<u>MATTER ANTI-MATTER ASYMMETRY</u>

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Abstract

Examining the constituent quaternionic processes that go into the creation of particles in the DGO Standard Model reveals an imbalance in the ratio of matter and anti-matter particles, which may explain the subsequent imbalance observed in the Universe, also known as the Charge-Parity violation.

Keywords

Matter, antimatter, CP violation.

Matter & Anti-matter

Matter and anti-matter are created in equal parts. So why is there more matter in the Universe than anti-matter? If the amount of anti-matter was equal to the amount of matter at the creation of the Universe, then it would have all annihilated leaving only radiation. Since this obviously didn't occur, physicists reason that there must be some factor that privileges the existence of matter over anti-matter. They have spent the last number of decades trying to figure out what that factor is.

To date, physicists have examined the strong interaction and the quark sector. But the effects they have found have been too minor. In this paper, we ask could the answer lie in the DGO take on the Standard Model? If so, then, it may reside in the quaternionic procedures used to generate fermions and bosons in the DGO model.

The first step in this process is to !Δ multiply two quaternionic four-vectors (Here, I'm using '•' as the matrix multiplication operator):

$$(a1 + bi + cj + dk) \bullet (e1 + fi + gj + hk)$$

This gives us the following results:

-ae - af(i) - ag(j) - ah(k)
-be(i) + bf - bg(k) + bh(j)
-ce(j) + cf(k) + cg - ch(i)
-de(k) -df(j) + dg(i) + dh

The matrix result for !Δ and Δ can be seen below and correspond to the W and Z boson matrices, in the DGO Model. We will label them W and V for Δ and ! Δ respectively:

```
W = [[-1,  1, -1],
     [-1, -1,  1],
     [ 1, -1, -1]]

V = [[ 1, -1,  1],
     [ 1,  1, -1],
     [-1,  1,  1]]
```

In order to make these into real valued coordinates in preparation for their summation in Δ and !Δ, each of the above matrices (W and V) must be multiplied by the following two matrices respectively.

```
W1 = [ 1,  1, -1],
     [-1,  1,  1],
     [ 1, -1,  1]

V1 = [-1, -1,  1],
     [ 1, -1, -1],
     [-1,  1, -1]
```

Following on from this, the results are individually summed together with W and V to make the first generation of quarks; *u* and *d*.

```
u = [-2,  0,  0],
    [ 0, -2,  0],
    [ 0,  0, -2]
```

$$d = \begin{bmatrix} 0 & 2 & -2 \\ -2 & 0 & 2 \\ 2 & -2 & 0 \end{bmatrix}$$

But clearly there is no reason why W and V and W1 and V1 should be summed in this way or even summed at all. Since addition in !Δ is simply equal to subtraction, it makes just as much sense to subtract as it does to add and to add and subtract in different permutations leads to yet more results. These results include the anti-matter particles.

$$u^* = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$$

$$d^* = \begin{bmatrix} 0 & -2 & 2 \\ 2 & 0 & -2 \\ -2 & 2 & 0 \end{bmatrix}$$

If matter-antimatter creation follows the above rules in a completely random sense, then it will produce all such possible combinations. First we have the addition combinations:

$$\{W + W1\}\ \{W + V1\}\ \{V + V1\}\ \{W1 + V\}$$

Then, there are the set of subtractions:

$$\{W - W1\}\ \{W - V1\}\ \{V - V1\}\ \{W1 - V\}$$

These are the results of the addition and subtractions:

$$\{W + W1\} = d$$
$$\{W + V1\} = u$$
$$\{V + V1\} = d^*$$
$$\{W1 + V\} = u^*$$

$$\{W - W1\} = u$$
$$\{W - V1\} = d$$
$$\{V - V1\} = d^*$$
$$\{V - W1\} = d^*$$

The final tally is 2 d quarks, 3 anti-down quarks, 2 up quarks and 1 anti-up quarks:

$$d, u, d^*, u^*, u, d^*, d^*, d$$

Pairing these 8 particles off gives us 3 π^0 and 1 π^- :

$$(d, d^*), (u, u^*), (u, d^*), (d^*, d)$$

There are, of course, other ways of arranging the above material. We could for example arranged it as 5 different π mesons.

$$(u, d^*), (d, u^*), (d, d^*), (d^*, u)$$

These mesons are unstable and breakdown further into lepton matter anti-matter pairs. Since d quarks are heavier than u quarks, there is an asymmetry in mass-energy here between matter and anti-matter. The asymmetry goes in the direction of the anti-matter, which suggests that our universe is actually made of anti-matter. But since that doesn't matter to us, we could simply switch the matter and anti-matter signs from now on.

Alternately, it means that we have our matrices labelled backwards (i.e. u should be u*, and so forth). This, however, leads us to back to our original conclusion that what we label as matter is actually anti-matter. The reason for this is that the natural way of producing these matrices (Δ) should lead — presumably — to matter and not anti-matter. The fact that it doesn't suggests that matter is more of an afterthought in the creation of the Universe than anti-matter, which is counter-intuitive. Either that or Δ summation is the afterthought and our universe is privileges $!\Delta$ rules, which is ultimately equivalent to saying that the entire basis of our mathematical system is an afterthought, and not how the Universe views it at all.

Lepton Sector

Naturally, we can do the same operation with the weakly charged leptons.

e, ve, e*, ve*, ve, e*, e*, e

These can be rearranged in various ways.

> {('e*', 'e*'): 6, ('ve*', 've*'): 1, ('ve', 'e*'): 5, ('ve*', 'e'): 1, ('e', 've'): 2, ('ve*', 've'): 1, ('e*', 've*'): 1, ('e', 've*'): 1, ('ve', 've'): 3, ('e*', 'e'): 3, ('ve*', 'e*'): 2, ('ve', 've*'): 1, ('e*', 've'): 1, ('ve', 'e'): 2, ('e', 'e'): 3, ('e', 'e*'): 3}

Some of these result in annihilations and others are themselves the results of interactions or decays or other particles. Since many of the decays would imply the existence of nucleons for them to occur, we shall focus our attention there, in the quark sector.

Quark Sector

There were 8 possible new particles pairs in the quark sector. These pair up to form the following groups:

(d, d*), (u, u*), (u, d*), (d*, d)

If we generate a Cartesian Product set of these particles taken 3 at a time, we arrive at a universe of 512 nucleons. We can write a small program to make sense of our miniature Universe and weed out the impossible nucleons:

> ('d*', 'd*', 'u*') 9, (‘u*', 'd*', 'd*') 9, (‘d*', 'u*', 'd*') 9 = 27 antineutrons
> ('d*', 'u*', 'u*') 3, (‘u*', 'u*', 'd*') 3, (‘u*', 'd*', 'u*') 3 = 9 antiprotons
> ('u', 'd', 'd') 8, (‘d', 'u', 'd') 8, (‘d', 'd', 'u') 8 = 24 neutrons
> ('u', 'u', 'd') 8, (‘d', 'u', 'u') 8, (‘u', 'd', 'u') 8 = 24 protons

After annihilation, we are left with 3 antineutrons and 15 protons, which suggests the balance of matter-antimatter is now swinging back in the direction of matter. This is a Universe, where no neutrons exist, which is certainly a problem. However, from a purely mass-energy point of view, it is also a universe with considerably more matter in it, with a ratio of about 455:116 matter to antimatter, which is close to a 4-fold increase: or ~3.9224137931034483.

Compared with other methods, which look at the CP Violation in relation to the Strong Interaction, the quark sector or the lepton sector, the DGO method can find an imbalance in the quarks, leptons, and in the bosons which bridge and govern their creations. Therefore, the CP violation is not limited to one corner of the particle universe. It is a system-wide event.

Conclusion

DGO quaternion multiplication naturally produces a matter-antimatter imbalance by means of the permutations of particle creations. However, the imbalance is not perfect and leads to a universe devoid of neutrons. From a mass-energy point of view, this is a 4-fold CP Violation.