Full Research Paper

Asymmetrical genesis by remanufacture of antielectrons

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Abstract: *The asymmetrical genesis problem concerns why the universe should have an abundance of matter over antimatter. This paper shows how the baryogenesis and leptogenesis asymmetries may both be resolved. The solution is given in terms of the transformation of particles under a set of remanufacturing processes. Specific predictions are given for these processes in terms of the discrete field structures of the Cordus theory. It is proposed that two initial photons are converted via pair production into an electron and antielectron. A second process remanufactures the antielectron into a proton. Two antineutrinos are emitted, removing the antimatter handed field structures. The original electron and proton may bond to form a simple hydrogen atom, or combine via electron capture to form a neutron and hence heavier nuclides. The preponderance of the matter pathways in the genesis production sequence is explained as domain warfare between the matter and antimatter species.*

1   Introduction

A deep foundational question is why the universe should have an abundance of matter over antimatter. This is the asymmetrical baryogenesis problem. The energy at genesis should have created equal amounts of matter and antimatter, which should have subsequently annihilated. 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 [1,2]. Therefore it is generally accepted that the observed matter universe is more likely a result of an asymmetrical production of matter in the first place. But what might have caused matter to predominate? Charge conservation, which applies everywhere else in physics and is generally thought to apply to the universe as a whole, requires two processes: one to create a predominance of protons over antiprotons (baryogenesis), and another to make electrons rather than positrons (leptogenesis). So two processes are required and both are obscure. The Sakharov criteria for the imbalance of matter-antimatter require, inter alia, that charge-parity (CP symmetry)

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violation must occur [3]. However the mechanism for CP violation is uncertain. In this paper we provide a novel alternative solution to both the baryogenisis and leptogenesis problems. Somewhat unusually, the solution does not require any new particles. It only uses known particles, but it does require them to have a specific covert-structure, reminiscent of a type of non-local hidden-variable (NLHV) design, which we elaborate.

2 Existing approaches to the asymmetry

At present neither the Standard Model, quantum mechanics (QM), or supersymmetry, can satisfactorily explain baryogenesis [4]. More complex models of those theories may yet be successful, or it may be that a different physics is required. Existing theories include the idea that 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 [2]. Another idea, also not considered likely is that the antimatter is still around [5], in some hidden places in the universe. Many of the theories attempt to directly show how CP or CPT violation may generate asymmetry [6] [7]. Leptogenesis is a common focus area, e.g. via gravity waves [8] or via neutrino oscillation and the see-saw mechanism [9]. There is also 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 [10]. *Sterile neutrinos* are also a contender [11] [12]. There are theories that propose electroweak baryogenesis in the Standard Model [13-15]. Modifications to the Standard Model have also been proposed. One pathway is that *right-handed* neutrinos might decay into leptons, and those in turn converted by *sphalerons* into bosons [16]. 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. A variety of supersymmetry theories exist including grand unification theories (GUT), the Affleck–Dine mechanism [17], and heavy Majorana neutrinos [18-20]. However the evidence for supersymmetry is not compelling, and the simpler versions are not evident in the LHC data from CERN [21] 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 [22-25]. There is no obvious way to judge the validity of the many candidate solutions.

A characteristic of many of these theories is that they are particle-centric: they formulate the problem in terms of a new particle being required to carry each new interaction. This approach has several difficulties. It is not easy to empirically validate the existence of the particles. Smaller particles require the construction of higher energy –and hence larger- colliders. Even with existing colliders, the empirical evidence for certain particles, especially those of super-symmetry, is lacking where it might be expected to be evident. And the unreactivity of the neutrino particles, which feature in many of the theories, makes them intrinsically difficult to observe. Also, there is no single strong candidate solution to have emerged from the

particle perspective, only many contenders. So there is no obvious ontological convergence towards a solution, other than a predominance of neutrino-based solutions.

3   Purpose and Approach

PURPOSE

Recent developments have suggested that the physics at the next deeper foundational level can be described by permitting particles to have internal functionality including the emission of discrete fields. A specific solution is the Cordus theory [26], which has shown wide-ranging relevance. The theory is a deeper interpretation than QM. It recovers QM and explains how the probabilistic formalism of QM arises from a deeper deterministic mechanics. Thus it proposes that physical realism exists and underpins the functional behaviour observed at the fundamental level. This is consistent with the original EPR idea [27]. The theory is therefore broadly compatible with QM, likewise also with general relativity and string/M theory.

The purpose of this paper was to use this new foundational physics to attempt a solution, if one could be found, to the problem of asymmetrical genesis of matter. This is worth attempting for several reasons. First, that existing theories have fared poorly and it is therefore worth looking more widely for solutions. Second, the Cordus theory has separately shown the feasibility of explaining the table of nuclides (stability behaviour H to Ne) [28] from first principles of the strong force [29], which has not been achieved by any other theory. There would be great value in also being able to explain the asymmetrical genesis process, since this would give a comprehensive production sequence for matter.

JUSTIFICATION OF ROBUSTNESS OF APPROACH

A brief justification is provided as to why such an approach should be considered scientifically sound. This new theory purports to provide a solution based on physical realism, using *covert variables*. That is similar to a *hidden variable* solution, and the soundness of such an approach needs to be addressed. There are particular challenges with taking a hidden-variable approach, since the Bell type inequalities [30-32] preclude *local* hidden-variable solutions. They do not preclude *non-local* hidden-variable (NLHV) solutions [33,34]: this is not contentious. However the *non-local* sector has not been productive, since it has been difficult to find candidate solutions in this area. The only historical candidate of note is the de-Broglie-Bohm theory of the pilot-wave [35,36], but this is still limited in its application to particle-locus situations, and has poor relevance to wider physics such as the nucleosynthesis situation under examination here. The NLHV sector is scientifically sound, but has generally been dismissed as worthless due to its inability to offer relevant solutions. It is notable that the other theories of fundamental physics also have their equivalents of 'hidden' variables. Thus quantum mechanics has its 'intrinsic' variables for which it is unable to provide any deeper explanation. Similarly string/M theory has its extra 'dimensions' which are presumed to be hidden, but also unexplained. So there cannot be any objection on philosophical

grounds of implausibility to the idea of covert variables, since all theories have them.

The Cordus theory [26] proposes that particles have a *covert structure* comprising internal structures and discrete fields. It identifies the general principles for these structures and predicts specific designs for each of the particles in the Standard Model and the corresponding antimatter species. These covert structures were identified using a design methodology, on the basis of identifying what minimal set of structure would be necessary and sufficient to explain the observed phenomena of wave-particle duality. Thus the initial concept was designed on the principle of requisite variability. Regarding the covert structures, the core postulate of the Cordus theory is that all particles are one dimensional structures of finite length, and from their two ends emit discrete forces that travel down flux lines in three orthogonal directions (hence hyperfine emission directions, or HEDs). This combination of internal structure and external discrete field structures is called a *particule*. A larger theory has been developed by systematic and logical development of the implications of the conjectured covert structures. This has been used to explain wave-particle duality, unification, nuclides (H to Ne), and time [26,29,28,37]. This has demonstrated that the initial idea of covert structures, which was developed to explain wave-particle duality, does have the capability to explain a wide range of phenomena with otherwise problematic causality, i.e. the theory has internal and external construct validity. This Cordus theory is the starting point for the present work. The results show that it is indeed possible to conceive of a solution to the genesis problem, with an outcome that takes a surprising and unexpected twist of causality.

A systems engineering design method was used for the overall theoretical development. The systems part of the method ensures that the sub-theories are logically consistent with each other, and the design part involves taking the *functional requirements* (observed physics) and inferring the *requisite attributes* (internal mechanics of the phenomenon). The discrete field model of the Cordus theory, specifically its HED mechanics (explained below) [38] was used to explore the theoretical feasibility of various genesis production routes. Several candidate processes were examined, but one stands out and is reported here. This involves the transformation of the antielectron (positron) into the proton. The following sections elaborate by showing the overall genesis process.

4   Results

4.1   Overall theory for the genesis production sequence

We propose a specific causality for the genesis production sequence, as shown in Figure 1. This diagram uses the systems engineering notation of integration definition zero (IDEF0) [39]. The IDEF0 model represents the proposed relationships of causality, and thus achieves for conceptual theory-development what mathematical formalism does in other areas of

physics. With IDEF0 the object types are inputs, controls, outputs, and mechanisms (ICOM) and are distinguished by placement relative to the box, with inputs always entering on the left, controls above, outputs on the right, and mechanisms below.

The theory proposes that the genesis process starts with pair production (1) converting a photon pair into an electron and antielectron. This is not controversial, but what is novel is that the Cordus theory provides a NLHV solution for how this might occurs at the fundamental level [40]. This explanation was based on a new operational definition of the matter-antimatter species differentiation, which is by the emission sequence of discrete forces, hence hand [41]. The theory also identified the processes of annihilation within this NLHV framework [42].

In the conventional narrative of physics, the asymmetrical baryogenesis problem is formulated as a need to bias the pair production process into the electron branch as opposed to the antielectron. However, here we make a conceptual departure from the orthodox by proposing that the asymmetry instead arises by the antielectron being consumed. Application of the HED mechanics (next section) identifies a route whereby the antielectron may be converted into a proton (2). This is also a parsimonious solution as not only does it explain asymmetrical baryogenesis, but asymmetrical leptogenesis is automatically taken care of too. However the HED mechanics also predicts a contrary process whereby the electron could be transformed into the antiproton, and consequently it is still necessary to explain why the process favoured the matter production route. The explanation (3) involves the Cordus *fabric*, which is the NLHV equivalent of space-time, and consists of three-dimensional space filled with the discrete forces of the other particules in the accessible universe [43].

The output of these processes are an electron and proton, which are sufficient to make a simple hydrogen atom. Neutrons are needed for the synthesis of more complex nuclei, and proton electron capture (4) can explain this. The Cordus theory also has an explanation for how this occurs at the fundamental level [38]. The final step of the genesis production sequence is nucleosynthesis (5). Here again the Cordus theory is able to offer explanations, this time to explain the nuclides (H to Ne) [28]. In summary, the solution proposed here for asymmetrical baryogenesis is not an isolated or ad-hoc concept, but is rather part of a systematic new NLHV theory for fundamental physics, a theory that is able to explain the whole process from the mass-energy equivalence of pair production, through to the preponderance of matter over antimatter at genesis, and onward to nucleosynthesis of the nuclides and their decay processes.
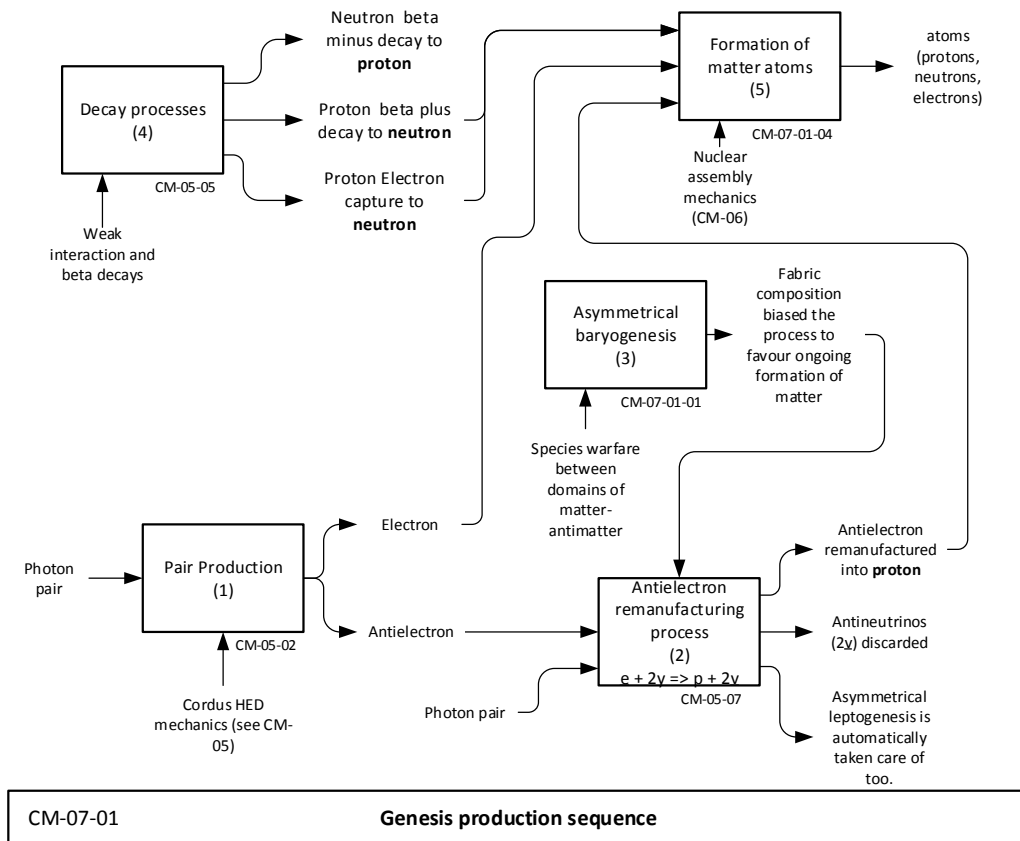
Figure 1. *Representation of the overall Cordus theory for the genesis production processes that resulted in matter.*

So it is conceptually possible to start with the discrete field structures of the photon, i.e. the evanescent field, and explain within one logically consistent theory how these are manufactured into the matter nuclides.

4.2 Pair production

By way of a brief summary of the Cordus theory, we present the inputs and outputs of the pair production process, see Figure 2. The detailed processes are described elsewhere [40].
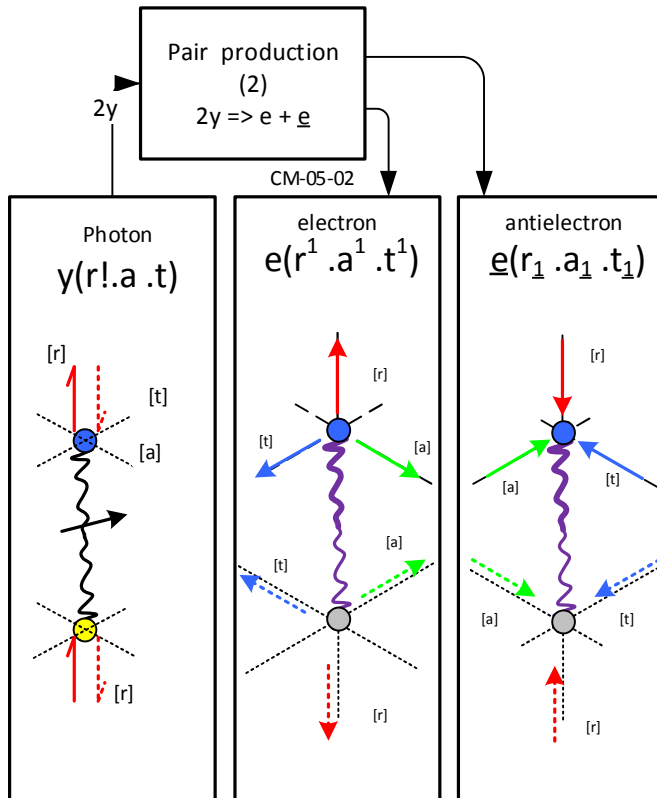
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Figure 2. *Pair production and the covert structures of the photon, electron, and antielectron particules according to the Cordus theory.*

MATHEMATICAL FORMALISM OF THE HED MECHANICS

The Cordus theory is mostly a conceptual theory, for two reasons. One is that it arose from a conceptual design methodology, and hence its core ideas were expressed in conceptual terms from the outset. The second is that it is a young theory and has not yet converted all those concepts into mathematical formalism. Nonetheless a formalism does exist for representing the discrete force arrangements of particules and predicting how those discrete forces may be remanufactured to create different particules. This is termed the *HED mechanics*.

The hyperfine-fibril emission direction (HED) mechanics is the covert-structure equivalent of Feynman diagrams for 0-D points. The HED mechanics is a set of rules for the manipulation of discrete forces. They are summarised as follows, as per [38]. These rules arise naturally from a core principle that a particule is defined by the pattern of discrete forces it emits, and therefore changes to the discrete forces cause the particule to change its nature. The pattern of discrete forces is represented in HED notation, which simply indicates the number of discrete forces in each of three orthogonal spatial directions [r, a, t], their charge (negative: x^1, positive: x_1) and matter-antimatter hand (antimatter uses underscore, e.g. $x_{\underline{1}}$). There are a number of assumptions in the HED mechanics, which are noted as lemmas. None are unreasonable, since they correspond to conservation principles that are already accepted in other physical theories.

1. The HED mechanics require the discrete forces to be conserved, rearranged, or even transformed, during transmutation and decay processes. Thus all discrete forces have to be accounted for, though they can be changed into other types as the annihilation theory shows.
2. The HED mechanics allow a charge- and hand-neutral complex of discrete forces to be added to any particle. This neutral complex comprises $x_{1.1}{}^{1.1}$ where x is one of the HED axes. The complex is represented symbolically by $\uparrow\downarrow$ where $\uparrow = x_1{}^1$ and $\downarrow = x_1{}^{\underline{1}}$. Being charge- and hand-neutral, this complex has no net energy. It is analogous to QM's idea of a vacuum fluctuation. Note that neither a single discrete force (say) x^1 nor a single pair (say)$\uparrow$ may be added to a particule ex vacuua: all such additions must be neutral as regards *both* charge and hand.
3. The structure $\uparrow\uparrow\uparrow$ = $[r_{\underline{1}}{}^1 \; . \; a_{\underline{1}}{}^1 \; . \; t_{\underline{1}}{}^1]$ corresponds to a pair of photons, alternatively an electron-antielectron pair [42]. This set of discrete forces may be added to a particule as part of energy absorption.

The application of HED mechanics to a particule, or assembly of particules, is best understood as a remanufacturing process. The discrete forces are permitted to change to other axes (HEDs), and separate/combine into other groupings, and thereby redefine the identity of the particule.

4.3   Remanufacture of the antielectron

A core proposition of the Cordus theory is that matter and antimatter are differentiated by hand, and that hand corresponds to the sequence of emission of the discrete forces [41]. There are only two ways this sequence can be arranged, hence only two species. Related to this, the Cordus decay theory [38] identified that the neutrino (or antineutrino) is an agent for changing the handedness of an assembled particule, while preserving charge. In other words, the neutrino species carry away unwanted matter or antimatter hand structures. In this theory the neutrino species are both a consequence and cause of species transformation. This explains why neutrino species are involved wherever there is a transformation between matter and antimatter products, as typically evident in the beta decays [38]. The Cordus theory also proposes that any particule is defined by its discrete force arrangements. This means that if some process rearranges the discrete forces, then that also changes the identity of the particule. Again, the beta decays are a typical example, where we see such actions as a proton being converted into a neutron. It is also possible to convert one type of discrete force into another, as is shown in the Cordus theory for pair production [40] and annihilation [42]. These transformation processes and their underlying mechanics are represented in HED mechanics [38]. Since this theory defines the matter-antimatter species in terms of hand, any transformation that involves crossing from one species to the other is here termed 'remanufacturing', and a variety of such processes are explained in the Cordus theory.

It follows that the genesis asymmetry problem may be reformulated as problem of *un-wanted hand*. Thus we suspected that the neutrino species may be involved in removing the antimatter hand from the antielectron and remanufacturing it to something different. We then explored the feasibility of this process. We found, by considering the discrete forces, that there is a route whereby this might occur, and it leads unexpectedly to the proton. Here follows the explanation, in terms of the HED mechanics, showing how the antielectron (positron) may be remanufactured into a proton. The HED mechanics makes the specific prediction that the waste antimatter hand is discarded in two output antineutrinos.

Start with pair production, where the electron (e) and antielectron ($\underline{e}$) pair arise from photons (y) [40]:

$$2y => e(r^1 .a^1 .t^1) + \underline{e}(r_1 .a_1 .t_1) \tag{1}$$

Note the use of underscore to denote antimatter species, superscript for negative charge, subscript for positive. Now add discrete forces: the energy equivalent of an additional two photons in the form of an electron-antielectron bolus ($\downarrow\downarrow\downarrow = r_1{}^1 .a_{.1}{}^1 .t_1{}^1$). Also add a twin-pair $z = [\uparrow\downarrow] = (x_1{}^1{}_1{}^1)$ which may be a vacuum fluctuation effect or photons (the theory is not specific on this point). These structures are justified in prior work [38]. Then:

$$2y + 2y + z => e(r^1 .a^1 .t^1) + \underline{e}(r_1.a_1 .t_1) + [\downarrow\downarrow\downarrow] + [\uparrow\downarrow] \tag{2}$$

Now bring the discrete force pairs (arrows) into the antielectron and expand them to create a transitional structure O:

$$4y+z => e(r^1 .a^1 .t^1) + \underline{e}(r_1\uparrow\downarrow\downarrow .a_1\downarrow .t_1\downarrow)$$
$$4y+z => e(r^1 .a^1 .t^1) + O(r_{1.1}{}^1{}_1{}^1{}_1{}^1 .a_{1.1}{}^1 .t_{\underline{1}.1}{}^1) \tag{3}$$

Note the assumption that it is the antielectron that transforms, not the electron - we explain why later. Intermediate structures like this are unstable since they have discrete forces of mixed hand (matter-antimatter) and are unbalanced. Other examples of these assemblies are the W and Z bosons [38]. The synchronous interaction (strong force) [29] constrains them to reorganise into simpler and more stable structures. Extract the *explicit* structure of a proton $p(r_{11}{}^1.a_1.t_1)$ [38] and put the remaining discrete forces into another transitional structure O_1:

$$4y+z => e(r^1 .a^1 .t^1) + p(r_{11}{}^1.a_1.t_1) + O_1(r_{\underline{1}.1}{}^{1.1} .a_{\underline{1}}{}^1 .t_{\underline{1}}{}^1) \tag{4}$$

By observation of the antineutrino structure $\underline{v}(r_1{}^1 .a .t_{\underline{1}}{}^1)$ [38], note that the transitional structure can be uniquely partitioned into two antineutrinos:

$$4y+z => e(r^1 .a^1 .t^1) + p(r_{11}{}^1.a_1.t_1) + \underline{v}(r_1{}^1 .a .t_{\underline{1}}{}^1) + \underline{v}(r_1{}^1 .a_{\underline{1}}{}^1 .t) \tag{5}$$

However we are not quite done, because other work [38] shows that the proton likely also has an *implicit* structure comprising balanced discrete forces that contribute to mass but not to change. Thus the full proton structure is expected to be:

$$p(uud) = p[(r_{1.1}{}^{1.1}{}_1{}_{.1}{}^1 .a_1{}^1{}_1{}_{.1}{}^1 .t_1{}^1{}_1{}_{.1}{}^1)$$
$$= p[(r_{1.1}{}^1 .a_1 .t_1)+(r^1{}_{\underline{1}.1}{}^1 .a^1{}_{1.1}{}^1 .t^1{}_{\underline{1}.1}{}^1)]$$
$$= p[(r_{1.1}{}^1 .a_1 .t_1)+(r\uparrow\downarrow .a\uparrow\downarrow .t\uparrow\downarrow)]$$
$$= p(r_{1.1}{}^1 .a_1 .t_1)* \tag{6}$$

Note that the implicit part is $[\uparrow\uparrow\uparrow] + [\downarrow\downarrow\downarrow]$, which by HED mechanics is four photons. These will need to be added to the initial inputs at Eqn 2.

Consequently the process of remanufacturing of the antielectron as a whole is predicted to be:

$$8y+z => e + p + 2\underline{v} \qquad (7)$$

To sum up, the Cordus theory for genesis proposes that eight photons (possibly nine depending on the identity of the z) are remanufactured into an electron, a proton, and two antineutrinos. This prediction may be testable and falsifiable. The overall process, including the initial pair production, is shown in Figure 3.
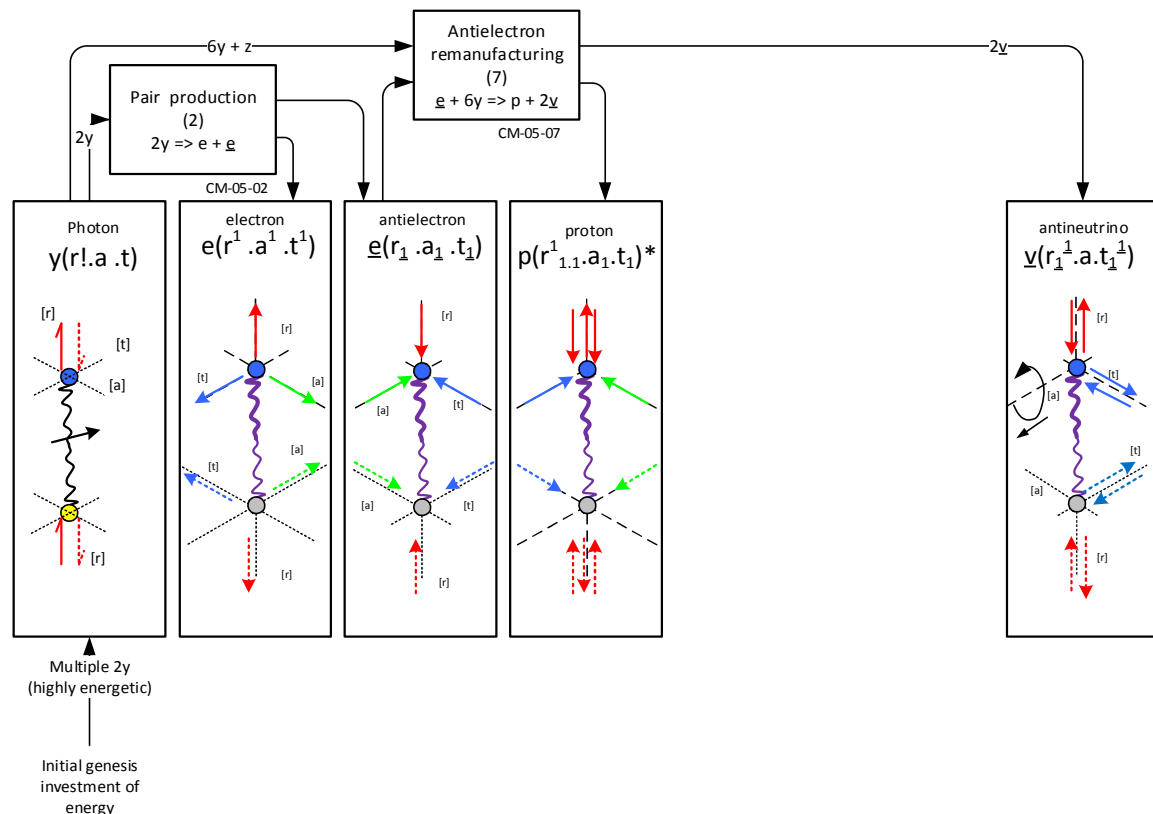

Figure 3. HED mechanics predict a process whereby the antielectron from pair production is remanufactured into a proton, with two antineutrinos ejected in the waste stream.

However, there is still a question that must be addressed, which is why the production processes were biased to remanufacture the antielectron rather than the electron. We return to that later.

PROTON INSTABILITY

Looking at the equation $ny => e + p + 2\underline{v}$ and noting that in general all these equations can be rearranged (particules change hand when transferred across the equality), suggests that that the proton may not be absolutely stable. Interacting it with two antineutrinos may remanufacture as follows:

$$p + 2\underline{v} => p(r_{11}{}^1.a_1.t_1) + [\uparrow\uparrow\uparrow] + [\downarrow\downarrow\downarrow] + 2\underline{v}$$
$$=> p(r_{11}{}^1.a_1.t_1) + [2y] + [2y] + \underline{v}_1(r_{\underline{1}}{}^1.a.t_{\underline{1}}{}^1) + \underline{v}_2(r_{\underline{1}}{}^1.a.t_{\underline{1}}{}^1)$$
$$=> (r_{11}{}^1{}_{1.1}{}^{1.1}.a_1.t_{1.\,\underline{11}}{}^{\underline{11}}) + [4y] \qquad (8)$$
$$=> \underline{e}(r_{\underline{1}}.a_{\underline{1}}\,.t_{\underline{1}}) + (r_{11}{}^1{}_{\underline{1}}{}^{1.1}.a_1{}^1.t_1{}^1) + [4y]$$

$$\Rightarrow \underline{e} + (r_1{}^1.a_1{}^1.t_1{}^1) + (r_1{}^{1\,1}.a.t) + [4\gamma]$$
$$\Rightarrow \underline{e} + (\downarrow\downarrow\downarrow) + (\uparrow\downarrow) + [4\gamma]$$
$$\Rightarrow \underline{e} + 2\gamma + z + [4\gamma]$$
$$\Rightarrow \underline{e} + 6\gamma + z$$

What this means is that the proton could unravel back into a positron and photons, with the right kind of inducement by antineutrinos. This prediction may be testable and falsifiable. This result also implies that proton decay would not be fundamentally random, but rather a result of a specific coincidence of antineutrinos. A HED analysis suggests that presupplying the proton with two neutrinos has no effect.

Another possible process is direct decay of the proton:

$$p(r_{11}{}^1.a_1.t_1) + [\uparrow\uparrow\uparrow] + [\downarrow\downarrow\downarrow]$$
$$\Rightarrow p(r_{11}{}^1.a_1.t_1) + [{}^1_1\,{}^1_1\,{}^1_1] + [{}_1^1\,{}_1^1\,{}_1^1]$$
$$\Rightarrow v(r_1{}^1.a.t_1{}^1) + \underline{e}(r_{\underline{1}}.a_{\underline{1}}.t_{\underline{1}}) + v(r^1{}_1.a.t_1{}^1) + [r_1{}^1.a\,{}_1^1.t\,{}_1^1]$$
$$\Rightarrow \underline{e} + 2v + 2\gamma$$

(9)

Thus the proton may spontaneously decay into an antielectron, two neutrinos, and two photons. However this may require a strong antimatter fabric (see next section) to initiate the process.

4.4 Dominance of the matter-production stream

WHY DID THE MATTER HAND PREVAIL?

This theory 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 $n\gamma \Rightarrow \underline{e} + \underline{p} + 2v$ instead? While we may have solved the problems of how the asymmetry arises, and where the antimatter has gone to, there is a deeper question: What switched the production process to the matter route? We anticipate this may be answered in terms of warfare between the matter-antimatter species. Under this scenario, *both* production processes were initially at work. We imagine an initial extraordinarily energetic photon-pair colliding and producing an electron and antielectron, which then radiated further energetic photons. However, these photons would not have been able to propagate away, since there was no fabric [43] (the NLHV equivalent of general relativity's spacetime) within which to move, so they would have been available for further pair-production sequences. 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 were available to feed back into the production processes again, providing they were still energetic enough. Once some matter and antimatter particles had formed they would produce handed discrete forces and propagate those out, producing a fabric [43]. That fabric would carry a hand depending on its origin with matter or antimatter. In turn that fabric would bias the production processes it encountered to switch to the same hand. This is because particles, as they are created, must emit discrete forces into the fabric, and the fabric pressure pushes back and affects the emission. This also relates to the Cordus explanation for time dilation [37]. The massy

particules would have extraordinary energy, hence high frequency, which would create an enormously high mass and strong fields.

In this scenario, domains of matter and antimatter 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. There would have been a stage of domain warfare as the domains aggregated, broke up, and forcibly converted parts of 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 initially. This last idea of frozen domain warfare is our currently preferred model.

COSMOLOGICAL START-UP PROCESS

Continuing this scenario, the matter fabric obtained the edge in supremacy, and grew that to dominate the emerging cosmos. This fabric then controlled which branch the subsequent remanufacturing process took, and thus antielectrons were converted to protons, rather than electrons to antiprotons. Thus the proto-universe became dominated by matter, rather than antimatter. The cascade of formation-annihilation would have produced neutrino-species, and expelled them outward, thereby creating the fabric. A cloud of photons would have followed, thus reducing the energy available for genesis. 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?

According to this theory, the outward expansion of the universe has reduced the fabric density, to the point where the density in the current epoch is insufficient to convert antielectrons into protons. So the antielectrons from the pair production process are allowed to exist at this stage, whereas in the early universe they would have been converted to protons.

5 Discussion

QUALITATIVE SUMMARY OF GENESIS

This genesis process is therefore conceptually simple: two initial photons are converted into an electron and an antielectron. These radiate photons. The antielectron receives more photons, the field structures of which are used to form a larger structure that re-assembles into a proton and two antineutrinos. The antimatter hand of the antielectron is carried away by the antineutrinos. The remanufacture process initially had two balanced work-streams, converting antielectrons into protons, and electrons into antiprotons. However the process was biased into the matter production

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stream, perhaps because the two process streams oscillated in their dominance and this was frozen-in as the system cooled.

The original electron and proton combine to form a simple hydrogen atom. The antineutrinos have almost no reactivity with matter, so they simply escape the scene. This is fortunate for us as the model predicts that antineutrinos can denature a proton. 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.

Finally, we note that production paths for the neutron are already known in the β decays. There is also a Cordus theory that anticipates how these processes work at the level of discrete forces [38]. Taken together, the Cordus theory offers a complete set of forward production processes for electron, proton, and neutron, through to the nuclides. The complete set of proposed remanufacturing processes for matter are shown in Figure 4.
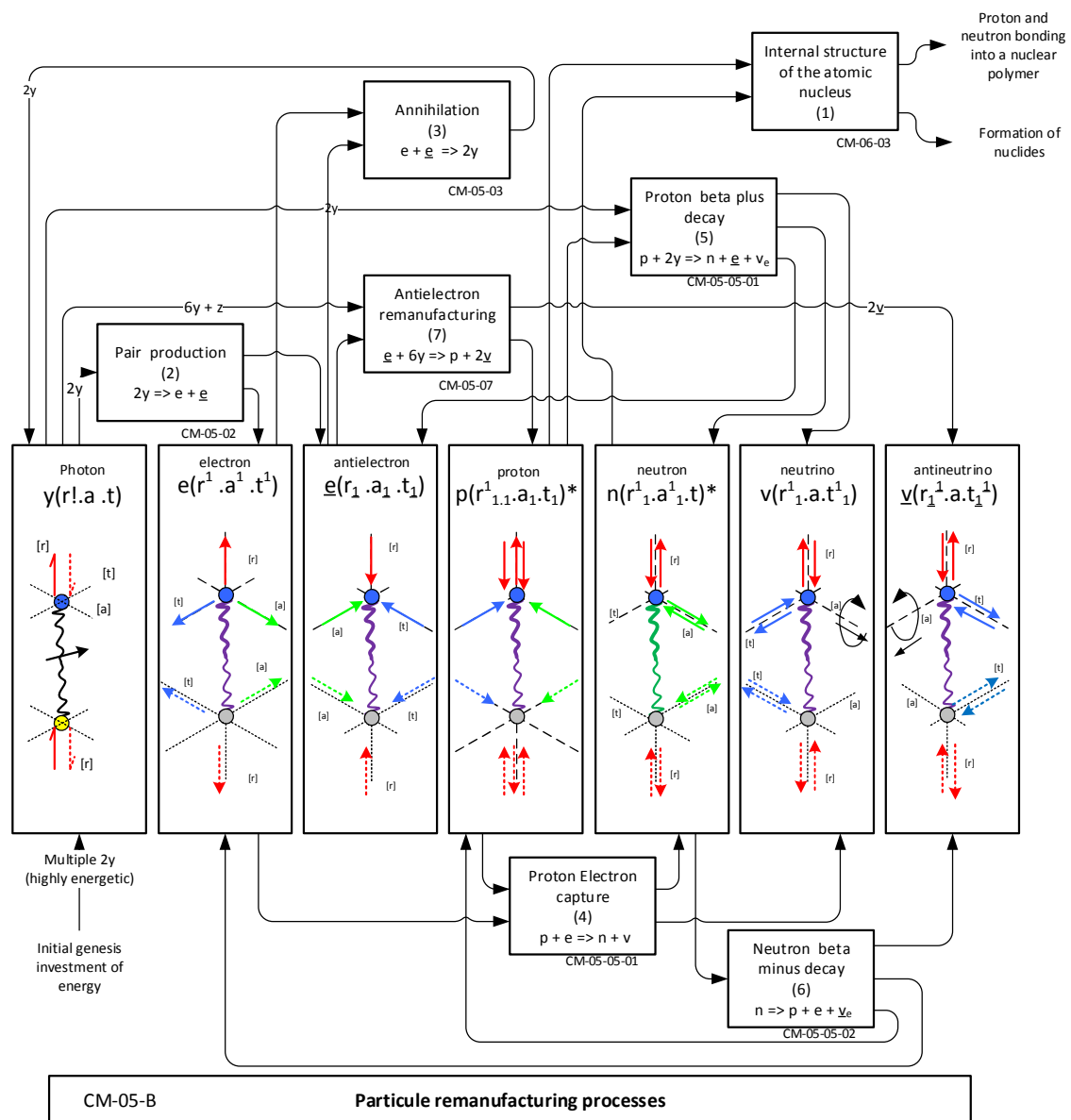

CM-05-B   **Particule remanufacturing processes**

Figure 4. Summary of the remanufacturing routes for the genesis production sequence for a matter universe. This diagram shows the proposed discrete force structures for a variety of particules.

RESOLVING THE ASYMMETRY

The significance is that we do not need to worry about the asymmetry of baryogenesis. Where has all the antimatter gone? Hiding in plain sight, having been remanufactured into the matter baryons themselves. 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 concentrated at its horizon.

WHAT HAS BEEN ACHIEVED?

This work makes several novel contributions of a conceptual nature. The first is the identification of a process for remanufacturing an energetic antielectron into a proton and two antineutrinos. The idea itself is a novel contribution, as is being able to determine a plausible set of mechanics under a NLHV scenario. While neutrinos have featured in other baryogenesis scenarios, they have not had any role like this. In addition, the proposed production process itself is detailed, and the inputs and outputs are predicted, which makes it potentially testable and falsifiable. A second contribution is that this process accounts for both asymmetrical baryogenesis as well as leptogenesis. This is a parsimonious solution: by comparison other theories need additional mechanisms for the two asymmetries. A third contribution is that of providing a still deeper mechanism for the asymmetry, the idea being that frozen domain warfare may be responsible. This is a simple explanation, at least conceptually, and obviates the need for elaborate mechanisms or coincidences. As another output, the conditions are identified under which the proton may decay. While the idea of proton decay is not new, the prediction that it is susceptible to impact by two antineutrinos is a novel contribution and one that also may be tested and falsified.

IMPLICATIONS

The implications, if this theory is correct, is that the matter-antimatter asymmetry of genesis is explainable. Importantly, this does not require any new particles or new forces, unlike most of the competing theories which do. All it requires is a plausible set of assumptions in a covert-structure design. Another implication of this theory is that the asymmetries in the baryogenesis and leptogenesis processes are conjoined. This is in contrast to the conventional perspective that treats them as independent.

The corollary is that the Cordus theory is shown to be capable of profoundly novel solutions for both fundamental physics and cosmology. It is relevant to note that the Cordus theory has achieved not only a solution for asymmetrical genesis, as shown here, but also a comprehensive and logically consistent set of explanations for a wide variety of physical phenomena, including wave-particle duality, unification of forces, annihilation, decay, the nuclides (H to Ne), among many other

phenomena. All those are ontologically problematic for conventional physics.

We acknowledge the limitations of the Cordus model, particularly its conjectural nature. While the theory has high coherence (internal validity), and provides an excellent fit to empirical data (e.g. for the nuclides [28]), it is conceptual in nature. Consequently a mathematical formalism is not yet available for the theory. On its own this does not detract from the accomplishment of showing a solution to asymmetrical genesis. There is reason to believe that it should be possible to express the Cordus theory in such a formalism, but this is a significant venture that is beyond the scope of this paper, and is instead left to future work.

IMPLICATIONS FOR FUTURE WORK

There are several streams of potential future work. First, the Cordus mechanics are currently mostly conceptual, and could be given a mathematical formulism. It might be worth starting a formalism using string theory, due to the dimensional similarity of these theories. QM is not expected to be a suitable starting point as it is premised on 0-D point particles which are simplifications of the Cordus particule. Second, there is more conceptual work to be done as we have not explained the actual process of inflation nor the stellar processes of nucleosynthesis of the heavier elements. There are deeper foundational questions to explore too: how the reactive ends transform, and the composition of the fibrils and discrete forces. At this point we simply propose their existence as necessary for the Cordus model, and leave their elucidation for future work.

6   Conclusions

What has been achieved here is a novel alternative conceptual theory for the asymmetry of matter over antimatter in the universe. We started with the basic Cordus idea that particles are not 0-D points but have a distinct internal structure with two ends and discrete external fields. We then created a descriptive model for electron-antielectron pair-production, showing how the structures of the photon could be reassembled into an electron and antielectron [40]. Thereafter we showed in the present paper that it was conceptually feasible that the antielectron could be remanufactured into a proton, discarding antineutrinos in the process. We predicted a specific process for this.

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 offered a tentative explanation why the matter hand prevailed over antimatter during the cosmological start-up process.

In contrast to other competing theories of genesis, this only requires particles already known to the Standard Model. However it does require

them to have a specific covert-structure. We conclude that if particles were to have such a structure then plausible solutions arise for asymmetrical genesis. This does not imply that all NLHV theories are so endowed.

To answer the question identified at the outset: *Why is there more matter than antimatter in the Universe?* Our answer is that the initial genesis 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 the protons, and the waste antimatter component was carried off by antineutrinos. Therefore according to this interpretation, the apparent asymmetry of baryogenesis is because the antimatter is hiding in plain sight, having been remanufactured into the matter baryons themselves.

Taken together with other developments, the Cordus theory offers a complete set of forward production processes from the energy of the evanescent field of the photon [40], through genesis [this paper] and the strong force (synchronous interaction) [29], up to the nuclides [28], back down through the decay processes [38], to annihilation back to energy [41,42]. The processes for mass-energy equivalence are therefore fully mapped out at the conceptual level.

Author Contributions

All authors contributed to the creation of the underlying concept, development of the ideas, and editing of the paper. DP created the drawings.

Conflict of interests

The authors declare no conflict of interest regarding the publication of this paper. The research was conducted without commercial or financial benefit from a third party. There was no third-party influence in the work: its approach, interpretation of data, writing, or submission decisions. There were no external funding bodies involved in this work.

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