The preponderance of matter: Asymmetrical genesis via the antineutrino route

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Abstract

The existence of the universe is an enigma because the energy at genesis should have created equal amounts of matter and antimatter, which should have subsequently annihilated. What happened in the baryogenesis process to cause matter to predominate in the cosmos? A candidate conceptual solution is presented based on the cordus conjecture, and featuring the antineutrino in a prominent role. A detailed model is produced for the production of an electron-antielectron pair from photons. The novel contribution is showing how the discrete field structures of the photon dynamically transform into those of the two massy particules. A new production process is detailed whereby an energetic antielectron is remanufactured into a proton and two antineutrinos. The production process could equally have converted electrons to antiprotons, and a tentative explanation is given for why this might not have happened. Therefore it is suggested that the apparent asymmetry of baryogenesis is because the antimatter is hiding in plain sight, having been remanufactured into the matter baryons themselves. In this model four photons are transformed into an electron and proton, i.e. a hydrogen atom, and two antineutrinos. The antimatter field structure of the antielectron is carried away by the antineutrinos as a waste stream. This paper therefore provides an alternative conceptual solution to the baryogenesis asymmetry in the universe, and it also explains the leptogenesis asymmetry. As a corollary, the conditions are identified under which the proton may decay.

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1 Introduction

The conversion of energy, i.e. a photon, into a matter-antimatter pair is well known. Indeed, while energy and matter are interchangeable as per $E = mc^2$, the transaction always involves both matter *and* antimatter. We never see energy transfer directly to only matter. Current technology is able to replicate these processes. However there is a deeper question when it comes to applying these principles to the formation of the universe, and this is the asymmetrical abundance of matter and antimatter.

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Asymmetry of baryogenesis

The universe, at least our part of it, is made of matter. The energy at genesis *should have* created equal amounts of antimatter, which should have subsequently annihilated. It is an enigma as to why a matter-based universe should even exist. Given that photons can convert to matter and antimatter, what happened in the baryogenesis process at the formation of the universe to cause matter to predominate?

While it is not impossible that there might be parts of the universe that consist of antimatter, and thereby balance the matter, neither is there any evidence that this is the case [1]. Therefore it is generally accepted that the observed matter universe is probably a result of an asymmetrical production of matter in the first place. What biased the genesis process to form matter?

Some unknown process caused baryogenesis, the asymmetrical production of baryons, i.e. the heavy particles like quarks, protons and neutrons. Another process, also unknown, is required for asymmetrical leptogenesis, i.e. production of matter electrons. This is a requirement of charge conservation, which applies everywhere else in physics and is generally thought to apply to the universe as a whole. Thus we need two processes: one to create a predominance of protons over antiprotons, and another to make electrons rather than positrons (antielectrons).

Existing theories include:

- The initial conditions imposed on the universe favoured matter. In other words the constraint came from outside the universe. This explanation is generally dismissed as unnatural [1].
- The Sakharov criteria for the imbalance of matter-antimatter require, inter alia, that charge-parity (CP symmetry) violation must occur [2]. However the mechanism for CP violation is unknown. Leptogenesis via gravity waves have been suggested [3].
- Electroweak baryogenesis in the Standard Model [4, 5].
- Modifications to the Standard Model. One pathway is that right-handed neutrinos might decay into leptons, and those in turn converted by *sphalerons* into bosons. The sphalerons are assumed to have existed at the high temperatures at the formation of the universe, and not thereafter. However right-handed neutrinos are controversial as they have not yet been observed, and even the existence of mass for standard neutrinos is uncertain.
- Leptogenesis using a hypothesised *singlet neutrino* that subsequently decays preferentially into antineutrinos, which are in turn converted to matter. Alternatively, that neutrinos and antineutrinos have slightly different native properties [6]. Sterile neutrinos are also a contender [7].
- A variety of supersymmetry theories including grand unification theories (GUT), the Affleck–Dine mechanism [8], and heavy Majorana neutrinos [9]. However the evidence for supersymmetry is not compelling, and the simpler versions are not evident in the LHC data from CERN [10] as might be expected.

This is not a complete list, but rather indicative of the theoretical approaches. There are many hybrids between these approaches, and some also address dark matter, e.g. [11]. The predominant method is mathematical analysis and modelling, almost without fail, and within the bounds of such a method there is evidence of much creativity and innovation. However there is no obvious way to judge the validity of the many solutions, except by building large colliders to check the existence of the new particles they predict.

At present neither the Standard Model of quantum mechanics (QM), nor current extensions thereof, nor supersymmetry, can explain baryogenesis [12]. More complex models of those theories may yet be successful, or it may be that a different physics is required.

The purpose of this paper is to apply the cordus conjecture [13], which re-conceptualises the internal structure of particules, to explore the asymmetrical genesis of matter-antimatter. Cordus proposes that the particle is *not* a zero-dimensional point, but has two reactive ends and discrete field structures, see Figure 1 for some examples of the structure.[2] The idea has been used to explain several effects including wave-particle duality [14], entanglement [15], electricity-magnetism-gravitation [16], matter and antimatter [17], annihilation [18], neutrino structure [19], and the weak interaction [20].

Our previous cordus work on the field structure of the neutrino [19], suggested that the neutrino was not a Majorana particle, and also precluded the existence of the right-handed neutrino. If true, this would invalidate many of the above theories, so it is clear from the outset that the cordus approach is not going to be orthodox.

[2] The cordus conjecture is that all particles, e.g. photons and electrons, have a specific internal structure of a *cordus,* comprising two *reactive ends*, with a *fibril* joining them. The reactive ends are a small finite *span* apart, and energised (typically in turn) at a frequency, at which time they behave like a particle. When energised they emit a transient force pulse along a line called a *hyperfine fibril (hyff),* and this makes up the field. We call this a cordus 'particule', and stress it is very different to the zero-dimensional point assumed by conventional physics.

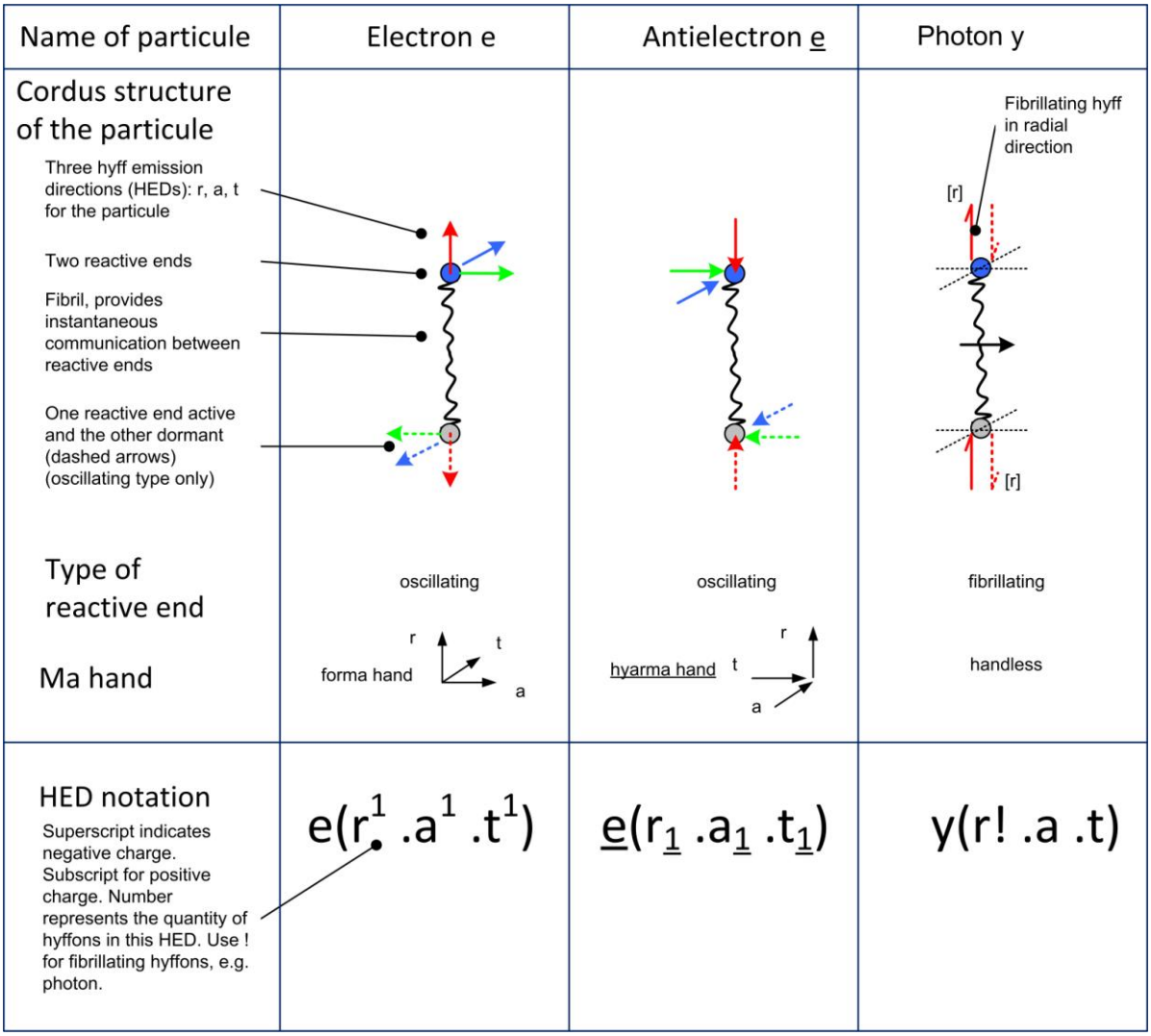

Figure 1: Cordus models for the electron, antielectron, and photon. The basic cordus structure is shown, including reactive ends, fibril and hyff. Also shows are the different characteristics of their hyff pumps: oscillating and fibrillating. Underneath is the shorthand representation of the field structures using cordus HED notation. For HED notation see [21].

Fundamentally what we need to do is show how photons could be converted to massy particles including electrons and protons, with a lesser number of antiparticles.

Pair production and Two-photon physics

Where two photons are involved, conventional physics assumes that photons do not couple directly with each other, but instead one of the photons fluctuates into a particle-antiparticle pair, and the other photon is absorbed into (couples to) one of those particles, hence *two-photon physics*. The particle-antiparticle pair is thought to comprise leptons or quarks, and their antiparticle, e.g. pion or kaon pairs. The fluctuation is held to be a random event driven by the Heisenberg uncertainty principle.

Unfortunately the mechanism for converting a photon into a matter-antimatter pair is unknown. This is an obstacle to the understanding of baryogenesis: if we do not understand the first stage of conversion into particle-antiparticle pairs, then it is going to be difficult to find where the asymmetry creeps in. So we probably have to understand the pair production process first.

Cordus has already shown why the problem is difficult: the nature and number of field structure (hyff) for the photon (one at each reactive end, fibrillating) is very different to those of the massy particules like the electron (one or more, pulsating) [22]. So the conceptual leap from the one to the other is large: they are not simply similar states that can randomly jump from one to the other in some Markov-like process. Instead there are substantial structural changes that are required to convert a photon into a quark or electron.

Fortunately cordus also suggests some solution paths that could be explored, and some to be avoided. There is no value in approaching it from the uncertainty principle, for two reasons. First, that principle is devoid of deeper mechanisms: it is merely a statistical summary. Second, cordus refutes the conventional uncertainty principle as it is usually formulated, though supports a modified form [15]. Instead a more useful approach would seem to be via the discrete field structures of particules. QM does not have a robust theory in this area, but cordus does and has already used it to explain the annihilation process [18, 21], infer the structure of the neutrino [19] and the W bosons [20]. So the idea is to draw on this theory to work out how photons are converted to electron-antielectron pairs, and then examine how the antielectron can be remanufactured.

2 Method

Our previous work on neutrino structure [19] provided an interesting clue for the genesis question, since it suggested that the purpose of the neutrino was to remove unwanted HEDs, including those of the unwanted hand, from assemblies.

'Unwanted hand' is exactly the genesis asymmetry problem. This is because the difference between matter and antimatter is ma-hand, at least in the cordus explanation [17]. So the germ of the concept is this: Is it possible that the neutrino (or antineutrino) might have removed the unwanted hand from antimatter? Starting from photons, is it possible to conceptualise a genesis process where the antimatter is consumed within the process, so that the asymmetry never arises?

We now explore that idea by working out the field structures for a genesis scenario. The method used is HED notation [21] and the HED mechanics for the manipulation of these field structures in re-assembly situations [19]. HED notation models the three *hyff emission directions* (HEDs) at each of the two reactive ends of a particule, and how those HEDs are filled with hyffons (discrete field elements).

3 Genesis via discarded neutrinos

There are three stages in this genesis model, and they are all important. We first provide a cordus model for the production of an electron-antielectron pair from photons. We then show how the involvement of the antineutrino can remanufacture the antielectron into a proton. Thereafter we explain why the process consumed antielectrons rather than electrons.

3.1 Production of an electron-antielectron pair

Cordus model for annihilation

We have already shown how the process of electron-antielectron annihilation occurs [18]. We produced a 3D model of how the discrete field structures (hyffons) of those two particules reassemble and form photons. We can also represent the process symbolically in the HED notation [21]:

$e(r^1 .a^1 .t^1)|_{0\ deg} + \underline{e}(r_{\underline{1}} .a_{\underline{1}} .t_{\underline{1}})|_{180\ deg}$

$=> O(r^1_{\underline{1}} .a^1_{\underline{1}} .t^1_{\underline{1}})$

$=> y_b(r! .a .t)|_{0\ deg} + y_c(r! .a .t)|_{180\ deg}$

$=> y_b + y_c$

$=> 2y$

Thus an electron-antielectron pair annihilates to two photons.

The inverse process is known to occur, whereby a photon transforms into an electron and antielectron, hence pair production. It is commonly represented as involving a single input photon.

Cordus production of an electron-antielectron pair

The cordus model for production of an electron-antielectron pair is simply a reverse of the annihilation process:

$2y => y_b(r! .a .t)|_{0\ deg} + y_c(r! .a .t)|_{180\ deg}$

$=> O(r^1_{\underline{1}} .a^1_{\underline{1}} .t^1_{\underline{1}})$

$=> e(r^1 .a^1 .t^1) + \underline{e}(r_{\underline{1}} .a_{\underline{1}} .t_{\underline{1}})$

However we need to check that process further, and work out the details. Note that cordus suggests that two photons are required (not one) for the production of an electron-antielectron pair, and that they need to be in complementary (opposite) phases. So there is a small discrepancy between cordus and conventional physics regarding the number of photons involved, and the way they couple. Possibly this may be testable.

Of course, if a single photon is able to split into two sub-photons of opposite phase – which cordus does not forbid – then there may be no discrepancy at all. Either way, we do not think it is a big obstacle, as the

larger point is that production of an electron-antielectron pair is possible: both cordus and quantum mechanics agree on that.

The 3D field-model for cordus electron-antielectron pair production is shown in Figure 2.

The Reader is referred to the diagram for a detailed explanation. In essence, the incoming photons are unable to negotiate shared use of the field emission directions (HEDS) (1.3), nor evade each other, so are forced to convert to the oscillating type of reactive end instead (2.1). This type has one reactive end active and the other dormant, thereby satisfying the constraints. The process also creates a new fibril to coordinate the new pairs of reactive ends (2.2). This type also requires three hyff, so a 3D field structure is set up (3.1) according to the ma hand system (4.1).

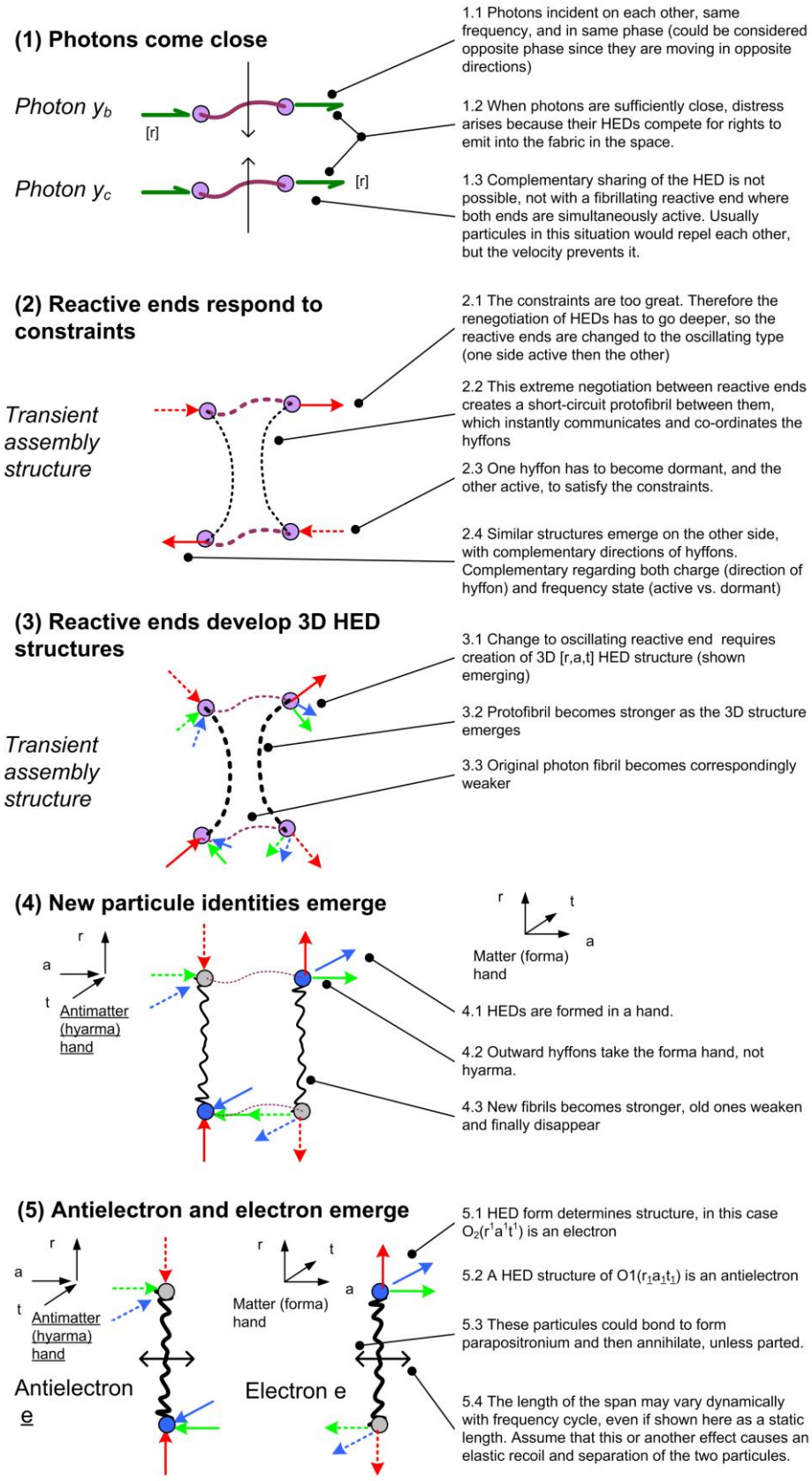

Figure 2: The cordus production process for converting two photons into an electron-antielectron pair.

Curious features and future work

We acknowledge that we have not explained all the deeper mechanics of how the reactive ends transform, nor even identified the composition of the fibrils and hyffons. At this point we simply propose their existence as part of the cordus lemmas, and leave their elucidation for future work. However there are two effects that are curious and need commenting.

The first is that we need to assume that the outward hyffons take the forma hand, not hyarma (4.2). We do this to avoid the formation of the positive notElectron $!e(r_1 .a_1 .t_1)$ and negative antinotElectron $\underline{!e}(r^{\underline{1}} .a^{\underline{1}} .t^{\underline{1}})$ at step 5.2. We came across these structures previously in the model for the neutrino-antineutrino annihilation process [20](lemma Ma.7.3). We do not see these structures in our universe. As we identified there, we are uncertain whether these structures are an artefact of the cordus HED method, or really are forbidden. If the latter, we suspect that the verboten-constraint arises with the ma hand: the primary charge in the forma hand is negative, as indeed the definition of the hand shows. In other words, there are only two hands in a 3D world, and for these to be unique regardless of rotation, the direction of the arrows (direction of propagation of hyffons) must also be built into the hand.[3]

To put it another way, a notElectron cannot form alone, but would be accompanied by an antinotElectron. There is a precursor assembly structure, and it has no incentive to go down this particular path. Also, where notPositronuim assemblies might occur, they can reverse back out into photons instead [20].

The second issue is that the output electron and antielectron particules could bond to form parapositronium and then annihilate back to photons (5.3), see [18, 21]. To avoid this, they must be parted before they form such bonds. We have not worked out the parting mechanism in detail. Our current concept is that an elastic recoil and separation of the two particules occurs, due to the way the span varies dynamically with frequency cycle (5.4).

Therefore, these other matters outstanding, we have provided a conceptual model for how the field structures of the photons are reassembled into an electron and antielectron.

The next concept shows how to get rid of the antielectron.

[3] So there are two basic configurations of the twin-hand-system, and therefore the deeper question is why the pre-universe physics chose forma to be negative charge not positive (and hyarma positive not negative). However we can dismiss this, on the grounds that the universe had to go with one configuration or the other, and the outcome would have been the same to any observer inside the universe.

3.2 Remanufacture of the antielectron

We now show how the antielectron (positron) may have its hand changed to convert it into matter.[4] In summary, the waste antimatter hand is discarded in the antineutrino. We illustrate this process with the HED notation.

HED model of leptogenesis and baryogeneis

Given the electron-antielectron pair production:

$$2y \Rightarrow e(r^1 .a^1 .t^1) + \underline{e}(r_{\underline{1}} .a_{\underline{1}} .t_{\underline{1}})$$

Now add the energy equivalent of an additional two photons in the form of a triple bolus ($\downarrow\downarrow\downarrow = r_1^{\underline{1}} .a_{.1}^{\underline{1}} .t_1^{\underline{1}}$), and a twin-pair ($\uparrow\downarrow = x_{\underline{1}}^{\ 1}{}_1^{\underline{1}}$). These arrows represent balanced pairs of hyffon-antihyffon, and their mechanics were identified in the work on neutrinos [19]. Essentially, these structures are balanced regarding *both* charge *and* hand (matter-antimatter). Thus a single hyffon pair, ↑ or ↓ may not be added, only a twin set or a triple bolus. The hyffon pairs are added by inspection, with a particular target in mind. In this case the target is a proton, the HED structure of which has also been previously inferred [19]. Thus the production process is:

$$2y + 2y \Rightarrow e + \underline{e}(r_{\underline{1}}.a_{\underline{1}} .t_{\underline{1}})(\downarrow\downarrow\downarrow)(\uparrow\downarrow)$$

Now bring all the hyffon-antihyffon pairs (arrows) into the antielectron[5] and expand them to create a transitional structure O:

$$\Rightarrow e + \underline{e}(r_{\underline{1}\uparrow\downarrow\downarrow} .a_{\underline{1}\downarrow} \ .t_{\underline{1}\downarrow})$$

$$\Rightarrow e + O(r_{\underline{1}.\underline{1}}^{\ 1}{}_1^{\underline{1}}{}_1^{\underline{1}} .a_{\underline{1}.1}^{\ \underline{1}} \ .t_{\underline{1}.1}^{\ \underline{1}})$$

Intermediate structures like this are unstable since they have hyffons of mixed hand (matter-antimatter) and they are overloaded with hyffons. Other examples of these assemblies are the W and Z bosons [20]. They have a tendency to reorganise into simpler and more stable structures. Extract a proton $p(r_{11}^{\ 1}.a_1.t_1)$ and put the remaining hyffons into another transitional structure O_1:

$$\Rightarrow e + p(r_{11}^{\ 1}.a_1.t_1) + O_1(r_{\underline{1}.\underline{1}}^{\ \underline{1.1}} .a_{\underline{1}}^{\ \underline{1}} \ .t_{\underline{1}}^{\ \underline{1}})$$

Extract an antineutrino $\underline{\nu}(r_{\underline{1}}^{\ \underline{1}} .a \ .t_{\underline{1}}^{\ \underline{1}})$ and put the remaining hyffons into a transitional structure O_2:

$$\Rightarrow e + p + \underline{\nu}(r_{\underline{1}}^{\ \underline{1}} .a \ .t_{\underline{1}}^{\ \underline{1}}) + O_2(r_{\underline{1}}^{\ \underline{1}} .a_{\underline{1}}^{\ \underline{1}} \ .t)$$

Move the hyffons about in O_2 (colour change) and identify it as another antineutrino:

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[4] We generally use the term 'reassembly' for the movement (colour change) of hyffons in the processes of particule transformation. However we use 'remanufacture' in this particular transformation since it is the change in hand (L: *manus*) that is the focus.

[5] Note the assumption that it is the antielectron that transforms, not the electron. We explain why later.

$$\Rightarrow e + p + \underline{v} + \underline{v}\ (r_{\underline{1}}^{\underline{1}} .a\ .t_{\underline{1}}^{\underline{1}})$$

Therefore the reaction as a whole is

$$2y + 2y \Rightarrow e + p + 2\underline{v}$$

To sum up, the cordus model for genesis shows that four photons are remanufactured into an electron, a proton, and two antineutrinos.

This prediction may be testable and falsifiable.

3.3 Dominance of the matter-production stream

Why did the forma matter hand prevail?

This model starts with the production of an electron-antielectron pair, after which the antielectron is remanufactured. By why the antielectron? Why were electrons not remanufactured to antiprotons? Why not 2y + 2y => $\underline{e}$ + $\underline{p}$ + 2v instead?

In other words, while we may have solved the problem of where the antimatter has gone to, there is a deeper asymmetry. What switched the production process to the matter route?

Our current conceptual answer is that there may have been a species war in the beginning, where *both* production processes were at work. We imagine an initial extraordinarily energetic photon-pair colliding[6] and producing an electron and antielectron. With both streams of the remanufacturing process active, electrons and protons would have been created, alongside antielectrons and antiprotons. Any mixing across the species would have further annihilated back to photons. Those photons in turn would have been available to feed back into the production processes again, providing they were energetic enough.

At this point we invoke the cordus field model for electrostatic-magnetism-gravitation and the fabric [16, 23, 24]. Once some matter and antimatter particules had formed they would produce handed hyff and propagate those out, producing a proto-fabric (spacetime). That fabric would carry a matter forma hand, or an antimatter hyarma hand [17]. In turn that fabric would predispose the production processes it encountered to switch into the same hand. The massy particules would have extraordinary energy, hence high frequency. In turn that frequency would create an enormously high mass and strong fields.

Domains of matter and antimatter may have formed, being multiple separate volumes of space where one of the hands dominated. Generally we would expect that these domains would be geometrically symmetrical with respect to each other.

[6] Readers who prefer a faith interpretation could call this the 'Handclap of God'.

There could have been a stage of domain warfare as the domains aggregated, broke up, and forcibly converted opposing domains. We assume that somewhere in there the geometric symmetry broke down, so that the matter and antimatter domains were not the *exact* mirror images of each other. We can see several possibilities for how the geometric asymmetry might first have arisen: external perturbation from outside the universe; a random event in an increasingly large and disorderly system, i.e. a consequence of growing complexity; a natural oscillating dominance between the two species that was frozen in as the system expanded and cooled, i.e. the proto-universe was flipping between matter and antimatter dominated states when suddenly the fuel was cut off and the state at the time dominated. This last idea is our currently preferred model.

Cosmological start-up process

Whatever the cause of the switch, the forma fabric obtained the edge in dominance, and grew that to dominate the cosmos. This forma fabric then controlled which branch the remanufacturing process took, and thus antielectrons were converted to protons, rather than electrons to antiprotons. With time[7] the proto-universe became dominated by matter.

The production process would have caused the particules to move outwards (Ma.9.1.5). Also, the initially high-energy protons and electron would blow off their extra energy as photons. This and the cascade of formation-annihilation would have produced a cloud of photons, the energy of which would have decreased as the process consolidated energy into massy particules and the products expanded. Also, the photons themselves would move and escape, and therefore become unavailable for reuse. Eventually the genesis photon cloud would be too cool and lacking in density, and the formation of matter would abruptly cease.

Why do we not see this process today?

The photon density and energy in the current universe are insufficient for the remanufacture process to convert antielectrons into protons. Also, the fabric density in the current epoch is too low to predispose the remanufacture process exclusively into the matter branch. So antielectrons are allowed to exist at this stage, whereas they would have been mangled to protons in the early universe.

To sum up, the remanufacture process initially had two balanced workstreams, converting antielectrons into protons, and electrons into antiprotons. However the process was biased into the former. The tentative explanation is that the two process streams oscillated in their dominance and this was frozen-in as the system cooled.

[7] Time in the cordus context refers to the frequency cycles of the particules involved, rather than any absolute time. So time would have passed in the early universe, but since the particules had high energy and therefore high frequency, time would have flowed very fast.

3.4 Other implications

Looking at the equation 2y + 2y => e + p + 2$\underline{v}$ and noting that in general all these equations can be reversed, suggests that that the proton may not be absolutely stable. Hitting it with two antineutrinos should remanufacture as follows:

$$p + 2\underline{v} => p(r_{11}{}^{1}.a_1.t_1) + \underline{v}_1(r_{\underline{1}}{}^{\underline{1}}.a.t_{\underline{1}}{}^{\underline{1}}) + \underline{v}_2(r_{\underline{1}}{}^{\underline{1}}.a.t_{\underline{1}}{}^{\underline{1}})$$
$$=> O(r_{11}{}^{1}{}_{\underline{1.1}}{}^{\underline{1.1}}.a_1.t_{1.\underline{11}}{}^{\underline{11}}) => |_{\%} + O(r_{11}{}^{1}{}_{\underline{1.1}}{}^{\underline{1.1}}.a_{1.\underline{1}}{}^{\underline{1}}.t_{1.\underline{1}}{}^{\underline{1}})$$
$$=> \underline{e}(r_{\underline{1}}.a_{\underline{1}}.t_{\underline{1}}) + O_1(r_{11}{}^{1}{}_{\underline{1}}{}^{\underline{1.1}}.a_1{}^{\underline{1}}.t_1{}^{\underline{1}})$$
$$=> \underline{e} + O_2(r_1{}^{\underline{1}}.a_1{}^{\underline{1}}.t_1{}^{\underline{1}}) + |_{\%} + O_3(r_1{}^{1}{}_{\underline{1}}{}^{\underline{1}}.a.t)$$
$$=> \underline{e} + O_2(\downarrow\downarrow\downarrow) + O_3(r_{\underline{1}}{}^{1}{}_{1}{}^{\underline{1}}.a.t)$$
$$=> \underline{e} + 2y + O_3(r\uparrow\downarrow.a.t)$$
$$=> \underline{e} + 2y$$

Where:

$(r_1{}^{\underline{1}}.a_1{}^{\underline{1}}.t_1{}^{\underline{1}}) = (\downarrow\downarrow\downarrow) = 2y$

$r_{\underline{1}}{}^{1}{}_{1}{}^{\underline{1}} = \uparrow\downarrow$ = nil

$|_{\%}$ = movement of hyffon to different HED (colour change)

This conceptually confirms the reverse direction. What this means is that the proton could unravel back into a positron and two photons, with the right kind of forcing by antineutrinos. However, given the low reactivity of antineutrinos, and their high speed, this would be a rare event.

4 Discussion

4.1 What has been achieved?

The main conceptual contributions of this work are:

- A detailed model has been produced for the production of an electron-antielectron pair from photons. The novel contribution is showing how the discrete field structures of the photon dynamically transform into those of the two massy particules. This model is conceptual in nature.
- A production process has been envisaged whereby an energetic antielectron is remanufactured into a proton and two antineutrinos. This idea appears not to have been considered before, and therefore may be novel in itself. In addition, the possible production process itself is detailed, and the inputs and outputs are predicted.
- The production process could equally have converted electrons to antiprotons, and a tentative explanation is given for why this might not have happened.
- The conditions are identified under which the proton may decay.

Qualitative description of genesis

This genesis process is therefore conceptually very simple: two initial photons get converted into an electron, and an antielectron. The antielectron receives another two photons, the field structures of which are used to form a larger structure that re-assembles into a proton and two antineutrinos. The original electron and proton combine to form a simple hydrogen atom. Fortunately for us in this universe, the antineutrinos have almost no reactivity with matter, so they simply escape the scene. The antineutrinos produced at the original genesis of the universe will now mostly be at the outer edge of the universe, having got into motion before the massy particules.

Purpose of the neutrino

Effectively the antielectron (positron) is reassembled, with some input energy, into a proton. The antimatter hand of the antielectron is carried away by the antineutrinos as a waste stream. Thus the purpose of the neutrino and antineutrino in the grand scheme of the particules is to remove unwanted HEDs, and in doing so it has the ability to also remove unwanted hand.

Dissolving the asymmetry

The significance is that we do not need to worry about the asymmetry of baryogenesis. Where has all the antimatter gone? The antimatter is hiding in plain sight, having been remanufactured into the matter baryons themselves. Well, almost all, since a small amount of the original antimatter energy has been discarded into the waste stream of antineutrinos.

Curiously, this cordus explanation suggests that it could be true, in a way, to say that the antimatter has been pushed to another part of the universe. However it is not antimatter in the form of antiatoms, antisuns, and antigalaxies, but a plain desert of relatively inert antineutrinos spread through the matter universe and at its edge.

4.2 What are the implications?

Parity violation

It may not be explicit, but the cordus genesis solution also implies a new concept for parity. Quantum mechanics struggles with parity. Historically there was an expectation that a particle and its oppositely-changed antiparticle should behave with the same physics (C-symmetry). This has been observed to be the case for effects like electromagnetism. However, it does not hold for quark-level interactions, so the next step was to add parity-symmetry, which is mirroring the co-ordinate system. Thus parity refers to symmetry of behaviour between a particle and its mirror structure (spatial inversion). Combining this with charge symmetry results in CP-symmetry, in which it is expected that behaviour should be the same for a particle and its spatially inverted antiparticle, i.e. that charge and parity were always inverted together so that the combination was still

preserved. However that too has been observed to be violated in kaons (particles comprising two quarks).

QM cannot explain why parity is violated, nor use the information in its baryogenesis models. This is a consequence of the QM insistence that particles are 0D points. A point has insufficient dimensions to support many variables, so it is reasonably obvious that particles cannot really be points at all, if we wish to have physical realism. Cordus provides an internal structure for particules, and therefore many more variables to explain effects like polarisation, spin and parity. The *reason* for CP violation becomes clear with cordus: the particule has a finite span, being the geometric distance between the two reactive ends. Nor are the two reactive ends energised simultaneously (except for the photon). Thus a particule is not symmetrical: a mirror image of the handed HED field structures of one reactive end is not identical to the other end. Furthermore, the mirror image of one whole particule is not identical to itself, and this is a key feature in the cordus model for antimatter [17].

Parity/handedness proved to be one of the keys in the cordus method for unlocking the problem of asymmetrical genesis. (That and the neutrino structure). The concepts of parity and handedness are core components in the cordus explanations of matter-antimatter, annihilation, and pair production. In turn those ideas were all used in the cordus genesis model. It is difficult to see how *any* genesis model could be created *without* some prior concepts for parity/handedness. The problem with quantum mechanics is that it assumes that matter is a zero-dimensional point [25] and therefore cannot construct a handed co-ordinate system.

Limitations

Cordus is a conjecture and there is no certainty that its mechanics are valid. It is based on a large set of assumptions or lemmas, any number of which could be wrong. We prefer to consider it a thought-experiment, or candidate solution, and a contribution to the ongoing epistemic journey of fundamental physics. The cordus conjecture does not have to be totally correct to achieve that. If the cordus conjecture were to be substantively true, then the implications for fundamental physics would be profound, because it refutes the 0D point construct of orthodox physics, and the edifice built on that conceptual foundation.

The whole of the cordus conjecture could readily be falsified by showing empirically that there is no possible way that data support an interpretation of a particle having two ends.

Implications for future work

There are several streams of potential future work. First, that the cordus conjecture needs testing for validity. Second, and if it passes that test, it will be necessary to quantify it, i.e. build a mathematical model around the concepts. *If* cordus is correct, then we would still expect it to be able to accommodate much of the QM machinery [26], which obviously works for most things.

5 Genesis lemmas

We made several assumptions in the genesis model, and these are summarised below as a set of lemmas. Each of these papers in the cordus series has identified its assumptions in this way, and together they form a qualitative statement of the cordus mechanics.

Ma.9 Asymmetrical genesis

Ma.9.1 Production of an electron-antielectron pair from photons.

Ma.9.1.1 Two photons are required (not one) for the production of an electron-antielectron pair.

Ma.9.1.2 These need to be in reinforcing phases, incident on each other, and the same frequency.

Ma.9.1.3 Where hyffons from fibrillating reactive ends (photons) are unable to negotiate shared use of the field emission directions (HEDS), nor evade each other, the issuing reactive ends may be forced to convert to the oscillating type of reactive end instead. The process also creates a new fibril to coordinate the new pairs of reactive ends, and requires the setup of a 3D field structure according to the ma hand system.

Ma.9.1.4 Outward hyffons must take the forma hand, not hyarma. Hence the formation of the positive notElectron $!e(r_1 .a_1 .t_1)$ is verboten. This is because the primary charge in the forma hand is negative.

Ma.9.1.5 An elastic recoil and separation of the resulting electron and antielectron occurs, rather than immediate annihilation, due to the way the span varies dynamically with frequency cycle.

Ma.9.2 Cordus model for genesis

Ma.9.2.1 Four photons are remanufactured into an electron, a proton, and two antineutrinos:
$2y + 2y \Rightarrow e + p + 2\underline{v}$

Ma.9.2.2 The antimatter hand of the antielectron is carried away by the antineutrinos as a waste stream.

Ma.9.2.3 The predominance of the forma (matter) hand at the start-up of the cosmos was due to warfare between the matter and antimatter domains. The currently preferred model, though there are other candidates, is that a natural oscillating dominance between the two species was frozen in as the system expanded and cooled.

Ma.9.2.4 The apparent asymmetry of baryogenesis is because the antimatter is hiding in plain sight, having been remanufactured into the matter baryons themselves.

Ma.9.3 Proton stability

Ma.9.3.1 The proton could unravel back into a positron and two photons, when struck by two antineutrinos.

6 Conclusions

What has been achieved here is a novel alternative conceptual model for the asymmetry of matter over antimatter in the universe. We started with the basic cordus idea that particles are not 0D points but have a distinct internal structure with two ends, and accept previous conceptual models for matter and antimatter and the annihilation process.

We then created a descriptive model for electron-antielectron pair-production, showing how the structures of the photon are reassembled into an electron and antielectron. That is a novel accomplishment in itself, though of course its validity depends on that of the underlying cordus conjecture itself.

Thereafter we showed that it was conceptually feasible that the antielectron could be eliminated using antineutrinos. In this cordus model for genesis it is proposed that four photons are remanufactured into an electron, a proton, and two antineutrinos. The original electron and proton combine to form a simple hydrogen atom. The antineutrinos have little reactivity, so they escape. The antimatter field structure of the antielectron is carried away by the antineutrinos as a waste stream.

We also gave some explanations for why the matter hand prevailed, not antimatter, during the cosmological start-up process. Therefore the apparent asymmetry of baryogenesis is because the antimatter is hiding in plain sight, having been remanufactured into the matter baryons themselves.

To answer the question identified at the outset:

Why is there more matter than antimatter in the Universe?

> The initial process converted energy into equal quantities of matter and antimatter, in the form of electrons and antielectrons (positrons). We propose that a second process converted the antielectrons into a matter form, namely the protons, and the waste antimatter component was carried off by antineutrinos.

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