Strong interaction reconceptualised: Synchronous interlocking of discrete field elements

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Abstract

The purpose of this work was to create a new conceptual model of the strong force (interaction). This is necessary because existing models, of which quantum chromodynamics is the dominant paradigm, are not yet capable of explaining nucleus structure ab initio starting from the strong force. A design method was used to search for alternative concepts within the cordus structure (a non-local hidden variable solution). One such successful concept is presented. In this model the strong force arises from the synchronisation of discrete field elements between particules. This causes the participating particules to be interlocked: the interaction pulls or repels particules into co-location and then holds them there, hence the apparent attractive-repulsive nature of that force and its short range. This force only applies to particules in coherent assembly. The concept of virtual particles can still be accommodated, but is not the preferred interpretation. The model also provides a conceptual unification of the strong and electro-magnetic-gravitation (EMG) forces, with the weak force having a separate causality. It is proposed that the EMG forces and the strong force are different manifestations of a single underlying mechanism. The EMG forces are proposed to be based on the linear strength, bending, and torsional deflection (respectively) caused by these hyffons, whereas the strong force is based on the synchronicity of the field elements. By implication particules can EITHER perceive the strong force, OR the EMG forces, not both. Which it is depends on the nature of their bonding and their proximity. Thus the strong force is predicted to be intimately linked to coherence, with the EMG forces being the associated discoherent phenomenon. This also means that there is no need to overcome the electrostatic force, because it is inoperative when the strong force operates. Hence we suggest that 'strong' is an inappropriate way of thinking about this interaction. 'Synchronous force' would be better. The cordus model makes several testable predictions, particularly about the behaviour of the strong force in coherent bodies.

Keywords: nucleus; physical explanation; strong force; alternative conceptual model; unification of forces; hyffon; cordus conjecture; QCD; coherence; annihilation; Meissner effect; superconductor

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1 Introduction

There is currently no way of showing how the strong force results in nuclear structures. This is problematic because it means that there is a conceptual gap between existing models for the strong force, e.g. quantum chromodynamics (QCD), and the elements of the periodic table and the nuclides. That there is a bonding relationship between protons and neutrons is evident, but the mechanism is unclear. The existing theories struggle to model the simplest nuclei. Other fundamentals, like the relationship of the electron to the nucleus, cannot currently be modelled from the perspective of the strong force, though the electron external orbital shapes are predicted by the Schrödinger wave equation. The present paper puts forward a new model of the strong force.

2 Existing models of the strong force

There are several levels to this problem: (1) How do the quarks bond together within the nucleon? (2) How do the proton and neutrons bind within the hydrogen nucleus? (3) How do the nucleons form the elements and nuclides? There are existing methods to model the structure of the nucleus, such as the shell model, liquid drop, and semi-empirical mass formula (SEMF). These model the proton-neutron numbers and overall properties of the nucleus. However there is a disconnect between these models for overall structure, and that for the strong force. (4) How is the electron bonded to the nucleus?

Nuclear binding energy

The basic explanation of the strong force is that nuclear binding energy holds the nucleus together, where that energy is created from the mass deficit between the masses of the individual components compared to the mass of the assembly. But that is of itself not an explanation, because it does not explain the mechanism whereby the mass deficit is converted into binding force. Nor does it explain why that force, once created and sufficient to overcome the electrostatic repulsion, does not simply crush the nucleus into a singularity.

Quantum chromodynamics

A more detailed theory of the strong force (interaction) is available in quantum chromodynamics (QCD). That theory partitions the strong force into a nuclear force that holds the protons and neutrons together in the nucleus, and a colour force that holds the quarks together to form the nucleons.

At the deeper level of the quarks, QCD proposes that the strong force is created by gluons (a type of virtual particle of which there are nine types) being exchanged between the quarks. In this model quarks have a property called colour charge (red, blue, green) which codes for the three distinct quantum states the particle can take (whereas particles more generally only have two states). Antiquaqrks take anticolours. According to this model, the quarks emit and receive gluon particles, which carry the colour charge. This exchange creates a force between the quarks, binding them together. This colour-force is believed to confine the quarks to the nucleon: it allows them some freedom within the nucleon but strongly prevents them making a wider separation, hence asymptotic freedom [1]. Attempting to separate the quarks only causes a quark-antiquark pair to be produced instead. Gluons can interact between themselves, and this diminishes their effect at close range, thus the force is not infinitely strong at close range.

The force that holds the nucleons together is then explained as the residual effect of the gluons leaking outside the nucleons, hence residual strong force, or residual colour force. Thus the nuclear force is understood as arising from the exchange of pi mesons (pions) between nucleons, in the Yukawa interaction. Pions (π^0, π^+, π^-) are combinations of up and down quarks, where one of each pair is the antimatter type. The explanation for the bonding between neutrons is that these point structures are polarised such that a residual element of the strong force binds them together. The mechanism for the repulsive nature of the nuclear force is the gluons interacting with each other.

3 Foundational issues

The theory of QCD is generally considered successful. It offers a conceptual model (gluons and colour-force), and an associated mathematical representation. QCD provides predictions that are consistent with outcomes measured at colliders, e.g. three-jet events. It is an important part of the standard model of physics, wherein it provides the framework for modelling the inner structures of the nucleons.

Gaps in the body of knowledge

Nonetheless there are still large gaps in the body of knowledge regarding atomic structure. QCD is primarily focussed on only one of the fundamental questions: how the quarks bond together. Its solution is formulated in terms of quark confinement, gluons, and colour force between the quarks. It is vague about the larger scale bonding of protons and neutrons within the nucleus, and the concept of polarised points is paradoxical. There are also unfinished conceptual issues: the strong force is explained in terms of a colour-force, which thus also needs an explanation. This adds to the overall problem, because the fundamental mechanisms of force are unknown. How does exchange of particles cause force to arise? Adding more forces, colour in this case, may be useful for explaining quark behaviour, but is not parsimonious for the wider problem and potentially makes it harder to achieve a unified explanation for force. Attempts to extend QCD's mathematical formulation have not increased its explanatory power.

So the predicament is that the current models of the strong force are unable to predict nuclear structure. This is problematic, given that the strong force was originally conceived as a method of binding the protons and neutrons together in the nucleus.

This is a foundational matter, and therefore a conceptual issue rather than mathematical. The fact that there is conceptual incongruence between the QCD model and nuclear structure, suggests that there is a foundational concept that is wrong somewhere. It is possible that there could be a deeper and different mechanism at work, of which QCD merely happens to be a representation.

Purpose

In this work we apply a design methodology to prospect for different foundational concepts for the strong nuclear force. Ultimately we seek a model with potential to yield a structural model of the nucleus. We already have a precursor model, which is the cordus conjecture [2], and we are curious to see whether that model has the fitness to explain the strong force, and if so whether it provides any new insights. Cordus is a non-local hidden-variable solution.

4 Approach

To tackle this conceptual problem we need a suitable epistemic approach, one able to generate new concepts.[3] We find this in design. This method excels at finding alternative concepts. It uses logic to deconstruct the external requirements (in this case the known behaviours of the strong force), creatively generate new concepts using intuitive processes, and then synthesise the fittest of those into a new model.

As part of the design approach, we start by seeking to understand the problem in terms of the required output behaviour, i.e. what the model of the strong force is really required to do. This is important because the way one chooses to define a problem determines the solution that emerges. This premises that are accepted at the outset shape the solution path, and give outcomes that are coherent with those initial premises. For a good design, we need to make clear the tacit premises of the situation and test whether they are mandatory.

The conventional Specification for the strong force

The required attributes of the strong force are conventionally understood as follows. These are inferred from the behaviour of the protons and neutrons in the nucleus.

1. The nuclear force is required to overcome the electrostatic force of repulsion between protons. It needs to be ‘strong’ as the electrostatic force becomes stronger as the separation decreases.
2. Also, the strong force is required to exert its attraction between nucleons, whether they are neutral or charged. So it cannot be a charge-effect in the usual sense of charge.

[3] We acknowledge that mathematics is better at formulating the details of a problem. But here the issue is not about refining the detail but seeking an altogether new concept,.

3. And while it needs to be stronger than the electrostatic force, it needs to weaken at distance so that it does not interfere with that other force.
4. Moreover, it needs to turn into a repulsive force if the nucleons come too close, or it would crush the nucleus.

These expectations create a mental model of what the force should be like, and even the name, 'strong' is a consequence of the construct. We question these premises and their logical structure. We suggest that they frame the problem inefficiently, and perhaps even erroneously.

Questioning the premises

We do not disagree with the output behaviour of the system, i.e. that protons repel each other electrostatically, or that protons and neutrons are bonded in the nucleus. However we do question the way these behaviours are conventionally interpreted into the *Specification*, and the hence the way that solutions like QCD attempt to meet such a specification.

For a start, we question the assumption that the strong force has three levels of operation: weak Strong force at long range > strongly attractive Strong force at middle range > repulsive Strong force at close range. Is it really necessary to have a force that changes its characteristics? Is there no more efficient way? The conventional approach first needs to have a mechanism for a 'strong' force. Then it needs to have a mechanism to dilute that force at large range. Then a third mechanism is required to change the force into a repulsive one.

Therein lies the problem, because any solution that seeks to explain the conventional *Specification* is, from a design perspective, a very inefficient epistemic arrangement. The more so when electrostatic repulsion is added to the mix. Inefficient, in that it requires diverse mechanisms and many variables to represent this. That inefficiency leads us to suspect that there might be a deeper and simpler concept, one still hidden, from which those characteristics emerge more efficiently.[4]

So as a starting point, we have identified a logical weakness in the existing knowledge foundations of the strong force. There is a possibility that a more efficient design might exist, one with fewer mechanisms and greater explanatory power, and that if it existed it would be at a deeper level. That gives us a clue about what would be required of an alternative solution. Finding such a solution is the obvious next challenge. We need a starting point, and clearly that is not the existing mental models like QCD. We also need a creative mechanism. Fortunately, we have both, in the form of the cordus conjecture and the design method respectively.[5]

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[4] Note that this is only our intuition, based on design considerations. There is no requirement for physics to be parsimonious with its variables.

[5] We also need another ingredient: creative intuition. That comes from within the cognition, and is much harder to describe or replicate. Thus others might start with the same initial assumptions and apply the design method, and using their own intuition come up with a totally different model. We therefore acknowledge that the solution we generate is not necessarily unique.

Refining concepts by evaluating fitness

The design process is then to take existing concepts, and any new candidate concepts, and check whether by extending them it is possible to provide a solution. In this case we start with a single concept, the cordus, rather than many. Therefore we cannot be sure that there is not a better solution than the one we develop. Even so, many variants arise when extending a single basic concept, and the more promising have to be identified and further developed. This sorting is done by evaluating the fitness of the candidates, where fitness is explanatory power. In this case of having a prior seed concept we have an additional constraint, which is that the solution also has to be logically consistent with all the other constructs within that seed. These are the prior lemmas of the cordus conjecture. If this coherence can be achieved then the solution as a whole grows in fitness, but if not then either the seed concept or the extensions are wrong somewhere, and need reconceptualisation again. We show that the former occurs.

The results of this design process are shown below. This only represents the fittest solution that we found, and neither the intermediate models nor the dead-ends are shown here.

4 Results

We start by introducing the cordus model, and then explore how its discrete field structures provide a solution to the problem.

4.1 Cordus model

In the cordus conjecture [2], particles are not zero dimensional points, but instead are proposed to have a specific internal structure called a cordus particule [3-4] – note the small change in spelling that indicates a different yet similar concept. Briefly, cordus particules consist of two reactive ends some geometric distance apart, but connected. The ends take turns to energise, with the one de-energising as the other energises. As they energise they emit discrete field pulses (hyffon) down field lines (hyper-fine fibrils, or hyff) in the three orthogonal hyff emission directions (HEDs). This makes up the field, which is thus also discretised. The direction of hyffon pulses, outwards or inwards, represents negative and positive charge respectively (a sign convention). These hyffons are therefore available in discrete units, and the number and arrangement thereof determine the nature of the particule, see Figure 1. We have shown that Bell-type inequalities do not preclude such internal structures [5].

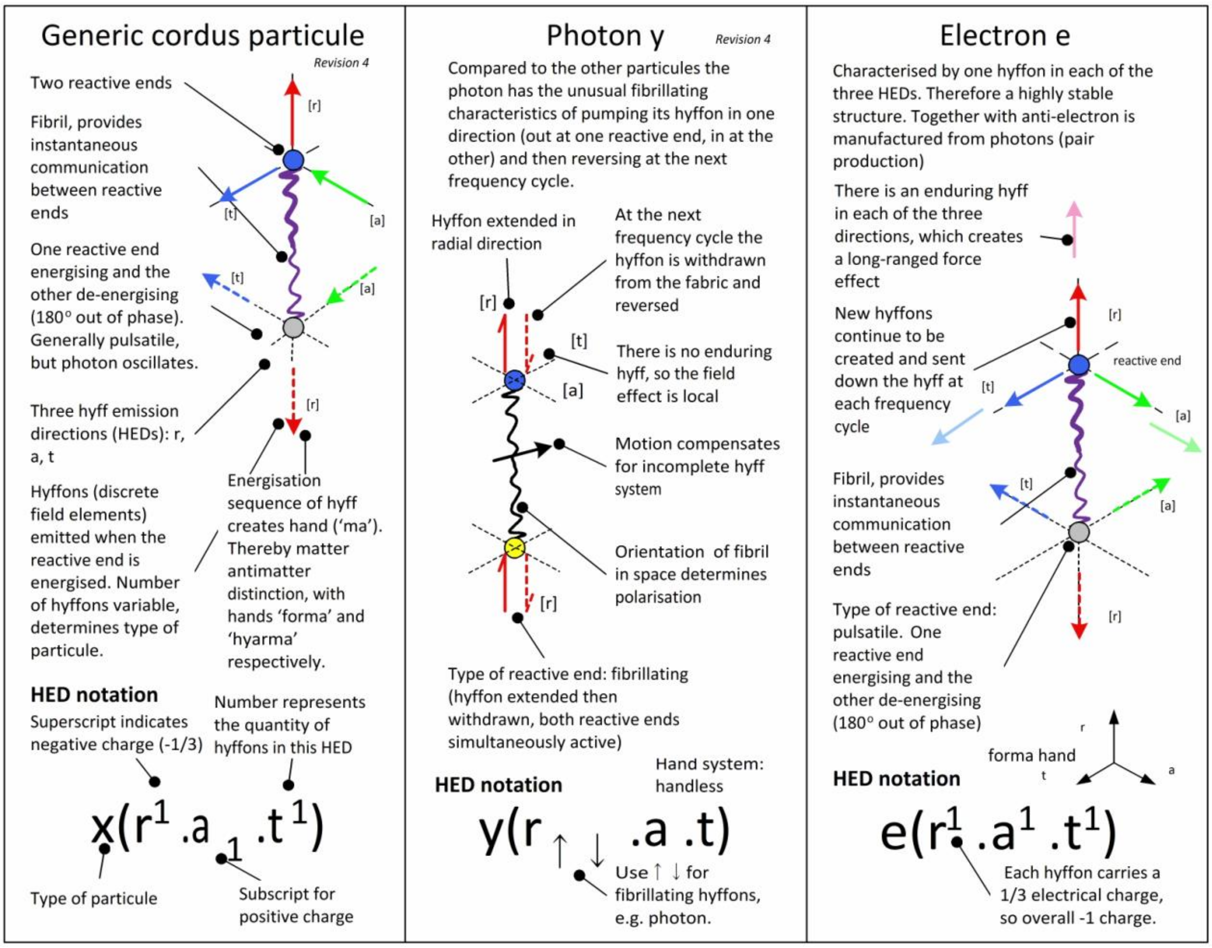

Figure 1: Model for a generic particule, showing the general principles of the cordus conjecture. The models for the photon and electron are also shown for reference and contrast. The HED notation is a symbolic representation of the HED arrangements for the particule.

Thus the basic particule structure, in terms of what it presents to the external environment, is a set of orthogonal discrete field elements: hyff that extend out into space in three hyff emission directions. These hyff are energised with transient hyffon pulses according to the type of particule.[6] Multiple hyffon pulses may be present in any one HED, but for stability the net total must be zero or multiples of three: each hyffon pulse carries a 1/3 charge, and the sign is determined by the direction. Various features of the hyff and hyffon carry the electrostatic field, magnetism, and gravitation simultaneously.

The proposed structure of the proton is shown in Figure 2. The diagram shows the proposed 3D geometric structures for the particule and its field arrangements in the three orthogonal axes, [r], [a] & [t]. The HED notation

[6] The central concept of a cordus particule has remained the same through this sequence of papers, but the design has been revised. An earlier revision was the proposal that the reactive ends were not so much off vs on, but energising vs de-energising. This paper introduces a fourth design variant, which changes the orientation of the HEDs at the de-energising reactive end. However this design feature looks likely to remain unsettled, and hence liable to further change, until the fibril mechanics are better understood.

is a shorthand symbolic representation of the HED arrangements for this particule, and includes the three axes and the number and direction of hyffons in each (superscripts are negative charge, subscripts positive charge). For antimatter the axes and field system takes the other hand. The background explanations for *how* we came up with this model are described elsewhere [6-7].

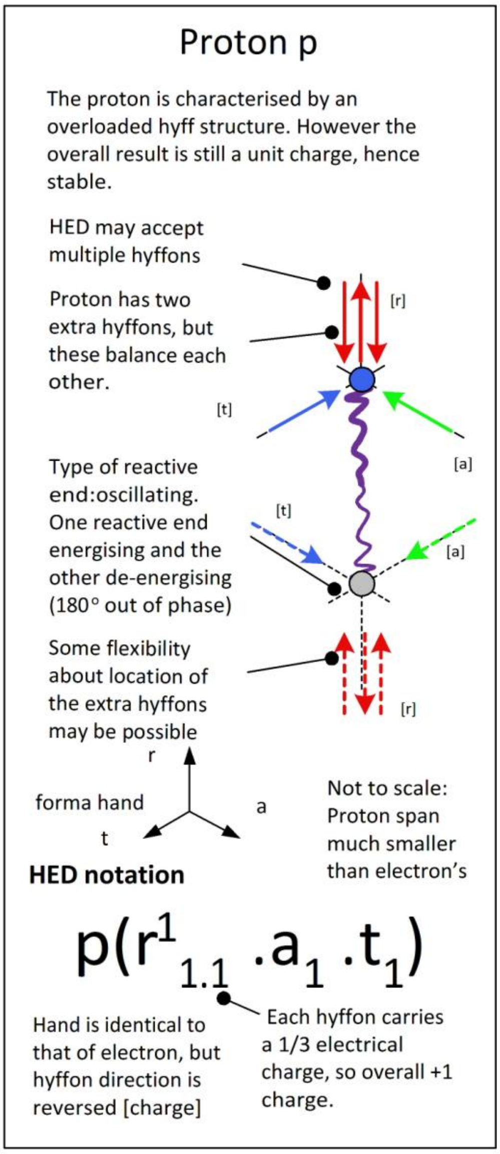

Figure 2: Cordus model for the proton. In the case of the proton one of these axes has an extra pair of hyffons, giving four hyffons in total but still a net charge of +1.

The cordus model may look strange compared to the zero-dimensional point construct that dominates our mental models of physics. The idea is relatively radical, and certainly is unorthodox. Nonetheless it offers explanations for many fundamental phenomena, and in this way has high conceptual fitness. As the name suggests, it is only a conjecture, and its validity is uncertain. Even so, it offers new insights and interesting new possibilities. We explore one of these regarding the strong force.

4.2 Model of the strong nuclear interaction

We now introduce a major point of departure relative to the conventional specification for the strong force. That specification requires the force to change its effect at different ranges, from being weak, to strongly attractive, to repulsive. Instead, we suggest that all these behaviours can be explained in a totally different way.

We propose that the strong nuclear interaction arises from the synchronisation of hyffons (discrete energisation pulses of the electric field) between particules, and is thus an assembly interlock effect. This simple proposition has a number of far-reaching implications. We expand on the idea in the following proposals:

<u>(1) Strong force arises from the synchronisation of hyffons between particules</u>

According to the cordus interpretation the strong interaction is the synchronous interlocking between hyffons (discrete field elements), the action of which tends to pull or repel particules into co-location and then hold them there. This force only applies to particules in coherent assembly. Coherence is discussed elsewhere [8].

Thus the strong force arises from the need for particules to share hyff emission directions. This applies when they come sufficiently close to each other. Particules can also completely co-locate, i.e. geometric superposition of reactive ends from different particules.[7] Since the hyffon pulses are discrete, presumably being emitted at a frequency, it is necessary for particules to synchronise their emissions if they wish to remain co-located. Thus the strong force is a stabilising effect due to synchronous hyff emission directions (SHEDs) [9].

<u>(2) Hyffons are the common underlying mechanism for all forces (interactions)</u>

The cordus model leads us to propose that that there is a single fundamental mechanism, the hyffon, for the strong force and the electron-magnetic-gravitational (EMG) forces. The four hyff variables are synchronicity, strength, bending, and torsion (hand), respectively [10]. Thus it is proposed that all interactions between particules are mediated by hyffons.

The mechanism for force is that the external hyffons constrain the position of re-energisation of the reactive end of the recipient particule, i.e. force is fundamentally a prescribed displacement effect. Hence the attractive-repulsive nature of the strong force is readily accommodated.

<u>(3) Strong force is proposed to be a different category of force to EMG and exclusive to coherent assemblies</u>

The cordus model leads us to propose that the strong force is a fundamentally different type of force category to the macroscopic electro-

[7] However, this is not the same as the temporal superposition of quantum mechanics, which cordus rejects

magnetic-gravitational forces [10-12]. We propose that the differentiating factor is the synchronicity and hence coherence (or lack thereof) of the participating particules.

- For the strong force, the interacting particules necessarily have synchronous frequencies, i.e. emit their hyffons (discrete field forces) at one common frequency, and interact synchronously. Thus these particules are in coherence with each other [8].
- For the EMG forces there need be no synchronicity. The cordus model is that the electrostatic, magnetic, and gravitational forces are macroscopic forces. They are explained as arising from the disjointed rain of hyffons on the recipient particule. Thus the fields are all discrete, but their macroscopic effect is practically smooth and continuous.

The EMG forces therefore apply to both coherent and discoherent bodies, but the synchronous strong force only to coherent bodies.

Thus central to this model is a proposed new concept of coherence and discoherence, for which we have elsewhere provided a more detailed model and explanation [8], including a proposal that time is also a discoherent phenomenon [13]. The cordus model suggests that the strong force and coherence are both manifestations of a single deeper mechanics: the coordinated access to synchronised hyff emission directions (SHEDs) [9].

<u>(4) Strong force gives rise to specific bonding structures</u>

We propose that the strong force produces a variety of specific structural assemblies between particules. (This only applies in coherent situations, see above). The differentiating factor is proposed to be the phase offset of the frequency of the particules (spin). (Note the assumption that coherent particules already have a common frequency). There are two discrete states that particularly interest us: the particules may be in or out of phase with each other, which we term cis- and trans-phasic behaviour. This readily explains the simple ${}_1H_1$ nuclear structure and H_2 molecular structure.

<u>(5) Annihilation is another manifestation of the strong force</u>

In the cordus conjecture the differentiating factor between matter and antimatter is the hand of the reactive end. The mechanisms for annihilation are also anticipated by the cordus conjecture [14-15]. Here we simply propose that the interaction at annihilation is another sub-type of the strong interaction. We propose that the synchronisation of hyffons from same-handed particules results in an additive effect and hence bonding, whereas the interaction of dissimilar handed species results in cancellation of hyffons and hence annihilation.

<u>(6) Singularity avoidance</u>

This also explains why the electron that is bonded to a proton is not merged into the proton, something which is problematic to conventional models. The electron has two reactive ends, and only one can be co-located with any one reactive end of the proton. So the electron always has a span, and therefore an identity. In this way the cordus model also avoids the singularity problems that trouble the 0-D point model.

(7) Energy equity mechanism

A general characteristic of all the strong force interactions in the cordus model is that participating particules are coupled together. The need to preserve the same re-energising locations means that the energy systems are joined. They can (and must) redistribute excess incoming energy between them.[8] This transmission is probably within a frequency cycle, if not instantaneous, and the overall effect can be superluminal if the assembly can be contrived to exist at a macroscopic scale.

This also explains two other effects. The first is mass deficit. Here the cordus explanation is that the assembly of the subcomponents (quarks into nucleons, or nucleons into nucleus), requires for synchronicity that they have a common frequency. This may be different to the native frequencies of those subcomponents. Consequently the subcomponents may have a different frequency in the assembly to that which they adopt when isolated. In the cordus model, as in conventional physics, frequency corresponds to mass, and hence the mass of subcomponents may differ from that of the assembly. Cordus also offers a mechanism for mass: that the number of hyffons emitted, and the frequency of emission, determine mass.

The second effect is photon emission. If an assembly cannot contain all the energy it receives, then either it must disassemble, or emit the surplus as a photon. Cordus also provides a detailed model for photon emission [16].

4.3 Categorisation of the strong force

Taken together, these proposals allow us to construct a categorisation diagram of the forces (interactions), as summarised in Figure 3. The categorisation is primarily regarding synchronous vs. asynchronous interactions.

[8] The redistribution of energy between assembled particules is essential because any energy different in one particule will cause its frequency (and in matter particules also the span) to change. In turn this will put pressure on the particule to desynchronise. The HED-based strong force resists that, and the hyffons transfer the excess energy to the other particule. If the input energy is too great for the HED negotiation to accommodate, then the particules disassemble.

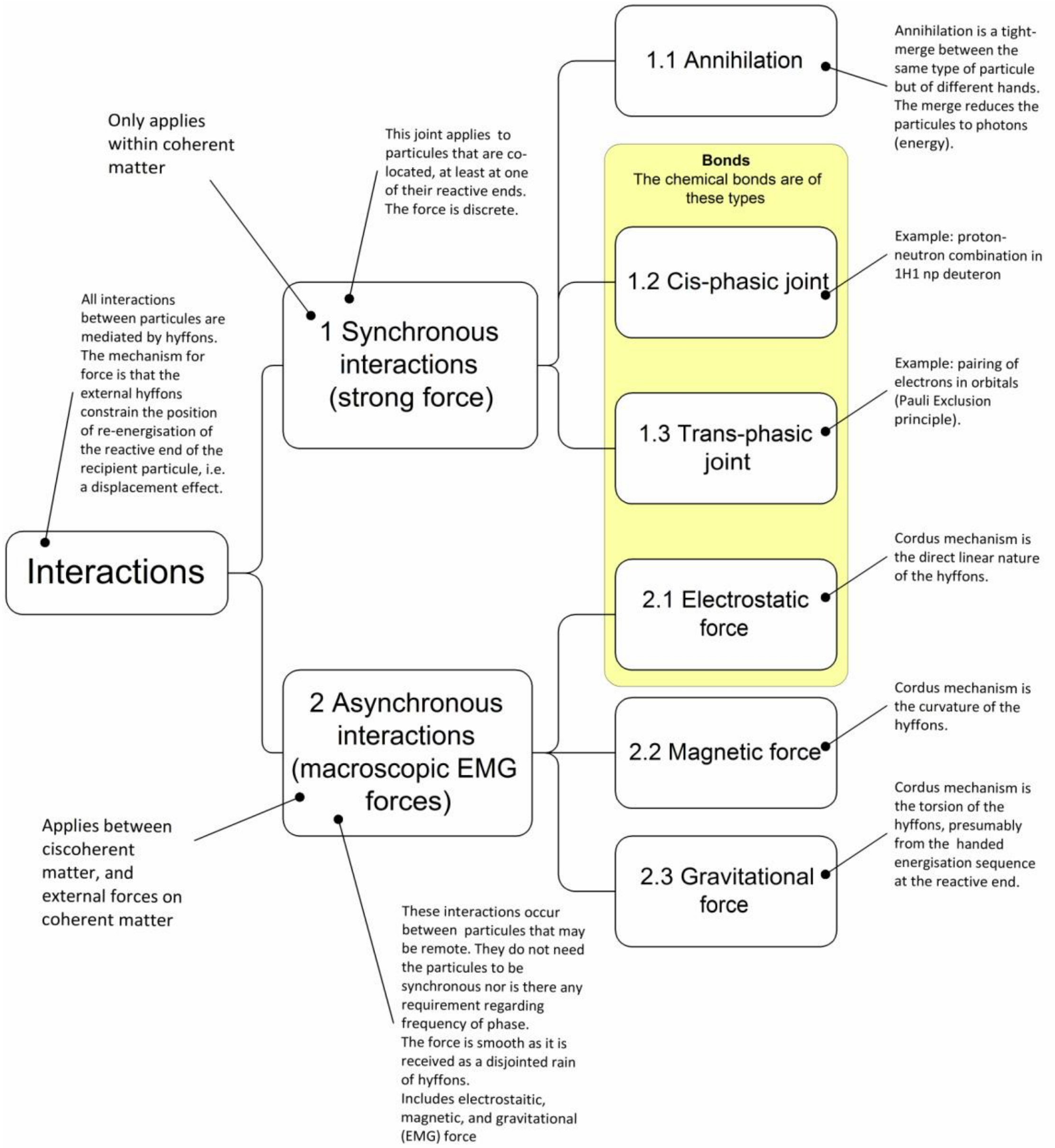

Figure 3: Cordus force hierarchy model. All interactions between particules are mediated by hyffons. The mechanism for force is that the hyffons constrain the position of re-energisation of the reactive end of the recipient particule, i.e. a displacement effect. The state of the particules, particularly the synchronicity and phase of their frequency, results in several types of forces/interactions as shown.

Thus the cordus model proposes a single mechanism, the hyffons, for all the forces. The forms of the strong force that particularly interest us here are the cis- and trans-phasic forms, because these are implicated as determinants of the nuclear structure. We intend to cover that more explicitly in a companion paper.

This cordus model also proposes that the term 'strong' force (interaction) is a misnomer. 'Synchronous force' would be a more apt description of the mechanisms, if we are correct. The term 'strong' is a construct that emerges from a blind acceptance of the conventional *Specifications.* By being able to field a viable alternative model, we cast doubt on the validity of that whole logical construct.

4.4 Synchronicity lemma NP.1

The above assumptions and proposed mechanics are summarised in a set of lemmas. These should be interpreted as proposed statements of causality.

NP.1 General principles of the synchronous (strong) force

NP.1.1 The process of assembly provides, through the hyffons, for particules to negotiate with each other beforehand. This is via the hyffons they receive from the other particule.

NP.1.2 All forces, the strong, electrostatic, magnetic, and gravitational, are carried by the hyffons. The four hyff variables are synchronicity, strength, bending, and torsion (hand), respectively.

NP.1.3 The mechanism for force is prescribed positional constraints on the reactive end of the recipient particule.

NP.1.4 The strong force is the synchronous interlocking between hyffons (discrete field elements), the action of which tends to pull or repel particules into co-location and then hold them there.

NP.1.5 The strong force only applies to particules in coherent assembly. The corollary is that synchronous interactions between particules are mediated by the strong force.

NP.1.6 The strong force and coherence are both manifestations of a single deeper mechanics: the coordinated access to synchronised hyff emission directions (SHEDs).

NP.1.7 The electro-magnetic-gravitational (EMG) forces do not require synchronicity between particules, and are a macroscopic manifestation of the strong force.

NP.1.8 Particules are able to re-arrange their active HEDs, i.e. move their hyffons about, to align with the new HEDs presented by mating particules. (This lemma is tentative).

NP.1.9 The strong force results in several different structural assemblies, depending on the relative phase of the component particules.

NP.1.10 Particules assembled by the strong force can (and must) redistribute excess incoming energy between them, or disassemble. The proposed mechanism is that the synchronisation of hyffons (which is the basic feature of the strong interaction), also means that the frequencies of the particules have to be synchronised (harmonics are accepted). Thus the frequency of any one particule cannot vary greatly, even if it has absorbed or emitted a photon, and must instead distribute that change in energy to neighbouring particules, or re-emit it as a photon. This means that assembled particules mutually control each other’s frequencies. Hence also mass deficit at assembly.

These new lemmas do not appear to be inconsistent with those already in the wider cordus set, so no rework of prior assumptions is necessary. This is useful to know as it confirms the logical consistency of the model.

5 Discussion

5.1 What has been achieved?

Overview

Using the cordus conjecture we make several new proposals regarding the forces (interactions). Specific subcomponents to this model are:

1. Mechanisms are proposed for the strong force, in terms of the interlocking of discrete field elements (hyffons) between particules. This is a novel alternative perspective.
2. A single mechanism, the hyffon, is proposed to underlie all of the strong force, annihilation, and the EMG forces. This is also a novel alternative perspective.
3. The strong force is predicted to be intimately linked to coherence. The EMG forces are the associated discoherent phenomenon. This also means that any one particule will influence another <u>either</u> via the strong force <u>or</u> the EMG forces, not both. Consequently there is no need to switch off or overcome the electrostatic force, hence we suggest that 'strong' is an incorrect way of thinking about this interaction. This is another novel alternative perspective.

So we have provided a drastic reconceptualisation of the strong force. If this is a valid solution, then it has some interesting implications as follow.

Reconceptualisation of the strong force

This paper makes the contribution of providing a new conceptualisation of the strong interaction. The attributes conventionally expected of the nuclear force are: that it is attractive between nucleons whether neutral neutrons or positively charged protons; that it is repulsive at close range; that its effect drops off with range.

The cordus model accommodates all these, though in radically different ways. Thus in cordus the nuclear force is caused by the alignment of HEDs between bonding particules, and the interlocking of their hyffons. Those hyffons are discrete field elements that are renewed at the frequency of the particule, which is thus dependent on the mass. The signs of those hyffons (which depends on the type of particule) are important in determining whether the joint is viable.

Conceptually what we have achieved is to transform the inefficient conventional requirements for the strong force (weak > strongly attractive > repulsive) into another solution space where it can be represented with a much simpler and more efficient solution. Doing so also integrates the electrostatic force into the solution, which is another bonus feature.

Cordus also predicts that the strong force will be unable to bond all types of particules: those that cannot obtain a frequency match (or a harmonic thereof) will not be bonded this way but will feel the EMG forces instead.

Thus cordus also readily explains why the nuclear force depends on the alignment of the spins of the nucleons (a known effect). The explanation is that one reactive end of the first particule is energising and its other is de-energising, and the correct end needs to aligned with the second particule, hence an orientation or 'spin'. The QM concept of spin becomes the angular orientation of the fibril (or phase angle) of the particule. But providing the spin criterion is met then the interaction is simply based on phased interlocking of hyffons, so the force can bind particles where electrostatic forces would otherwise not allow. Specifically, a proton and neutron (${}_1H_1$), or even two protons (H_2). These bonds are easy to explain from the cordus perspective.

That interlocking of the hyffons requires the participants to have the same frequency (or a harmonic) and thus the interaction also couples the energy systems of the particules, and hence also their geometric spans. The strong interaction is therefore, according to the cordus interpretation, a constraint on the location of re-energisation of a reactive end. Consequently the interlocking also prevents the particules from moving away from or closer to each other. Thus the attractive and repulsive features of the nuclear force are accommodated.

As the reactive end of a particule tries to move out of a nuclear relationship, it encounters synchronisation constraints that pull in back into interlock. This also explains why a particule that gains sufficient energy may break out of the relationship. Likewise decay is explained as particules that were not very strongly bound together in the first place, being vulnerable to obtaining sufficient energy, e.g. from perturbation by hyffons in the fabric, to escape the relationship. Also, in cordus there is no singularity when one reactive end from each particule co-locates, and hence collapse is not an issue.

Provision of a conceptual framework for unification of forces

A second contribution is the provision of a novel holistic framework for the unification of forces. This model encompasses the strong and electro-magnetic-gravitational forces. They all rely on discrete field elements (hyffons). The EMG forces are proposed to be based on the linear strength, bending, and torsional deflection (respectively) caused by these hyffons, whereas the strong force is based on the synchronicity of the hyffons. It provides a qualitative explanation of the mechanism for transmission of those forces (hyffons) and the mechanism of force (prescribed displacement of reactive ends). This unification is achieved by the discrete field elements (i.e. hyffons) being common to all the interactions. The weak force is not a force at all, according to cordus, but rather a decay process for neutrons and has different proposed causality [7, 17].

Integrating coherence into the force model

A third contribution is the conceptual integration of coherence into the force models. Several novel propositions emerge from this line of thinking, e.g. the idea that the strong force is simply another aspect of coherence within matter, whereas the EMG forces are felt when matter is discoherent, see *Implications* below. Likewise the new perspective that annihilation is a type of strong-force interaction.

Crucially, these concepts only become conceivable for a cordus type particule with its additional dimensions (internal variables). From an epistemic perspective, what has happened here is an expansion of the dimensions available to a particule. In particular, QM constructs particles as merely zero-dimensional points, and therefore cannot conceive of anything but a single strong force. Concepts like 'spin' and 'frequency' are abstract concepts to QM. Consequently QM relies on creating more particles whenever it needs more variables to explain something. In contrast, cordus provides particules with several additional dimensions: span, frequency, phase, and orientation angles.[9]

5.2 Comparison with QCD

Quantum chromodynamics provides a theory of this interaction at the level of quarks, based on 'colour-charge'. QCD models the force as occurring by the quarks transmitting and exchanging gluons with each other. QCD requires multiple forces and messenger particules. There is an electrostatic force (transmitted by virtual photons) that stays on at all scales. This must then be overcome by the nuclear force (transmitted by virtual pions) which in turn is a derivative of the colour force (transmitted by gluons). It is not yet possible to model nuclear structure from the ground up using QCD.

The cordus conjecture provides a different construct: it proposes that a particular behaviour of the hyffons carries the strong force. Where QCD has gluons, cordus has hyffons, though they are not equivalent. The cordus explanation is that QCD's colour charge (a charge-like property of quarks and gluons) corresponds to the three hyff emission directions (HEDs) and the hyffons therein. So the outcomes are similar, but the mechanisms and conceptual foundations are different. Cordus has a much wider role for its hyffons than QCD has for its gluons. Cordus proposes that the hyffons determine both the strong and nuclear force, make up the wider electro-magnetic-gravitational (EMG) fields, provide a discrete

[9] If one wishes to consider each cordus internal variable a dimension, then the tally from cordus is 3 linear dimensions [x, y, z] for location of a reactive end, 1 for the length of the span (related to energy of the particule), 3 polarisation angles for the orientations of the HEDs (field emission directions) assuming that the [r] axis is not necessarily always in the linear direction of the span (which we think is the case with the photon though we are unsure about massy particules), 1 variable for each of three HEDs to denote the field activation status (hyffons) of that HED, and 1 variable to indicate which reactive end is energising (spin). Not all these dimensions are ratio variables. That gives a total of 11 (or 10) variables (dimensions) to fully define a cordus particule. Note also that the cordus model does not accept macroscopic time as another dimension, as is the common interpretation of conventional physics.

force field, and make up the fabric of space and time [10-12]. So the strong force is writ large on the universe.

In the cordus conjecture there is a single conceptual model for both the strong interaction between quarks and the nuclear force between nucleons. There is no issue in cordus with the idea of pions generally, and these structures are readily accommodated in the cordus matter-antimatter model [14]. However cordus does not specifically need pions to explain the nuclear force. Cordus provides a more parsimonious model in that the electrostatic force (and EMG forces in general) is merely the hyffon effect at the larger scale where synchronisation no long applies. So in cordus there is only one force operating at the nucleon-to-nucleon interaction, not multiple. The cordus concept provides a unified model for all the forces, and requires no family of new particles. It requires no separate mechanism for repulsion of the strong force, but instead simply explains it as synchronisation having a strong central tendency.

Cordus also obviates the need for the families of 'virtual particles' of the standard model: neither virtual photon nor graviton, nor any other force boson is required. It is not that these are disallowed. Rather the cordus model permits that transients in the vacuum fabric of background hyffons [12] may be interpreted as conventional virtual point-particles if one wishes to take the point perspective instead. It is just that cordus suggests that a much richer, and also more epistemically efficient, interpretation is available by abandoning that point perspective.

The cordus model also has the potential to explain nuclear structure. Certainly simple assemblies like the $_1H_1$ deuteron and H_2 structures are readily explained as cis- and trans-phasic joints respectively. We explore that in a companion paper.

5.3 Implications for coherent bodies

Conventionally the strong force overcomes the electrostatic repulsion of protons. But the cordus model proposes a totally different mechanism whereby one particule affects another either by the strong force, or the EMG forces, not both.

Applying this to the nucleus, this implies that immediate neighbouring nucleons would interact by the strong force, and potentially feel the effect of more distant nucleons (in the same atom or other atoms) as the EMG forces (particularly the electrostatic since this is a direct tension/compression whereas the magnetic requires relative motion, and the gravitational is weak). This is consistent with the liquid drop model of the nucleus.

In the nucleus the arrangement of nucleons will possibly, even likely, be geometrically complex, such that nucleons <u>far from each other</u> in the assembly may perceive the EMG forces (primarily electrostatic) rather than the strong force. One could alternatively say that the coherence is short-ranged. Certainly at the level of molecules the interaction is generally understood to be electrostatic rather than the strong force.

However there is the possibility that macroscopic coherent bodies, e.g. superfluids, may have the strong force synchronised throughout the whole body. Below we explore the intriguing possibilities and novel predictions if this were to be the case.

Alternative explanation for superconduction effects

We have previously given an explanation for the expulsion of magnetic fields from superconductors (the Meissner effect), in terms of the coherent complementary frequency synchronisation (CoFS) network providing lateral stiffness: the hyff from neighbouring electrons lock the nodes of the entire network in place [18]. Therefore an external magnetic field cannot displace the reactive ends: its effect is resisted, and the flux lines are denied passage so they go round the wire instead. Surface currents arise as compensatory consequences of the load on the CoFS network [18]. We now suggest another explanation, complementary to the first: that a coherent body (of electrons in the case of a superconductor) uses the strong force to support that coherence and therefore cannot use it to also create EMG forces within the body. Thus a second, complementary, explanation is provided for the Meissner effect.

Implications for response of a coherent body to EMG fields

This model suggests that all EMG forces between neighbouring bonded coherent particules are switched off because the interaction manifests as the strong force instead. There are some curious implications for gravitation. If, as the cordus sub-model for force suggests [10], the EMG forces are linear, bending, and torsional effects respectively of the hyff, and given that cordus explains coherence as a regime of the strong interaction that applies step-wise throughout a body [8], then the logic implies that a coherent body may also feel only the strong force (not the self-EMG forces) internally.

Taken together, we can thus make some tentative predictions for a coherent body, e.g. a superconductor, superfluid or supersolid:

1. This cordus model predicts that electric and magnetic forces, and presumably also gravitational, cannot be transmitted within a coherent body. The coherent body as a whole is predicted to respond to external EMG forces at its skin layer. This coherent bodies should be unable to sustain an internal voltage gradient, magnetic field, or gravitational field (should apply to superfluids too). The prediction regarding gravitation is likely to the be controversial one, as gravity is otherwise thought to be unshieldable. This could be testable, and thus this part of the model is falsifiable.
2. The EMG fields emitted outwards by a coherent body are predicted to be pulsed (like a laser) and not continuous (as opposed to decoherent bodies emitting macroscopically smooth fields).
    a. The frequency will be that of the basic individual particule, not the mass of the body as a whole.
    b. The frequency will be independent of the number of particules in coherence.

    c. The fields will be polarised.
3. The categorisation into EMG vs. strong force leads us to predict that self-gravitation (i.e. of internal origin) too is inoperative *within* a coherent body.
    a. Specifically, that self-gravity does not operate in coherent bodies: the atoms are not gravitationally attracted to each other. Thus such a body should not collapse under self-weight (at least while the coherence is able to be maintained).
    b. High gravitational loading, presumably acceleration too, may be able to overload the skin and cause decoherence of the body as a whole.
    c. We anticipate that external gravitational fields should interact with the coherent body at its skin, not with its bulk.
    d. External gravitational fields are presumably also diverted around a coherent body.

This is a peculiar combination of unusual predictions, and could eventually be testable. We have separately proposed a model of coherence, its probable requirements (especially regarding composition), its likely practical limitations [8], and why macroscopic bodies are generally incapable of being put into coherent states [19].

5.4 Limitations and opportunities for further research

The ideas expressed here are founded in a radically different concept for 'particle', and cut across conventional thinking. This is a thought experiment which starts with the question, 'What if the 0-D construct for particles were fundamentally wrong? We have shown, through the collection of cordus papers, that this is an interesting question to ask, and that surprising answers are possible. Thus we make no apology for the unorthodoxy of the concepts expressed here, though we are likewise quick to point out that the conjectural nature of the cordus model is naturally a limitation. The model has good *fitness* to qualitatively explain a diverse variety of phenomena [2], but this is still not validation. At this stage it is primarily a conceptual model, or in design terms, a *candidate* solution.

Reconceptualising the strong force is a stage of a longer journey. The ultimate research question would be to explain nuclear structure from the strong force upwards. An ideal model would explain the range of isotopes observed, predict why certain isotopes are more or less stable than others, explain why certain nuclei are uncharacteristically unstable (e.g. ${}_{4}Be_{4}$), and explain the trends in the progression of the stable nuclei/isotopes. Obviously this is still some way off.

6 Conclusions

The purpose of this work was to create a new conceptual model of the strong force. We have achieved that, and in the process provided a novel explanation for the other forces too.

A new conceptual model of the strong force (interaction) has been developed, including a qualitative description of the proposed mechanics.

The central idea is based on the cordus structure and predicts that the interaction arises from the synchronisation of discrete field elements (hyffons). This causes the reactive ends of participating particules to be interlocked: the interaction pulls or repels particules into co-location and then holds them there. This readily explains the attractive-repulsive nature of that force and its short range. This force only applies to particules in coherent assembly.

A new conceptual model for the unification of the strong and electro-magnetic-gravitation (EMG) forces has been provided.

The cordus model proposes that the EMG forces and the strong force are different manifestations of a single underlying mechanism. The EMG forces are proposed to be based on the linear strength, bending, and torsional deflection (respectively) caused by these hyffons, whereas the strong force is based on the synchronicity of the hyffons.

In addition this model makes the novel prediction that the nature of the force perceived by a particule depends on whether or not it is in a coherent relationship with the emitting particule. The strong force is the more fundamental interaction: it binds the particules together by creating interlocked constraints on the geometric location of the particules, if they are coherent. It then escapes that assembly and propagates outwards (as hyffons in the fabric), affecting other more remote particules that it encounters.

The important implication of this theory is that any one particule can perceive the fields of another external particule EITHER as the strong force, OR as EMG forces, not both. Which it is depends on whether or not they are coherent (respectively). Thus the nature of their bonding and their proximity determines the forces they receive. Thus also the strong force is predicted to be intimately linked to coherence, with the EMG forces being the associated discoherent phenomenon.

This also means that there is no need to switch off or overcome the electrostatic force, hence we suggest that 'strong' is an inappropriate way of thinking about this interaction. 'Synchronous force' would be better.

These concepts only make sense in the context of a particule with an internal structure, and are inaccessible to the 0-D point construct of the standard model of physics. Thus we have also shown that it is worthwhile questioning the fundamental premises of physics, for the interesting outcomes that can result. The cordus conjecture, as the name suggests, is not claimed to be a validated theory. Nonetheless it does have high fitness to explain a wide variety of fundamental effects. And if nothing else it provides a thought-provoking contrast to the conventional interpretations.

We conclude also that the conventional premises and logic of the strong force, namely its weak>strongly attractive>repulsive nature, can be challenged. It is indeed possible to reconceptualise a single deeper mechanism, one that displays all these behaviours without needing multiple separate mechanisms. The cordus conjecture of synchronous force is a conceptual primitive that provides the required attributes in a more parsimonious way than existing theories. As an additional benefit it also offers a unification of the forces.

References

1. Wilczek, F., *Asymptotic freedom: From paradox to paradigm.* Proceedings of the National Academy of Sciences, 2005. **102**(24): p. 8403-8413.

2. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Cordus Conjecture: Overview*. viXra **1104.0015**, 1-17 DOI: vixra.org/abs/1104.0015.

3. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Frequency. Cordus optics: Part 2.1* viXra **1104.0019**, 1-10 DOI: vixra.org/abs/1104.0019.

4. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Electromagnetism. Cordus in extremis: Part 4.1* viXra **1104.0027**, 1-17 DOI: vixra.org/abs/1104.0027.

5. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Wider Locality. Cordus matter: Part 3.1* viXra **1104.0022**, 1-7 DOI: vixra.org/abs/1104.0022.

6. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Quarks. Cordus in extremis: Part 4.4* viXra **1104.0030**, 1-15 DOI: vixra.org/abs/1104.0030.

7. Pons, D.J. (2011) *Stability and decay: Mechanisms for stability and initiators of decay in the neutron*. vixra **1112.0002**, 1-17.

8. Pons, D.J. (2012) *Limits of Coherence: Where and Why is the Transition to Discoherence?* vixra **1201.0043**, 1-12.

9. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Quarks. (Cordus in extremis Part 4.4)* viXra **1104.0030**, 1-15 DOI: vixra.org/abs/1104.0030.

10. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Gravitation, Mass and Time. (Cordus in extremis Part 4.3)* viXra **1104.0029**, 1-14 DOI: vixra.org/abs/1104.0029.

11. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Electromagnetism. (Cordus in extremis Part 4.1)* viXra **1104.0027**, 1-17 DOI: vixra.org/abs/1104.0027.

12. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Fabric of the universe. (Cordus in extremis Part 4.2)* viXra **1104.0028**, 1-8 DOI: vixra.org/abs/1104.0028.

13. Pons, D.J. (2012) *Time: Frequency, irreversibility, and connectedness of matter*. vixra, 1-17 DOI: vixra.org/abs/1201.0060.

14. Pons, D.J. (2011) *Mirror images: Cordus reconceptualisation of Matter and Antimatter*. viXra **1109.0009**, 1-15 DOI: vixra.org/abs/1109.0009.

15. Pons, D.J. (2011) *Annihilation mechanisms: Intermediate processes in the conversion of electron and antielectron into photons* viXra **1109.0047**, 1-21 DOI: vixra.org/abs/1109.0047.

16. Pons, D.J. (2012) *Photon emission and absorption: The electron's internal processes*. vixra, 1-18 DOI: vixra.org/abs/1206.0047.

17. Pons, D.J. (2011) *Weak interaction: Reassembly of particules*. viXra **1111.0023**, 1-9 DOI: vixra.org/abs/1111.0023.

18. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Special states of matter. (Cordus matter Part 3.4)* viXra **1104.0025**, 1-12 DOI: vixra.org/abs/1104.0025.

19. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Why does quantum mechanics not scale up?* viXra **1107.0019**, 1-18 DOI: vixra.org/abs/1107.0019.