

Mirror images: Matter and Antimatter

Pons, D.J.¹

Abstract

*Existing theories of physics struggle to explain the difference between matter and antimatter in ways that make physical sense. This paper offers a reconceptualisation based on the cordus conjecture. We create a new concept of handedness, called *ma*, and an operational definition based on the energisation sequence of the cordus reactive-ends. Each reactive end for a stable matter particuloid, e.g. the electron, has three orthogonal hyff. The hand of these is held to be the same for all matter particuloids, whether positive or negative charge. For all antimatter particuloids the hand is inverted. The inversion also changes the direction of the hyff, and thus reverses the charge, but this is a secondary effect. This cordus concept permits models to be created differentiating between the electron, proton, and antielectron (positron). This explains why the antielectron is very different to the proton despite the same charge, and why the photon does not have an antiparticle. It also allows the wider integration of bonding and annihilation as manifestations of a single deeper mechanics.*

Keywords: antimatter, hand, chirality, fundamental physics

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1 Introduction

Reality is concrete enough, at least at our level of experience, but what exactly is all that matter made of? What is antimatter (aM) and how does it differ from matter? Why and how do the two annihilate? Why does the universe contain so little antimatter compared to matter? Those questions are difficult to answer with current fundamental physics.

Part of the problem is that conventional physics does not really know what matter is. We think that matter is made of particles, and we think they are only points with no internal structure (other than assemblies of more points), but we don't know what makes up the *point*. We also think that particles are waves, but other than being able to describe their mathematical behaviour as a wave, we really do not know what that *wave* comprises either. We think that particles are in two positions at once, i.e. superposition and can represent that with the wavefunction – indeed we see confirming empirical evidence at the microscopic scale: but not at the macroscopic, which is perplexing. We don't really know what matter *is*. Naturally that also means we don't know antimatter to the level that we would like. The dominant explanation for antimatter is quantum

¹ Please address correspondence to Dr Dirk Pons, University of Canterbury, Christchurch, New Zealand. Copyright D Pons 2011.

mechanics. However QM cannot explain the *structure* of antimatter, and has practically nothing to say about the *process* of annihilation.

This paper shows how antimatter can be conceptualised from the cordus conjecture [1]. Doing this provides a better explanation of the difference between matter and antimatter in ways that make physical sense.

2 The conventional perspective of antimatter

Antimatter: content and formation

The most abundant type of antimatter is antielectrons (e, positrons), but antiprotons (p) and antineutrons (n) have also been synthesised. Note that we use the underscore to denote antimatter.²

The $E=mc^2$ relation superficially suggests that energy can be converted into matter (or the inverse). However that is only half the story, because antimatter is always created when matter is created: the formation of only matter particles has not been observed. Energy always transforms into a particle and its antiparticle.

Antimatter particles are regularly produced by natural phenomena, e.g. cosmic rays striking the atmosphere, and radioactive decay. They are also produced artificially, e.g. in colliders. Whole antimatter atoms have also been produced, currently limited in size to the smaller assemblies: antihydrogen, antideuterium, antihelium (-3 & -4).

Existing theories of antimatter

The common idea is that antimatter is simply opposite charge. On its own that cannot be correct as it suggests that the electron and proton should also annihilate, which doesn't happen.³ Also, it is not immediately clear why neutral particles, e.g. neutrons, have antiparticles too.

From the perspective of quantum mechanics, antimatter is opposite charge *and* opposite quantum numbers. This concept of antimatter as opposite chirality is a more thoughtful approach, but chirality is an incompletely defined physical concept in physics: it is variably related to helicity and spin. It is mostly a mathematical abstraction rather than a physical effect, though that is a feature of many of the other intrinsic variables of QM. Thus there is no clear explanation from conventional

² Conventionally the antielectron is given a special name, the positron, since it was first discovered, whereas other antiparticles do not have special names. Here we simply stay with 'antielectron', because it is a better cognitive reminder about the special complementary features of antimatter in the cordus model. Our notation also departs regarding the abbreviated representations, which conventionally have a signed superscript (positron: e^+ , antiproton: p^-) or an overprinted bar (antiparticle: \bar{a}). We avoid the former because our model shows that the antimatter effect is not simply a matter of opposite charge. Instead we use an underscore, as in antiparticle a, to signal the cognitive break with conventional ideas of antimatter, but yet the retention of some of the conventional constructs.

³ That is usually popularly explained away as the electron orbiting too fast around the nucleus, though that too is a superficial explanation as orbitals are not orbits.

physics as to what chirality corresponds to in a 'particle', and how it contributes to annihilation.

The concept of quantum numbers is also helpful, but there is no universal set of quantum numbers. Instead the number of these variables depends on the particle situation under examination. At a deeper level one has to question the QM premise that antimatter is opposite quantum numbers, because realistically the main quantum numbers for fermions are charge and spin, but these are common throughout any one generation. This does not explain why particles from dissimilar generations do not directly annihilate. Instead annihilation is primarily a process between a particle and its exact opposite antiparticle, not a different type of antiparticle. The logical conclusion is that there may be additional quantum numbers, or more accurately additional *variables or qualitative factors* that govern the annihilation behaviour. What are those? Whatever they are, they do seem to be hidden to QM. So we have to be open to the possibility that there might be additional hidden variables involved in the matter-antimatter definition.

There are other theories of physics, the most complete of, and almost at the state of mainstream acceptance, is string theory and the related M-theory [2]. However the focus there is on cosmology,⁴ and while it does not conceptually preclude antimatter, nor is the idea particularly advanced either. So all the mainstream theories have an incomplete explanation of antimatter.

3 Background: Cordus conjecture

The cordus conjecture is a novel alternative theory of fundamental physics, and has been shown to provide radically different interpretations of many physical effects. It is a different way of thinking, both about the subject of 'particles', and also in the cognitive approach. It is primarily a qualitative conceptual method as opposed to the quantitative mathematical method of conventional physics. It is a type of hidden variable solution that circumvents the limitations of Bell's theorem [3].

The conjecture states that all 'particles', e.g. photons of light, electrons, and the protons in the nucleus of the atom, are not one-dimensional points, but have a specific internal structure called a 'cordus'. The cordus consists of two 'reactive ends', which are a small finite distance apart

⁴ In String theory all particles are one-dimensional oscillating lines, and this requires that the universe have additional dimensions that we cannot see. There are several variants of the theory, with different prescriptions for the required dimensions. It is believed that the variants are all subsets of M-theory, with its 11 dimensions. There is hope that string theory may unify gravitation with electromagnetism, and describe the fundamental reality of nature, but it is not yet capable of that. It is a mathematical approach, but even so has not made quantitative predictions that can be verified one way or the other. Also, it has many formulations, and it is difficult to know which applies to the real world, i.e. it is still abstract rather than concrete. It is a class of theories, and a work in progress rather than a complete solution.

(‘span’), and each behave like a particle in their interaction with the external environment. A ‘fibril’ joins the reactive ends, and is a persistent and dynamic structure but does not interact with matter [4]. The reactive ends are energised (typically in turn) at a frequency [5]. The reactive ends emit one or more force lines called ‘hyperfine fibrils’ (hyff) into space, and when the reactive end is energised it sends a transient force pulse (‘hyffon’) outwards along the hyff curve [6]. This makes up the field, which is thus also discretised. Various features of the hyff and hyffon carry the electrostatic field, magnetism, and gravitation simultaneously. In this model the photon has a single radial hyff which it periodically extends and withdraws, see Figure 1 [4].

By comparison all massy particuloids, including neutral particuloids like the neutron, have permanent hyff [6]. Electric charge is carried at 1/3 charge per hyff, so stable particuloids like the electron are surmised to have three hyff, and these are presumed to be arranged orthogonally [7]. The hyff around massy particuloids compete for emission directions and may synchronise their emissions to access those spaces -the cordus concept of synchronous hyff emission directions (SHED) [7]. Thus there is an element of mutual negotiation, based on shared geometric timing constraints[7].

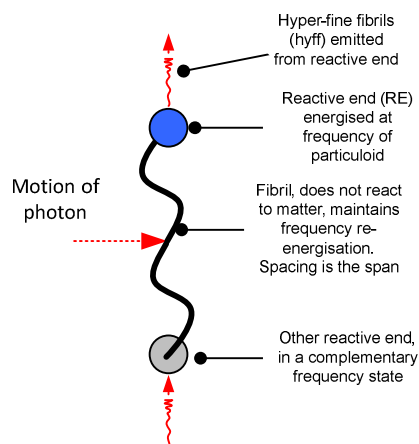


Figure 1: Cordus model of the photon. It is proposed that the photon probably only has a single radial hyff at each reactive end, whereas the electron has three, but the fundamental structural concept is similar.

Image is in the common domain
http://en.wikipedia.org/wiki/File:CordusConjecture2.21_PhotonCordus.png

The core concept in the cordus conjecture is thus a particular bipolar internal structure for the photon and indeed all ‘particles’. We term this a *cordus*, and emphasise that it is the *internal* structure of what is otherwise called a ‘particle’, and is not the same as a ‘dipole’ (separation of negative and positive charges) which is an *external* structure of multiple charges. Nor is it appropriate to call this a ‘particle’, because it is not a zero-dimensional point. The idea of a cordus allows many puzzling phenomena to be explained at a conceptual level, such as wave-particle duality [8],

why quantum mechanics does not scale up to macroscopic objects [9], among other lesser conundrums of fundamental physics like Casimir effect superfluidity, local realism, entanglement, strong force, etc.

We now apply the cordus concept to differentiate matter and antimatter. This novel explanation is an important part in eventually explaining the annihilation process itself.

4 Cordus model for matter and antimatter

The cordus model for antimatter builds on some of the previous work on quarks, and is briefly summarised below.

4.1 Consolidating existing principles

The basic HEDs

The core idea, which also differentiates the cordus M-aM model from conventional perspectives, is that of hyff emission directions (HED) [7]. Each reactive end of a massy particuloid emits three hyff: one in each of three orthogonal directions, here named [r,a,t], hence hyff emission directions. Each HED carries a 1/3 charge, so the overall charge of the particuloid depends on how many HED are active.

These concepts were already anticipated and encapsulated in the Quark lemmas (E.6) [7]:

E.6.2	The magnitude of the charge of a quark refers to the number of hyff emitted at a reactive end, out of three possible directions, i.e. the arrangement is 3D geometric.
E.6.2.1	We term these hyff emission directions (HEDs).
E.6.2.2	Particuloids with unit charge have one hyff in each of three orthogonal directions.
E.6.3	The colour (red, blue, green) refers to the arrangement of the hyff in the orthogonal 3 axes of the HEDs.
E.6.3.1	The axes are named [r] radial outwards co-linear with the span, [a] and [t] perpendicular to the span and to each other.
E.6.3.2	A single hyff (e.g. D -1/3) may be arranged in one of three ways: [a], [r], or [t].
E.6.3.3	A double hyff (e.g. U +2/3) may be arranged in one of three ways: [a, r], [a, t], [r, t]
E.6.4	The operative principle governing the sharing of hyff spaces is Complementary frequency state synchronisation (CoFS). A maximum of all three directions [a, r, t] may be filled with hyff, i.e. a synchronous hyff emission direction structure (SHEDS) is created.
E.6.5	Opposed charge hyff may be considered to cancel each other's use of the hyff emission directions. However they do not cancel the contribution to the fabric.

Structure of the electron

We consolidate these concepts by providing a cordus model of the electron, see Figure 2.

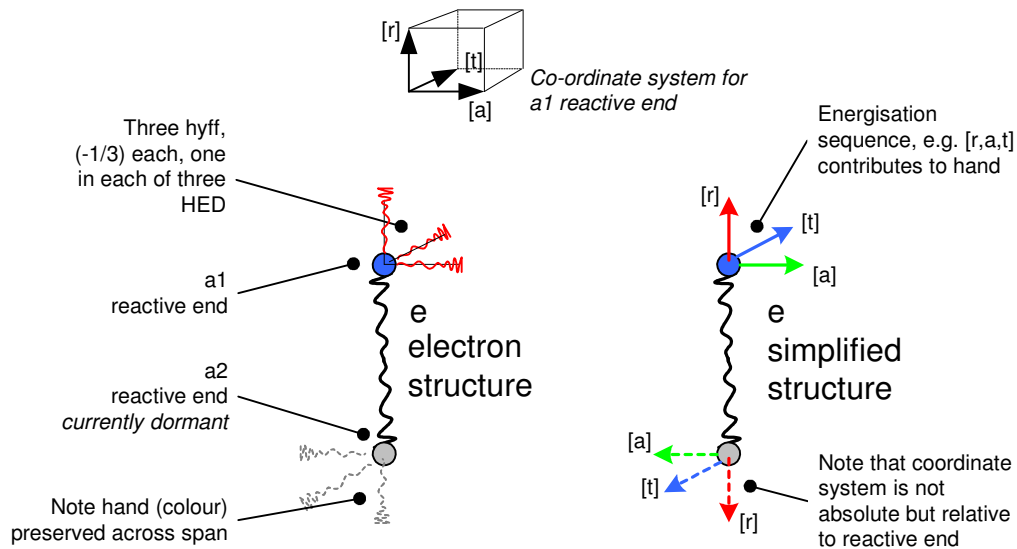


Figure 2: Cordus model of the electron. It is proposed that the particuloid has three orthogonal hyff, energised in turn at each reactive end.

At this point we are not too concerned about the further divisibility or not of the electron.⁵ However for the present we can treat the three hyff as a unit, albeit one that energises in some sequence such as [r, a, t]. Nor are we concerned about the mechanisms that sustain the reactive ends, hyff, hyffons, or fibril: we acknowledge those as the next deeper level in the mechanics.

4.2 Cordus hand: ma

Handedness of matter

In the cordus model, we have already encountered a handedness effect, in Lemma E6 [7], as follows.

E.6.11 The nature of the SHED process within a nucleon creates the handedness (chirality) of matter, e.g. the right-hand rule of the Lorentz magnetic force.

Now we extend this idea to build the concept of hand ('ma') and thence to an operational definition of matter and antimatter. The cordus concept is very different to the quantum mechanics concepts of 'hand' and 'chirality', so it is important to differentiate the terminology and introduce new concepts.

The cordus interpretation is that all matter and antimatter particuloids have three orthogonal hyff emission directions (HEDs) at their reactive ends, as per the above model for the electron. **The arrangement of the**

⁵ We anticipate that the hyff *might* be separable at higher energies into endogenous elements, like the quarks make up the baryons.

three hyff around the reactive end has a hand, which we call ma. We use this different term to differentiate the constructs from QM.⁶

Handedness in QM refers to the direction of spin of the particle relative to its linear motion [10]. When the spin is in the same direction as the momentum, then it is termed right-handed. The particles of QM may have either right or left spin-hand, and this spin-hand inverts for antiparticles. From the cordus perspective this is a spin effect, which for convenience we refer to as 'spin-hand'. It is not the same as the *ma* hand. However the concepts are possibly related at a deeper level of mechanics.

For convenience and consistency with our previous nomenclature for the photon, we name the three orthogonal HEDs the radial [r], axial [a], and tangential [t] hyff. We acknowledge that the directions may be ambiguous as they imply motion. It is assumed that all particuloids have at least a momentary motion-on-the-spot of their reactive ends, even if the particle as a whole is stationary. (We note this as a lemma at the end).

We have two candidates for the origin of the handedness. One is that it is built into the structure of the fabric, and is thus a deeper level of mechanics than the cordus structure. The other, and the current working model, is that the handedness arises because of the *sequence* of activation of the hyff, e.g. [r], then [a], then [t] at the first reactive end, followed by r-a-t at the other, as the particuloid oscillates at its frequency.

The *ma* mechanism ensures that the three hyff, [r, a, t] are consistently arranged in the same way relative to each other. Further, it is assumed that this handedness is set at the point in time when the particuloid is created and cannot be subsequently changed while the assembly remains.

The *ma* requirement might seem artificial, but is not unreasonable because something similar already exists in all the other models of physics: classical physics already has the right-hand-rule for electromagnetism, and quantum theory has chirality. And even the basic QM concept of spin suggests that there is some directionality to a zero-dimensional stationary particle. None of these are well explained: Why does the right-hand-rule exist? How can a 0D point (or a wave) have spin and directionality? Cordus provides a more substantial concept for handedness than any of these other models. Having created a concept for *ma* hand, we now apply it to differentiate matter from antimatter.

4.3 Cordus matter and antimatter

From the cordus perspective all stable *matter* particles, including the electron and the proton, have three orthogonal hyff at each reactive end, and these are all of the same hand, for convenience called *forma* (right hand). Note that the hand is the same for all matter particuloid, whatever

⁶ The concept of chirality is known in QM, but in a different theoretical formulation, e.g. chiral perturbation theory in quantum chromodynamics. Here we reconceptualise it, and therefore use a different term, *ma*, to distinguish the cordus concept.

their charge. The difference made by charge is simply that the negative hyff (e.g. for the electron) are all propagating outwards (a cordus sign convention), whereas those for positive charges are inwards-directed.

Inversion of hand

The cordus interpretation for antimatter is that antiparticuloids have opposite hand, i.e. the sequence of energisation of the hyff is spatially inverted (mirrored). The inversion is about the long axis of the fibril, so the [r] axis is preserved – though it changes sign, see Figure 3. We term the inverted hand hyarma (left-hand - since this hand was left-behind at the genesis of the universe). Importantly, note that inversion of the hand also changes the sign of the charge.⁷

Cordus thus conceptualises the inversion of hand in terms of the functional geometry of the cordus structure. Thus it provides a physically natural ('ordinary') interpretation for antimatter. Note that the inversion is about the fibril axis. Thus the [r] axis is conserved in both hands, though the sign changes.

There is a subtle, but important distinction between this cordus definition and that of quantum mechanics. First, cordus creates an operational definition out of handedness, which QM with its premise of zero-dimensional points (alternatively waves) does not, and cannot. Second, cordus states that that the difference between matter and antimatter is primarily in the hand, and the changed sign of the charge is a secondary effect and dependent on the first. By comparison QM conceptualises antimatter in terms of opposite charge and opposite spin, as independent variables, and does not define the relationship between the two. (Obviously there must be a relationship between the two, since there are not four species of matter).

Thus it is hand AND charge that is important in cordus. Incidentally, this definition also makes it easier to understand why a neutral particuloid like the neutron does have an antineutron. In the cordus model the neutron has internal charges but these neutralise so that there is no net external charge: but nonetheless hyffons are propagated on the forma hand, hence gravitation and mass [7]. An antineutron is easily explained as having inverted hand and therefore charge, i.e. is still charge-neutral externally, but has the hyarma hand. By comparison, it is not intuitive in quantum mechanics why neutral particles should have antiparticles. By comparison cordus readily accommodates a neutral particuloid having an antiparticuloid: the hands are different, even if the changed sign of the charges is still neutral.

Note that the cordus model states that all matter (and antimatter) comprises charged particuloids, it is just that sometimes the positive and negative are balanced. Thus neutral matter particuloids, e.g. neutron, still

⁷ It is not so much that the charge reverses, but its direction *relative to the reactive end* is inverted, and thus the sign changes. Note that in cordus the sign of the charge is simply the direction of *action* of the hyffon relative to the reactive end.

have internal charges, and hence there is no conceptual difficulty with these charges changing sign (i.e. hyff changing directions) for antimatter.

Comparison of electron, proton, and antielectron

One of the paradoxes of conventional theories of antimatter is that it is not immediately clear what the difference is between the proton and the positron. After all, they both have charge +1. Why then does the electron not annihilate with the proton, but does with the positron? Why do the proton and positron have such difference masses, given that their charge is the same?

With the cordus concept of ma hand, the explanation is easy. The structures for these three particuloids, as proposed by cordus, are shown in Figure 3. Note that we deliberately prefer the term 'antielectron' and avoid 'positron': this is because antielectron is a much truer representation of the structure. The word 'anti-' refers in cordus to inverted hand, and this feature is much more important in understanding what is happening than the charge perspective. Thus the electron is a structure with forma hand and outgoing hyffons, the proton is forma with incoming hyffons, and the antielectron is hyarma (anti-forma) with incoming hyffons.

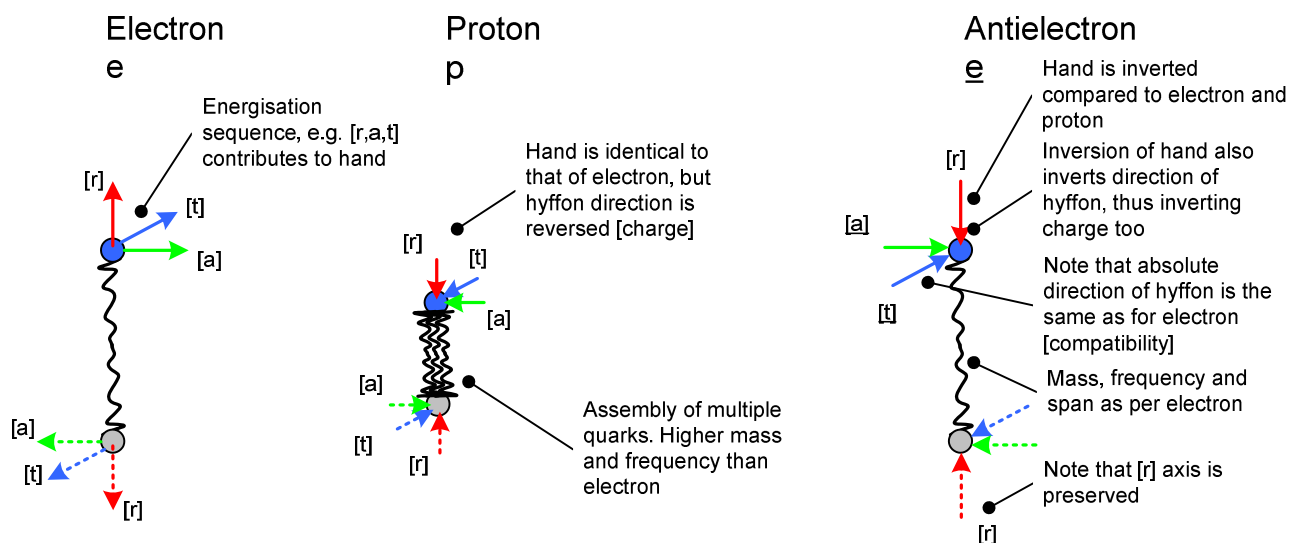


Figure 3: Models for the electron, proton, and antielectron. Note that the electron and proton have the same hand (forma) but the hyff are reversed, hence the reversion of charge. The proton is also a different type of assembly, being a composite of quarks at this level, whereas the electron is a unified structure at this same level. The difference between the electron and antielectron is inversion of hand: the electron is forma, and the antielectron hyarma. The inversion is about the fibril axis [r] and this also inverts all the hyff, hence reversing of charge.

We will stop this development here, having established the basic principle of ma hand, and leave its further development, such as the process of annihilation itself, to companions papers. But before we go, we consolidate the current assumptions into the following lemma.

4.4 Lemma

The following lemma summarises the assumptions in this antimatter model, and the principles involved.

- Ma.1.1 All matter and antimatter particuloids have three orthogonal hyff emission directions (HEDs) at their reactive ends: [r,a,t].
- Ma.1.2 It is assumed that all particuloids have at least a momentary motion-on-the-spot of their reactive ends, even if the particle as a whole is stationary, which gives a direction to the [r,a,t] axes.
- Ma.1.3 The arrangement of the three hyff around the reactive end has a hand, which we call *ma*.
- Ma.1.4 Mechanism for ma hand: The current working model is that the handedness arises because of the *sequence* of activation of the hyff, e.g. [r], then [a], then [t] at the first reactive end, followed by the same at the other, as the particuloid oscillates at its frequency.
- Ma.1.5 This handedness is set at the point in time when the particuloid is created.
- Ma.1.6 Cordus assumes that all particuloids (except the photon) have a hand.
- Ma.1.6 The hand differentiates matter from antimatter.
- Ma.1.6.1 All *matter* particuloids, e.g. electron and proton, are of the same hand, forma, regardless of charge. (Charge refers instead to the direction of propagation of the hyffons: outwards for negative charge, inwards for positive. A sign convention).
- Ma.1.6.2 All *antimatter* has the inverted ma hand, termed hyarma. The inversion is about the long axis of the fibril.

5 Discussion

Cordus has a radically different conceptual foundation to other theories of fundamental physics. It also differs in being a qualitative approach as opposed to the mathematical modelling that otherwise dominates theoretical developments in physics. These large differences mean that cordus is able to provide a fresh perspective on an old subject.

5.1 Outcomes: what has been achieved?

An operational model of handedness and matter-antimatter

Using the cordus conjecture, a model has been created for the handedness of matter, and this becomes the primary differentiating factor between matter and antimatter. This has been used to create models of the electron, proton, and positron, as representative of the two species. It is proposed that the quarks and other leptons follow the same pattern, though in the case of the quarks not all the hyff emission directions [r,a,t] are filled (hence their fractional charge).

Note that in this model the antielectron is very different to the proton. They are dissimilar regarding mass, span, frequency, and ma . The only thing that is common is that they both show positive-charge behaviour.⁸ From the cordus perspective it is a fallacy to think of antimatter as being primarily characterised by opposite charge.

A different method

Another unusual feature about this cordus model is the methodology. It has been noted that strategies based on mathematical hypotheses have generally not delivered interpretations that make physical sense [11]. Cordus takes a different path, one of engineering design synthesis towards a solution. It is a qualitative approach, and while it does not (yet) have the mathematics embedded, of its very nature it provides explanations that make physical sense. We have managed to create a novel model of antimatter, using *concepts* and without needing *mathematical* analogies or formalism. That on its own makes cordus stand out as a radically different methodology.

With the addition of this latest explanation for the two species of matter, cordus can now offer a coherent explanation for effects ranging from wave-particle duality through to the antimatter problems considered here. That of itself does not constitute validity, but it is a reassuring feature since it is what would be expected of a deeper mechanics.

⁸ This dissimilarity is why we prefer not to use the word 'positron'. The term is too conceptually limiting as it implies a similarity with the proton. Also, it reinforces the impression that antimatter is merely about reversed charge, which cordus refutes. The orthodox theories of antimatter are charge-centric. Cordus suggests instead that the main factor is ma (hand), and the reversion of charge is a secondary effect. Thus the annihilation energy is due to the hand, not the charge. This should not be surprising, because the electron and proton do not annihilate despite their opposite charges (cordus can also explain why this should be – the hands are the same). So evidently opposite charge is not the main factor for annihilation, and therefore cannot be the main factor that differentiates matter and antimatter either.

5.2 What are the implications?

The cordus model also explains why the photon does not have an antiparticle: it does not have a hand. The photon is a single hyff, and a fibrillating one too.

The differentiation by ma hand is very important in what follows because we subsequently show that both electron-proton bonding and electron-antielectron annihilation have the same underlying mechanism: complementary frequency synchronisation (CoFS) [12]. Thus CoFS is the deeper mechanism for holding the nucleus together (strong force), the electron orbitals, the filling of orbitals (Pauli exclusion principle), bonding between atoms, superfluidity, superconductivity, entanglement.

What is positive charge in the hyffon model?

The cordus model for the electron has the reactive end producing a new set of hyffons (EMG force pulses, see below) at each re-energisation, and the outward propagation of these distally down the hyff, at the speed of light.

The positive charge is shown as hyffons moving proximally: being drawn inwards. What is the physical interpretation? We offer some suggestions. The first is that the positive hyffons are indeed extracted from the remote hinterland. A second and related idea is that all positive hyff connect up the corresponding negative hyff from their lepto/baryogenesis twin, or network thereof, like magnetic poles. Another, and the currently preferred working model is that the positive hyffon are force increments directed proximally, but they themselves propagate distally. In other words that the *action* is directed medially. We acknowledge that we have not satisfactorily explained exactly what a hyffon is, or how its underlying mechanisms operate regarding its propagation and exertion of force – we leave such matters to the next deeper level of conceptualisation.

What about gravitation?

The cordus model for the unity of electro-magneto-gravito (EMG) force uses a speculative mechanism whereby the gravitation component is the torsion in the hyffon, and this is identical to the hand [13].

An analogy for our working model for EMG force is that the hyffon is like a nut spinning off a screw, and then engaging with another remote screw, pulling it closer. The hand of the hyffon is thus a similar concept to the hand of a thread. If this analogy is correct, then there exists the possibility that matter and antimatter may not interact gravitationally (which of course is not the same as repulsion), though they will electrostatically and magnetically. However this is highly speculative and uncertain.⁹

⁹ The interesting issue with this idea is that it could have the side-effect of decoupling mass (velocity, acceleration effects) and gravitation across the M-aM divide. This is because cordus provides different mechanisms for the generation of the different forms of mass. Thus in the cordus model, mass-as-resistance-to-acceleration arises from the embedment

The cordus model for gravitation is that the hyffon have a hand – which is minted by the emitting reactive end, and that engages with the reactive end of the remote particuloid, thereby forcing it to re-energise a little closer to the calling particuloid. Force in the cordus model is therefore a positional constraint on re-energisation, i.e. a fundamentally a displacement effect.

Comparison with quantum mechanics

Quantum mechanics explains antimatter in terms of quantum numbers. It has no physical meaning for these, and instead considers them to be ‘intrinsic’: properties that are disembodied from any physical structure. At the same time, the conventional interpretations of QM generally take Bell’s theorem to mean that particles like the photon and electron cannot have any internal structure, i.e. no ‘hidden variables’. The logical inconsistency of this approach is worth remarking on: to believe in internal variables yet deny their physical existence. What really is the difference between an intrinsic variable (which QM accepts) and a hidden one (which QM denies)? QM deals with this dissonance by its choice of methodology: mathematical modelling. Doing so neatly obviates the need to ground the results in physical interpretations. QM has thereby inured itself from the dissonance. But the consequences of this expediency is that the methodology of QM is disconnected from the fundamental premise of science: that observed physical effects have rational and physical underlying causes.

In contrast, cordus takes the perspective that any output functionality of a system, i.e. observed behaviour, MUST arise from some physical internal substructure, and that internal mechanisms MUST exist (relationships of causality) that generate the observed external behaviour. That is our premise in constructing the cordus conjecture, and it is very radically different to that of quantum mechanics. QM is undoubtedly the dominant paradigm for fundamental physics, but we would argue that our method is truer to the scientific method. Our criticism is not so much of the machinery of QM but of the conceptual complacency of the method, particularly the lack of coherence in the conceptual foundations, and the compromised logic of intrinsic/hidden variables.

of the particuloids hyff in the surrounding moving-fabric. In contrast, mass-as-gravitation arises from the handedness of the emitted hyffons. Thus cordus suggests that there is one underlying mechanism – the emission of hyffon along the hyff, that unites the two aspects of mass. But mass as we experience it is an output behaviour, not the fundamental effect. Thus it is conceivable that the acceleration and gravitational components of mass might not always be evidenced together, and antimatter *might* show this. Antimatter is known to have mass, since it appears in the pions and kaons (matter-antimatter chimera particuloids). Note also that these structures have greater mass than the individual quarks: the mass-excess problem has in general already been explained by cordus. However the observed mass is most likely acceleration-mass, since it is *measured* as momentum, i.e. resistance to change in direction. It is possible that the gravitational response could be different, even absent. For example, the pions and kaons *might* have different responses to acceleration and gravitation.

By taking a different approach using intuitive creative thinking from the engineering methods, we have synthesised an alternative model for matter and antimatter. This immediately opens up new possibilities, both for the interpretation of the structure of matter, and further conceptual advance. We are not saying that these concepts are necessarily valid, but rather that the generation of alternative concepts is a worthwhile activity in its own right.¹⁰

5.3 What are the limitations and implications for further research?

Uncertain validity

We acknowledge that the validity of the cordus conjecture is untested. It therefore needs to be treated as a conjecture and its mechanics as speculative. The explanation uses the idea of *ma* hand, and the underlying mechanism for this is only tentatively identified as energisation sequence of the HEDs, linked to the also tentative idea of the three [r,a,t] HEDS having a motion-induced sense of orientation. So this is a specific area of potential weakness in the current model.

Cordus is a very radically different way of conceptualising fundamental physics and conflicts with QM – to the point of asserting that most of the conceptual premises of QM are fallacious [9]. However in this particular area its explanations of antimatter are broadly consistent with quantum mechanics, though it takes the handedness concept further.

If the cordus model for antimatter is valid, then there would be significant implications for further research, because of the deeper mechanics that cordus starts to expose, including the potential to explain the process of annihilation itself.

5 Conclusions

The main difference between matter and antimatter (M-aM), according to cordus, is that the *ma* hand is inverted. Each reactive end for a stable matter particuloid, e.g. the electron, has three orthogonal hyff, in the axes [r,a,t]. The hand of these is held to be the same for all matter particuloids, whether positive or negative charge, and nominated as *forma*. The hand is presumably created by the sequence of energisation of the hyff. For all antimatter particuloids the hand is inverted, and is termed *hyarma*. The inversion of the hand changes the direction of the hyff, and thus reverses the charge, but this is a secondary effect. Thus from the cordus perspective positive and negative charges (of like *ma* hand) do not destroy each other but instead bond through complementary frequency

¹⁰ In conceptual design there are no bad concepts, only more or less useful concepts. Innovation is a cognitive process of creating intuitive associations between existing ideas to create a successful solution. The more ideas, the more novel, and the more diverse, the better: we accept that some may not be workable.

synchronisation (CoFS). This cordus concept permits models to be created differentiating between the electron, proton, and antielectron (positron).

References

1. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus Conjecture: Overview*. vixra, 2011. **1104.0015**. From <http://vixra.org/abs/1104.0015>
2. Witten, E., *String theory dynamics in various dimensions*. Nuclear Physics B, 1995. **443**: p. 85-126. From http://arxiv.org/PS_cache/hep-th/pdf/9503/9503124v2.pdf
3. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus matter: Part 3.1 Wider Locality*. vixra, 2011. **1104.0022**. From <http://vixra.org/abs/1104.0022>
4. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus Conjecture: Part 1.1 Quis es tu photon?* . vixra, 2011. **1104.0016**. From <http://vixra.org/abs/1104.0016>
5. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus optics: Part 2.1 Frequency*. vixra, 2011. **1104.0019**. From <http://vixra.org/abs/1104.0019>
6. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus in extremis: Part 4.1 Electromagnetism*. vixra, 2011. **1104.0027**. From <http://vixra.org/abs/1104.0027>
7. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus in extremis: Part 4.4 Quarks*. vixra, 2011. **1104.0030**. From <http://vixra.org/abs/1104.0030>
8. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Wave-Particle Duality: a Proposed Resolution*. vixra, 2011. **1106.0027**. From <http://vixra.org/abs/1106.0027>
9. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Why does quantum mechanics not scale up?* vixra, 2011. **1107.0019**. From <http://vixra.org/abs/1107.0019>
10. Murayama, H., *Origin of Neutrino mass*. Physics World, 2002. **May**: p. 35-39. From <http://hitoshi.berkeley.edu/neutrino/PhysicsWorld.pdf>
11. Mrozek, J., *The role of mathematical analogies in creating physical theories*. Physics Essays, 2011. **24(2)**: p. 192-195. From
12. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus matter: Part 3.4 Special states of matter*. vixra, 2011. **1104.0025**. From <http://vixra.org/abs/1104.0025>
13. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Cordus in extremis: Part 4.3 Gravitation, Mass and Time*. vixra, 2011. **1104.0029**. From <http://vixra.org/abs/1104.0029>