Photon emission and absorption: The electron's internal processes

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Abstract

A conceptual model is developed for the processes of photon emission and absorption. While the emission of light is well known in terms of quantum changes in energy levels of an electron, the fundamental physical processes are incompletely understood. How exactly does the photon emerge from the electron? How is light absorbed by matter? These foundational conceptual questions are the focus of this paper. We show that it is possible to develop new insights into this problem, based on the cordus model, which is a non-local hidden-variable solution. We start by predicting the structures of the photon and electron, both the internal geometric sub-structures, and their discrete fields. The model predicts that there are different mechanisms for the fields of the photon and electron, and uses this to explain the characteristics of the evanescent and electric fields. We then show how the bonding constraints arise on the electron, and how these require the electron to emit its excess energy. The process whereby a photon is created and separated out of the electron is identified. Photon emission and absorption thus result from an interaction between the discrete field elements and the internal structures. Emission is thus an escapement mechanism whereby matter particules that are over-prescribed in position can get rid of that energy.

Keywords: photon, light, electron, absorption, emission, emit, processes, cordus conjecture, physical interpretation

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1 Introduction

Our world is full of light and its interactions with matter. Yet describing how photons are emitted and absorbed is surprisingly difficult. The mathematical formulations of quantum mechanics (QM) and electromagnetic wave theory are good at quantifying *what* happens, but not at describing *how* the photon emerges from the electron at emission, or is absorbed back into it. Even asking how an electron physically emits a single photon is practically a meaningless question from the zero-dimensional point perspective of QM: it can only go so far as to explain it in terms of quantum changes in energy levels. And wave theory does not extend to single particles. So the question remains: *How is a photon emitted from an electron?* And the complementary question: *How is light absorbed by matter?*

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The purpose of this work is to explore these fundamental questions about the physical process of photon emission and absorption. We show that it is possible to develop a new way of understanding this problem, using the cordus model [1] as the starting point, and some specific models for the electron and photon [2]. We present a novel conceptual model of the processes for emission and absorption. The particular area of examination is the interaction of a photon and an electron. We propose processes for how the photon emerges from, or is absorbed, into the electron.

2 Background: Cordus conjecture

The cordus conjecture is a novel non-local hidden-variable solution. Thus it proposes that particules have an internal structure (hidden variables), and that it is not only the fields at one point that affect the particule (non-local). This is in contrast to quantum mechanics which treats particles as zero-dimensional points. Cordus goes further, in that it makes specific predictions about the composition of the internal sub-structures of the particule, and the discrete fields it emits. Other papers have shown how the cordus idea generates new candidate solutions for physical effects that are otherwise difficult to explain from the conventional paradigm [3].

What is the cordus particule?

The cordus consists of two 'reactive ends', which are a small finite distance apart ('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 [1]. It provides instantaneous connectivity and synchronicity between the two reactive ends, hence a non-local solution. The reactive ends are energised (typically in turn) at a frequency [4]. The reactive ends emit one or more field lines (hyperfine fibrils or 'hyff') into space, and when the reactive end is energised it sends a transient force pulse ('hyffon') outwards along the hyff curve [5]. This makes for a field of discrete elements. 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 [1]. By comparison all massy particules have permanent hyff (including neutral particules like the neutron)[5]. Electric charge is carried at 1/3 charge per hyff, so the electron has three hyff, arranged orthogonally [6], hence hyff emission directions (HEDs). The hyff around massy particules compete for emission directions, and may synchronise their emissions to access those spaces. Thus there is an element of mutual negotiation, between interacting particules, based on shared geometric timing constraints [6], and this is proposed as the mechanism for the strong force.

We use the term 'particule' to differentiate this from the zero-dimensional (0-D) 'particle' construct of quantum mechanics. Central to the cordus conjecture is the idea that fundamental particules have internal structure. But is this idea of internal structure really legitimate: doesn't Bell's theorem explicitly prohibit particles from having internal variables?

Bell's theorem

Bell's theorem predicts that either superluminal entanglement[2] or locality[3] exists, not both [7]. Since entanglement is observed, the logical conclusion is that locality is false. Locality refers to the surroundings, and thus Bell's theorem excludes designs where particles are only influenced by the values of the fields or effects at that particular point. This is commonly, and incorrectly, interpreted as proving that particles can have no hidden variables. However it only limits *local* hidden variable solutions. Bell's theorem does not exclude hidden-variable theories of the *non-local* kind. This is not contentious, though the difficulty is creating such a theory. A prominent one is the de Broglie-Bohm pilot wave theory [8-10] which proposes that the wave-function guides the moving particles down trajectories with position and momentum being hidden variables. It is therefore akin to quantum theory in its use of a wave-function.

We have shown that the cordus model provides another example of a *non-local* hidden-variable theory [11]. This is not precluded by any of the Bell and other inequalities, and is therefore a legitimate solution. We also suggest that the inequalities approach is not a useful approach anyway, because it is initially premised on particules being zero-dimensional points and then concludes in a circular manner that particles are points. We suggest that the better interpretation of entanglement and the Bell-type theorems is that both locality and the zero-dimensional point construct are false [11]. The cordus model produces a new concept for the mechanism for locality and the extents thereof, and implies the need to abandon strict locality and local realism, at least at the deeper level [11].

We now apply and extend these cordus concepts to anticipate the mechanisms for emission and absorption of photons in their interactions with electrons.

3 Approach

Methodology used

The method we used was conceptual design, wherein solutions are found in an iterative process that creates new concepts, checks them against the

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[2] Superluminal entanglement involves two geometrically separated particles, typically photons, affecting each other. If one photon is changed the other adjusts too (hence 'entanglement'), and does so faster than the speed of light ('superluminal').

[3] *Locality* is that the behaviour of an object is only affected by its immediate surroundings, not by distant objects or events elsewhere. (A similar, though not identical concept is *local realism*, that the properties of an object pre-exist before the object is observed, and independent of observation.) Non-local theories are those that propose that a particle is somehow affected by remote events or fields that exist some distance away. While a non-local theory has the potential to solve a lot of fundamental problems (including entanglement), it also creates more of its own in that we don't obviously see non-local behaviour in our world. Also, it has historically been difficult to design non-local hidden-variable solutions, so they have mostly been discussed in a very abstract way. The pilot-wave theory of 1925 was the most recent solution of substance, and even then it was largely abstract. Cordus provides a very specific design for a non-local hidden-variable solution, one that can be examined, applied, and which makes testable predictions.

requirements, and changes and refines the concepts accordingly. The design process seeks the fittest solution to a problem, though the nature of the creative process means that there cannot be any guarantee that the best solution has been found: there is always the possibility of a better solution. The results of the process are candidate solutions: there can be more than one. Concept design produces predominately descriptive solutions, plus there is the inherent subjectivity of the creative process, so the results are conjectural.

The design approach is widely used in other fields such as new product development, and has established methodologies and its own literature. Its benefits are that it produces novel lateral-thinking concepts that often are inconceivable from within the orthodoxy. It questions existing premises, and challenges implicit assumptions and cognitively fixed ways of looking at a problem.

Approach

We started with models for the photon and electron. These were created and refined within other parts of the cordus conjecture [2], and came loaded with a set of proposed operating principles in the form of lemmas. We then used the design method to create a solution for the process of photon-emission. Thereafter we ran the process in reverse to model the photon-absorption process, on the assumption that the process as a whole was symmetrical. This also allowed the forward logic to be checked. We then made further changes to both processes. Developments elsewhere in the wider cordus model, particularly the antimatter and strong force models, also contributed principles back into this model. Many conceptual iterations were performed but only the final results are shown below.

4 Cordus model for photon emission and absorption

Features of the photon [4] and electron [12] have been described and contrasted [2] in the cordus conjecture, and we now refine those ideas and infer the emission and absorption processes.

4.1 Photon as a fibrillating hyff-pump

Our previous work on optics suggests that the hyff of the photon have some particular characteristics [1, 2, 12-14]. According to the cordus model the photon has a fibrillating hyff-pump, whereas the electron and indeed all other matter and antimatter have pulsating pumps [2]. The photon reactive end pumps *out* a hyffon, and then promptly *withdraws* it, never releasing it (lemma Ma.2.1 [2]). See Figure 1. The outward motion corresponds to negative charge, and inward to positive (a sign convention). Thus the photon changes sign. This is consistent with the observation that the electric field of the photon reverses sign. The frequency model for the photon is set out in a companion paper [4].

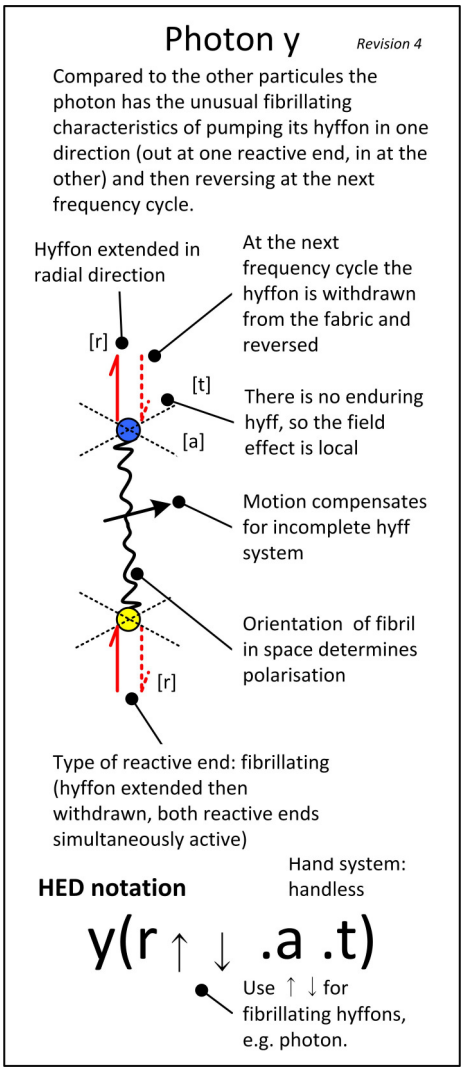


Figure 1: Cordus model for the internal structure of the photon, and its field. The photon has a pump that shuttles energy outwards into the fabric. Then at the next frequency cycle it draws the energy out of that field, instantaneously transmits it across the fibril, and expels it at the opposite reactive end.

4.2 Electron as a pulsating hyff-pump

The electron, and all matter and antimatter, pushes a hyffon pulse outwards along a persistent hyff, or pulls inwards in the case of positive charge. The hyff is enduring, and the direction of propagation of the hyffons is consistently outwards (or inwards as the case may be), see Figure 2. The hyffons are force pulses transmitted along the hyff lines, and remain connected to the reactive end at the base. Each frequency cycle sends out another set of hyffons. Hence we call this a pulsating pump, as opposed to the fibrillating pump of the photon (lemma Ma.2.2 [2]).

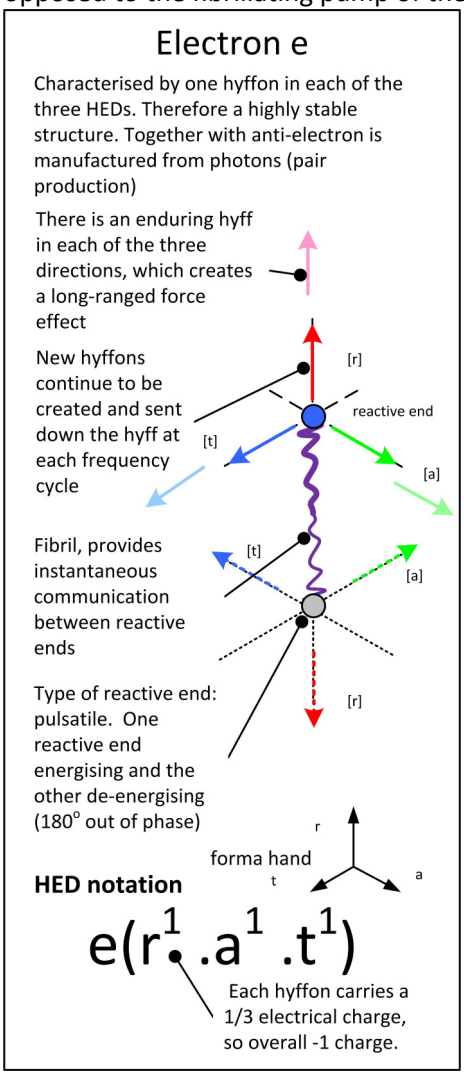


Figure 2: Cordus model for the internal structure and external field arrangements of the electron. The electron pushes discrete force fragments (hyffons) consistently outwards in a pulsating manner. All other matter and antimatter behaves like the electron, though the direction of pumping is reversed for positive charge, and the hand is inverted for antimatter. (By comparison the photon withdraws its hyffon. Both cordi therefore have a frequency, but the difference is what they do with it.)

4.3 Explanation of the ranged effects of the evanescent and electric fields

This cordus field model is also consistent with the known ranged effects of the two particules, and explains why there is a difference. The photon is known to have only a short range for its electromagnetic (EM) field: the strength drops off exponentially with distance. In optics this is termed the evanescent wave.

Evanescent field

The cordus explanation is that the photon draws (or pushes) its hyffon into the local external space where its effect is absorbed into the volume of space. The exponential nature of the distribution arises because the relative absorption of the energy into the space is constant with radius. Another way of explaining this is that the photon pushes its energy into the entire local volumetric supply-chain of space.

Elsewhere we have identified that space consists of a fabric comprising the hyffons of all the other massy particules, like the electron [13]. Thus a third explanation is that the photon pushes its energy into a transient disturbance of the surrounding fabric hyffons. This last explanation is consistent with that from wave-theory, which also considers the photon as a self-propagating field-disturbance. These explanations are all complementary.

The photon generates a volumetric strain in the fabric, with a constant differential in the radial direction. This strain is created at each of its two reactive ends. At any point in the frequency cycle one reactive end is a source and the other a sink, (positive and negative charge) but both require energy. It is not helpful to think of the one reactive end borrowing energy from the fabric and the other pushing it into the fabric.

The absorption into space is elastic, and at the next frequency cycle the photon receives the energy back from the fabric and transmits it out of the other reactive end. Thus the fabric of space has a temporal impedance, which we identify as determined by the fine-structure constant [13] and hence a finite speed of light despite an instantaneous communication across the fibril. This cordus model is consistent with the known impedance of free space,[4] and is therefore not contentious, though this explanation comes at it from a novel direction.

Electric field

The electron has a much greater range for its electromagnetic fields – potentially infinite – and though they do drop off with radius squared it is not as quickly as the photon's. Indeed all of the electro-magnetic-gravitational (EMG) fields reduce this way. The cordus explanation is that

[4] Impedance of free space $Z_o = 1/(\varepsilon_o c) = 2\alpha h/e^2$, with electric constant ε_o (also called vacuum permittivity), and the speed of light in the vacuum c. Fine structure constant $\alpha = e^2/(2\varepsilon_o hc)$, with elementary charge e [coulombs], Planck constant h, as c as before. All these are generally considered physical constants.

all three EMG forces are carried by hyffons, as tension, bending and torsion (handedness) of the hyff (respectively) [14]. Thus one underlying element, the hyffon, is proposed as the mechanism for all three forces.[5]

The conventional explanation for the radius-squared reduction of the EMG forces is the inverse-square law. This states that the fields are conserved and therefore spread over the surface area of an expanding sphere as they propagate outwards. The cordus model agrees with this explanation, but can add another level of detail: the hyffons themselves are discrete, and produced at the frequency of the massy particule. So for a given body and energy the rate of hyffon production is constant, and hence the total number available is conserved as they propagate outwards over the area of the sphere. In addition, cordus predicts that the hyffons, and hence also the fields, are not consumed by interaction with remote matter particules, but instead continue to propagate outwards indefinitely [3,17].

Comparison

So Cordus explains that the photon's hyffon is pushed into (or pulled from) a recruited volume of space and impeded in the process, hence the exponential reduction with range. In contrast the electron hyffons are propagated outwards as discrete field elements that are not weakened, and therefore their density is diluted across the surface of a growing sphere. Hence a reduction with radius-squared for all the EMG forces.[6]

We now have a model for the structure of the photon and electron, comprising the internal structure and the external field features. Next we use this to offer an explanation of the mechanics of photon emission.

4.4 Photon emission process

How does the electron absorb and emit a photon? The previous work of the cordus conjecture has established some general principles for photon absorption, Crompton scattering, mid-energy interactions, photoelectric effect, heat, and photon emission [15]. However that work was in general terms, and did not go into the possible deeper mechanics at the hyff level,

[5] We also propose that another feature of the hyffon, its synchronicity, is responsible for the strong force.

[6] If we were disembodied spirits contemplating a physics that was being designed but yet to be built, we might naturally expect all fields to recruit the full volume of space they traverse and thus reduce exponentially with radius. That the EMG fields do not, despite propagating into the same medium as those of the photon, shows that there is something profoundly different and unusual about them. We are so used to seeing the $1/r^2$ relationship in the EMG fields that we take it as the norm and perceive the exponential relationship of the photon evanescent field as the anomaly, when the inverse is true. The radius-squared nature of the EMG forces is the odd relationship, and points to a fundamentally different mechanism for those forces. This characteristic of the EMG fields strongly suggests that the field elements are discrete (i.e. hyffons for Cordus, or bosons for QM), are diluted over an expanding front, only affect other objects as that front passes through, are not consumed in the usage, and cannot be shielded. The cumulative effect of many small such interactions is the electro-magnetic-gravitational field, and hence electromagnetic wave theory is the coarse overall representation of a deeper discrete effect, just as the QM wave function is an average representation of a deeper determinism in particule location.

which is the present purpose. Here we explore the possible finer behaviours of the cordus structures of the electron and photon as they interact.

Model of photon release

We start with an electron that has excess energy. We anticipate several pathways for this state to arise:

- The electron immediately previously absorbed a photon.
- The electron received energy from other particules with which it is bonded. The cordus model is that assemblies of matter that are bonded by the strong force, which is to say coherent, will share energy throughout the assembly.
- The electron has changed its bonding configuration to one that needs less energy, so a surplus exists. The cordus model is that bonding involves particules with compatible geometry and frequency. So a change to a bond causes the span to change. In turn this causes the frequency to change, and thus changing the energy that the electron is allowed to contain. [7]

We also anticipate that the electron is constrained by bonding, at least to some extent. Thus a free electron is able to accommodate greater or lesser amounts of energy, simply by adjusting its frequency and span. However an electron that is bonded has less freedom, or even none, to make these adjustments and must therefore either dispose of the energy or break the assembly. Those assembly forces are variants of the strong force. This is consistent with the observation that sufficiently energetic electrons will break out of their assemblies, hence ionising radiation, whereas less energetic cases result in photon emission or temperature rise. The thermal case is explained in the cordus model as a phonon effect [15], and not discussed further here as our interest lies with the photon emission category.

[7] This relationship between span and frequency is a core idea in the cordus conjecture. It enables the external bonding constraints to affect the span of the particule, hence frequency, hence allowable energy. This concept of causality is unique to cordus. By comparison QM has no such causal link, nor is one conceivable from within a 0-D point perspective.

Energised but constrained electron

This initial state of an energised but constrained electron is shown in Figure 3. The electron is fixed at one or both reactive ends (REs) by bonding arrangements, not shown, which occur through its hyff. These constraints mean that the hyff are expected to energise in a particular place, time, and phase. The temporary higher energy state of the electron nominally requires that it move to a higher frequency and shorter span. The changed frequency cannot be accommodated by the bond commitments. The shorter span results in target re-energisation locations as shown, though these too are not achievable.

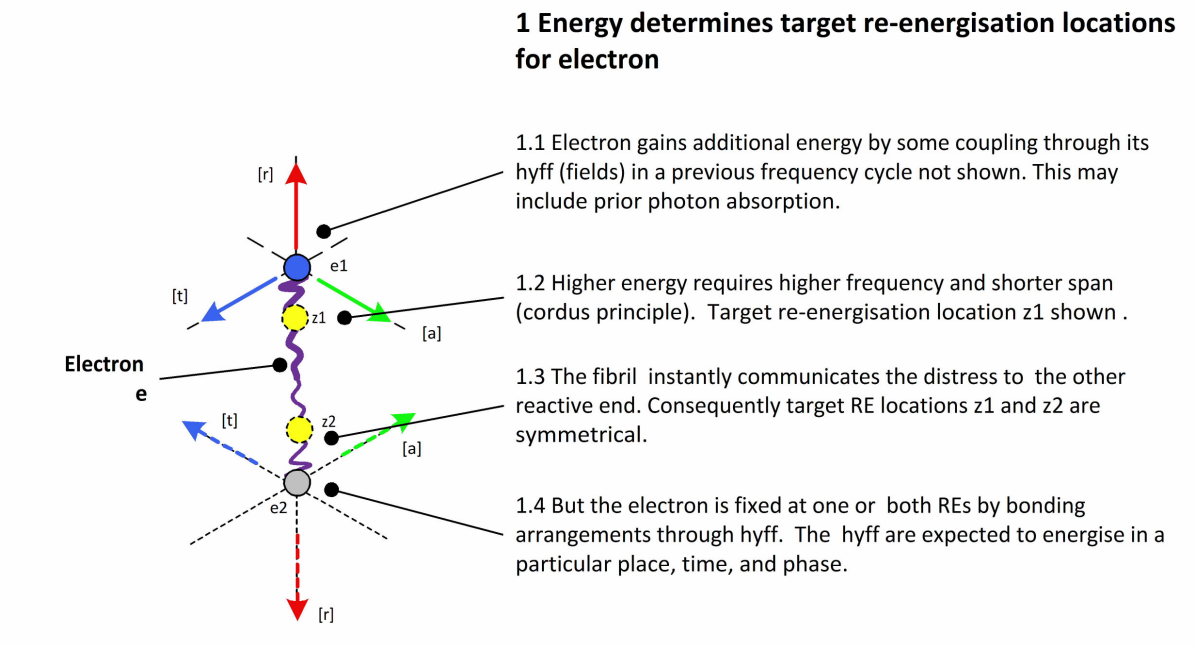


Figure 3: Energetic electron

Compensation by dumping energy

To compensate for these constraints, the electron dumps the extra energy into the external fabric, where it is temporarily taken up as a volumetric strain, and appears as a photon hyffon, see Figure 4. Off-loading this energy allows the reactive end to stay at its current location, and preserve its frequency. The second reactive end does likewise, because the instantaneous communication of the fibril keeps the two ends synchronised. The second RE therefore also creates a volumetric strain in the fabric, but of the opposite charge. This nonetheless also requires energy. So half the excess energy goes into each of the two newly created fields. These fields are of the exponential type as they involve progressive recruitment of a volume of fabric.[8]

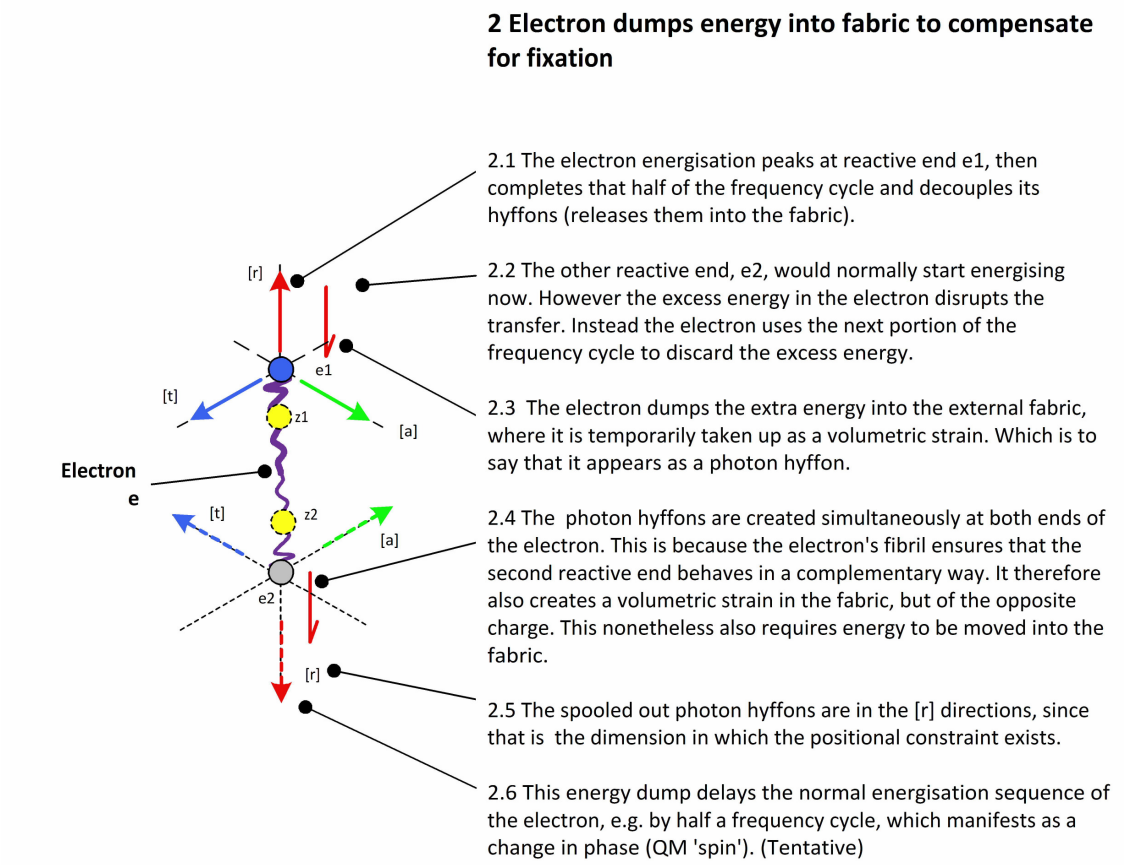
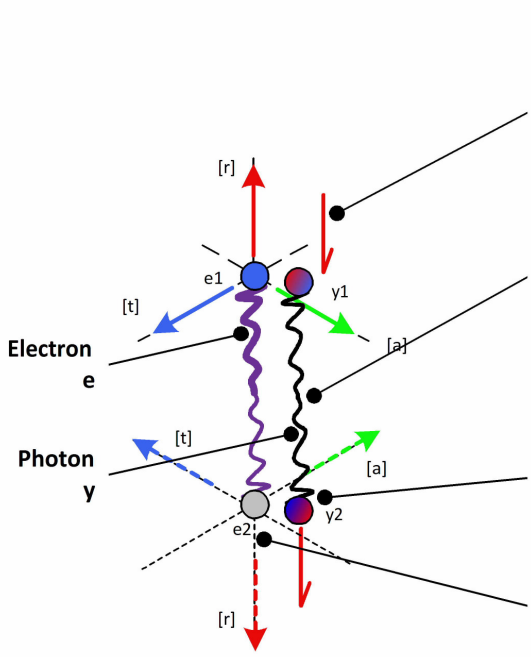


Figure 4: Electron dumps energy

[8] It would not work for the electron to instead put the excess energy into the electric field, since this would create an enduring commitment: the electron would feel the constraint when that hyffon interacted with another remote body some time in the future. The electric hyff system is not an energy storage system: it only transmits the force (displacement) when the hyffon reaches a target. By comparison the evanescent field is an energy storage system, and without future liabilities, and therefore a more convenient place for the electron to dump excess energy.

Formation of photon

A prototype photon then forms, as new reactive ends and fibril emerge from the electron structures to support the new hyffons. The photon only needs a single fibril, which also makes up the hyff at each end, so the reactive ends are not as distinct as for the electron. The new fibril is of the fibrillating type. These photon structures and are briefly co-incident with those of the electron, see Figure 5.



3 Prototype photon formed

3.1 The initiation of the energy dump requires new structures: photon-type hyffons, reactive ends and a fibril. These emerge from the electron structures and are briefly co-incident with them.

3.2 The ongoing connectedness of the electron fibril ensures that the two photon hyffons are co-ordinated, i.e. instantaneously synchronised and complementary. However the different nature of the pumps means that a new fibrillating photon fibril is required, and this emerges from the electron fibril.

3.3 The two photon hyffons each require a reactive end, this being the termination points of the fibril. Consequently photon reactive ends emerge.

3.4 Electron span may change in the process, e.g. the span of a free energetic electron will lengthen as it releases a photon.

Figure 5: Prototype photon forms

Photon release

The photon moves away with velocity perpendicular to the [r] axis of the common assembly, see Figure 6. The need for movement arises as a stability requirement to compensate for the photon only having hyff in the [r] direction (lemma Ma.2.6 [2]).

Thus the orientation of the original electron particule determines the direction of release of the photon. This model tentatively also predicts that the direction of motion of the photon in the [a,t] plane would be determined by the energisation sequence of the electron hyff, i.e. the hand. However, other than saying the photon would be emitted in the [at] plane, we cannot yet be more specific. We tentatively assume emission at 45° off both these axes. We leave this as an open question.[9]

[9] In which case we would expect antielectrons to emit photons in a direction 90° to that of a similarly constrained electron.

The photon's use of the fabric to store energy is dynamic, and the volumetric strain is reversed at the frequency cycle of the photon. The velocity of the photon is determined by the impedance of getting its hyffon energy into and extracted from the fabrics (hence fine-structure constant α and the density of the external hyffons in the fabric) and thus limited to the speed of light in the medium.[10]

Cordus suggests that the span of the photon is likely initially that of the electron that released it. Cordus states that the span of the photon is flexible, being is decoupled from the frequency, whereas the span for any massy particule is inversely linked to frequency.[11] This is also consistent with the Planck relationship for energy, E = hf with Planck constant h, and frequency f. The cordus explanation is the greater the energy to be stored in volumetric strain, the quicker the renewal needs to be. Hence higher energy photons have proportionately higher frequency of the fibril.

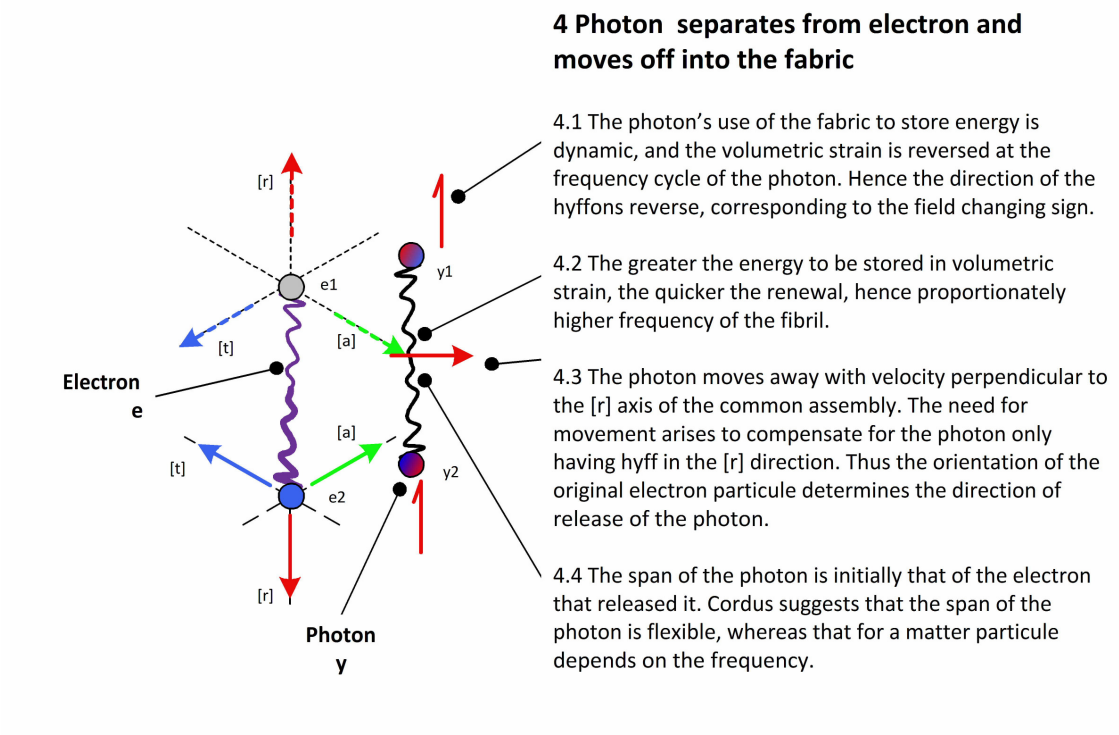


Figure 6: Photon separates from electron and moves off into fabric

Comments and ambiguities

This completes the description of the proposed photon emission process. The main points are: (1) external positional constraints cause, via changes to geometric span, constraints on the internal frequency that the electron can take; (2) an independent constraint is that the electron that is bonded to an atom can take only certain discrete frequencies, these being a

[10] In the cordus model the speed of light in turn is determined by the density of the fabric hyffons and is therefore locally consistent and relativistic, but ultimately dependent on the past history of matter density in the locally available universe.

[11] In a way this means that the electron has a well-defined reactive ends where the fibril terminates and the hyff commence, whereas the photon has no clear distinction and might even be considered to have no reactive ends.

consequence of the bonding; (3) the electron is therefore required to dispose of any excess energy, which it does by temporarily dumping it into the external three-dimensional space; (4) doing this creates discrete photon hyffon field structures and the associated supporting structures of reactive ends and fibril. These are extracted from the electron structures. (We acknowledge that we have not detailed how this creation might occur at the next deeper level of mechanics.) The photon thereafter takes a life of its own and moves in the fabric. Our current explanation for its necessity to move is because it has incomplete hyff structures and therefore needs to access hyffons from the fabric to maintain stability, hence moving at the same speed as the fabric. This too points to a still deeper mechanism at work.

The cordus model for annihilation of positronium made an assumption that photon emission changes the phase of the electron (see lemma Ma.3.3) [16]. There is reasonably strong evidence that this effect applies when the electron is being accelerated (includes deceleration) or forced to change its orientation (spin). We suspect that this may be universal to photon emission, i.e. that the electron changes phase in all situations where it emits a photon, though we cannot be certain.[12] The proposed mechanism for this is provided at the energy dump stage, see Figure 4, note 2.6.

4.5 Photon absorption process

It is now possible to provide a process for the absorption of the photon into the electron. We do this by running the above process in reverse, on the assumption that the process as a whole is symmetrical.

The photon hyff, which is one axis only [r], comes within range of the hyffons of the electron, and starts to interact with them. The interaction is initially only within the wider fabric: the electron is contributing enduring hyffons to the fabric, and the photon is creating transient hyffon disturbances within that same fabric. Therefore the hyff systems of the two particules need to be interacting, but the particules themselves as defined by their reactive ends, do not need to be coincident.[13] It may not matter precisely which HED of the electron engages with the photon hyff, because they can likely redistribute the energy into the rest of the cordus.

The next stage is a decision point as to which process the particules follow. The options are absorption, partial energy transfer, disturbance, deflection, reflection, or no interaction. We suggest this is deterministic, and depends on the relative orientation of the two particules, their

[12] If this were true we might expect in some situations that the electron did not change its energisation by a half-cycle increment but rather by whatever fraction is necessary to dispose of the photon energy. However it is more likely that the electron, in many bonding situations, is not free to unilaterally change its phase, because it is synchronised with other particules including the nucleus. Thus if one electron of a bound pair changes phase, the other partner will need to as well. Hence also entanglement.

[13] Cordus does not support locality, instead proposing that that the two-ended nature of the particule and the ranged effect of the hyff creates a 'wider locality'. Thus a particule has access to discrete fields beyond its nominal centre-point.

proximity, momentum, relative phases, and frequency. Thus there are more variables available than in the conventional 0-D point model.

We anticipate that for absorption the particules need to be at least somewhat aligned so that the four reactive ends can sense each other's hyff, and the same phase at the respective reactive ends (cis-phasic).

Continuing the absorption process, the electron pulls the photon into final alignment and synchronicity, via the hyff. We assume that the mechanisms are flexible enough to accommodate some degree of initial mismatch in both these variables. We also assume that the photon span is capable of changing length to match the electron span. It may take several frequency cycles to achieve sufficient match, hence the possibility that absorption does not occur but some degree of energy transfer does.

Once the electron and photon reactive ends are sufficiently coincident, the energy of the photon, which is dynamic, is captured by the electron through the hyff structures. The photon structures (fibril and reactive ends) collapse or are absorbed into the electron. A phase change is presumably involved here, if it applies at emission.

The general sequence is proposed to be the reverse of the figures previously given for emission.

5 Discussion

What has been achieved?

This paper makes several novel contributions. The first is that it proposes the identity of internal structures to the photon and electron, and the relationships between those internal variables and the external fields produced by the particules. Particularly important here is the proposed causality whereby bonding constraints affect geometric span of the particule which affects frequency, and hence constrains the energy that the electron can contain. A second contribution is the proposed differentiation between the photon and electron by the type of their discrete fields, fibrillating and pulsating hyff respectively. This provides a new way to understand the mechanics and purpose of these fields.

The third contribution is the identification of a proposed set of processes for emission and absorption of a photon. We have generated a qualitative mechanics for the interaction of the external field with the internal structural variables, so we can start to put answers to the foundational questions of emission and absorption. These contributions are primarily conceptual and descriptive.

The photon's mission: an interpretation from the cordus perspective

This model provides insights into purpose of the photon, and confirms the earlier work [2]:

> There is significance, from the cordus perspective, in the peculiar fibrillating field of the photon: it makes the photon a universal

> energy carrier. The photon is not out to create an electro-magnetic-gravitational (EMG) empire for itself, like the matter and antimatter particules. Instead it is the unit of energy currency between assemblies of matter. The photon transfers spare energy around the place. It is an escapement mechanism whereby particules that are over-prescribed in terms of positional constraints on re-energisation can get rid of that energy. The free photon is not quantised, but flexible in its ability to contain whatever energy it is given: like an expandable container. Yet it is sufficiently like a matter particule to be able to interact with matter. Further, it has no hand ('ma' in the cordus concept) and is therefore predicted to be able to freely interact with, and transfer energy between, both matter and antimatter. It is the slim bridge between the world of matter particules, and the antiworld. The photon is therefore a key component in the formation of matter, hence leptogenesis and ultimately baryogenesis. [2]

Subsequent cordus work has indeed delivered a baryogenesis model [16, 17].

Limitations and implications for further research

As the term *conjecture* suggests, this is a proposed conceptual model, not a law with proven validity. It does have high fitness in its ability to provide a logically consistent explanation for a wide variety of physical phenomena, including some of the most problematic issues at the foundation of physics. Yet fitness does not necessarily equate to validity. So finding the flaws, extracting testable predictions from it, and generally checking the logical consistency is an important area of further research. Specifically, what is needed next is to check whether the results from this model are consistent with the known physical emission and absorption phenomena.

6 Conclusions

We have used the particular non-local hidden-variable solution provided by the cordus model, and with this have modelled the physical process of photon emission and absorption from the electron. This model provides some answers to the deep questions of *how* the electron emerges from, or is absorbed into, the electron. The explanations are in terms of a hypothesised difference in the field-generating structures ('hyff' type) between the photon and electron, and the discrete field elements ('hyffons') that activate these fields. The model provides a new conceptual framework for explaining the process, and hints at yet deeper internal variables and inner-causality.

While abandoning the zero-dimensional point paradigm makes this a drastic idea, the resulting cordus model provides a physically descriptive explanation for the process of photon-emission and absorption, and has good fitness to explain a wide range of phenomena where explanations are otherwise lacking.

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