s\,\bar{s})$	-1	0
$(b\,b\,b\,s\,\bar{s})$	-1	0

TABLE 23: *Some of the properties of the pentaquarks predicted at point* Z_{-1} *according to case 1b. It should be remarked that the total strangeness for each pentaquark of this table (shown in pink) is also zero. This is so because the strange quark has a strangeness of -1 while the anti-strange quark has a strangeness of + 1, so the total strangeness of the particle is* $-1+1=0$.

Case 2

Electric charge condition	$-\frac{1}{3}-\frac{1}{3}-\frac{1}{3}+\frac{2}{3}-\frac{2}{3}$
Quarks that satisfy the electric charge condition.	$d \quad d \quad d \quad u \quad \bar{u}$ $b \quad b \quad b \quad c \quad \bar{c}$ $t \quad \bar{t}$

(see next page)

Z_{-1} CASE 2 **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(d\,d\,d\,u\,\bar{u})$	$(d\,d\,d\,u\,\bar{c})$	$(d\,d\,d\,u\,\bar{t})$	-1	0
$(d\,d\,d\,c\,\bar{u})$	$(d\,d\,d\,c\,\bar{c})$	$(d\,d\,d\,c\,\bar{t})$	-1	0
$(d\,d\,d\,t\,\bar{u})$	$(d\,d\,d\,t\,\bar{c})$	$(d\,d\,d\,t\,\bar{t})$	-1	0
$(d\,d\,b\,u\,\bar{u})$	$(d\,d\,b\,u\,\bar{c})$	$(d\,d\,b\,u\,\bar{t})$	-1	0
$(d\,d\,b\,c\,\bar{u})$	$(d\,d\,b\,c\,\bar{c})$	$(d\,d\,b\,c\,\bar{t})$	-1	0
$(d\,d\,b\,t\,\bar{u})$	$(d\,d\,b\,t\,\bar{c})$	$(d\,d\,b\,t\,\bar{t})$	-1	0
$(d\,b\,b\,u\,\bar{u})$	$(d\,b\,b\,u\,\bar{c})$	$(d\,b\,b\,u\,\bar{t})$	-1	0
$(d\,b\,b\,c\,\bar{u})$	$(d\,b\,b\,c\,\bar{c})$	$(d\,b\,b\,c\,\bar{t})$	-1	0
$(d\,b\,b\,t\,\bar{u})$	$(d\,b\,b\,t\,\bar{c})$	$(d\,b\,b\,t\,\bar{t})$	-1	0
$(b\,b\,b\,u\,\bar{u})$	$(b\,b\,b\,u\,\bar{c})$	$(b\,b\,b\,u\,\bar{t})$	-1	0
$(b\,b\,b\,c\,\bar{u})$	$(b\,b\,b\,c\,\bar{c})$	$(b\,b\,b\,c\,\bar{t})$	-1	0
$(b\,b\,b\,t\,\bar{u})$	$(b\,b\,b\,t\,\bar{c})$	$(b\,b\,b\,t\,\bar{t})$	-1	0

TABLE 24: *Some of the properties of the pentaquarks predicted at point* Z_{-1} *according to case 2.*

8.4.2 Point $Z_1'(+1, 0)$: Analysis of the Electric Charge and Strangeness

So far we have used the above pentaquarks to obtain the corresponding antipentaquarks by replacing the quarks by the corresponding anti-quarks and the anti-quark by the corresponding quark. However, we may also carry out a direct analysis for antiparticles without using the pentaquark composition obtained in the previous subsection. The direct analysis is illustrated here.

Case 1: antiparticles
The electric charge in this case is

$$\left(+\frac{1}{3}+\frac{1}{3}+\frac{1}{3}\right)-\frac{1}{3}+\frac{1}{3} = +\frac{3}{3}+0 = +1$$

Note that in this case we have included the corresponding cases: *case 1a* and *case 1b* of the previous subsection.

Case 2: antiparticles
The electric charge in this case is

$$\left(+\frac{1}{3}+\frac{1}{3}+\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3} = +\frac{3}{3}+0 = +1$$

Case 1

$$\left(+\frac{1}{3}+\frac{1}{3}+\frac{1}{3}\right)-\frac{1}{3}+\frac{1}{3} = +\frac{3}{3}+0 = +1$$

Z'_1 CASE 1 **antipentaquarks**		
PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e\rvert$)	STRANGENESS
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{d}\,d)$	$+1$	0
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{b}\,d)$	$+1$	0
$(\bar{d}\,\bar{d}\,\bar{b}\,\bar{b}\,d)$	$+1$	0
$(\bar{d}\,\bar{b}\,\bar{b}\,\bar{b}\,d)$	$+1$	0
$(\bar{b}\,\bar{b}\,\bar{b}\,\bar{b}\,d)$	$+1$	0
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{d}\,b)$	$+1$	0
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{b}\,b)$	$+1$	0
$(\bar{d}\,\bar{d}\,\bar{b}\,\bar{b}\,b)$	$+1$	0
$(\bar{d}\,\bar{b}\,\bar{b}\,\bar{b}\,b)$	$+1$	0
$(\bar{b}\,\bar{b}\,\bar{b}\,\bar{b}\,b)$	$+1$	0
$(\bar{d}\,\bar{d}\,\bar{d}\,\bar{s}\,s)$	$+1$	$-1+1=0$
$(\bar{d}\,\bar{d}\,\bar{b}\,\bar{s}\,s)$	$+1$	$-1+1=0$
$(\bar{d}\,\bar{b}\,\bar{b}\,\bar{s}\,s)$	$+1$	$-1+1=0$
$(\bar{b}\,\bar{b}\,\bar{b}\,\bar{s}\,s)$	$+1$	$-1+1=0$

TABLE 25: *Some of the properties of the particles predicted by this theory at point* Z'_1 *according to case 1. It should be remarked that the total strangeness for each of the last 4 pentaquarks of this table (shown in pink) is also zero. This is so because the strange quark has a strangeness of -1 while the anti-strange quark has a strangeness of + 1, so the total strangeness of the particle is* $-1+1=0$.

Case 2

$$\left(+\frac{1}{3}+\frac{1}{3}+\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3}=+\frac{3}{3}+0=+1$$

Z'_1 CASE 2 **antipentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
$(u\bar{d}\bar{d}\bar{d}\bar{u})$	$(c\bar{d}\bar{d}\bar{d}\bar{u})$	$(t\bar{d}\bar{d}\bar{d}\bar{u})$	$+1$	0
$(u\bar{d}\bar{d}\bar{d}\bar{c})$	$(c\bar{d}\bar{d}\bar{d}\bar{c})$	$(t\bar{d}\bar{d}\bar{d}\bar{c})$	$+1$	0
$(u\bar{d}\bar{d}\bar{d}\bar{t})$	$(c\bar{d}\bar{d}\bar{d}\bar{t})$	$(t\bar{d}\bar{d}\bar{d}\bar{t})$	$+1$	0
$(u\bar{d}\bar{d}\bar{b}\bar{u})$	$(c\bar{d}\bar{d}\bar{b}\bar{u})$	$(t\bar{d}\bar{d}\bar{b}\bar{u})$	$+1$	0
$(u\bar{d}\bar{d}\bar{b}\bar{c})$	$(c\bar{d}\bar{d}\bar{b}\bar{c})$	$(t\bar{d}\bar{d}\bar{b}\bar{c})$	$+1$	0
$(u\bar{d}\bar{d}\bar{b}\bar{t})$	$(c\bar{d}\bar{d}\bar{b}\bar{t})$	$(t\bar{d}\bar{d}\bar{b}\bar{t})$	$+1$	0
$(u\bar{d}\bar{b}\bar{b}\bar{u})$	$(c\bar{d}\bar{b}\bar{b}\bar{u})$	$(t\bar{d}\bar{b}\bar{b}\bar{u})$	$+1$	0
$(u\bar{d}\bar{b}\bar{b}\bar{c})$	$(c\bar{d}\bar{b}\bar{b}\bar{c})$	$(t\bar{d}\bar{b}\bar{b}\bar{c})$	$+1$	0
$(u\bar{d}\bar{b}\bar{b}\bar{t})$	$(c\bar{d}\bar{b}\bar{b}\bar{t})$	$(t\bar{d}\bar{b}\bar{b}\bar{t})$	$+1$	0
$(u\bar{b}\bar{b}\bar{b}\bar{u})$	$(c\bar{b}\bar{b}\bar{b}\bar{u})$	$(t\bar{b}\bar{b}\bar{b}\bar{u})$	$+1$	0
$(u\bar{b}\bar{b}\bar{b}\bar{c})$	$(c\bar{b}\bar{b}\bar{b}\bar{c})$	$(t\bar{b}\bar{b}\bar{b}\bar{c})$	$+1$	0
$(u\bar{b}\bar{b}\bar{b}\bar{t})$	$(c\bar{b}\bar{b}\bar{b}\bar{t})$	$(t\bar{b}\bar{b}\bar{b}\bar{t})$	$+1$	0

TABLE 26: *Some of the properties of the pentaquarks predicted at point* Z'_1 *according to case 2.*

9. Analysis Along the Straight Lines $Q=0$ and $Q'=0$

(to be completed in future versions)

9.1 Analysis of Points $X_0(0,-2)$ and $X'_0(0,-2)$

9.1.1 Point $X_0(0,-2)$: Analysis of the Electric Charge and Strangeness

9.1.2 Point $X'_0(0,+2)$: Analysis of the Electric Charge and Strangeness

9.2 Analysis of Points $Y_0(0,-1)$ and $Y'_0(0,+1)$

9.2.1 Point $Y_0(0,-1)$: Analysis of the Electric Charge and Strangeness

9.2.2 Point $Y'_0(0, +1)$: Analysis of the Electric Charge and Strangeness

9.3 Analysis of Points $Z_0(0, 0)$ and $Z'_0(0, 0)$

9.3.1 Point $Z_0(0, 0)$: Analysis of the Electric Charge and Strangeness

9.3.2 Point $Z'_0(0, 0)$: Analysis of the Electric Charge and Strangeness

10. Analysis Along the Straight Lines $Q = +1$ and $Q' = -1$

10.1 Analysis of Points $Y_1(+1, -1)$ and $Y_{-1}'(-1, +1)$

(to be completed in future versions)

10.1.1 Point $Y_1(+1, -1)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the QS coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9 (the analysis of the Y_{-1}' will be included in future versions of this theory). The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to $+1$ ($Q = +1$).

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to -1 ($S = -1$).

We shall consider 2 cases

case 1: particles

The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{1}{3}\right)+\frac{2}{3}-\frac{1}{3}-\frac{1}{3} = +\frac{3}{3}+0 = +1$$

There are two possibilities

case 1a

The pentaquark contains only one strange quark. Therefore, its total strangeness is -1

case 1b

The pentaquark contains two strange quark and one anti-strange quark. Therefore, its total strangeness is also -1.

case 2: particles

The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3}=+\frac{3}{3}+0=+1$$

Case 1a

Rearranged electric charge condition	$+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition. We don't consider one of the *s* quarks (e.g. the one in the 3rd column) and additionally, we don't consider the anti-strange quark $\bar{s}$ in the 5th column.	$u \quad u \quad d \quad d \quad \bar{d}$ $c \quad c \quad s \quad s \quad \bar{b}$ $t \quad t \quad b \quad b \quad \bar{s}$
Furthermore, because one of the quarks has to be an *s* quark, we don't have to consider the *d* and *b* quarks of the 4th column. Therefore, the number of pentaquarks is reduced to $3\times3\times2\times1\times2=36$	$u \quad u \quad d \quad \quad \bar{d}$ $c \quad c \quad \quad s \quad \bar{b}$ $t \quad t \quad b$

(see next page)

Y_1 CASE 1a **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(uud s\bar{d})$	$(cud s\bar{d})$	$(tud s\bar{d})$	$+1$	-1
$(uud s\bar{b})$	$(cud s\bar{b})$	$(tud s\bar{b})$	$+1$	-1
$(uub s\bar{d})$	$(cub s\bar{d})$	$(tub s\bar{d})$	$+1$	-1
$(uub s\bar{b})$	$(cub s\bar{b})$	$(tub s\bar{b})$	$+1$	-1
$(ucd s\bar{d})$	$(ccd s\bar{d})$	$(ucd s\bar{d})$	$+1$	-1
$(ucd s\bar{b})$	$(ccd s\bar{b})$	$(tcd s\bar{b})$	$+1$	-1
$(ucb s\bar{d})$	$(ccb s\bar{d})$	$(tcb s\bar{d})$	$+1$	-1
$(ucb s\bar{b})$	$(ccb s\bar{b})$	$(tcb s\bar{b})$	$+1$	-1
$(utd s\bar{d})$	$(ctd s\bar{d})$	$(ttd s\bar{d})$	$+1$	-1
$(utd s\bar{b})$	$(ctd s\bar{b})$	$(ttd s\bar{b})$	$+1$	-1
$(utb s\bar{d})$	$(ctb s\bar{d})$	$(ttb s\bar{d})$	$+1$	-1
$(utb s\bar{b})$	$(ctb s\bar{b})$	$(ttb s\bar{b})$	$+1$	-1

TABLE 27: *Some of the properties of the pentaquarks predicted by this theory at point* Y_1 *according to case 1a.*

Case 1b

Rearranged electric charge condition	$+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}-\frac{1}{3}+\frac{1}{3}$
Quarks that satisfy the electric charge condition.	$u \quad u \quad d \quad d \quad \bar{d}$ $c \quad c \quad s \quad s \quad \bar{b}$ $t \quad t \quad b \quad b \quad \bar{s}$
The condition is satisfied if the 3th,4th and 5th quarks are s, s and $\bar{s}$, respectively. Therefore, the number of pentaquarks is reduced to $3\times3\times1\times1\times1=9$	$u \quad u$ $c \quad c \quad s \quad s$ $t \quad t \quad \quad \quad \bar{s}$

Y_1 CASE 1b **pentaquarks**			
ROW number	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
1	$(u\,u\,s\,s\,\bar{s})$	$+1$	-1
2	$(u\,c\,s\,s\,\bar{s})$	$+1$	-1
3	$(u\,t\,s\,s\,\bar{s})$	$+1$	-1
4	$(c\,u\,s\,s\,\bar{s})$	$+1$	-1
5	$(c\,c\,s\,s\,\bar{s})$	$+1$	-1
6	$(c\,t\,s\,s\,\bar{s})$	$+1$	-1
7	$(t\,u\,s\,s\,\bar{s})$	$+1$	-1
8	$(t\,c\,s\,s\,\bar{s})$	$+1$	-1
9	$(t\,t\,s\,s\,\bar{s})$	$+1$	-1

TABLE 28: *Some of the properties of the pentaquarks predicted by this theory at point* Y_1 *according to case 1b.*

Case 2

Rearranged electric charge condition	$\left(+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3}$
Quarks that satisfy the electric charge condition. The number of pentaquarks is reduced to $3\times3\times3\times1\times3=81$	$u \quad u \quad u \quad s \quad \bar{u}$ $c \quad c \quad c \quad \quad \bar{c}$ $t \quad t \quad t \quad \quad \bar{t}$

(see next page)

Y_1 CASE 2 **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(uus\bar{u})$	$(cuus\bar{u})$	$(tuus\bar{u})$	$+1$	-1
$(uuus\bar{c})$	$(cuus\bar{c})$	$(tuus\bar{c})$	$+1$	-1
$(uuus\bar{t})$	$(cuus\bar{t})$	$(tuus\bar{t})$	$+1$	-1
$(uucs\bar{u})$	$(cucs\bar{u})$	$(tucs\bar{u})$	$+1$	-1
$(uucs\bar{c})$	$(cucs\bar{c})$	$(tucs\bar{c})$	$+1$	-1
$(uucs\bar{t})$	$(cucs\bar{t})$	$(tucs\bar{t})$	$+1$	-1
$(uuts\bar{u})$	$(cuts\bar{u})$	$(tuts\bar{u})$	$+1$	-1
$(uuts\bar{c})$	$(cuts\bar{c})$	$(tuts\bar{c})$	$+1$	-1
$(uuts\bar{t})$	$(cuts\bar{t})$	$(tuts\bar{t})$	$+1$	-1
$(ucus\bar{u})$	$(ccus\bar{u})$	$(tcus\bar{u})$	$+1$	-1
$(ucus\bar{c})$	$(ccus\bar{c})$	$(tcus\bar{c})$	$+1$	-1
$(ucus\bar{t})$	$(ccus\bar{t})$	$(tcus\bar{t})$	$+1$	-1
$(uccs\bar{u})$	$(cccs\bar{u})$	$(tccs\bar{u})$	$+1$	-1
$(uccs\bar{c})$	$(cccs\bar{c})$	$(tccs\bar{c})$	$+1$	-1
$(uccs\bar{t})$	$(cccs\bar{t})$	$(tccs\bar{t})$	$+1$	-1
$(ucts\bar{u})$	$(ccts\bar{u})$	$(tcts\bar{u})$	$+1$	-1
$(ucts\bar{c})$	$(ccts\bar{c})$	$(tcts\bar{c})$	$+1$	-1
$(ucts\bar{t})$	$(ccts\bar{t})$	$(tcts\bar{t})$	$+1$	-1
$(utus\bar{u})$	$(ctus\bar{u})$	$(ttus\bar{u})$	$+1$	-1
$(utus\bar{c})$	$(ctus\bar{c})$	$(ttus\bar{c})$	$+1$	-1
$(utus\bar{t})$	$(ctus\bar{t})$	$(ttus\bar{t})$	$+1$	-1
$(utcs\bar{u})$	$(ctcs\bar{u})$	$(ttcs\bar{u})$	$+1$	-1
$(utcs\bar{c})$	$(ctcs\bar{c})$	$(ttcs\bar{c})$	$+1$	-1
$(utcs\bar{t})$	$(ctcs\bar{t})$	$(ttcs\bar{t})$	$+1$	-1
$(utts\bar{u})$	$(ctts\bar{u})$	$(ttts\bar{u})$	$+1$	-1
$(utts\bar{c})$	$(ctts\bar{c})$	$(ttts\bar{c})$	$+1$	-1
$(utts\bar{t})$	$(ctts\bar{t})$	$(ttts\bar{t})$	$+1$	-1

TABLE 29: *Some of the properties of the pentaquarks predicted by this theory at point* Y_1 *according to case 2.*

10.1.2 Point $Y_{-1}{}'(-1,+1)$: Analysis of the Electric Charge and Strangeness

A similar analysis shows that point $Y_{-1}{}'(-1,+1)$ contains the following antipentaquarks

$Y_{-1}{}'$ CASE 1a **antipentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
$(\bar{u}\,\bar{u}\,\bar{d}\,\bar{s}\,d)$	$(\bar{c}\,\bar{u}\,\bar{d}\,\bar{s}\,d)$	$(\bar{t}\,\bar{u}\,\bar{d}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{d}\,\bar{s}\,b)$	$(\bar{c}\,\bar{u}\,\bar{d}\,\bar{s}\,b)$	$(\bar{t}\,\bar{u}\,\bar{d}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{b}\,\bar{s}\,d)$	$(\bar{c}\,\bar{u}\,\bar{b}\,\bar{s}\,d)$	$(\bar{t}\,\bar{u}\,\bar{b}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{b}\,\bar{s}\,b)$	$(\bar{c}\,\bar{u}\,\bar{b}\,\bar{s}\,b)$	$(\bar{t}\,\bar{u}\,\bar{b}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{c}\,\bar{d}\,\bar{s}\,d)$	$(\bar{c}\,\bar{c}\,\bar{d}\,\bar{s}\,d)$	$(\bar{u}\,\bar{c}\,\bar{d}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{c}\,\bar{d}\,\bar{s}\,b)$	$(\bar{c}\,\bar{c}\,\bar{d}\,\bar{s}\,b)$	$(\bar{t}\,\bar{c}\,\bar{d}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{c}\,\bar{b}\,\bar{s}\,d)$	$(\bar{c}\,\bar{c}\,\bar{b}\,\bar{s}\,d)$	$(\bar{t}\,\bar{c}\,\bar{b}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{c}\,\bar{b}\,\bar{s}\,b)$	$(\bar{c}\,\bar{c}\,\bar{b}\,\bar{s}\,b)$	$(\bar{t}\,\bar{c}\,\bar{b}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{t}\,\bar{d}\,\bar{s}\,d)$	$(\bar{c}\,\bar{t}\,\bar{d}\,\bar{s}\,d)$	$(\bar{t}\,\bar{t}\,\bar{d}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{t}\,\bar{d}\,\bar{s}\,b)$	$(\bar{c}\,\bar{t}\,\bar{d}\,\bar{s}\,b)$	$(\bar{t}\,\bar{t}\,\bar{d}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{t}\,\bar{b}\,\bar{s}\,d)$	$(\bar{c}\,\bar{t}\,\bar{b}\,\bar{s}\,d)$	$(\bar{t}\,\bar{t}\,\bar{b}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{t}\,\bar{b}\,\bar{s}\,b)$	$(\bar{c}\,\bar{t}\,\bar{b}\,\bar{s}\,b)$	$(\bar{t}\,\bar{t}\,\bar{b}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{d}\,\bar{s}\,d)$	$(\bar{c}\,\bar{u}\,\bar{d}\,\bar{s}\,d)$	$(\bar{t}\,\bar{u}\,\bar{d}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{d}\,\bar{s}\,b)$	$(\bar{c}\,\bar{u}\,\bar{d}\,\bar{s}\,b)$	$(\bar{t}\,\bar{u}\,\bar{d}\,\bar{s}\,b)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{b}\,\bar{s}\,d)$	$(\bar{c}\,\bar{u}\,\bar{b}\,\bar{s}\,d)$	$(\bar{t}\,\bar{u}\,\bar{b}\,\bar{s}\,d)$	-1	$+1$
$(\bar{u}\,\bar{u}\,\bar{b}\,\bar{s}\,b)$	$(\bar{c}\,\bar{u}\,\bar{b}\,\bar{s}\,b)$	$(\bar{t}\,\bar{u}\,\bar{b}\,\bar{s}\,b)$	-1	$+1$

TABLE 30: *Some of the properties of the pentaquarks predicted by this theory at point* $Y_{-1}{}'$ *according to case 1a.*

Y_{-1}' CASE 1b **antipentaquarks**			
ROW number	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
1	$(\bar{u}\,\bar{u}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
2	$(\bar{u}\,\bar{c}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
3	$(\bar{u}\,\bar{t}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
4	$(\bar{c}\,\bar{u}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
5	$(\bar{c}\,\bar{c}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
6	$(\bar{c}\,\bar{t}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
7	$(\bar{t}\,\bar{u}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
8	$(\bar{t}\,\bar{c}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$
9	$(\bar{t}\,\bar{t}\,\bar{s}\,\bar{s}\,s)$	-1	$+1$

TABLE 31: *Some of the properties of the pentaquarks predicted by this theory at point* Y_{-1}' *according to case 1b.*

(see next page)

Y_{-1}' CASE 2 **antipentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(\bar{u}\bar{u}\bar{u}\bar{s}u)$	$(\bar{c}\bar{u}\bar{u}\bar{s}u)$	$(\bar{t}\bar{u}\bar{u}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{u}\bar{u}\bar{s}c)$	$(\bar{c}\bar{u}\bar{u}\bar{s}c)$	$(\bar{t}\bar{u}\bar{u}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{u}\bar{u}\bar{s}t)$	$(\bar{c}\bar{u}\bar{u}\bar{s}t)$	$(\bar{t}\bar{u}\bar{u}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{u}\bar{c}\bar{s}u)$	$(\bar{c}\bar{u}\bar{c}\bar{s}u)$	$(\bar{t}\bar{u}\bar{c}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{u}\bar{c}\bar{s}c)$	$(\bar{c}\bar{u}\bar{c}\bar{s}c)$	$(\bar{t}\bar{u}\bar{c}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{u}\bar{c}\bar{s}t)$	$(\bar{c}\bar{u}\bar{c}\bar{s}t)$	$(\bar{t}\bar{u}\bar{c}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{u}\bar{t}\bar{s}u)$	$(\bar{c}\bar{u}\bar{t}\bar{s}u)$	$(\bar{t}\bar{u}\bar{t}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{u}\bar{t}\bar{s}c)$	$(\bar{c}\bar{u}\bar{t}\bar{s}c)$	$(\bar{t}\bar{u}\bar{t}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{u}\bar{t}\bar{s}t)$	$(\bar{c}\bar{u}\bar{t}\bar{s}t)$	$(\bar{t}\bar{u}\bar{t}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{c}\bar{u}\bar{s}u)$	$(\bar{c}\bar{c}\bar{u}\bar{s}u)$	$(\bar{t}\bar{c}\bar{u}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{c}\bar{u}\bar{s}c)$	$(\bar{c}\bar{c}\bar{u}\bar{s}c)$	$(\bar{t}\bar{c}\bar{u}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{c}\bar{u}\bar{s}t)$	$(\bar{c}\bar{c}\bar{u}\bar{s}t)$	$(\bar{t}\bar{c}\bar{u}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{c}\bar{c}\bar{s}u)$	$(\bar{c}\bar{c}\bar{c}\bar{s}u)$	$(\bar{t}\bar{c}\bar{c}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{c}\bar{c}\bar{s}c)$	$(\bar{c}\bar{c}\bar{c}\bar{s}c)$	$(\bar{t}\bar{c}\bar{c}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{c}\bar{c}\bar{s}t)$	$(\bar{c}\bar{c}\bar{c}\bar{s}t)$	$(\bar{t}\bar{c}\bar{c}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{c}\bar{t}\bar{s}u)$	$(\bar{c}\bar{c}\bar{t}\bar{s}u)$	$(\bar{t}\bar{c}\bar{t}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{c}\bar{t}\bar{s}c)$	$(\bar{c}\bar{c}\bar{t}\bar{s}c)$	$(\bar{t}\bar{c}\bar{t}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{c}\bar{t}\bar{s}t)$	$(\bar{c}\bar{c}\bar{t}\bar{s}t)$	$(\bar{t}\bar{c}\bar{t}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{t}\bar{u}\bar{s}u)$	$(\bar{c}\bar{t}\bar{u}\bar{s}u)$	$(\bar{t}\bar{t}\bar{u}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{t}\bar{u}\bar{s}c)$	$(\bar{c}\bar{t}\bar{u}\bar{s}c)$	$(\bar{t}\bar{t}\bar{u}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{t}\bar{u}\bar{s}t)$	$(\bar{c}\bar{t}\bar{u}\bar{s}t)$	$(\bar{t}\bar{t}\bar{u}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{t}\bar{c}\bar{s}u)$	$(\bar{c}\bar{t}\bar{c}\bar{s}u)$	$(\bar{t}\bar{t}\bar{c}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{t}\bar{c}\bar{s}c)$	$(\bar{c}\bar{t}\bar{c}\bar{s}c)$	$(\bar{t}\bar{t}\bar{c}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{t}\bar{c}\bar{s}t)$	$(\bar{c}\bar{t}\bar{c}\bar{s}t)$	$(\bar{t}\bar{t}\bar{c}\bar{s}t)$	-1	$+1$
$(\bar{u}\bar{t}\bar{t}\bar{s}u)$	$(\bar{c}\bar{t}\bar{t}\bar{s}u)$	$(\bar{t}\bar{t}\bar{t}\bar{s}u)$	-1	$+1$
$(\bar{u}\bar{t}\bar{t}\bar{s}c)$	$(\bar{c}\bar{t}\bar{t}\bar{s}c)$	$(\bar{t}\bar{t}\bar{t}\bar{s}c)$	-1	$+1$
$(\bar{u}\bar{t}\bar{t}\bar{s}t)$	$(\bar{c}\bar{t}\bar{t}\bar{s}t)$	$(\bar{t}\bar{t}\bar{t}\bar{s}t)$	-1	$+1$

TABLE 32: *Some of the properties of the pentaquarks predicted by this theory at point* Y_{-1}' *according to case 2.*

10.2 Analysis of the Points $Z_1(+1, 0)$ And $Z'_{-1}(-1, 0)$

10.2.1 Point $Z_1(+1, 0)$: Analysis of the Electric Charge and Strangeness (Includes the Discovered Pentaquark – see Case 2 Part II)

In this analysis we only consider the QS coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9 (the analysis of the Z_1' will be included in future versions of this theory). The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to $+1$ ($Q=+1$).

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to 0 ($S=0$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is 0 (see TABLE 1 of section 2), there are two possibilities:

(Possibility 1)
One way a particle can have a strangeness of 0 is if there are no strange quarks in the composition of this particle.

(Possibility 2)
Another way a particle can have a strangeness of 0 is if one of its quarks were a strange quark ($S=-1$), another one were an anti-strange quark ($S=+1$) and the rest of the quarks were neither non-strange quarks nor non-anti-strange quarks. Thus, the total strangeness of this particle would still be 0.

One may think that the particles on the Q axis for particles (and on the Q axis for antiparticles) should not contain any strange quarks (or any anti-strange quarks) because the delta baryons: Δ^- , Δ^0 , Δ^+ , Δ^{++} , which are also located on the Q axis, do not contain any strange quarks. The reason why baryons cannot contain an $(s\,\bar{s})$ pair is that a baryon such as $(u\,s\,\bar{s})$ would satisfy the second above condition ($S=0$) without problems but not the first one ($Q=+1$). Thus, the $(u\,s\,\bar{s})$ baryon is forbidden because it would have a fractional electric charge of $+2/3$ which is not allowed (The electric charge of a baryon must be an integer multiple of the elementary charge). A pentaquark, on the other hand, can contain a strange quark and an anti-strange quark and still satisfy the above conditions. For example, the $(\bar{d}\,\bar{d}\,\bar{d}\,\bar{s}\,s)$ pentaquark has a total electric charge of +1 and a total strangeness of 0. Therefore this pentaquark satisfies both conditions (a) and (b). Let's have a look at the cases that satisfy condition (a):

Case 1: particles
The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{1}{3}\right)+\frac{2}{3}-\frac{1}{3}-\frac{1}{3}=+\frac{3}{3}+0=+1$$

Case 2: particles
The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}\right)+\frac{2}{3}-\frac{2}{3} = +\frac{3}{3}+0 = +1$$

Case 3: particles
The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}\right)+\frac{1}{3}-\frac{1}{3} = +\frac{3}{3}+0 = +1$$

These cases give us the following pentaquarks

Case 1

Rearranged electric charge condition	$+\frac{2}{3}$	$-\frac{1}{3}$	$+\frac{2}{3}$	$-\frac{1}{3}$	$+\frac{1}{3}$
Quarks that satisfy the electric charge condition (*)	u	d	u	d	$\bar{d}$
	c	b	c	b	$\bar{b}$
	t		t	s	$\bar{s}$

(*) Because pentaquarks on the Q axes must have total strangeness of 0, the strange quark s and the anti-strange $\bar{s}$ must be included as a pair $s\,\bar{s}$ or unit. These pentaquarks are shown in a separate table.

(see next page)

Z_1 CASE 1 (PART I) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(uudd\bar{d})$	$(cudd\bar{d})$	$(tudd\bar{d})$	$+1$	0
$(uudd\bar{b})$	$(cudd\bar{b})$	$(tudd\bar{b})$	$+1$	0
$(uudb\bar{d})$	$(cudb\bar{d})$	$(tudb\bar{d})$	$+1$	0
$(uudb\bar{b})$	$(cudb\bar{b})$	$(tudb\bar{b})$	$+1$	0
$(uubb\bar{d})$	$(cubb\bar{d})$	$(tubb\bar{d})$	$+1$	0
$(uubb\bar{b})$	$(cubb\bar{b})$	$(tubb\bar{b})$	$+1$	0
$(ucdd\bar{d})$	$(ccdd\bar{d})$	$(tcdd\bar{d})$	$+1$	0
$(ucdd\bar{b})$	$(ccdd\bar{b})$	$(tcdd\bar{b})$	$+1$	0
$(ucdb\bar{d})$	$(ccdb\bar{d})$	$(tcdb\bar{d})$	$+1$	0
$(ucdb\bar{b})$	$(ccdb\bar{b})$	$(tcdb\bar{b})$	$+1$	0
$(ucbb\bar{d})$	$(ccbb\bar{d})$	$(tcbb\bar{d})$	$+1$	0
$(ucbb\bar{b})$	$(ccbb\bar{b})$	$(tcbb\bar{b})$	$+1$	0
$(utdd\bar{d})$	$(ctdd\bar{d})$	$(ttdd\bar{d})$	$+1$	0
$(utdd\bar{b})$	$(ctdd\bar{b})$	$(ttdd\bar{b})$	$+1$	0
$(utdb\bar{d})$	$(ctdb\bar{d})$	$(ttdb\bar{d})$	$+1$	0
$(utdb\bar{b})$	$(ctdb\bar{b})$	$(ttdb\bar{b})$	$+1$	0
$(utbb\bar{d})$	$(ctbb\bar{d})$	$(ttbb\bar{d})$	$+1$	0
$(utbb\bar{b})$	$(ctbb\bar{b})$	$(ttbb\bar{b})$	$+1$	0

TABLE 33: *Some of the properties of the pentaquarks predicted by this theory at point* Z_1 *according to case 1*

Z_1 CASE 1 (PART II) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(u u d s \bar{s})$	$(c u d s \bar{s})$	$(t u d s \bar{s})$	$+1$	0
$(u u b s \bar{s})$	$(c u b s \bar{s})$	$(t u b s \bar{s})$	$+1$	0
$(u c d s \bar{s})$	$(c c d s \bar{s})$	$(t c d s \bar{s})$	$+1$	0
$(u c b s \bar{s})$	$(c c b s \bar{s})$	$(t c b s \bar{s})$	$+1$	0
$(u t d s \bar{s})$	$(c t d s \bar{s})$	$(t t d s \bar{s})$	$+1$	0
$(u t b s \bar{s})$	$(c t b s \bar{s})$	$(t t b s \bar{s})$	$+1$	0

TABLE 34: *Some of the properties of the pentaquarks predicted by this theory at point* Z_1 *according to case 1 (Part II). These pantaquarks contain the* $(s \bar{s})$ *quark/antiquark pair. However, the total strangeness of these particles is zero.*

case 2

Rearranged electric charge condition $$+\frac{2}{3}+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}-\frac{2}{3}$$

Quarks that satisfy the electric charge condition

u	u	u	d	$\bar{u}$
c	c	c	b	$\bar{c}$
t	t	t		$\bar{t}$

(see next page)

Z_1 CASE 2 (Part I) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(u u u d \bar{u})$	$(u c u d \bar{u})$	$(u t u d \bar{u})$	$+1$	0
$(u u u d \bar{c})$	$(u c u d \bar{c})$	$(u t u d \bar{c})$	$+1$	0
$(u u u d \bar{t})$	$(u c u d \bar{t})$	$(u t u d \bar{t})$	$+1$	0
$(u u u b \bar{u})$	$(u c u b \bar{u})$	$(u t u b \bar{u})$	$+1$	0
$(u u u b \bar{c})$	$(u c u b \bar{c})$	$(u t u b \bar{c})$	$+1$	0
$(u u u b \bar{t})$	$(u c u b \bar{t})$	$(u t u b \bar{t})$	$+1$	0
$(u u c d \bar{u})$	$(u c c d \bar{u})$	$(u t c d \bar{u})$	$+1$	0
$(u u c d \bar{c})$	$(u c c d \bar{c})$	$(u t c d \bar{c})$	$+1$	0
$(u u c d \bar{t})$	$(u c c d \bar{t})$	$(u t c d \bar{t})$	$+1$	0
$(u u c b \bar{u})$	$(u c c b \bar{u})$	$(u t c b \bar{u})$	$+1$	0
$(u u c b \bar{c})$	$(u c c b \bar{c})$	$(u t c b \bar{c})$	$+1$	0
$(u u c b \bar{t})$	$(u c c b \bar{t})$	$(u t c b \bar{t})$	$+1$	0
$(u u t d \bar{u})$	$(u c t d \bar{u})$	$(u t t d \bar{u})$	$+1$	0
$(u u t d \bar{c})$	$(u c t d \bar{c})$	$(u t t d \bar{c})$	$+1$	0
$(u u t d \bar{t})$	$(u c t d \bar{t})$	$(u t t d \bar{t})$	$+1$	0
$(u u t b \bar{u})$	$(u c t b \bar{u})$	$(u t t b \bar{u})$	$+1$	0
$(u u t b \bar{c})$	$(u c t b \bar{c})$	$(u t t b \bar{c})$	$+1$	0
$(u u t b \bar{t})$	$(u c t b \bar{t})$	$(u t t b \bar{t})$	$+1$	0

TABLE 35: *Some of the properties of the pentaquarks predicted by this theory at point* Z_1 *according to case 2 (first part).*

(see next page)

Z_1 CASE 2 (Part II) **pentaquarks** Includes the Discovered Pentaquark: $c\,u\,u\,d\,\bar{c}$				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(c\,u\,u\,d\,\bar{u})$	$(c\,c\,u\,d\,\bar{u})$	$(c\,t\,u\,d\,\bar{u})$	$+1$	0
$(c\,u\,u\,d\,\bar{c})$	$(c\,c\,u\,d\,\bar{c})$	$(c\,t\,u\,d\,\bar{c})$	$+1$	0
$(c\,u\,u\,d\,\bar{t})$	$(c\,c\,u\,d\,\bar{t})$	$(c\,t\,u\,d\,\bar{t})$	$+1$	0
$(c\,u\,u\,b\,\bar{u})$	$(c\,c\,u\,b\,\bar{u})$	$(c\,t\,u\,b\,\bar{u})$	$+1$	0
$(c\,u\,u\,b\,\bar{c})$	$(c\,c\,u\,b\,\bar{c})$	$(c\,t\,u\,b\,\bar{c})$	$+1$	0
$(c\,u\,u\,b\,\bar{t})$	$(c\,c\,u\,b\,\bar{t})$	$(c\,t\,u\,b\,\bar{t})$	$+1$	0
$(c\,u\,c\,d\,\bar{u})$	$(c\,c\,c\,d\,\bar{u})$	$(c\,t\,c\,d\,\bar{u})$	$+1$	0
$(c\,u\,c\,d\,\bar{c})$	$(c\,c\,c\,d\,\bar{c})$	$(c\,t\,c\,d\,\bar{c})$	$+1$	0
$(c\,u\,c\,d\,\bar{t})$	$(c\,c\,c\,d\,\bar{t})$	$(c\,t\,c\,d\,\bar{t})$	$+1$	0
$(c\,u\,c\,b\,\bar{u})$	$(c\,c\,c\,b\,\bar{u})$	$(c\,t\,c\,b\,\bar{u})$	$+1$	0
$(c\,u\,c\,b\,\bar{c})$	$(c\,c\,c\,b\,\bar{c})$	$(c\,t\,c\,b\,\bar{c})$	$+1$	0
$(c\,u\,c\,b\,\bar{t})$	$(c\,c\,c\,b\,\bar{t})$	$(c\,t\,c\,b\,\bar{t})$	$+1$	0
$(c\,u\,t\,d\,\bar{u})$	$(c\,c\,t\,d\,\bar{u})$	$(c\,t\,t\,d\,\bar{u})$	$+1$	0
$(c\,u\,t\,d\,\bar{c})$	$(c\,c\,t\,d\,\bar{c})$	$(c\,t\,t\,d\,\bar{c})$	$+1$	0
$(c\,u\,t\,d\,\bar{t})$	$(c\,c\,t\,d\,\bar{t})$	$(c\,t\,t\,d\,\bar{t})$	$+1$	0
$(c\,u\,t\,b\,\bar{u})$	$(c\,c\,t\,b\,\bar{u})$	$(c\,t\,t\,b\,\bar{u})$	$+1$	0
$(c\,u\,t\,b\,\bar{c})$	$(c\,c\,t\,b\,\bar{c})$	$(c\,t\,t\,b\,\bar{c})$	$+1$	0
$(c\,u\,t\,b\,\bar{t})$	$(c\,c\,t\,b\,\bar{t})$	$(c\,t\,t\,b\,\bar{t})$	$+1$	0

TABLE 36: *Some of the properties of the pentaquarks predicted by this theory at point* Z_1 *according to case 2 (second part). The highlighted quark in the first column, second row, whose quark composition is:* $c\,u\,u\,d\,\bar{c}$ *(or* $u\,u\,d\,c\,\bar{c}$ *), has been discovered by CERN's Large Hadron Collider in 2015 which confirms the predictions of this formulation.*

(see next page)

Z_1 CASE 2 (part III) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(tuud\bar{u})$	$(tcud\bar{u})$	$(ttud\bar{u})$	$+1$	0
$(tuud\bar{c})$	$(tcud\bar{c})$	$(ttud\bar{c})$	$+1$	0
$(tuud\bar{t})$	$(tcud\bar{t})$	$(ttud\bar{t})$	$+1$	0
$(tuub\bar{u})$	$(tcub\bar{u})$	$(ttub\bar{u})$	$+1$	0
$(tuub\bar{c})$	$(tcub\bar{c})$	$(ttub\bar{c})$	$+1$	0
$(tuub\bar{t})$	$(tcub\bar{t})$	$(ttub\bar{t})$	$+1$	0
$(tucd\bar{u})$	$(tccd\bar{u})$	$(ttcd\bar{u})$	$+1$	0
$(tucd\bar{c})$	$(tccd\bar{c})$	$(ttcd\bar{c})$	$+1$	0
$(tucd\bar{t})$	$(tccd\bar{t})$	$(ttcd\bar{t})$	$+1$	0
$(tucb\bar{u})$	$(tccb\bar{u})$	$(ttcb\bar{u})$	$+1$	0
$(tucb\bar{c})$	$(tccb\bar{c})$	$(ttcb\bar{c})$	$+1$	0
$(tucb\bar{t})$	$(tccb\bar{t})$	$(ttcb\bar{t})$	$+1$	0
$(tutd\bar{u})$	$(tctd\bar{u})$	$(tttd\bar{u})$	$+1$	0
$(tutd\bar{c})$	$(tctd\bar{c})$	$(tttd\bar{c})$	$+1$	0
$(tutd\bar{t})$	$(tctd\bar{t})$	$(tttd\bar{t})$	$+1$	0
$(tutb\bar{u})$	$(tctb\bar{u})$	$(tttb\bar{u})$	$+1$	0
$(tutb\bar{c})$	$(tctb\bar{c})$	$(tttb\bar{c})$	$+1$	0
$(tutb\bar{t})$	$(tctb\bar{t})$	$(tttb\bar{t})$	$+1$	0

TABLE 37: *Some of the properties of the pentaquarks predicted by this theory at point* Z_1 *according to case 2 (third part)*

(see next page)

case 3

$$\left(+\frac{2}{3}+\frac{2}{3}-\frac{1}{3}\right)+\frac{1}{3}-\frac{1}{3}=+\frac{3}{3}+0=+1$$

Z_1 CASE 3 **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(u u d d \bar{d})$	$(c u d d \bar{d})$	$(t u d d \bar{d})$	+1	0
$(u u d d \bar{b})$	$(c u d d \bar{b})$	$(t u d d \bar{b})$	+1	0
$(u u d b \bar{d})$	$(c u d b \bar{d})$	$(t u d b \bar{d})$	+1	0
$(u u d b \bar{b})$	$(c u d b \bar{b})$	$(t u d b \bar{b})$	+1	0
$(u u b b \bar{d})$	$(c u b b \bar{d})$	$(t u b b \bar{d})$	+1	0
$(u u b b \bar{b})$	$(c u b b \bar{b})$	$(t u b b \bar{b})$	+1	0
$(u c d d \bar{d})$	$(c c d d \bar{d})$	$(t c d d \bar{d})$	+1	0
$(u c d d \bar{b})$	$(c c d d \bar{b})$	$(t c d d \bar{b})$	+1	0
$(u c d b \bar{d})$	$(c c d b \bar{d})$	$(t c d b \bar{d})$	+1	0
$(u c d b \bar{b})$	$(c c d b \bar{b})$	$(t c d b \bar{b})$	+1	0
$(u c b b \bar{d})$	$(c c b b \bar{d})$	$(t c b b \bar{d})$	+1	0
$(u c b b \bar{b})$	$(c c b b \bar{b})$	$(t c b b \bar{b})$	+1	0
$(u t d d \bar{d})$	$(c t d d \bar{d})$	$(t t d d \bar{d})$	+1	0
$(u t d d \bar{b})$	$(c t d d \bar{b})$	$(t t d d \bar{b})$	+1	0
$(u t d b \bar{d})$	$(c t d b \bar{d})$	$(t t d b \bar{d})$	+1	0
$(u t d b \bar{b})$	$(c t d b \bar{b})$	$(t t d b \bar{b})$	+1	0
$(u t b b \bar{d})$	$(c t b b \bar{d})$	$(t t b b \bar{d})$	+1	0
$(u t b b \bar{b})$	$(c t b b \bar{b})$	$(t t b b \bar{b})$	+1	0

TABLE 38: *Some of the properties of the pentaquarks predicted by this theory at point* Z_1 *according to case 3.*

10.2.2 Point $Z_{-1}'(-1, 0)$: Analysis of the Electric Charge and Strangeness

11. Analysis Along the Straight Lines $Q = +2$ and $Q' = -2$

11.1 Analysis of the Points $Z_2(+2, 0)$ and $Z_{-2}'(-2, 0)$

11.1.1 Point $Z_2(+2, 0)$: Analysis of the Electric Charge and Strangeness

In this analysis we only consider the *QS* coordinate system for particles which is shown in blue colour on the right hand side of FIGURE 9. The predicted particles must satisfy the following two conditions:

(a) the first condition the unknown particle (pentaquark) must satisfy is that its electric charge should be equal to $+2$ ($Q = +2$).

(b) The second condition the unknown particle (pentaquark) must satisfy is that its strangeness should be equal to 0 ($S = 0$). Because strange quarks are the only particles which possess the strangeness property, and because the value of this property is 0 (see TABLE 1 of section 2), there are two possibilities:

(Possibility 1)
One way a particle can have a strangeness of 0 is if there are no strange quarks in the composition of this particle.

(Possibility 2)
A second way a particle can have a strangeness of 0 is if there is strange quark and an anti-strange quark in the composition of this particle.

I shall consider the following cases

Case 1: particles
The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{2}{3}+\frac{2}{3}\right)+\frac{2}{3}-\frac{2}{3} = +\frac{6}{3}+0 = +2$$

Case 2: particles
The electric charge in this case is

$$\left(+\frac{2}{3}+\frac{2}{3}+\frac{2}{3}\right)+\frac{1}{3}-\frac{1}{3} = +\frac{6}{3}+0 = +2$$

Case 1

Electric charge condition $+\frac{2}{3}+\frac{2}{3}+\frac{2}{3}+\frac{2}{3}-\frac{2}{3}$

Quarks that satisfy the electric charge condition

$$\begin{matrix} u & u & u & u & \bar{u} \\ c & c & c & c & \bar{c} \\ t & t & t & t & \bar{t} \end{matrix}$$

Z_2 CASE 1 **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
$(u\,u\,u\,u\,\bar{u})$	$(u\,c\,u\,u\,\bar{u})$	$(u\,t\,u\,u\,\bar{u})$	$+2$	0
$(u\,u\,u\,u\,\bar{c})$	$(u\,c\,u\,u\,\bar{c})$	$(u\,t\,u\,u\,\bar{c})$	$+2$	0
$(u\,u\,u\,u\,\bar{t})$	$(u\,c\,u\,u\,\bar{t})$	$(u\,t\,u\,u\,\bar{t})$	$+2$	0
$(u\,u\,u\,c\,\bar{u})$	$(u\,c\,u\,c\,\bar{t})$	$(u\,t\,u\,c\,\bar{u})$	$+2$	0
$(u\,u\,u\,c\,\bar{c})$	$(u\,c\,u\,c\,\bar{c})$	$(u\,t\,u\,c\,\bar{c})$	$+2$	0
$(u\,u\,u\,c\,\bar{t})$	$(u\,c\,u\,c\,\bar{t})$	$(u\,t\,u\,c\,\bar{t})$	$+2$	0
$(u\,u\,u\,t\,\bar{u})$	$(u\,c\,u\,t\,\bar{u})$	$(u\,t\,u\,t\,\bar{u})$	$+2$	0
$(u\,u\,u\,t\,\bar{c})$	$(u\,c\,u\,t\,\bar{c})$	$(u\,t\,u\,t\,\bar{c})$	$+2$	0
$(u\,u\,u\,t\,\bar{t})$	$(u\,c\,u\,t\,\bar{t})$	$(u\,t\,u\,t\,\bar{t})$	$+2$	0
$(u\,u\,c\,u\,\bar{u})$	$(u\,c\,c\,u\,\bar{u})$	$(u\,t\,c\,u\,\bar{u})$	$+2$	0
$(u\,u\,c\,u\,\bar{c})$	$(u\,c\,c\,u\,\bar{c})$	$(u\,t\,c\,u\,\bar{c})$	$+2$	0
$(u\,u\,c\,u\,\bar{t})$	$(u\,c\,c\,u\,\bar{t})$	$(u\,t\,c\,u\,\bar{t})$	$+2$	0
$(u\,u\,c\,c\,\bar{u})$	$(u\,c\,c\,c\,\bar{u})$	$(u\,t\,c\,c\,\bar{u})$	$+2$	0
$(u\,u\,c\,c\,\bar{c})$	$(u\,c\,c\,c\,\bar{c})$	$(u\,t\,c\,c\,\bar{c})$	$+2$	0
$(u\,u\,c\,c\,\bar{t})$	$(u\,c\,c\,c\,\bar{t})$	$(u\,t\,c\,c\,\bar{t})$	$+2$	0
$(u\,u\,c\,t\,\bar{u})$	$(u\,c\,c\,t\,\bar{u})$	$(u\,t\,c\,t\,\bar{u})$	$+2$	0
$(u\,u\,c\,t\,\bar{c})$	$(u\,c\,c\,t\,\bar{c})$	$(u\,t\,c\,t\,\bar{c})$	$+2$	0
$(u\,u\,c\,t\,\bar{t})$	$(u\,c\,c\,t\,\bar{t})$	$(u\,t\,c\,t\,\bar{t})$	$+2$	0

TABLE 39: *Some of the properties of the pentaquarks predicted by this theory at point* Z_2 *according to case 1*

Case 2

Electric charge condition $+\frac{2}{3}+\frac{2}{3}+\frac{2}{3}+\frac{1}{3}-\frac{1}{3}$

Quarks that satisfy the electric charge condition (*).

$$\begin{matrix} u & u & u & \bar{d} & d \\ c & c & c & \bar{b} & b \\ t & t & t & \bar{s} & s \end{matrix}$$

(*) Because pentaquarks on the Q axes must have total strangeness of 0, the strange quark s and the anti-strange $\bar{s}$ must be included as a pair $s\,\bar{s}$ or unit. These pentaquarks are shown in a separate table.

Z_2 CASE 2 (Part I) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(u\,u\,u\,d\,\bar{d})$	$(u\,c\,u\,d\,\bar{d})$	$(u\,t\,u\,d\,\bar{d})$	$+2$	0
$(u\,u\,u\,d\,\bar{b})$	$(u\,c\,u\,d\,\bar{b})$	$(u\,t\,u\,d\,\bar{b})$	$+2$	0
$(u\,u\,u\,b\,\bar{d})$	$(u\,c\,u\,b\,\bar{d})$	$(u\,t\,u\,b\,\bar{d})$	$+2$	0
$(u\,u\,u\,b\,\bar{b})$	$(u\,c\,u\,b\,\bar{b})$	$(u\,t\,u\,b\,\bar{b})$	$+2$	0
$(u\,u\,c\,d\,\bar{d})$	$(u\,c\,c\,d\,\bar{d})$	$(u\,t\,c\,d\,\bar{d})$	$+2$	0
$(u\,u\,c\,d\,\bar{b})$	$(u\,u\,c\,d\,\bar{b})$	$(u\,t\,c\,d\,\bar{b})$	$+2$	0
$(u\,u\,c\,b\,\bar{d})$	$(u\,c\,c\,b\,\bar{d})$	$(u\,t\,c\,b\,\bar{d})$	$+2$	0
$(u\,u\,c\,b\,\bar{b})$	$(u\,c\,c\,b\,\bar{b})$	$(u\,t\,c\,b\,\bar{b})$	$+2$	0
$(u\,u\,t\,d\,\bar{d})$	$(u\,c\,t\,d\,\bar{d})$	$(u\,t\,t\,d\,\bar{d})$	$+2$	0
$(u\,u\,t\,d\,\bar{b})$	$(u\,c\,t\,d\,\bar{b})$	$(u\,t\,t\,d\,\bar{b})$	$+2$	0
$(u\,u\,t\,b\,\bar{d})$	$(u\,c\,t\,b\,\bar{d})$	$(u\,t\,t\,b\,\bar{d})$	$+2$	0
$(u\,u\,t\,b\,\bar{b})$	$(u\,c\,t\,b\,\bar{b})$	$(u\,t\,t\,b\,\bar{b})$	$+2$	0

TABLE 40: *Some of the properties of the pentaquarks predicted by this theory at point* Z_2 *according to case 2 (part I).*

Z_2 CASE 2 (Part II) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(c u u d \bar{d})$	$(c c u d \bar{d})$	$(c t u d \bar{d})$	$+2$	0
$(c u u d \bar{b})$	$(c c u d \bar{b})$	$(c t u d \bar{b})$	$+2$	0
$(c u u b \bar{d})$	$(c c u b \bar{d})$	$(c t u b \bar{d})$	$+2$	0
$(c u u b \bar{b})$	$(c c u b \bar{b})$	$(c t u b \bar{b})$	$+2$	0
$(c u c d \bar{d})$	$(c c c d \bar{d})$	$(c t c d \bar{d})$	$+2$	0
$(c u c d \bar{b})$	$(c u c d \bar{b})$	$(c t c d \bar{b})$	$+2$	0
$(c u c b \bar{d})$	$(c c c b \bar{d})$	$(c t c b \bar{d})$	$+2$	0
$(u u c b \bar{b})$	$(u c c b \bar{b})$	$(u t c b \bar{b})$	$+2$	0
$(c u t d \bar{d})$	$(c c t d \bar{d})$	$(c t t d \bar{d})$	$+2$	0
$(c u t d \bar{b})$	$(c c t d \bar{b})$	$(c t t d \bar{b})$	$+2$	0
$(c u t b \bar{d})$	$(c c t b \bar{d})$	$(c t t b \bar{d})$	$+2$	0
$(c u t b \bar{b})$	$(c c t b \bar{b})$	$(c t t b \bar{b})$	$+2$	0

TABLE 41: *Some of the properties of the pentaquarks predicted by this theory at point* Z_2 *according to case 2 (part II).*

(see next page)

Z_2 CASE 2 (Part III) **pentaquarks**				
PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
$(tuud\bar{d})$	$(tcud\bar{d})$	$(ttud\bar{d})$	$+2$	0
$(tuud\bar{b})$	$(tcud\bar{b})$	$(ttud\bar{b})$	$+2$	0
$(tuub\bar{d})$	$(tcub\bar{d})$	$(ttub\bar{d})$	$+2$	0
$(tuub\bar{b})$	$(tcub\bar{b})$	$(ttub\bar{b})$	$+2$	0
$(tucd\bar{d})$	$(tccd\bar{d})$	$(ttcd\bar{d})$	$+2$	0
$(tucd\bar{b})$	$(tucd\bar{b})$	$(ttcd\bar{b})$	$+2$	0
$(tucb\bar{d})$	$(cccb\bar{d})$	$(ttcb\bar{d})$	$+2$	0
$(tucb\bar{b})$	$(tccb\bar{b})$	$(ttcb\bar{b})$	$+2$	0
$(tutd\bar{d})$	$(tctd\bar{d})$	$(tttd\bar{d})$	$+2$	0
$(tutd\bar{b})$	$(tctd\bar{b})$	$(tttd\bar{b})$	$+2$	0
$(tutb\bar{d})$	$(tctb\bar{d})$	$(tttb\bar{d})$	$+2$	0
$(tutb\bar{b})$	$(tctb\bar{b})$	$(tttb\bar{b})$	$+2$	0

TABLE 42: *Some of the properties of the pentaquarks predicted by this theory at point* Z_2 *according to case 2 (part III).*

(see next page)

Z_2 CASE 2 (Part IV) **pentaquarks**			
ROW number	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
1	$(u u u s \bar{s})$	$+2$	0
2	$(u u c s \bar{s})$	$+2$	0
3	$(u u t s \bar{s})$	$+2$	0
4	$(c u u s \bar{s})$	$+2$	0
5	$(c u c s \bar{s})$	$+2$	0
6	$(c u t s \bar{s})$	$+2$	0
7	$(t u u s \bar{s})$	$+2$	0
8	$(t u c s \bar{s})$	$+2$	0
9	$(t u t s \bar{s})$	$+2$	0
10	$(u c u s \bar{s})$	$+2$	0
11	$(u c c s \bar{s})$	$+2$	0
12	$(u c t s \bar{s})$	$+2$	0
13	$(c c u s \bar{s})$	$+2$	0
14	$(c c c s \bar{s})$	$+2$	0
15	$(c c t s \bar{s})$	$+2$	0
16	$(t c u s \bar{s})$	$+2$	0
17	$(t c c s \bar{s})$	$+2$	0
18	$(t c t s \bar{s})$	$+2$	0
19	$(u t u s \bar{s})$	$+2$	0
20	$(u t c s \bar{s})$	$+2$	0
21	$(u t t s \bar{s})$	$+2$	0
22	$(c t u s \bar{s})$	$+2$	0
23	$(c t c s \bar{s})$	$+2$	0
24	$(c t t s \bar{s})$	$+2$	0
25	$(t t u s \bar{s})$	$+2$	0
26	$(t t c s \bar{s})$	$+2$	0
27	$(t t t s \bar{s})$	$+2$	0

TABLE 43: *Some of the properties of the pentaquarks predicted by this theory at point* Z_2 *according to case 2 (part IV).*

11.1.2 Analysis of the Point $Z_{-2}'(-2, 0)$: Electric Charge and Strangeness

Case 1: antiparticles
The electric charge in this case is

$$-\frac{2}{3}-\frac{2}{3}-\frac{2}{3}+\left(\frac{2}{3}-\frac{2}{3}\right)=-\frac{6}{3}+0=-2$$

Because of the quark composition we predict that this case will generate antipentaquarks.

Case 2: antiparticles
The electric charge in this case is

$$-\frac{2}{3}-\frac{2}{3}-\frac{2}{3}+\left(\frac{1}{3}-\frac{1}{3}\right)=-\frac{6}{3}+0=-2$$

Because of the quark composition we predict that this case will generate antipentaquarks.

Case 1: antiparticles

Electric charge condition	$-\frac{2}{3}-\frac{2}{3}-\frac{2}{3}-\frac{2}{3}+\frac{2}{3}$
Quarks that satisfy the electric charge condition	$\bar{u}\ \bar{u}\ \bar{u}\ \bar{u}\ u$ $\bar{c}\ \bar{c}\ \bar{c}\ \bar{c}\ c$ $\bar{t}\ \bar{t}\ \bar{t}\ \bar{t}\ t$

Combining these quarks we get the following pentaquarks

(see next page)

$Z_{-2}{}'$ CASE 1 (Part I) **antipentaquarks**					
ROW number	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
1	$(\bar u \bar u \bar u \bar u u)$	$(\bar u \bar c \bar u \bar u u)$	$(\bar u \bar t \bar u \bar u u)$	-2	0
2	$(\bar u \bar u \bar u \bar u c)$	$(\bar u \bar c \bar u \bar u c)$	$(\bar u \bar t \bar u \bar u c)$	-2	0
3	$(\bar u \bar u \bar u \bar u t)$	$(\bar u \bar c \bar u \bar u t)$	$(\bar u \bar t \bar u \bar u t)$	-2	0
4	$(\bar u \bar u \bar u \bar c u)$	$(\bar u \bar c \bar u \bar c u)$	$(\bar u \bar t \bar u \bar c u)$	-2	0
5	$(\bar u \bar u \bar u \bar c c)$	$(\bar u \bar c \bar u \bar c c)$	$(\bar u \bar t \bar u \bar c c)$	-2	0
6	$(\bar u \bar u \bar u \bar c t)$	$(\bar u \bar c \bar u \bar c t)$	$(\bar u \bar t \bar u \bar c t)$	-2	0
7	$(\bar u \bar u \bar u \bar t u)$	$(\bar u \bar c \bar u \bar t u)$	$(\bar u \bar t \bar u \bar t u)$	-2	0
8	$(\bar u \bar u \bar u \bar t c)$	$(\bar u \bar c \bar u \bar t c)$	$(\bar u \bar t \bar u \bar t c)$	-2	0
9	$(\bar u \bar u \bar u \bar t t)$	$(\bar u \bar c \bar u \bar t t)$	$(\bar u \bar t \bar u \bar t t)$	-2	0
10	$(\bar u \bar u \bar c \bar u u)$	$(\bar u \bar c \bar c \bar u u)$	$(\bar u \bar t \bar c \bar u u)$	-2	0
11	$(\bar u \bar u \bar c \bar u c)$	$(\bar u \bar c \bar c \bar u c)$	$(\bar u \bar t \bar c \bar u c)$	-2	0
12	$(\bar u \bar u \bar c \bar u t)$	$(\bar u \bar c \bar c \bar u t)$	$(\bar u \bar t \bar c \bar u t)$	-2	0
13	$(\bar u \bar u \bar c \bar c u)$	$(\bar u \bar c \bar c \bar c u)$	$(\bar u \bar t \bar c \bar c u)$	-2	0
14	$(\bar u \bar u \bar c \bar c c)$	$(\bar u \bar c \bar c \bar c c)$	$(\bar u \bar t \bar c \bar c c)$	-2	0
15	$(\bar u \bar u \bar c \bar c t)$	$(\bar u \bar c \bar c \bar c t)$	$(\bar u \bar t \bar c \bar c t)$	-2	0
16	$(\bar u \bar u \bar c \bar t u)$	$(\bar u \bar c \bar c \bar t u)$	$(\bar u \bar t \bar c \bar t u)$	-2	0
17	$(\bar u \bar u \bar c \bar t c)$	$(\bar u \bar c \bar c \bar t c)$	$(\bar u \bar t \bar c \bar t c)$	-2	0
18	$(\bar u \bar u \bar c \bar t t)$	$(\bar u \bar c \bar c \bar t t)$	$(\bar u \bar t \bar c \bar t t)$	-2	0
19	$(\bar u \bar u \bar t \bar u u)$	$(\bar u \bar c \bar t \bar u u)$	$(\bar u \bar t \bar t \bar u u)$	-2	0
20	$(\bar u \bar u \bar t \bar u c)$	$(\bar u \bar c \bar t \bar u c)$	$(\bar u \bar t \bar t \bar u c)$	-2	0
21	$(\bar u \bar u \bar t \bar u t)$	$(\bar u \bar c \bar t \bar u t)$	$(\bar u \bar t \bar t \bar u t)$	-2	0
22	$(\bar u \bar u \bar t \bar c u)$	$(\bar u \bar c \bar t \bar c u)$	$(\bar u \bar t \bar t \bar c u)$	-2	0
23	$(\bar u \bar u \bar t \bar c c)$	$(\bar u \bar c \bar t \bar c c)$	$(\bar u \bar t \bar t \bar c c)$	-2	0
24	$(\bar u \bar u \bar t \bar c t)$	$(\bar u \bar c \bar t \bar c t)$	$(\bar u \bar t \bar t \bar c t)$	-2	0
25	$(\bar u \bar u \bar t \bar t u)$	$(\bar u \bar c \bar t \bar t u)$	$(\bar u \bar t \bar t \bar t u)$	-2	0
26	$(\bar u \bar u \bar t \bar t c)$	$(\bar u \bar c \bar t \bar t c)$	$(\bar u \bar t \bar t \bar t c)$	-2	0
27	$(\bar u \bar u \bar t \bar t t)$	$(\bar u \bar c \bar t \bar t t)$	$(\bar u \bar t \bar t \bar t t)$	-2	0

TABLE 44: *More particles (antipentaquarks) at point* $Z_{-2}{}'$.

$Z_{-2}{}'$ CASE 1 (Part II) **antipentaquarks**					
ROW number	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
1	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{u}\,u)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{u}\,u)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{u}\,u)$	-2	0
2	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{u}\,c)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{u}\,c)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{u}\,c)$	-2	0
3	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{u}\,t)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{u}\,t)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{u}\,t)$	-2	0
4	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{c}\,u)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{c}\,u)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{c}\,u)$	-2	0
5	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{c}\,c)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{c}\,c)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{c}\,c)$	-2	0
6	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{c}\,t)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{c}\,t)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{c}\,t)$	-2	0
7	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{t}\,u)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{t}\,u)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{t}\,u)$	-2	0
8	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{t}\,c)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{t}\,c)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{t}\,c)$	-2	0
9	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{t}\,t)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{t}\,t)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{t}\,t)$	-2	0
10	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{u}\,u)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{u}\,u)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{u}\,u)$	-2	0
11	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{u}\,c)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{u}\,c)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{u}\,c)$	-2	0
12	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{u}\,t)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{u}\,t)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{u}\,t)$	-2	0
13	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{c}\,u)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{c}\,u)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{c}\,u)$	-2	0
14	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{c}\,c)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{c}\,c)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{c}\,c)$	-2	0
15	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{c}\,t)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{c}\,t)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{c}\,t)$	-2	0
16	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{t}\,u)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{t}\,u)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{t}\,u)$	-2	0
17	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{t}\,c)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{t}\,c)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{t}\,c)$	-2	0
18	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{t}\,t)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{t}\,t)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{t}\,t)$	-2	0
19	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{u}\,u)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{u}\,u)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{u}\,u)$	-2	0
20	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{u}\,c)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{u}\,c)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{u}\,c)$	-2	0
21	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{u}\,t)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{u}\,t)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{u}\,t)$	-2	0
22	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{c}\,u)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{c}\,u)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{c}\,u)$	-2	0
23	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{c}\,c)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{c}\,c)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{c}\,c)$	-2	0
24	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{c}\,t)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{c}\,t)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{c}\,t)$	-2	0
25	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{t}\,u)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{t}\,u)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{t}\,u)$	-2	0
26	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{t}\,c)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{t}\,c)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{t}\,c)$	-2	0
27	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{t}\,t)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{t}\,t)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{t}\,t)$	-2	0

TABLE 45: *More particles (antipentaquarks) at point* $Z_{-2}{}'$.

Z_{-2}' CASE 1 (Part III) **antipentaquarks**					
ROW number	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
1	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{u}\,u)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{u}\,u)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{u}\,u)$	-2	0
2	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{u}\,c)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{u}\,c)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{u}\,c)$	-2	0
3	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{u}\,t)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{u}\,t)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{u}\,t)$	-2	0
4	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{c}\,u)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{c}\,u)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{c}\,u)$	-2	0
5	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{c}\,c)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{c}\,c)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{c}\,c)$	-2	0
6	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{c}\,t)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{c}\,t)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{c}\,t)$	-2	0
7	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{t}\,u)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{t}\,u)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{t}\,u)$	-2	0
8	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{t}\,c)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{t}\,c)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{t}\,c)$	-2	0
9	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{t}\,t)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{t}\,t)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{t}\,t)$	-2	0
10	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{u}\,u)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{u}\,u)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{u}\,u)$	-2	0
11	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{u}\,c)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{u}\,c)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{u}\,c)$	-2	0
12	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{u}\,t)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{u}\,t)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{u}\,t)$	-2	0
13	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{c}\,u)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{c}\,u)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{c}\,u)$	-2	0
14	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{c}\,c)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{c}\,c)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{c}\,c)$	-2	0
15	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{c}\,t)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{c}\,t)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{c}\,t)$	-2	0
16	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{t}\,u)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{t}\,u)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{t}\,u)$	-2	0
17	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{t}\,c)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{t}\,c)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{t}\,c)$	-2	0
18	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{t}\,t)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{t}\,t)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{t}\,t)$	-2	0
19	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{u}\,u)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{u}\,u)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{u}\,u)$	-2	0
20	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{u}\,c)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{u}\,c)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{u}\,c)$	-2	0
21	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{u}\,t)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{u}\,t)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{u}\,t)$	-2	0
22	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{c}\,u)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{c}\,u)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{c}\,u)$	-2	0
23	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{c}\,c)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{c}\,c)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{c}\,c)$	-2	0
24	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{c}\,t)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{c}\,t)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{c}\,t)$	-2	0
25	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{t}\,u)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{t}\,u)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{t}\,u)$	-2	0
26	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{t}\,c)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{t}\,c)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{t}\,c)$	-2	0
27	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{t}\,t)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{t}\,t)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{t}\,t)$	-2	0

TABLE 46: *More* particles *(antipentaquarks) at point* Z_{-2}' .

Case 2: antiparticles

Electric charge condition $\quad -\frac{2}{3}-\frac{2}{3}-\frac{2}{3}+\frac{1}{3}-\frac{1}{3}$

Quarks that satisfy the electric charge condition (*).

$\bar{u}$	$\bar{u}$	$\bar{u}$	$\bar{d}$	d
$\bar{c}$	$\bar{c}$	$\bar{c}$	$\bar{b}$	b
$\bar{t}$	$\bar{t}$	$\bar{t}$	$\bar{s}$	s

(*) Because pentaquarks on the Q axes must have total strangeness of 0, the strange quark s and the anti-strange $\bar{s}$ must be included as a pair $s\,\bar{s}$ or unit. These pentaquarks are shown in a separate table.

Combining these quarks we get the pentaquarks shown in the following tables

$Z_{-2}{}'$ CASE 2 (Part I) **antipentaquarks**					
ROW number	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\lvert e \rvert$)	STRANGENESS
1	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	-2	0
2	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,b)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{d}\,b)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{d}\,b)$	-2	0
3	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{b}\,d)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{b}\,d)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{b}\,d)$	-2	0
4	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{b}\,b)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{b}\,b)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{b}\,b)$	-2	0
5	$(\bar{u}\,\bar{u}\,\bar{c}\,\bar{d}\,d)$	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{d}\,d)$	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{d}\,d)$	-2	0
6	$(\bar{u}\,\bar{u}\,\bar{c}\,\bar{d}\,b)$	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{d}\,b)$	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{d}\,b)$	-2	0
7	$(\bar{u}\,\bar{u}\,\bar{c}\,\bar{b}\,d)$	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{b}\,d)$	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{b}\,d)$	-2	0
8	$(\bar{u}\,\bar{u}\,\bar{c}\,\bar{b}\,b)$	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{b}\,b)$	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{b}\,b)$	-2	0
9	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	-2	0
10	$(\bar{u}\,\bar{u}\,\bar{t}\,\bar{d}\,b)$	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{d}\,b)$	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{d}\,b)$	-2	0
11	$(\bar{u}\,\bar{u}\,\bar{t}\,\bar{b}\,d)$	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{b}\,d)$	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{b}\,d)$	-2	0
12	$(\bar{u}\,\bar{u}\,\bar{t}\,\bar{b}\,b)$	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{b}\,b)$	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{b}\,b)$	-2	0
13	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	-2	0
14	$(\bar{u}\,\bar{c}\,\bar{u}\,\bar{d}\,b)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{d}\,b)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{d}\,b)$	-2	0
15	$(\bar{u}\,\bar{c}\,\bar{u}\,\bar{b}\,d)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{b}\,d)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{b}\,d)$	-2	0
16	$(\bar{u}\,\bar{c}\,\bar{u}\,\bar{b}\,b)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{b}\,b)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{b}\,b)$	-2	0
17	$(\bar{u}\,\bar{c}\,\bar{c}\,\bar{d}\,d)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{d}\,d)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{d}\,d)$	-2	0

Z_{-2}' CASE 2 (Part I) **antipentaquarks**					
ROW number	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
18	$(\bar{u}\,\bar{c}\,\bar{c}\,\bar{d}\,b)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{d}\,b)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{d}\,b)$	-2	0
19	$(\bar{u}\,\bar{c}\,\bar{c}\,\bar{b}\,d)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{b}\,d)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{b}\,d)$	-2	0
20	$(\bar{u}\,\bar{c}\,\bar{c}\,\bar{b}\,b)$	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{b}\,b)$	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{b}\,b)$	-2	0
21	$(\bar{u}\,\bar{c}\,\bar{u}\,\bar{d}\,d)$	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{d}\,d)$	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{d}\,d)$	-2	0
22	$(\bar{u}\,\bar{c}\,\bar{t}\,\bar{d}\,b)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{d}\,b)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{d}\,b)$	-2	0
23	$(\bar{u}\,\bar{c}\,\bar{t}\,\bar{b}\,d)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{b}\,d)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{b}\,d)$	-2	0
24	$(\bar{u}\,\bar{c}\,\bar{t}\,\bar{b}\,b)$	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{b}\,b)$	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{b}\,b)$	-2	0
25	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{d}\,d)$	-2	0
26	$(\bar{u}\,\bar{t}\,\bar{u}\,\bar{d}\,b)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{d}\,b)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{d}\,b)$	-2	0
27	$(\bar{u}\,\bar{t}\,\bar{u}\,\bar{b}\,d)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{b}\,d)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{b}\,d)$	-2	0
28	$(\bar{u}\,\bar{t}\,\bar{u}\,\bar{b}\,b)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{b}\,b)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{b}\,b)$	-2	0
29	$(\bar{u}\,\bar{t}\,\bar{c}\,\bar{d}\,d)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{d}\,d)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{d}\,d)$	-2	0
30	$(\bar{u}\,\bar{t}\,\bar{c}\,\bar{d}\,b)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{d}\,b)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{d}\,b)$	-2	0
31	$(\bar{u}\,\bar{t}\,\bar{c}\,\bar{b}\,d)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{b}\,d)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{b}\,d)$	-2	0
32	$(\bar{u}\,\bar{t}\,\bar{c}\,\bar{b}\,b)$	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{b}\,b)$	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{b}\,b)$	-2	0
33	$(\bar{u}\,\bar{t}\,\bar{u}\,\bar{d}\,d)$	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{d}\,d)$	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{d}\,d)$	-2	0
34	$(\bar{u}\,\bar{t}\,\bar{t}\,\bar{d}\,b)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{d}\,b)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{d}\,b)$	-2	0
35	$(\bar{u}\,\bar{t}\,\bar{t}\,\bar{b}\,d)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{b}\,d)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{b}\,d)$	-2	0
36	$(\bar{u}\,\bar{t}\,\bar{t}\,\bar{b}\,b)$	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{b}\,b)$	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{b}\,b)$	-2	0

TABLE 47: *More* particles *(antipentaquarks) at point* Z_{-2}' *. This table has been split into two different parts to be able to fit it into the page.*

(see next page)

Z_{-2}' CASE 2 (Part II) **antipentaquarks**			
ROW number	PARTICLE COMPOSITION (quark contents)	ELECTRIC CHARGE (times $\|e\|$)	STRANGENESS
1	$(\bar{u}\,\bar{u}\,\bar{u}\,\bar{s}\,s)$	-2	0
2	$(\bar{u}\,\bar{u}\,\bar{c}\,\bar{s}\,s)$	-2	0
3	$(\bar{u}\,\bar{u}\,\bar{t}\,\bar{s}\,s)$	-2	0
4	$(\bar{u}\,\bar{c}\,\bar{u}\,\bar{s}\,s)$	-2	0
5	$(\bar{u}\,\bar{c}\,\bar{c}\,\bar{s}\,s)$	-2	0
6	$(\bar{u}\,\bar{c}\,\bar{t}\,\bar{s}\,s)$	-2	0
7	$(\bar{u}\,\bar{t}\,\bar{u}\,\bar{s}\,s)$	-2	0
8	$(\bar{u}\,\bar{t}\,\bar{c}\,\bar{s}\,s)$	-2	0
9	$(\bar{u}\,\bar{t}\,\bar{t}\,\bar{s}\,s)$	-2	0
10	$(\bar{c}\,\bar{u}\,\bar{u}\,\bar{s}\,s)$	-2	0
11	$(\bar{c}\,\bar{u}\,\bar{c}\,\bar{s}\,s)$	-2	0
12	$(\bar{c}\,\bar{u}\,\bar{t}\,\bar{s}\,s)$	-2	0
13	$(\bar{c}\,\bar{c}\,\bar{u}\,\bar{s}\,s)$	-2	0
14	$(\bar{c}\,\bar{c}\,\bar{c}\,\bar{s}\,s)$	-2	0
15	$(\bar{c}\,\bar{c}\,\bar{t}\,\bar{s}\,s)$	-2	0
16	$(\bar{c}\,\bar{t}\,\bar{u}\,\bar{s}\,s)$	-2	0
17	$(\bar{c}\,\bar{t}\,\bar{c}\,\bar{s}\,s)$	-2	0
18	$(\bar{c}\,\bar{t}\,\bar{t}\,\bar{s}\,s)$	-2	0
19	$(\bar{t}\,\bar{u}\,\bar{u}\,\bar{s}\,s)$	-2	0
20	$(\bar{t}\,\bar{u}\,\bar{c}\,\bar{s}\,s)$	-2	0
21	$(\bar{t}\,\bar{u}\,\bar{t}\,\bar{s}\,s)$	-2	0
22	$(\bar{t}\,\bar{c}\,\bar{u}\,\bar{s}\,s)$	-2	0
23	$(\bar{t}\,\bar{c}\,\bar{c}\,\bar{s}\,s)$	-2	0
24	$(\bar{t}\,\bar{c}\,\bar{t}\,\bar{s}\,s)$	-2	0
25	$(\bar{t}\,\bar{t}\,\bar{u}\,\bar{s}\,s)$	-2	0
26	$(\bar{t}\,\bar{t}\,\bar{c}\,\bar{s}\,s)$	-2	0
27	$(\bar{t}\,\bar{t}\,\bar{t}\,\bar{s}\,s)$	-2	0

TABLE 48: *These are the strange antipentaquarks at point* Z_{-2}' *which contain a pair of strange/anti-strange quarks each (total strangeness, S, equal to zero).*

12. Examples of Naive Pentaquark Diagrams

Naive diagrams of pentaquarks are simplified diagrams used to illustrate pentaquarks graphically. The diagrams are naive because they do not include all the parts or "building blocks" of the particles such as additional quark-antiquark pairs and gluons (a large number of them). Although these graphics have limitations, they are good enough to illustrate the principles outlined in this paper.

Example 1. FIGURE 10 shows the possible lightest pentaquark: $(u\,u\,u\,u\,\bar{u})$ (quadruply up pentaquark). This pentaquark is made of 4 up quarks (shown in red, green and blue) and one anti-blue up quark (shown in orange). Despite having two identical quantum numbers: colour charge (blue) and flavour (up), quarks u_B^{up} and u_B^{down} , do not violate the Pauli exclusion principle because they have opposite spins: one quark has spin up while the other one has spin down.

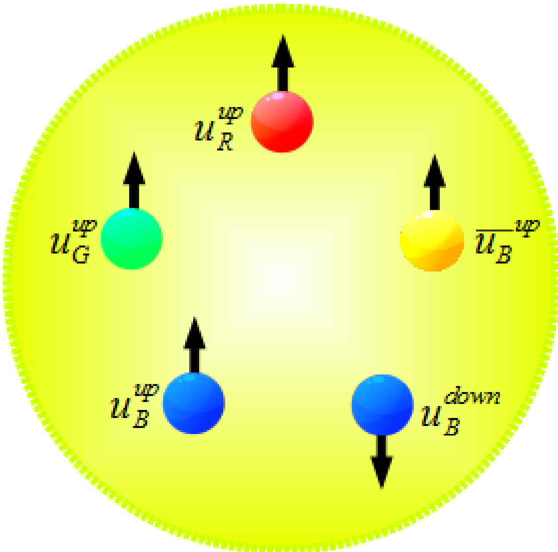

FIGURE 10: *The lightlest pentaquark:* $P_{4u\bar{u}} = (u\,u\,u\,u\,\bar{u})$ *. The two blue quarks have opposite spins due to the Pauli exclusion principle. This configuration is one of the possible combinations of quark colour charges and spins.*

Example 2. FIGURE 11 shows a triply strange pentaquark: $(s\,s\,s\,d\,\bar{u})$ (see TABLE 5). This pentaquark is made of 3 strange quarks (shown in red, green and blue), one down quark (shown in blue) and an anti-blue up quark (shown in orange). Despite having two identical quantum numbers: colour charge (blue) and spin (up), quarks s_B^{up} and d_B^{up} do not violate the Pauli exclusion principle because they have different flavours: one is strange (s) and the other one is down (d).

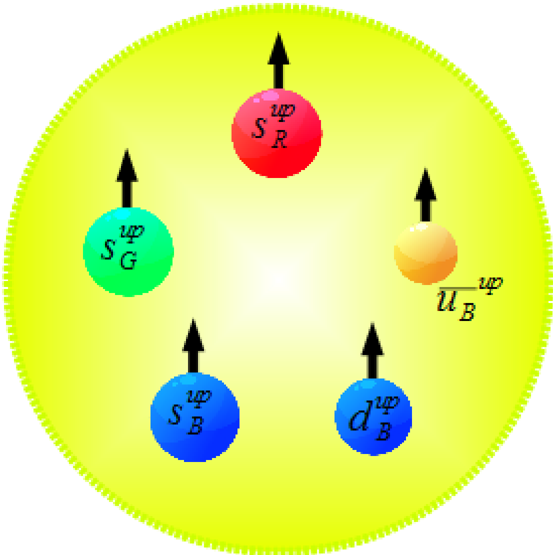

FIGURE 11: *The triply strange pentaquark:* $P_{3sd\bar{u}} = (s\,s\,s\,d\,\bar{u})$ *. In terms of its mass this pentaquark must be between the lightest and the heaviest pentaquarks. This configuration is one of the possible combinations of quark colour charges and spins.*

Example 3. FIGURE 12 shows the possible heaviest pentaquark: $(t\,t\,t\,t\,\bar{t})$ (quadruply bottom pentaquark). This pentaquark is made of 4 top quarks (2 shown in red, 1 in green and 1 in blue) and one anti-red top quark (shown in cyan). Despite having two identical quantum numbers: colour charge (red) and flavour (top), quarks t_R^{up} and t_R^{down} , do not violate the Pauli exclusion principle because they have opposite spins: one quark has spin up while the other one has spin down.

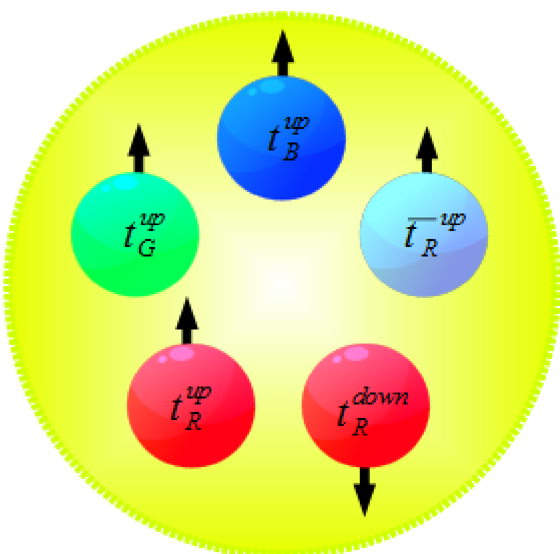

FIGURE 12: *The heaviest pentaquark:* $P_{4t\bar{t}} = (t\,t\,t\,t\,\bar{t})$ *. The two red quarks have opposite spins due to the Pauli exclusion principle. This configuration is one of the possible combinations of quark colour charges and spins.*

The circles representing the constituents (quarks and anti-quarks) are not to scale.

Example 4. FIGURE 13 shows the position of the pentaquark $(u\ u\ d\ c\ \bar{c})$ in the matter antimatter way.

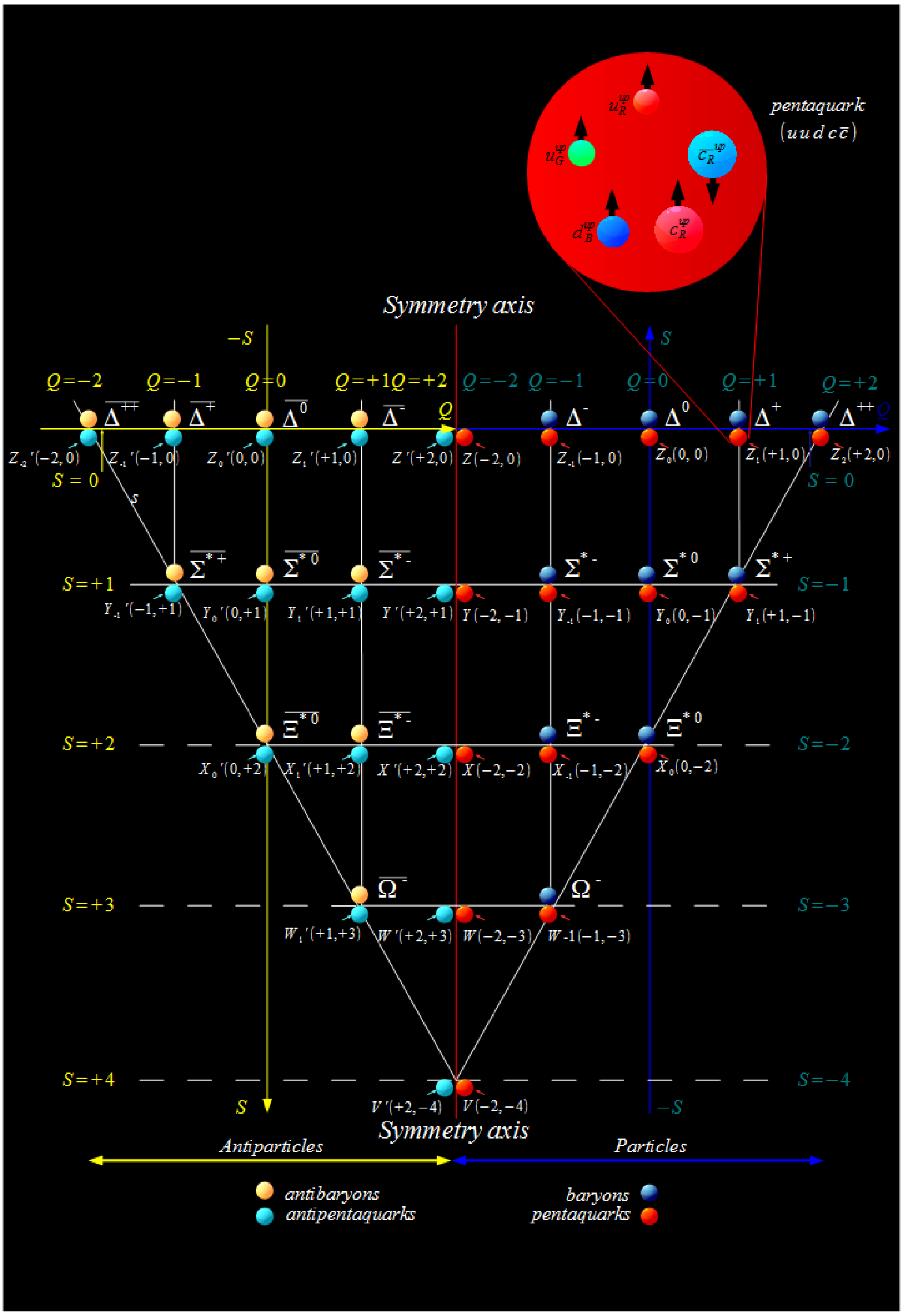

FIGURE 13: *The pentaquark* $(u\ u\ d\ c\ \bar{c})$ *and its position in the diagram. Note that this point* (Z_1) *is shared by other pentaquarks.*

13. Conclusions

The theory I propose in this paper is based on a symmetry principle between matter and antimatter, which in its graphic form, is what I call the matter-antimatter way. The diagram suggests it's possible that there exist both pentaquarks and anti-pentaquarks. In particular, this formulation predicts the existence of:

(1) quadruply up pentaquarks and their antiparticles: $u u u u \bar{x}$, $\bar{u} \bar{u} \bar{u} \bar{u} x$,
where x means u, c or t
(2) triply up pentaquarks and their antiparticles,
(3) doubly up pentaquarks and their antiparticles,
(4) singly up pentaquarks, and their antiparticles,

(5) quadruply down pentaquarks and their antiparticles: $d d d d \bar{x}$, $\bar{d} \bar{d} \bar{d} \bar{d} x$,
where x means u, c or t,
(6) triply down pentaquarks and their antiparticles,
(7) doubly down pentaquarks and their antiparticles,
(8) singly strange pentaquarks, and their antiparticles,

(9) quadruply strange pentaquarks and their antiparticles: $s s s s \bar{x}$, $\bar{s} \bar{s} \bar{s} \bar{s} x$,
where x means u, c or t,
(10) triply strange pentaquarks and their antiparticles,
(11) doubly strange pentaquarks and their antiparticles,
(12) singly strange pentaquarks, and their antiparticles,

(13) quadruply charm pentaquarks and their antiparticles: $c c c c \bar{x}$, $\bar{c} \bar{c} \bar{c} \bar{c} x$,
where x means u, c or t,
(14) triply charm pentaquarks and their antiparticles,
(15) doubly charm pentaquarks and their antiparticles,
(16) singly charm pentaquarks, and their antiparticles,

(17) quadruply bottom pentaquarks and their antiparticles: $b b b b \bar{x}$, $\bar{b} \bar{b} \bar{b} \bar{b} x$,
where x means u, c or t,
(18) triply bottom pentaquarks and their antiparticles,
(19) doubly bottom pentaquarks and their antiparticles,
(20) singly bottom pentaquarks, and their antiparticles,

(21) quadruply top pentaquarks and their antiparticles: $t t t t \bar{x}$, $\bar{t} \bar{t} \bar{t} \bar{t} x$,
where x means u, c or t,
(22) triply top pentaquarks and their antiparticles,
(23) doubly top pentaquarks and their antiparticles,
(24) singly top pentaquarks, and their antiparticles,

(25) two groups of pentaquarks and antipentaquarks with zero total strangeness:
(a) the first group contains neither strange nor anti-strange quarks,
(b) the second group contains a pair of quarks made of a strange quark and an anti-strange quark plus other three non-strange quarks (e.g. $\bar{d} \bar{b} \bar{b} s \bar{s}$),
(26) “bottom-top charmed” pentaquarks (e.g. $t c u b \bar{b}$). This is a type of pentaquark with 4 different flavours.

Another interesting point to mention is that, according to (26) this theory predicts the existence of pentaquarks made of four different flavours. For example the $t\,c\,u\,b\,\bar{b}$ contains four different flavours: up, charm, bottom and top. Thus, it seems appropriate to group together these types of pentaquarks under the name of **quadruply flavoured pentaquarks**. This is a feature we cannot find in baryons because, as the reader knows, baryons are made of three quarks only. Now, let's have a look at the most important prediction of this theory:

> This theory predicts the existence of a pentaquark that has recently been discovered by CERN scientists at Geneva, Switzerland (see note 5). This pentaquark, whose composition is believed to be $u\,u\,d\,c\,\bar{c}$, is made of two up quarks, one down quark, one charm quark and one anti-charm quark [11, 12, 13].

This theory, as all theories, have advantages and limitations. One advantage of this formulation is that it doesn't use the isospin property of particles, which by the way, is a concept very difficult to explain. A second advantage of this theory is the very simple framework on which it is based upon. A third advantage is that the theory predicts all pentaquarks there exist in nature. On the other hand, the limitation of this theory is that it does not predict the masses of the predicted particles. This, however, has nothing to do with the correctness or potential of this formulation. In summary, based on this formulation, I strongly believe that both pentaquarks and "baryomesonic molecules" are real, which motivated me to write this article in the first place. I also believe that soon the LHC will confirm the predictions of this theory.

Appendix 1

ACRONYMS

The following are the acronyms used in this paper

LHC = large hadron collider
QED = quantum electrodynamics
QCD = quantum chomodynamics
MAW = matter-antimatter way

NOMENCLATURE

The following are the symbols used in this paper

Q = electric charge of the unknown particle (pentaquark). Also, in the diagram of FIGURE 2, Q is the electric charge of a baryon or the electric charge of an antibaryon
q_u = electric charge of the up quark

q_d = electric charge of the up quark
q_s = electric charge of the strange quark
q_c = electric charge of the charm quark
q_b = electric charge of the bottom quark
q_t = electric charge of the top quark
$q_{\bar{u}}$ = electric charge of the antiup quark
$q_{\bar{d}}$ = electric charge of the antidown quark
$q_{\bar{s}}$ = electric charge of the antistrange quark
$q_{\bar{c}}$ = electric charge of the anticharm quark
$q_{\bar{b}}$ = electric charge of the antibottom quark
$q_{\bar{t}}$ = electric charge of the antitop quark
q_5 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the fifth quark.
q_4 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the forth quark.
q_3 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the third quark.
q_2 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the second quark.
q_1 = electric charge of one of the constituents (quark) of the unknown particle (pentaquark) (cannot be an *s* quark). This quark will be called the first quark.
Δ^- = Delta-minus particle – composition: *ddd*
Δ^0 = Delta-zero particle – composition: *udd*
Δ^+ = Delta-plus particle – composition: *uud*
Δ^{++} = Delta-plus-plus particle – composition: *uuu*
Σ^- = Sigma-minus particle – composition: *dds*
Σ^0 = Sigma-zero particle – composition: *uds*
Σ^+ = Sigma-plus particle – composition: *uus*
Ξ^- = Xi-minus particle – composition: *dss*
Ξ^0 = Xi-zero particle – composition: *uss*
Ω^- = Omega-minus particle – composition: *sss*
$\overline{\Delta^-}$ = Delta-minus antiparticle – composition: $\bar{d}\,\bar{d}\,\bar{d}$
$\overline{\Delta^0}$ = Delta-zero antiparticle – composition: $\bar{u}\,\bar{d}\,\bar{d}$
$\overline{\Delta^+}$ = Delta-plus antiparticle – composition: $\bar{u}\,\bar{u}\,\bar{d}$
$\overline{\Delta^{++}}$ = Delta-plus-plus antiparticle – composition: $\bar{u}\,\bar{u}\,\bar{u}$
$\overline{\Sigma^-}$ = Sigma-minus antiparticle – composition: $\bar{d}\,\bar{d}\,\bar{s}$
$\overline{\Sigma^0}$ = Sigma-zero antiparticle – composition: $\bar{u}\,\bar{d}\,\bar{s}$
$\overline{\Sigma^+}$ = Sigma-plus antiparticle – composition: $\bar{u}\,\bar{u}\,\bar{s}$
$\overline{\Xi^-}$ = Xi-minus antiparticle – composition: $\bar{d}\,\bar{s}\,\bar{s}$
$\overline{\Xi^0}$ = Xi- zero antiparticle – composition: $\bar{u}\,\bar{s}\,\bar{s}$
$\overline{\Omega^-}$ = Omega-minus antiparticle – composition: $\bar{s}\,\bar{s}\,\bar{s}$
Σ^{*-} = Excited state of the Sigma-minus particle – composition: *dds*
Σ^{*0} = Excited state of the Sigma-zero particle – composition: *uds*
Σ^{*+} = Excited state of the Sigma-plus particle – composition: *uus*
Ξ^{*-} = Excited state of the Xi-minus particle – composition: *dss*
Ξ^{*0} = Excited state of the Xi-zero particle – composition: *uss*
Σ^{*-} = Excited state of the Sigma-minus antiparticle – composition: $\bar{d}\,\bar{d}\,\bar{s}$

$\overline{\Sigma^{*0}}$ = Excited state of the Sigma-zero antiparticle – composition: $\bar{u}\,\bar{d}\,\bar{s}$
$\overline{\Sigma^{*+}}$ = Excited state of the Sigma-plus antiparticle – composition: $\bar{u}\,\bar{u}\,\bar{s}$
$\overline{\Xi^{*-}}$ = Excited state of the Xi-minus antiparticle – composition: $\bar{d}\,\bar{s}\,\bar{s}$
$\overline{\Xi^{*0}}$ = Excited state of the Xi-zero antiparticle – composition: $\bar{u}\,\bar{s}\,\bar{s}$
u = up quark
d = down quark
s = strange quark
c = charm quark
b = bottom quark
t = top quark
$\bar{u}$ = antiup quark or anti-up quark
$\bar{d}$ = antidown quark or anti-down quark
$\bar{s}$ = antistrange quark or anti-strange quark
$\bar{c}$ = anticharm quark or anti-charm quark
$\bar{b}$ = antibottom quark or anti-bottom quark
$\bar{t}$ = antitop quark or anti-top quark
u_R = up quark carrying red colour
u_G = up quark carrying green colour
u_B = up quark carrying blue colour
d_R = down quark carrying red colour
d_G = down quark carrying green colour
d_B = down quark carrying blue colour
s_R = strange quark carrying red colour
s_G = strange quark carrying green colour
s_B = strange quark carrying blue colour
c_R = charm quark carrying red colour
c_G = charm quark carrying green colour
c_B = charm quark carrying blue colour
b_R = bottom quark carrying red colour
b_G = bottom quark carrying green colour
b_B = bottom quark carrying blue colour
t_R = top quark carrying red colour
t_G = top quark carrying green colour
t_B = top quark carrying blue colour
u_R^{up} = up quark carrying red colour and spin up
u_G^{up} = up quark carrying green colour and spin up
u_B^{up} = up quark carrying blue colour and spin up
d_R^{up} = down quark carrying red colour and spin up
d_G^{up} = down quark carrying green colour and spin up
d_B^{up} = down quark carrying blue colour and spin up
s_R^{up} = strange quark carrying red colour and spin up
s_G^{up} = strange quark carrying green colour and spin up
s_B^{up} = strange quark carrying blue colour and spin up
c_R^{up} = charm quark carrying red colour and spin up
c_G^{up} = charm quark carrying green colour and spin up
c_B^{up} = charm quark carrying blue colour and spin up
b_R^{up} = bottom quark carrying red colour and spin up

$b_G^{up} =$ bottom quark carrying green colour and spin up
$b_B^{up} =$ bottom quark carrying blue colour and spin up
$t_R^{up} =$ top quark carrying red colour and spin up
$t_G^{up} =$ top quark carrying green colour and spin up
$t_B^{up} =$ top quark carrying blue colour and spin up
$u_R^{down} =$ up quark carrying red colour and spin down
$u_G^{down} =$ up quark carrying green colour and spin down
$u_B^{down} =$ up quark carrying blue colour and spin down
$d_R^{down} =$ down quark carrying red colour and spin down
$d_G^{down} =$ down quark carrying green colour and spin down
$d_B^{down} =$ down quark carrying blue colour and spin down
$s_R^{down} =$ strange quark carrying red colour and spin down
$s_G^{down} =$ strange quark carrying green colour and spin down
$s_B^{down} =$ strange quark carrying blue colour and spin down
$c_R^{down} =$ charm quark carrying red colour and spin down
$c_G^{down} =$ charm quark carrying green colour and spin down
$c_B^{down} =$ charm quark carrying blue colour and spin down
$b_R^{down} =$ bottom quark carrying red colour and spin down
$b_G^{down} =$ bottom quark carrying green colour and spin down
$b_B^{down} =$ bottom quark carrying blue colour and spin down
$t_R^{down} =$ top quark carrying red colour and spin down
$t_G^{down} =$ top quark carrying green colour and spin down
$t_B^{down} =$ top quark carrying blue colour and spin down
$\overline{u_R} =$ antiup quark carrying antired colour
$\overline{u_G} =$ antiup quark carrying antigreen colour
$\overline{u_B} =$ antiup quark carrying antiblue colour
$\overline{d_R} =$ antidown quark carrying antired colour
$\overline{d_G} =$ antidown quark carrying antigreen colour
$\overline{d_B} =$ antidown quark carrying antiblue colour
$\overline{s_R} =$ antistrange quark carrying antired colour
$\overline{s_G} =$ antistrange quark carrying antigreen colour
$\overline{s_B} =$ antistrange quark carrying antiblue colour
$\overline{c_R} =$ anticharm quark carrying antired colour
$\overline{c_G} =$ anticharm quarkv carrying antigreen colour
$\overline{c_B} =$ anticharm quark carrying antiblue colour
$\overline{b_R} =$ antibottom quark carrying antired colour
$\overline{b_G} =$ antibottom quark carrying antigreen colour
$\overline{b_B} =$ antibottom quark carrying antiblue colour
$\overline{t_R} =$ antitop quark carrying antired colour
$\overline{t_G} =$ antitop quark carrying antigreen colour
$\overline{t_B} =$ antitop quark carrying antiblue colour
$\overline{u_R}^{up} =$ antiup quark carrying antired colour and spin up
$\overline{u_G}^{up} =$ antiup quark carrying antigreen colour and spin up
$\overline{u_B}^{up} =$ antiup quark carrying antiblue colour and spin up
$\overline{d_R}^{up} =$ antidown quark carrying antired colour and spin up

$\overline{d}_G^{up} =$ antidown quark carrying antigreen colour and spin up
$\overline{d}_B^{up} =$ antidown quark carrying antiblue colour and spin up
$\overline{s}_R^{up} =$ antistrange quark carrying antired colour and spin up
$\overline{s}_G^{up} =$ antistrange quark carrying antigreen colour and spin up
$\overline{s}_B^{up} =$ antistrange quark carrying antiblue colour and spin up
$\overline{c}_R^{up} =$ anticharm quark carrying antired colour and spin up
$\overline{c}_G^{up} =$ anticharm quark carrying antigreen colour and spin up
$\overline{c}_B^{up} =$ anticharm quark carrying antiblue colour and spin up
$\overline{b}_R^{up} =$ antibottom quark carrying antired colour and spin up
$\overline{b}_G^{up} =$ antibottom quark carrying antigreen colour and spin up
$\overline{b}_B^{up} =$ antibottom quark carrying antiblue colour and spin up
$\overline{t}_R^{up} =$ antitop quark with carrying antired colour and up
$\overline{t}_G^{up} =$ antitop quark with carrying antigreen colour and up
$\overline{t}_B^{up} =$ antitop quark with carrying antiblue colour and up
$\overline{u}_R^{down} =$ antiup quark carrying antired colour and spin down
$\overline{u}_G^{down} =$ antiup quark carrying antigreen colour and spin down
$\overline{u}_B^{down} =$ antiup quark carrying antiblue colour and spin down
$\overline{d}_R^{down} =$ antidown quark carrying antired colour and spin down
$\overline{d}_G^{down} =$ antidown quark carrying antigreen colour and spin down
$\overline{d}_B^{down} =$ antidown quark carrying antiblue colour and spin down
$\overline{s}_R^{down} =$ antistrange quark carrying antired colour and spin down
$\overline{s}_G^{down} =$ antistrange quark carrying antigreen colour and spin down
$\overline{s}_B^{down} =$ antistrange quark carrying antiblue colour and spin down
$\overline{c}_R^{down} =$ anticharm quark carrying antired colour and spin down
$\overline{c}_G^{down} =$ anticharm quark carrying antigreen colour and spin down
$\overline{c}_B^{down} =$ anticharm quark carrying antiblue colour and spin down
$\overline{b}_R^{down} =$ antibottom quark carrying antired colour and spin down
$\overline{b}_G^{down} =$ antibottom quark carrying antigreen colour and spin down
$\overline{b}_B^{down} =$ antibottom quark carrying antiblue colour and spin down
$\overline{t}_R^{down} =$ antitop quark carrying antired colour and spin down
$\overline{t}_G^{down} =$ antitop quark carrying antigreen colour and spin down
$\overline{t}_B^{down} =$ antitop quark carrying antiblue colour and spin down

Notes

Note 1

There are other properties that have been left out because they are not relevant to this paper.

Note 2

Definition
Charge conjugation (C symmetry) is the operation of changing the reflection of the particles (in the mirror) by its antiparticles.

This definition deserves an explanation. The definition means that we have to reverse not only the electric charge but also all the internal quantum numbers such as the strangeness, the charmness, the bottomness, the topness, the lepton number, the baryon number, time, etc. However we do not have to reverse the energy, mass, the momentum and the spin. This means that electric charge reversal, strangeness reversal (if there are particles with strange quarks), charmness reversal (if there are particles with charm quarks), bottomness reversal (if there are particles with bottom quarks), topness reversal (if there are particles with top quarks), time reversal (*T* symmetry), etc., should all be included into the *C* operation.

The reason of including time reversal into the *C* operation is because, according to Feynman [6], antiparticles are particles with negative energy travelling backward in time, thus the direction of time flow or time travel is one of the properties of particles (move forward in time) and also one of the properties for antiparticles (move backward in time). In order to avoid confusions, it is better to think that there are physical entities moving backwards in time. Whether, these physical entities, are called particles or something else is irrelevant. Because the direction of time travel for particles and antiparticles does not coincide, we must reverse it, otherwise we would not be *changing the reflection of the particles (in the mirror) by its antiparticles* as the definition requires. We would be changing the reflection of the particles by something else (not antiparticles!). Therefore, according to the above definition, time reversal should be included into the *C* operation. This seems to be only a matter of definition but, unfortunately, is not. Having a separate time reversal operation is conceptually wrong and it may lead to incomplete or wrong interpretations or results. This is the reason why nature, in general, exhibits *PC+* symmetry (*CPT* symmetry) and not *PC* symmetry (or *CP* symmetry).

Note 3

Some of the symbols shown on Appendix 1 are not used in this article. They are shown for completeness only.

Note 4

There are two conventions when referring to anti-quarks. The first convention is (1) anti-up quark, anti-down quark, anti-strange quark, anti-charm quark, anti-bottom quark and anti-top quark. The second convention is (2) up anti-quark, down anti-quark, strange anti-quark, charm anti-quark, bottom anti-quark and top anti-quark. In this article I use the first convention.

Note 5

CERN researchers have later announced that the data is insufficient to indicate whether all five quarks are in a strong bound state (as the constituents of a single particle or pentaquark) or whether a baryon and a meson are weakly bound (meaning as two separate particles).

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