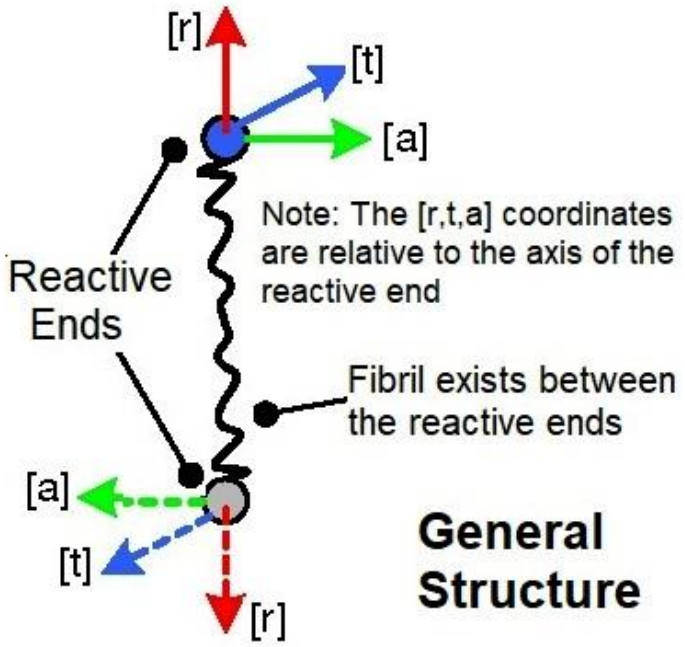
Cordus

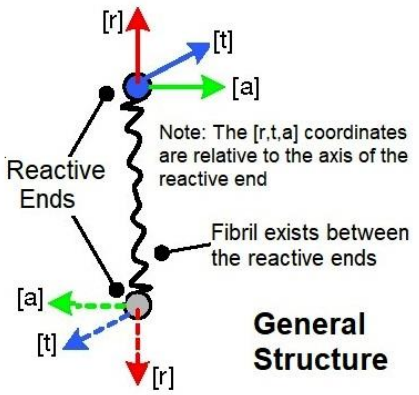


Conjecture

Contents

1.1 *Cordus Conjecture*

It is possibly sensible to start with a clarification of the word '*conjecture*' as it might convey the nature of the discussion to follow and the need not only for an open mind, but a critical one, if and where conjecture appears questionable.



> *Conjecture might be defined as a conclusion deduced by guesswork or possibly more likely as an inference formed without proof or alternatively a proposition before it has been proved or disproved.*

Of course, this discussion is also only the first step in another learning process associated with an idea called the '*Cordus Conjecture'*, such that it starts out in ignorance of its ideas and therefore many of its concepts may be initially misunderstood. However, the idea was first referenced within a discussion entitled *Summary of Assumptions*, which was part of the review of *Gabriel LaFreniere's website* describing his concept of *'Matter is Made of Waves'* – see links for more details. However, the review of this wave model is one of a number of different ideas discussed within *website-3*, which might be said to challenge the mainstream consensus within science, simply characterised in terms of *electromagnetism*, *relativity* and *quantum mechanics*. While these theories undoubtedly represent some of the most fundamental mechanisms underpinning the workings of the universe, they often provide an incompatible description of the causal mechanisms assumed to be at work. However, while *website-3* has reviewed a number of different models, it is unclear whether any of these models fully address the scope of issues that appear to be unresolved within present-day science. Therefore, there was considerable interest in the scope of the Cordus Conjecture, which claims to provide a potential approach to many of these open issues.

> *Note: While the link to the* Cordus website *will take you to its home page, the design of this website does not appear to provide an obvious top-down repository of its key papers. Therefore, the link to the* Cordus References *provides a possibly more convenient starting point, although the interested reader should check for later versions.*

While the *'Cordus Conjecture'* is by definition highly speculative, it suggests a possibly more open approach to science, which is more inductive than deductive in scope. In this context, inductive logic might be said to proceed from observation towards theory, while deductive logic might be seen as being more dependent on mathematical models. However, before going any further, the following quote will be restated as another note of caution about speculative ideas.

> *For every problem, there exists a simple and elegant solution, which is absolutely wrong.*

With this caution noted, the authors of the Cordus Conjecture appear to start out being very open about the speculative nature of their approach, which was first reference in terms of the following quote:

> *"Cordus is an audacious idea, and it produces a radical re-conceptualisation of fundamental physics. It is an unorthodox idea, one that cuts across conventional physics and challenges the premises on which those theories have been built. It is likely to be controversial. However, it is not deliberately confrontational: it is simply a process of taking a creative idea and running it through to its logical conclusions."*

However, while the style and tone of this initial quote appears to be conciliatory in its approach, especially as the word '*conjecture'* does not imply certainty, the next quote appears to throw down a *'gauntlet'* to accepted science.

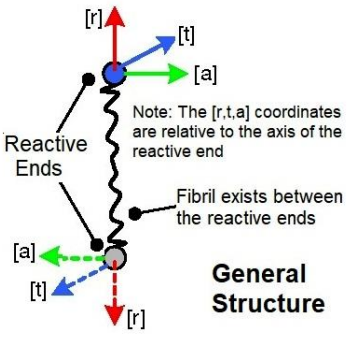
> *"It is in those conclusions that, if Cordus is correct, there are causalities for existing principles of conventional physics. For example, Cordus invalidates the 'particle' premise of quantum mechanics, refutes superposition, redefines the principle of locality, denies the existence of 'virtual particles', refutes the concept of interference of light, asserts that Bell's theorem is wrong, re-introduces a modified concept of the aether, and reconceptualises the fundamental forces. Cordus explains why Quantum mechanics, which seems to apply at the level of individual particles, does not scale up to macroscopic bodies: something that QM itself has been unable to explain. Furthermore, Cordus proposes a set of new principles for the next deeper level of physics."*

While the statement above refutes the description of the quantum point-particle, its model appears to have a particle-like nature, which is described in the form of a '*particule*' model that is outlined is the next discussion.

1.1.1 Basic Concepts

The goal of this discussion is simply an attempt to understand some of the basic concepts as many of the reference papers have not been read at this stage. However, most learning processes have to start somewhere, usually in ignorance, and then attempt to assimilate more details, while in the process highlighting any issues that appear questionable. Overall, the Cordus Conjecture describes itself as a non-local hidden-variable (NLHV) model. As such, it assumes that the structures of its particule model physically exist at the sub-particle level of the *standard model* although the scale at which these structures are assumed to exist is not necessarily specified. However, the Cordus model states that it wants to anchor its description of causality to physical mechanisms and variables that exist objectively, although they may not be measured directly, even if they exist.

> *Note: We might compare the Cordus model with* Bell's theorem *of quantum mechanics, which assumes each measurable quantity of a system is described by potentially random variables. The value of these variables might depend in some way on other values, which are not known or measurable, i.e. they are also hidden variables. In order to match the predictions of quantum mechanics, the variables of spatially separated systems are assumed to influence one another in a non-local way, i.e. without any known means of causality. Bell's theorem also implies that any other theory that reproduces the predictions of quantum mechanics either works by some means other than hidden variables or it is non-local. A non-local hidden variable theory implies that there are hidden variables, but they are non-local, such that the most fundamental laws of physics must also be non-local. In this respect, the main difference between the Cordus and quantum models is that the latter is essentially limited to a mathematical solution that possibly does not attempt to provide a description of physical causality.*



The Cordus model introduces the idea of a '*generic particule'* that is assumed to have a physical sub-structure, while recognising that its variables are both '*hidden*' and surrounded by '*conjecture*'. At this early stage many aspects of the particule model are not really understood, such that its description appears somewhat abstract for a model with the stated goal for physical realism. However, some attempt will be made to introduce the basic idea of a particule, which can be generally applied to both '*electrons'* and '*photons*', although the photon is subject to some caveats. So, as a general description, the sub-particle

structure of the particule is said to comprise of two '*reactive ends*' that are physically separated, but connected by a *'fibril*', which is described as a '*persistent and dynamic structure*' that does not interact with *'normal'* matter. The fibril is assumed to supports some form of *superluminal communication* between the reactive ends of the particule, which is then used to explain *quantum entanglement*. The *'reactive ends'* are also described as being *'energised'* at a given frequency that defines a specific particle and emit discrete forces along the [r,a,t] axes, although the exact number and direction of these forces also depends on the type of particule being described, e.g. electron, photon, neutrino etc. It is suggested that these forces propagate along '*flux lines'* out into the space between particules, where the nature of these flux lines can be used to explain electrostatic, magnetic, and gravitational fields. As a consequence, the vacuum of space is filled with a '*tangle of flux force lines*' that defines the functional nature of the fabric of space.

> *Note: Even at this initial stage, it is not unreasonable to question the physical nature of the 'reactive ends', if they are assumed to be physical entities. For example, we might ask whether they represent some form of energy-density and, if so, how do they exist and move in space-time?*

However, despite the degree of ambiguity surrounding the internal structure of the particule model, the Cordus Conjecture assumes that it can replace the point-particle of quantum theory. As such, this model claims to be different to the other NLHV models in that it can physically explain phenomena that quantum mechanics cannot. The model then claims to explain multiple phenomena encompassing particle, wave and cosmological effects, which are briefly summarised in the following list. As such, the Cordus Conjecture seeks to provide:

1. An alternative explanation of the *wave-particle duality* concept often associated with the double-slit experiment, but now anchored in physical realism.

2. The necessary internal structure and functionality of the most fundamental components of the *particle model*, i.e. electrons, positrons, neutrinos, quarks and photons.

3. An alternative derivation of *optical laws* from a particle perspective.

4. A more qualitative explanation of *quantum entanglement*.

5. An explanation of mass-energy equivalence by proposing a mechanism for pair production, e.g. the creation of an electron and positron from a photon and a complementary annihilation process.

6. A description of the physical process of photon emission, i.e. where a photon is emitted from an electron.

7. A description of entropy and the arrow of time, where time becomes an *emergent property of matter.*

8. An explanation of the finite speed of light [c], but with the prediction that this speed is not constant.

9. A mechanism explaining *asymmetrical baryogenesis* in the *cosmological model.*

10. A formulation for the *Lorentz transforms*, time-dilation and *Doppler effects* based on a particle model.

11. An explanation of the *strong nuclear force* that predicts the structure of atomic nuclei.

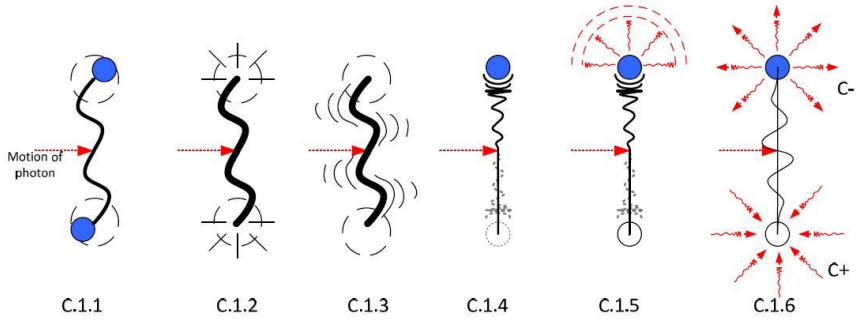
12. An explanation of decay processes and the instability of free neutrons.

13. An explanation of the quantum spin characteristics of neutrinos.

However, this review has yet to examine the substance of any of these claims as it is still in the process of trying to understand some of the many ideas and concepts being forwarded, such that the focus will return to some of the more basic details. For while bullet-1 above claims that the Cordus model can provide an alternative explanation of the wave-particle duality concept forwarded by quantum mechanics, it seems that this model is orientated to the semantics of particles, which differentiate it from earlier wave models.

> *Note: Wave models as described in terms of the WSE, WSM and WWM discussions formulate a fundamental model based on wave structures that confined energy propagating through the media of space as a function of time. As such, there are no particles, or particules, only forms of energy-density contained within spherical standing wave structures, which are then used to explain both the nature of matter waves and the phenomena of light waves. This leads to a fundamental difference in the concept of photons, which in the view of both the WSM and WMM models do not exist. See LaFreniere's webpage discussing light for more details.*

Therefore, in comparison to earlier wave models, the Cordus model appears to be more orientated towards a particle model, especially in terms of its description of a photon. The first 3 papers in the Cordus Conjecture series, as cited in *Cordus References,* are a description of the photon particule model, which this discussion will only attempt to briefly summarise. The behaviour of a photon is described in terms of its two '*reactive ends*' interacting with other matter particules in the form of reflection, refraction and absorption. However, it is assumed that the reactive ends of a single photon may take different paths, as per the double-slit experiment, where this positional duality may also provide an explanation of quantum entanglement. The *first paper* in the series details 6 variant developments of the photon particule model, although C.1.6 is now preferred.



Broadly, all variants encompass the idea of having two reactive ends connected by a fibril. In the final C.1.6 variant, energy is shown flowing in and out of the two respective reactive ends before reversing. Within this model, the two reactive ends of a single photon can pass through both slits of the double-slit experiment, although an extension of this experiment involving three slits seems more problematic. However, it is assumed that the photon particule model can provide a physical explanation of various quantum behaviours. For when one reactive end touches a material object, presumably a matter particule, its reactive end is described as being *'grounded'* such that the entire photon particule structure collapses. However, in the C.1.6 variant, only an *'energised'* reactive end can be grounded and the other reactive end ceases to exist.

Note: The photon model outlined above might be compared with the mainstream perception of wave-particle duality, which while able to predict outcomes appears to fall short in terms of its description of any physical mechanisms at work. Again, Bell's theorem suggests that there can be no internal model for the photon, such that the problems associated with the wave-particle duality approach may be unsolvable. Of course, this is one of the many issues that the Cordus conjecture now seeks to address.

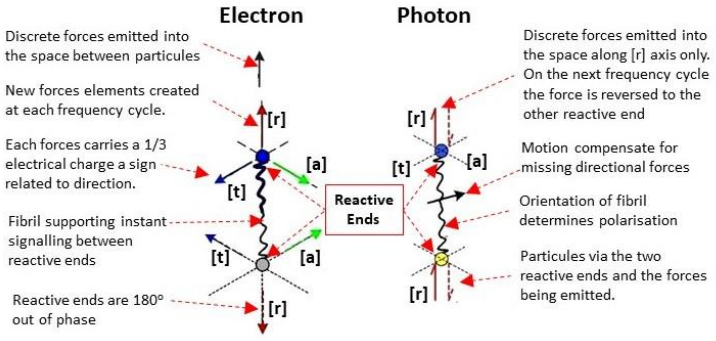
Within the obvious limitations of this initial outline, we might begin to understand how the Cordus model differs from the quantum model, which assumes that the most fundamental sub-atomic particles, e.g. electrons and quarks, have no sub-structure and can therefore be modelled as a conceptual point-particle. In contrast, the Cordus model introduces the concept of two *'reactive ends'* separated by a very small, but finite spatial distance, which in the case of a matter particle can emit '*discrete forces'* in up to three orthogonal directions, as defined by the [r,a,t] axes. However, we possibly need to table a more fundamental question at this point.

What is a force?

Normally, we might initially consider Newton's second law [F=ma], where [m] is mass and [a] acceleration, but we immediately run into another ambiguity, i.e. what is mass? Alternatively, a force [F=dE/dx] might be expressed in terms of a change in energy [dE] with distance [dx]. In terms of previously discussed wave models, see *Matter of Energy*, it was argued that the concept of mass [kg], which classical physics assumes to be one of four *basic units of measure*, has to eventually give way to the idea of energy at the most fundamental level of existence. Likewise, it has also been argued that the source of all motion is caused by a differential of potential energy between two spatial positions, which then creates an energy gradient to which a force [F=dE/dx] might then be associated. While this issue will not be pursued at this stage, the following note might be seen to question the use of the word *'force'* to explain one of the most fundamental causal mechanisms at work between particules within the Cordus model.

Note: Is it possible that energy has to be the most fundamental causal mechanism, not only of mass, but all kinematics, such that force is simply a convenient description of energy transfer. It is also highlighted that energy is a scalar quantity subject to conservation laws, while a force as a vector quantity is not.

At this stage, many of the concepts are only being introduced, although it is not unreasonable to highlight issues relating to the physical causal mechanisms being assumed by the Cordus model. However, this outline will now try to introduce both the similarities and differences between the electron and photon particule models.



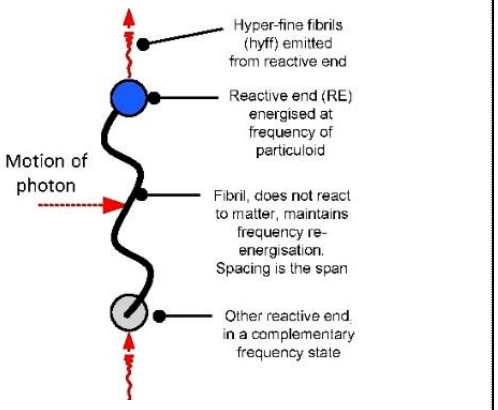
As a broad generalisation, the Cordus model replaces the idea of a point-particle in quantum mechanics with the idea of a particule that can have variations of sub-structure, as outlined above, which can presumably be extended to explain all the other fundamental particles of the standard model. However, issues have been raised about this model in terms of the physical nature of the reactive ends, i.e. how were they created, what are they made of, what causes them to oscillate with a given frequency and how does the fibril physically connect them.

> *Note: This model clearly identifies itself as being conjecture, where its primary components cannot be observed and possibly lack the necessary mathematical rigor when compared against modern quantum field theory. However, the stated objective of the Cordus model appears to want to anchor its description of causality to physical mechanisms, such that cause and effect must presumably be associated with every element of the particule model.*

From the perspective of any form of physical description, the idea of zero-dimensional point-particles has to be seen as a questionable mathematical abstraction to which the properties of mass, charge and spin are assigned without necessarily explaining the actual physical mechanisms at work. In this context, it is still unclear as to how the substructure of the Cordus particule model, i.e. reactive ends, fibrils and force flux lines, really provide a more substantive description of cause and effect at the most fundamental level. At this initial stage, the idea that a particule has two conceptual reactive ends interconnected by a somewhat ethereal description of a fibril supporting the questionable concept of superluminal signalling also appears to add little to the idea of physical realism. However, some attempt will now be made to expand the description of the photon and electron particule models in the following discussions.

1.1.2 Photon Particule

While this review will not attempt to consider all the details, which can be reviewed in the *cited references*, it will attempt to summarise some of the additional detail provided in the paper entitled: *Cordus Optics: Part 2.1 Frequency*, especially in terms of the issue of frequency within the particule model, which is not really understood. As aspects of the photon particule model have been previously outlined, only the simplified model, as shown right, will be used.



> *Note: The Cordus model considers the idea that there is a physical part of a photon that moves and has a frequency [f] of oscillation. In this model, the energy associated with this frequency, presumably conforming to [E=hf], alternates between the two reactive ends across the span of the 'cordus', as defined by the fibril. As such, frequency is not just an intrinsic variable, but a physical effect within the photon and is one of the fundamental building-blocks of the Cordus Conjecture, albeit a conceptual one. However, at this stage, the source of the energy responsible for this process is not understood.*

In the context of the Cordus model, it is assumed that the word '*cordus*' is intended to reflect the cord-like structure within the particule model. As such, a photon is no longer a point-particle without structure, but rather defined by two reactive ends connected by a fibril. In the diagram right, the initial idea of a '*discrete force*' being emitted along '*flux-lines*' now appears to be described in terms of hyperfine fibrils carrying lines of electrostatic force. The previous outline descriptions suggested that the cordus was *'energised'* at a specific frequency, which from an external perspective suggests the nature of light might be associated with some form of electrostatic field that that oscillates in strength at a given frequency. However, the Cordus model assumes that the reactive ends, internal to the photon particule structure, creates this

external effect. Up until this point, it has only been highlighted that the status of reactive ends oscillates between an energised and dormant state, although this description is now extended.

> *Note: As described, the electromagnetic field of light is only an external perception of the lines of an electrostatic force being emitted out along the hyff structure. This electrostatic field is then be quantified in terms the direction and strength of the force that might be conceptually measured on a test-charge placed near the centre of the photon. As such, this mechanism is assumed to form the basis of the interaction between the reactive ends of a photon and charged matter, e.g. an electron.*

As outlined, the reactive ends of the photon model must be in opposite frequency states, which may be qualified in terms of four field states, i.e. expanding, maximum, contracting or dormant. In this respect, the actual frequency would appear to align to the rate of change of these field states, where the cycle is assumed to represent a smooth transition in the strength of the field being output along the hyff. It might also be assumed that the strength of this field must still be a function of distance, e.g. inverse square law. However, the overall behaviour of the interactions with other particules depends of the frequency states, as defined above, but which might be simplified to just the expanding or contracting state:

- In the expanding state, the reactive end is repulsed with a strength proportional to distance.
- In the contracting state, the reactive end is attracted with a strength proportional to distance.

However, while this outline might provide some description of the frequency within the particule model, it is unclear that it explains its causal nature. As such, this outline will highlight some of the general statements made about frequency in connection to more classical wave and quantum models, which the Cordus Conjecture seeks to provide a better causal explanation as paraphrased below.

> *Frequency is an important concept in wave theory, optics and quantum mechanics. However, these theories struggle to explain frequency in physical terms. From the wave theory perspective, the frequency of light is the oscillation of the electric and magnetic fields; although this is not entirely satisfactory as it does not explain the origins of those fields, nor why the fields reverse polarity. However, it is generalised that light, i.e. all electromagnetic waves, are nothing more than a self-propagating field disturbance, such that the question 'what is frequency?' remains. In contrast, quantum theory assumes that the fundamental reality is predicated on point particles, which have a wave duality subject to a probabilistic wave-function. See discussion '*Nature of Light'* for further perspective of the wave-particle duality debate.*

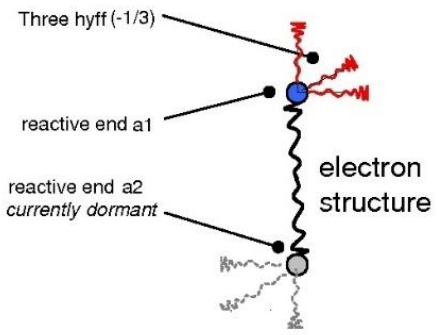
Based on the quantum model, properties like frequency, spin and momentum are not necessarily tied to any physical geometry or causal mechanism. However, the explanation provided by the Cordus Conjecture only appears to suggest that the photon-particule model, i.e. the reactive ends, are *'energised'* at some given frequency without necessarily explaining how the frequency is sourced as an energy mechanism. Despite these concerns, the conclusion of the Cordus paper being cited might be paraphrased as follows:

> *The Cordus model offers a physically coherent interpretation for frequency, such that parts of the photon-particule model really move with a frequency. In this model, the energy alternates between the reactive ends across the span, where the photon has internal variables that create the output observed as frequency. So, while this is a type of 'hidden-variable' solution, frequency is not just an intrinsic variable, but a physical effect within the photon.*

While recognising that the Cordus model is only conjecture at this stage, it appears to be a description of effect rather than a physical explanation of the cause of the frequency driving the mechanisms being described. So, while the Cordus model appears to reject the point-particle model of quantum mechanics, which it might be argued has been superseded in terms of *quantum field theory (QFT)*, the nature of the reactive ends appear analogous to point-particles interconnected by the somewhat ambiguous physical description of a fibril.

1.1.3 Matter Particule

Again, this outline review will only attempt to add some initial details to the previously introduced electron particule model taken from two papers entitled *Part 3.1 Wider Locality* and *Part 3.2 Matter Particuloids*. Again, only the simplified model, as shown right, will be used as a basic reference. However, we will start with a paraphrasing of the abstract taken from the first paper.



> *The dominant paradigm in conventional physics is that of a 'particle', which is assumed to be a flawed premise. The Cordus model is assumed to be more coherent concept in that it offers explanations of phenomena, which are otherwise puzzling. It also introduces the principle of complementary frequency state synchronisation (CoFS) as the deeper principle beneath the Pauli exclusion principle and coherence. It also assumes that Bell's Theorem is only applicable to 1D point particles and is therefore not applicable to the 3D structure model of a particule. Furthermore, it is suggested that the principle of locality is not viable in its present form and a principle of wider locality is proposed.*

While there are clearly a number of points in the statement above, which mainstream quantum theory might question, this review will start with a more general comment. In the context of *website-3*, which is broadly discussing various wave models, it appears that the Cordus model has to be described as a particle model. As has been previously noted, it is not clear that *Quantum Field Theory* can be considered only in terms of a 1D point-particle model. So, while the Cordus model wishes to differentiate itself from the mathematical abstraction of a point-particle model by introducing the conceptual sub-structure of the particule model, it does not appear to address the fundamental issue of '*substance*' or the *'causal mechanisms'* of its components, e.g. reactive ends, fibrils and hyffs.

> *Note: While the review of various wave models in website-3 also highlighted perceived issues with such models, they did appear to forward the logical idea that physical particles had to ultimately be replaced by energy propagating through space as a function of time. In this context, energy would be the most fundamental 'substance' of the universe, where frequency helps define time, while wavelength is analogous to a measure of spatial separation.*

However, even with the limitations of the diagram above, we might realise that the electron particule model is essentially a logical extension of the previous photon model. While this might also be seen as a form of wave-particle duality, both are now essentially being described in terms of a particule with a similar sub-structure.

So, how does the Cordus model differentiate an electron from a photon?

Starting with the similarities of both models, an electron also has two reactive ends separated by a fibril, which exerts a restoring force between them, such that it has a similar functionality in both types of particules. In this context, the electron statistically exists at both locations, as defined by the reactive ends, which are assumed to oscillate with a frequency defined by the deBroglie frequency. However, we might take a brief detour at this point to outline the general description of both the *Compton* and *deBroglie* wavelengths, where the deBroglie wavelength is assumed to only apply to matter waves, e.g. electron, which unlike photons have velocity [v] in the range of [0→c]. Both the formulation of the Compton and deBroglie wavelengths is given in [1].

[1] $$Compton\ [\lambda_C] = \frac{h}{mc};\quad deBroglie\ [\lambda_D] = \frac{h}{mv}$$

So, based on [1], an electron might have a deBroglie wavelength, which varies with velocity [v], but also a Compton wavelength, which is associated with the speed of light [c]. However, we might question the idea that an electron has a Compton wavelength that is inversely proportional to the assumed electron mass.

> *Note: The Compton wavelength of an electron is actually defined as the wavelength of a photon whose energy is the same as the electron mass, i.e. $E=hf=mc^2$. As such, there is not necessarily a direct physical inference that this wavelength is an attribute of the electron, although the various wave models in website-3 do make some assumptions that all matter particles are a construct of waves propagating with velocity [c] through the media of space.*

In terms of basic wave mechanics, wavelength is the product of a propagation velocity, i.e. [c] or [v], which is an attribute of the wave medium and the frequency of the source producing the wave, such that wavelength and frequency are related as follows.

[2] $$\lambda_C = \frac{c}{f_C} \quad or \quad \lambda_D = \frac{v}{f_D}$$

However, what remains unclear at this point is why the reactive ends within the electron particule oscillate with a deBroglie frequency, if a function of velocity [v], as defined in terms of the wavelength in [1] and qualified by [2]. As such, we return to the issue of the wave-particle duality of the electron, which the Cordus model only appears to quantify in terms of its oscillation rate between the two reactive ends. However, based on the conceptual description provided, it is assumed that a single electron, or least its two reactive ends, can simultaneously pass through two slits, if suitably spaced, while the fibril transparently passes the material in the gap between the slits.

> *Note: Again, it might be highlighted that aspects of the quantum behaviour observed in the standard double slit experiment have also been observed when the experiment uses three slots. If this is true, it might prove problematic for the particule model that only has two reactive ends.*

1.1.4 Locality and Superluminal

Generally, we might define the scope of *'locality'* in terms of the speed of light [c] and time [t], where the product represents a boundary beyond which a local particle cannot be affected – see *Light Cones* for more details. However, the basic idea of quantum entanglement seems to suggest that some form of superluminal signalling must occur between entangled particles. While this issue is beyond the scope of this review, the reader might consider whether the following two paraphrased statements, taken from Wikipedia, really provides any causal explanation. First, the issue of *superluminal communication*.

> *Superluminal communication is a hypothetical process in which information is sent at faster-than-light (FTL>ct) speeds. The current scientific consensus is that faster-than-light communication is not possible, and to date it has not been achieved in any experiment. Under present knowledge superluminal communication is impossible because it could be used to transmit information into the past that leads to logical paradoxes.*

So, at first glance, this statement would appear to rule out the possibility of any form of superluminal communication on the basis of any known physics. However, the article then goes on to qualify this position in terms of something called *quantum non-locality*, although the reader may also want to question whether the description below in anchored to any physical causal mechanism.

> *Quantum mechanics is non-local in the sense that distant systems can be entangled. Entangled states lead to correlations in end-states, even when the measurements are made nearly simultaneously and separated by distances in excess of [ct]. However, while it is assumed that quantum entanglement does not allow any information to propagate superluminally, quantum field theory defines a special case described in terms of the* no-communication theorem. *In an extension of the particule model, it might be suggested that entanglement does not occur between two particles, but rather one spatially extended construct. If so, the entanglement perceived might be explained by a mechanism constrained by [ct] within the substructure of the particle. Whether there would be some spatial limit to the extent of this structure would be guesswork at this stage - see* Coherence States *for other ideas.*

At this point, no attempt will be made to follow Alice down the rabbit-hole towards yet more quantum weirdness. While many may disagree, much of modern quantum theory now appears to rest on its own form of '*conjecture*' based on a *mathematical abstraction* that often appears to have no causal foundations and subject to *multiple interpretations*. In this respect, most of the ideas in *website-3* share a similar '*desire*' with the primary goal of the Cordus conjecture to anchor its descriptions to some form of physical causation, even though much of this review has questioned many aspects of the Cordus model. However, we shall attempt to pursue the description of nonlocality, as explained by the Cordus model, by citing the following statement.

> *The behaviour of an object is only affected by its immediate surroundings, not by distant objects or events elsewhere, such that it leads to a* local realism, *where the properties of an object pre-exist before the object is observed. However,* Bell's theorem *sets these against each other by implying that only one perspective can be correct: either superluminal effects or that local realism cannot exist.*

Of course, while much of quantum theory may be based on mathematical abstractions, it is also predicated on many empirical experiments, although there is considerable ambiguity about the physical processes occurring between the initial and final *quantum states*. However, despite the caveat highlighted, the general *consensus* supports the idea of non-locality and appears to accept Bell's theorem and its conclusion that no viable hidden-variable solution can exist.

So, how does the Cordus model address the issue of quantum entanglement?

In part, the answer to this question has already been generalised in the previous outline of the Cordus model, which accepts some form of superluminal effects, along with hidden variables, such that it revises the scope of locality. As indicated, the Cordus model allows superluminal effects, i.e. instantaneous communication, through the '*fibril*' that connects the '*reactive ends*' of the particule, presumably in the form of a photon or electron. However, this description rejects the conclusion of Bell's theorem on the grounds that quantum theory assumes a particle to be a 1D point with no substructure.

But how is the issue of superluminal communication address?

In essence, this issue remains unresolved in the Cordus model, which is one of the many concerns raised in this review. For many of the Cordus statements about physical realism rest on conjecture. As such, there are no obvious physical descriptions of the actual mass or energy constructs of the '*reactive ends'* or how they are physically connected by the fibril or the process of frequency propagation of flux lines that form the fabric density. While this may be acceptable within the confines of a conjecture, the suggestion that the Cordus model provides a better description of physical realism seems premature. However, while the Cordus model does offer up some initial response to such criticisms, it appears to do so by simply expanding the scope of speculative conjecture. Therefore, this outline review will return to the description of an '*energising frequency*' associated with the reactive ends of the particule model, which also appears to be surrounded by a descriptive ambiguity. For it is stated that the *'span'* between the '*reactive ends'* shortens as the frequency increases, which in-turn increases the emission rate of the discrete force that leads to an increase in mass, but does not necessarily explain how.

> *Note: It is assumed that the 'span' between the reactive ends refers to some unspecified spatial length occupied by the fibril. However, why this span/distance shortens with increased frequency is unclear. Equally, it is unclear as to what causes the reactive ends to oscillate at some given frequency rate, other than the possibility that this frequency is driven by the incoming frequency of the 'discrete forces' being output by other particles. Of course, this idea may only lead to a chicken-and-egg question, i.e. what is the fundamental source of energy in the fabric density and what mechanism describes its propagation through the fabric density.*

In this context, the Cordus model simply appears to state that when a reactive end is energised, it emits discrete forces in possibly three orthogonal directions. However, due to the alternating nature of this energy, the force emitted from the particule takes the form of a pulse. As such, it might be assumed that any particule might be receiving the output force pulses from other particules in the universe or, at least, those in the locality defined by [ct]. However, the Cordus model seems to suggest that the aggregation of these discrete force pulses creates an electro-magneto-gravitational field, which is also discrete in nature and forms a 3D composite field structure, i.e. the fabric density. The Cordus model further speculates that the discrete force pulse forms the basis of electrostatic interaction, while the bending of the force flux lines defines magnetism and torsion of these flux lines defines gravitation. Finally, the model speculates that synchronicity between discrete force elements of neighbouring particules is the basis of the strong force.

> *Note: Based on the outline description above, it appears that all of these fundamental force/fields are being linked to the aggregation of discrete forces being emitted from the particule model and propagate outwards into the space that separates all other types of particules. However, exactly how all these mechanisms work is also unclear at this stage.*

At this stage, the reader is left to review the details of the Cordus model for themselves as listed in the section entitled *Cordus Reference*. However, this review will now pursue two other Cordus papers entitled in the sections '*Relativistic Factors*' and '*Emergent Time*'.

1.1.5 Relativistic Factors

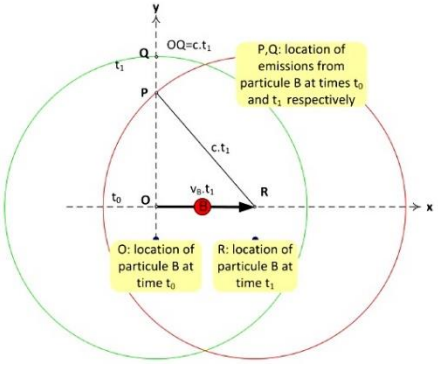
This section is an initial commentary on a paper entitled '*Effect of Matter Distribution on Relativistic Time Dilation*', which is included as part of the description of the *Cordus Conjecture*. This paper considers the possibility of an extension of the *Lorentz transforms* and the nature of relativistic time dilation assumed to take place within the moving frame with respect to a stationary frame. As this is an issue already discussed under the *MMW wave model* section of the Mysearch website, it might be compared against the Cordus model. In a wider context, the Lorentz transforms underpin the postulates of *special relativity*, which predict how an observer in one frame of reference will perceive motion in another, which it is generally assumed to require both length contraction and time dilation plus consideration of various *Doppler effects*. As an introduction of the Cordus model has already been outlined in previous discussions, this review shall start with the stated goal of the paper, which is to explain the Lorentz transforms in terms of a non-local hidden-variable model, such that it might unify its '*particule model*' with relativity. Since the goal of the Cordus model is to shown a physical causality does exist, an alternative derivation might provide a better explanation of relativistic motion grounded in physical causality. One of the fundamental assumptions of the Cordus model is that the speed of light [c] in vacuum and the rate of time are inversely related to the fabric density.

> *Note: By way of general reference, the Cordus particule model covers both matter and photons that are assumed to be 'energised' at a given frequency that defines the particule type. This particule model then emits discrete forces, although the exact number and direction of these forces also depends on the type of particule being described. These forces are then assumed to propagate along 'flux lines' out into the space between particules. As a consequence, the vacuum of space is filled with a tangle of flux force lines that defines the functional nature of the fabric of space.*

The Cordus model also assumes that the Lorentz transforms require modification to account for the fabric density, as it impacts the conventional concept of an inertial frame of reference. This idea then has implications on the definition of time dilation and the nature of any transverse *Doppler Effect,* when considered in terms of a particule model.

So, how might the Lorentz transforms be derived within this model?

The model starts by considering a mass particule [B], e.g. an electron, moving with constant velocity [v_B] along the x-axis, as shown in the diagram below. It then assumes that particule [B] is emitting a discrete frequency, which propagates outwards with a velocity initially assumed to be the speed of light [c].



> *Note: The diagram right might immediately be questioned, if the inference of the red circle implies the radius of the emission at time [t_1]. The details of this configuration have been discussed in some detail under the heading of* Ivanov Waves. *So while the emission first sourced at time [t_0] at [O] may have reached [Q], no emissions from [B] having just reach [R] at time [t_1] will have had time to propagate outwards.*

It is stated that the derivation of the Lorentz transforms can be achieved by a geometric consideration of the effect of movement on the '*flux tube of discrete forces*'. Based on this model, particule [B] passes point [O] at time [t_0] and emits a discrete field at this moment. After time [t_1] this field emission moves out radially on the y-axis to a distance [ct_1], i.e. point [Q]. During this same time [B] moves a distance

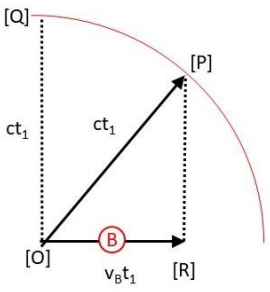
[$v_B t_1$] to point [R] along the x-axis. [B] continues its field emission during this process. Of course, if [B] had been stationary at [R], its emission would have reached point [P] on the original vertical y-axis based on the propagation [ct_1].

Note: While the description above might address the issue raised in the previous note, the statement: "the emission from [B] as it moves from [O] to [R] must have continuity of the flux tube rather than be broken" is not really understood, nor is the statement: "The emission from location [R] is not absent at [Q], but is instead stretched, hence redshifted".

Based on the Doppler effect, the wavelength associated with emissions from [B] may be subject to redshift or blueshift depending on whether the receiver is behind or in front of source [B]. We might also consider a number of other implications at this point. If [B] were stationary at [O] at time [t_0], then its emission would have reached [Q] after time [t_1] given a propagation velocity [c]. Alternatively, if [B] were stationary at [R] at time [t_0], then its emission would have reached [P] in the previous diagram after time [t_1] given a propagation velocity [c]. However, in the case where [B] is stationary, the wavelength would not have been '*stretched*'. If [B] were moving with velocity [v_B] then it would reach [R] after time [t_1]. However, in none of these scenarios does any emission from [B] at [R] have time to reach [Q] after time [t_1]. As such, the formulation in [1.1] appears to have no basis in terms of emission propagation from [B], i.e. [RP], in time [t_1] under any of the configurations suggested.

[1.1] $$(RP)^2 = (OR)^2 + (OP)^2 \; ; \; where \; (RP) = ct_1 \; and \; (OR) = v_B t_1$$

Therefore, an alternative diagram is proposed to explain the revised form in [1.2], where the emission from [B] at [O] at time [t_0] is seen propagating outwards with velocity [c] towards positions [Q] and [P], but where [P] is now defined as maintaining its vertical position above [B] at [R] at time [t_1]. As such, we now perceive a revised geometry based on propagation velocity of the emission from [B] in time [t_1], although it now requires the distance labels in [1.1] to be revised as follows.



[1.2] $$(RP)^2 = (OP)^2 - (OR)^2 \; ; \; where \; (OP) = ct_1 \; and \; (OR) = v_B t_1$$

$$(RP) = \sqrt{(ct_1)^2 - (v_B t_1)^2} = (ct_1)\sqrt{1 - \left(\frac{v_B}{c}\right)^2}$$

If we initially consider the revised result in [1.2] from the perspective of [B] being stationary, where [v_B=0], then [RP] is equal to [OQ], i.e. ct_1. Of course, by the postulates of special relativity, [B] might still consider itself as being stationary, as an inertial reference frame, but clearly from the perspective of the revised diagram, [B] is known to have velocity [v_B]. Therefore, the vertical distance [RP] might now be interpreted as having been subject to a length contraction relative to [OQ]. Again, while we need to revised the distance labels, we might still arrive at an analogous form of the Lorentz factor [γ] shown in [1.3]

[1.3] $$\frac{(OQ)}{(RP)} = \frac{ct_1}{ct_1\sqrt{1 - \left(\frac{v_B}{c}\right)^2}} = \frac{1}{\sqrt{1 - \left(\frac{v_B}{c}\right)^2}} = \gamma$$

While it is argued that [1.3] is generally compatible with the version in the Cordus paper, it is unclear that it depends on any of the assumptions of the Cordus particule model. Based on the revised diagram and the postulates of special relativity, [B] can consider itself to be an inertial reference frame, i.e. [v_B=0], such that there is a discrepancy between the perception that

distances [RP] and [OQ] are equivalent without knowledge of velocity [v_B]. However, the postulates of special relativity create two problems that the Lorentz transforms sought to solve. First, there is the implied length contraction of [OQ] to [RP], which if assumed to be the light propagation distance in the inertial frame also requires a time dilation of time [t_1], such that the speed of light [c] is maintained as invariant, which is also a postulate of special relativity.

But how might time dilation affect the measure of frequency of the emissions from [B]?

While the Doppler effect alone may cause a redshift or blueshift of wavelength depending on the position of the receiver with respect to a moving frequency source, time dilation is required to maintain the invariance of [c], which causes another effect on the perceived frequency of the source. Based on the accepted form of the Lorentz factor [γ] in [1.3], we can see that [γ] has a unity value when [v_B=0], which will increase towards infinity as [v_B] approaches [c]. However, a slowing of the rate of time in the moving frame also suggests that the frequency of any emission from [B] would also be a function of [γ], as per [1.4], although the subscript notation has been modified.

[1.4] $$f' = \frac{f}{\gamma}$$

The form of [1.4] has adopted the normal primed and unprimed notation to signified the relative value of frequency [f'] in the moving frame with respect to the frequency [f] in the stationary frame. However, again, it might be highlighted that the assumptions leading to time dilation are anchored to the postulates of special relativity without any obvious reference to any causal mechanisms assumed by the Cordus model

> *Note: If the assumptions of the Lorentz transforms are held true, then we might assume that they would apply to the Cordus particule model, i.e. the distance between the 'reactive ends' might be affected by length contraction. However, this assumption would only hold true if the axis of the particule model was orientated along the axis of motion.*

With the previous issues tabled, we will continue to pursue the idea that particle [B] is sourcing a discrete field with a given frequency, as described by the Cordus model. While it is not necessarily understood whether this really provides a causal explanation for this frequency, we shall assume that the particule emits an alternating '*discrete force*' from one of its two *'reactive ends'*. This force is then described as being confined within a *'flux tube'* that provides a rationale for the emissions from [O] and [R] being both stretched and synchronized. So, to reiterate some of the basic assumptions of the Cordus model, particule [B] has two reactive ends separated by a span, which is defined in terms of a fibril, although the physical structure and size of this span is unknown.

> *Note: The previous description has possibly given the impression that [B] is a single particule rather than an assembly of particles, such that there is only one field being emitted, rather than multiple overlapping fields. However, the model describes a single particule as being 'coherent' in the context that the concept of time is based on its own frequency cycle. In contrast, macroscopic assemblies of particules might generally be assumed to be 'decoherent' assemblies of multiple frequencies from different particule that overlap.*

While we have initially assumed that the speed of light [c] is a constant, the Cordus model predicts that this speed of light is not universally constant, but may depend on the local '*fabric density*'. As previously outlined, the fabric-density appears to refer to the mesh of moving flux tubes that are assumed to exist in 3D space, where the density is determined by the *'discrete forces'*

emitted by all particules within some region of space-time, which ultimately explain all the different type of observed fields, e.g. electric, magnetic and gravitational. Based on this possibly flawed outline, it is assumed that the fabric-density is not always constant, such that the speed of light [c] may also be a variable under certain conditions, which is some function of the particule flux density in a given region of space-time.

> *Note: The Cordus model assumes that light, i.e. all EM waves, are photon particules, such that we need to understand the causal mechanism that explains why photons propagate at a certain speed through the fabric-density, which is a 'tangle of discrete forces' collectively created by all other particules, presumably both photon and matter. While the Cordus model alludes to an interaction between the photon flux lines and the sum total of the flux lines comprising the fabric-density, the exact causal mechanism is unclear at this point.*

So, some attempt may be needed to clarify the scope of concepts being introduced in connection with the Cordus model. First, it is stated that time is described as an emergent property of matter, although the details behind this assumption are the subject of another paper – see next review section on *emergent time*. However, without going into these details, at this stage, the rate of time is assumed to exist on multiple levels, which is simply summarised in the note below.

> *Note: The perception that time exists at various spatial levels that define different coherence and decoherence boundaries, i.e. single electron particule, atom, molecules and organic cells. As such, time is initially correlated to the frequency of a single particule, but then aggregated as the structural complexity increases, which is then used to explain the irreversible nature of time, i.e. entropy, at the macroscopic level.*

At the most fundamental level of a particule, time is dependent on frequency which corresponds to the rate at which the particule emits a discrete force. However, this frequency cycle also quantifies the ability of a particule to interact with its surroundings, i.e. only when it is energized. As such, we might perceive several ambiguities within this model when trying to quantify any measure of space-time, when defined in terms of the speed of light [c] and time [t], if both can be variables within different frames of reference. However, at this point, it is highlighted that the connectivity of any particule in space-time is still generally defined by its *past light-cone* with the caveat of the constancy of [c] and the somewhat contentious issue of *superluminal communication* that may exist between reactive ends connected by a fibril.

What else might be highlighted in terms of time and frequency?

While the Cordus model addresses this question in its own way, it is not unreasonable that this commentary offers up a different perspective, although possibly equally speculative.

> *Note: We might realise that the question above is a somewhat of a 'chicken-and-egg' issue, which might be worthy of some wider consideration. For example, from a human perspective, it is difficult to defined the idea of frequency other than as a cycle-count per unit time, even though this definition might be reversed, such that time is defined in terms of frequency. There is also a similar issue as to whether wavelength is a measure of space or vice versa. However, both of these issues are implicitly making reference to wave mechanisms, i.e. frequency and wavelength, which do not require any reference to matter particles, such that we might question the fundamental causal mechanism at work in the universe. We might take this line of tangential reasoning a step further by inquiring into the 'substance' of any fundamental particle. If we accept the basic inference of the energy equations of Einstein and Planck, as shown in [A.1] below, we might transpose the definition of mass [m] into either energy [E] or frequency [f] as follows:*

[A.1] $$E = mc^2 = hf \Rightarrow m = \frac{E}{c^2} = \frac{hf}{c^2}$$

However, the scope of [A.1] possibly returns us to the quantum idea of the mass of a point-particule, which in any physical reality has to occupy some finite volume of space, such that it defines an energy-density. Of course, the idea of energy [E] can be an elusive concept, but one that might also be rationalised in terms of a wave model. In this context, energy is a scalar quantity that corresponds to some displacement within a wave media, i.e. potential energy, which then seeks to return to some equilibrium state. Again, it might be suggested that a wave mechanism might provide the most fundamental explanation of how this might be achieved, where excess energy is propagated away through the wave media with some unit velocity [c=1], which we might generalise in terms of the following equation.

[A.2] $$velocity[c] = frequency * wavelength = f\lambda \Rightarrow \lambda = \frac{c}{f}$$

In terms of known causal mechanisms, the basic relationship in [A.2] can be explained in terms of a displacement of a wave media, i.e. energy [E], where frequency [f] is associated with some physical oscillation and propagation velocity [c] is an attributes of the wave media, such that wavelength [λ] becomes a resulting function. In this context, we might return to the issue as to whether frequency and wavelength are any more fundamental than time and space. For while frequency and wavelength might be described as the most fundamental causal mechanisms in a wave model, they do not necessarily replace the concept of time and space. For the wave mechanisms outlined still require the spatial distribution implied by a wave media, while the process of energy dissipation still requires time, irrespective of the frequency and propagation velocity of the waves. So, while the Cordus model might define a fabric-density in terms of a 'tangle of discrete forces', the flux line associated with these forces still require the concept of a spatial distribution between particules, which propagate as a function of time.

If we return to the description of the Cordus model, the frequency of the particule is said to define its local rate of time, but where this frequency is also affected by the *'resistance'* of the surrounding fabric-density into which the particules is emitting its own discrete force lines. As outlined, the fabric-density is not necessarily uniform and can encompass a range of field types, e.g. electric, magnetic and gravitational. In this context, any field emissions being sourced by a particule may also affect the fabric-density, which can also be compounded by the velocity and acceleration of the particule. Collectively, all these factors lead to the assumption that the frequency of the particule field emission can be slowed, such that the local measure of time might be subject to a *'dilation'*.

But how is this idea incorporated into the Lorentz transforms?

A variable [ϕ] is now introduced and associated with the fabric density, which reflects the gradient of the fabric density, which may be linked to the expansion of universe and the assumption of a non-homogenous spatial distribution of matter. This latter assumption differs from the *standard cosmological model*, which assumes the universe to be homogeneous, at least, on a cosmological scale. Another difference in respect to the standard model, e.g. relativity, is that the Cordus model assumes that two inertial frames of reference are only equivalent if the fabric density is also equal. However, in terms of the previous example of particule [B], it was generally assumed that the fabric density [ϕ] was constant. However, in the case of a non-homogeneous fabric density, particule [B] will start in one fabric density and move into another fabric density. If this is the case, the frequency associated with particule [B] changes, as a function inversely proportional to fabric density, as indicated in [2.1].

[2.1] $$f \rightarrow \frac{1}{\phi}$$

Initially, we might consider a general case, where particule [B] is moving with a non-relativistic velocity [v_{B1}], when positioned in a fabric density [ϕ_1] with frequency [f_{B1}]. It then moves into a different fabric density [ϕ_2], such that the frequency becomes [f_{B2}], as characterised in [2.2].

[2.2] $$\phi_1 f_{B1} = \phi_2 f_{B2}$$

Again, the Cordus model assumes that frequency, at the fundamental level, defines the rate of time for the particule, although this discussion has questioned aspects of this assumption. However, according to the Cordus model, as particule [B] moves into a region of higher fabric density, e.g. [ϕ_2], then the fabric resistance to the emission of discrete forces increases, such that emission frequency decreases. As a consequence, all processes associated with [B] are subject to a slower rate of time.

> *Note: Previously, it was argued that frequency is measured in terms of time, not vice versa. However, if all processes built upon particules are subject to a lower frequency, then it is possible that they would also experience a slower rate of time. In this context, we might see a general correlation with accepted relativistic models, where time dilation is a description of time ticking slower, such that it would correspond to a higher fabric density.*

An extrapolation of [2.1] suggests that there would be a similar effect on the external measure of velocity, as it is also a function of time, as characterised in [2.3]. However, the causal mechanism by which the velocity [v] of a particule, i.e. single or multiple assembly, is affected is not understood in terms of the normal kinematic laws.

[2.3] $$\phi_1 v_{B1} = \phi_2 v_{B2} \Rightarrow v_2 = \left(\frac{\phi_1}{\phi_2}\right) v_1$$

So, as described, a change in the fabric density [ϕ_2] can cause an internal change in the frequency of emissions produced by the particule, which also affects the fabric density. If we are to correlate this effect with relativity, both special and general, then time dilation must be associated with a significant increase in the fabric density, which must be non-linear in order to conform to the Lorentz [γ] factor defined in [1.3]. We might also assume that the change defined by [2.2] and [2.3] would only be perceived by an external observer, who remains in some region of space-time, where the fabric density [ϕ_1] is unaffected.

> *Note: There is some confusion in the suggestion of [2.3] when considered in terms of special relativity. In this context, velocity as determined by the moving and stationary observers is normally invariant and reconciled by time dilation and length contraction as shown in [A.3], where the primed notation reflects the measure of time and length in the moving frame, where the unprimed notation is associated with the stationary frame.*

[A.3] $$v' = \frac{x'}{t'} = \frac{x}{t} = v$$

> *It is also highlighted that special relativity allows the assignment of the unprimed and primed frames to be reversed, if both are inertial frames. However, it is unclear that this reversal could take place in the Cordus model as it is not obvious how the fabric density could simply be reversed.*

In the description, so far, the inference has always been that particule [B] is a matter particle of some description, e.g. an electron. However, the Cordus model has a somewhat similar particule model for a photon of light, which it is assumed can only propagate through space at the speed of light [c], although this velocity is also inversely proportional to the fabric density [ϕ], such that [2.3] is extended to [2.4].

[2.4] $$\phi_1 c_1 = \phi_2 c_2 \Rightarrow c_2 = \left(\frac{\phi_1}{\phi_2}\right) c_1$$

Note: The form of [2.4] has been extended to highlight the implication that if the fabric density [φ_2] increases above [φ_1], for any reason, the speed of light [c_2] falls relative to [c_1].

Clearly, the idea that the speed of light in vacuum is not a universal constant is a major departure from mainstream models. While we will need to come back to the implications stemming from [2.4], the focus will now jump ahead of the detail in the paper to consider the issue of gravitational time dilation on matter particules. We might introduce the approach of the Cordus model by considering a matter particule, e.g. [B], moving away from some much larger gravitational mass [M]. In this context, it is assumed that [B] experiences a decrease in the surround fabric density [ϕ] as a function of an increasing radial distance from mass [M], where its velocity [v] is normally described as the escape velocity as per [2.9]

[2.9] $$v = \sqrt{\frac{2GM}{r}}$$

As the issue of *general relativity* has been previously discussed, reference can be made via the previous link, although it is highlighted that this discussion was in the context of a wave model. Based on a somewhat classical derivation of the Schwarzschild metric, an equivalent form of the relativistic [γ] factor, as first shown in [1.3], is revised as per [2.10].

[2.10] $$\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \Rightarrow \frac{1}{\sqrt{1-\left(\frac{2GM}{rc^2}\right)}} = \frac{1}{\sqrt{1-\left(\frac{Rs}{r}\right)}}$$

Note: The final equation above has adopted the definition of the Schwarzschild radius [Rs], which is defined as the radius at which the escape velocity [v], shown in [2.9], equals the speed of light [c], which is also the definition of an event horizon of a blackhole. However, the Schwarzschild radius [Rs] can be calculated for any mass [M], although in most cases it will be far smaller than the physical radius of mass [M].

While the form of [2.9] and [2.10] might be considered conformant to the standard model, the Cordus model does not require either [c], or [G], to be universal constants, which will have impact on subsequent assumptions. Again, the initial inference of general relativity in connection with particule [B] is that we are discussing matter interaction within a gravitational field. Of course, general relativity also has some predictions about the gravitational effects on light, either as an EM wave or photon. However, at this point, the Cordus paper makes some statements that are not understood, which are first paraphrased and then discussed.

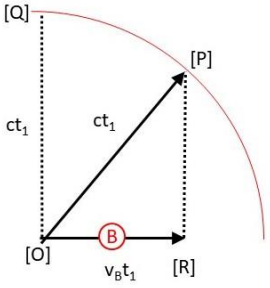
Gravitational redshift of photons: The previous case was for matter particules experiencing a changing gravitational field, where the frequency of the particule increases as it moves outward, i.e. away from mass [M], which is reflected in

a changing rate of time. However, a different behaviour arises when the particule is a photon, and in this case a redshift occurs. For when a photon moves outwards against a gravitational field, it moves from a higher fabric density [φ_2] to a lower [φ_1], where the relativistic prediction suggest the photon frequency will reduce as it moves outwards, hence it will be redshifted. Equation [2.2] appears to contradict this view, as it predicts that the frequency will increase as viewed in the co-moving frame, but highlighting that this equation only applies to matter particules. For a photon, the lower fabric density [φ_1] causes an increase in the velocity, as per [2.4], hence a stretch of the wavelength and a reduction in frequency. Thus, the Cordus model also predicts that the photon will display gravitational redshift, though attributes this to the change in fabric density rather than the gravitational field. As such, the Cordus model makes the falsifiable prediction that the gravitational redshift will depend not only on the gravitational potential, but also on the background fabric density. For situations with higher background [φ] the extent of the redshift will be reduced.

Many aspects of this description appear confusing. While there is a difference on the Cordus models for matter and photon particules in terms of velocity, i.e. [v] versus [c], the basic mechanism of field line emissions from the reactive ends appears generally equivalent. Equally, in the context of general relativity, the causal reason for an increase in the fabric density [ϕ_2] would be attributed to the gravitational mass [M], which would affect both matter and photon particules alike, i.e. both would be subject to increasing time dilation as a function of decreasing radial position [r] with respect to mass [M]. If so, then both would be emitting a reduced frequency, which would correspond to an increased wavelength, i.e. a redshift.

But, how do variable velocities [v] and [c] affect the Cordus model?

The standard model assumes [c] to be a universal constant, while [2.4] of the Cordus model suggests that it is a variable of fabric density [ϕ_2], which the extended form of [2.4] suggests falls from [c_1] to [c_2] as a function of decreasing radial position within the gravitation well of mass [M]. Based on the earlier revised geometric model involving a particle [B] moving with velocity [v], while emitting a frequency with a propagating velocity [c], we might attempt a modification of [1.1], which is now present in [3.1]



[3.1] $$(RP)^2 = (OR)^2 + (OP)^2 \; ; \; where \; (RP) = ct_1 \; and \; (OR) = v_B t_1$$

Note: The argument for the changed geometry was made on the basis that [RP] was the comoving equivalent of [OQ] in a stationary frame, when [v_B=0], such that [RP] might be considered in terms of length contraction in the moving frame with respect to the stationary frame. However, the implication of changing fabric densities [φ_1] and [φ_2] now needs to be taken into consideration as suggested by [3.2].

[3.2] $$(RP) = \sqrt{\left(\frac{\phi_1}{\phi_2} c_1 t_1\right)^2 - \left(\frac{\phi_1}{\phi_2} v_B t_1\right)^2} = \left(\frac{\phi_1}{\phi_2} ct\right)\sqrt{1 - \left(\frac{v}{c}\right)^2}$$

Again, it is highlighted that the Cordus model assumes that the ratio [ϕ_1/ϕ_2] affects both the frequency emissions propagating away with velocity [c] and the velocity [v] of the [B] equally. The causal explanation of this effect is not understood. However, it appears that [3.2] is anchored to [2.3] and [2.4], where [c_1] and [v_B] are assumed to be the velocities measured by a stationary observer surrounded by a fabric density [ϕ_1], where the normal velocity of light is [$c=c_1$]. On this basis, the final form in [3.2] has

simply adopted the unprimed notation [c,v]. Finally, as before, we can convert the form of [3.2] to reflect a revised form of the Lorentz [γ] factor, as presented as [3.4] in the paper, but now extended to include the form for gravitation.

[3.4] $$\gamma(\phi) = \frac{1}{\left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{v}{c}\right)^2}} \Rightarrow \frac{1}{\left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{Rs}{r}\right)}}$$

So, while we have reached the same form as defined by the Cordus model, some of its assumptions have been challenged along the way. It might be highlighted that the form of [3.4] is still required to collapse to a Newtonian approximation in the absence of any relativistic factors, which the addition of [ϕ_1/ϕ_2=1] would maintain. However, what is absence from [3.4] is any causal explanation how the fabric density changes as a function of velocity [v] or in the proximity of the gravitational mass [M], although we might still consider the net effect of this revised formulation. We know that normal relativistic effects defined by either the ratio [v/c] or [Rs/c] causes [γ] to increase from unity as [v] approaches [c] or [r] approaches [Rs]. However, the description of the fabric density ratio [ϕ_1/ϕ_2] suggests that this component of γ(ϕ) will decrease as the fabric density increases from [ϕ_1] to [ϕ_2] as implied in the case of an increasing gravitational field, although is unclear which factor is most significant.

Note: The standard relativistic model is anchored in the idea of time dilation in the moving frame relative to a stationary frame. Normally time is denoted as [dτ] in the moving or gravitational frame and [dt] in the stationary frame of flat spacetime. We can express the ratio of [dτ/dt] in the form of the [γ] variable defined in [3.4], but where the ratio of [φ_1/φ_2] is removed.

[A.4] $$\frac{d\tau}{dt} = \sqrt{1-\left(\frac{v}{c}\right)^2} \; or \; \sqrt{1-\left(\frac{Rs}{r}\right)}; \;\; where \; d\tau \le dt$$

As suggested by [A.4], [dτ] is normally always less than or equal to [dt], i.e. [dτ] is time dilated with respect to [dt]. Therefore, we might reasonably assume that frequency sourced within the moving frame would also conform to this relationship, i.e. [fτ] is less or equal to [ft]. If so, we might consider a modified form of [2.2], but then add the implications in [A.4]:

[A.5] $$f_2 = f_1\left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{v}{c}\right)^2} \; or \; f_1\left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{Rs}{r}\right)}$$

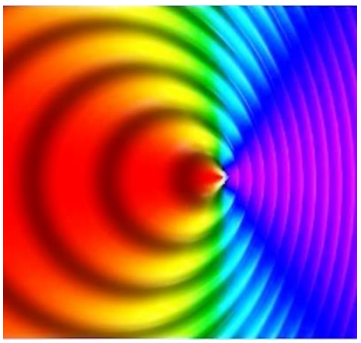
It is highlighted that the form of [A.5] in the note above is similar, but different in the subscript notation, where frequency [f_2] corresponds to a particule in a higher fabric density [ϕ_2] as measured by an observer positioned in a lower fabric density [ϕ_1], such that the frequency is subject to both the ratio [ϕ_1/ϕ_2] and the Lorentz [γ] factor associated with time dilation. However, while we can quantify the scaling of the Lorentz time dilation to either the velocity ratio [v/c] or [Rs/r], it is unclear how the ratio [ϕ_1/ϕ_2] scales under the same conditions or explained by the following statement:

The fabric density is determined by the spatial distribution of matter in the accessible universe around the location under examination. Thus, the fabric density is proposed to be the deeper causal mechanism that subsumes gravitational time dilation.

With some of the previous issues now noted, we will continue with the idea that the Lorentz transforms can be scaled to macroscopic objects, e.g. a billiard ball. Of course, such an object must consist of billions of particules that may emit different frequencies, but which it is assumed all scale by the same factor, i.e. γ(ϕ). However, recognising that these macroscopic objects also have a multitude of different interactions across all scales, i.e. sub-atomic and atomic, molecular and chemical bonding, field and particle kinematics, we might question how the revised Lorentz γ(ϕ) factor scales under all these causal mechanisms. However, having outline some of the primary assumptions of the Cordus model in relation to the Lorentz transforms, the next discussion will consider some of the issues associated with the Doppler effect.

Note: Before leaving the discussion of the Lorentz transforms, it might be highlighted that the Cordus model appears to say little about length contraction, which is another key assumption of the development of the Lorentz transforms used to explain the null results of the Michelson-Morley experiment*; although the link discusses this issue in terms of a wave model.*

1.1.5.1 *Doppler Effects*



In the previous section of discussion, we considered the Cordus model in terms of a modification of the Lorentz transforms, which introduced the idea of fabric density [ϕ] into the transforms. In the context of this model, matter and photons are assumed to emits discrete forces with a given frequency [f_1], which are then subject to an extended Lorentz γ(ϕ) factor, which modifies frequency when received by an observer in another reference frame.

Note: The following equation is simply presented by way of reference of [A.5], which is an extension of the Lorentz transforms. The definition of γ(φ) factor adds the ratio [φ_1/φ_2] to reflect the difference in the fabric density between the source and receiver of the frequency, which are located in different reference frame defined by velocity [v] or gravitational position [r] with respect to mass [M].

[A.6] $$f_2 = \gamma(\phi) * f_1; \quad where\ \gamma(\phi) = \left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{v}{c}\right)^2}\ or\ \left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{Rs}{r}\right)}$$

While there is still some ambiguity as to exactly how the 'flux lines' emanated by a particule propagate through the fabric density, it is assumed they do so at the speed of light [c], although this velocity is no longer a universal constant, but rather another variable of the fabric density [φ].

As far as it is understood, the particule model is assumed to be the most fundamental structure from which all macroscopic objects are scaled, e.g. a billiard ball for example. Of course, such macroscopic objects must consist of billions of particules that emit different frequencies, which are presumably subject to a multitude of different interactions across all scales, i.e. sub-atomic and atomic, molecular and chemical bonding, field and particle kinematics, such that we might question how the revised Lorentz γ(ϕ) factor scales when subject to so many potential causal mechanisms. While this discussion will not address this obvious complexity, it might consider the implication associated with two reference frames, i.e. source and receiver of the frequencies [f_1, f_2], as implied in [A.6] above, in terms of the Doppler effect. Many of the issues surrounding the Doppler effect have been discussed in several different sections of the Mysearch website, although primarily in connection with various wave

models. However, a link to the last *Doppler Effect* discussion might be a suitable initial reference as it provides a general overview of different Doppler effects, e.g. normal, composite, virtual and relativistic, plus an additional reference to a discussion entitled *Ivanov Waves*, which might also provide some useful background information.

Note: For the initial purpose of this discussion we might focus on the description of the normal Doppler effect, which is caused by a frequency source moving with velocity [v], such that it creates a Doppler effect that propagates out through a wave media. However, the resulting wavelength might be measured differently by a comoving receiver positioned at some angle [Θ] with respect to the moving source.

[A.7] $$\lambda_\theta = \lambda\sqrt{1-\beta^2\sin^2\theta} - v*\cos\theta;\quad where\ \beta = \frac{v}{c}$$

*It is highlighted that the value of ($\sin^2\Theta$) will be zero for the forward and backward directions, i.e. 0 and 180 degrees, while [v*cosΘ] will take on a [±] value, such that the wavelength [λ_Θ] will be compressed in the forward direction, i.e. blueshifted, and stretched in the backward direction, i.e. redshifted, according to (1±β). However, the source frequency and the wave propagation velocity [c] never change, only the wavelength, although subject to some caveats, where the receiving observer may interpret the incoming wavelength based on the relationship [λ=c/f].*

According to the Cordus model, a number of caveats apply as the frequency emitted by the particule may change due to a number of effects, i.e. i) the fabric density [ϕ], ii) the particule velocity [v] or iii) the gravitational field, which also result in a Doppler effect being propagated outwards. However, we might simplify the scope of [A.7] to just the forward and backward directions, where frequency [f_2] may be calculated on the basis of the received Doppler wavelength [λ_2] using the basic relationship [f=c/λ], which holds true in non-dispersive wave media, such that we might approximate the equation given in [5.1] and [5.2] in the original paper.

[5.1] $$\lambda_2 = \lambda_1\left(1 \pm \beta\right)$$

[5.2] $$f_2 = \frac{c}{\lambda_2} = \frac{c}{\lambda_1\left(1 \pm \beta\right)} = \frac{f_1}{\left(1 \pm \beta\right)}$$

However, the relationships shown in [5.1] and [5.2] clearly take no account of any relativistic effects associated with the Lorentz transforms or the Cordus model requirement associated with the fabric density [ϕ]. Therefore, we might attempt to combine the result in [5.2] and the Cordus equation given in [A.6], such that it conforms with equation [6.2], which has been extended to include reference to what is assumed to be an equivalent form in a gravitational field.

[6.2] $$f_2 = \frac{f_1}{\left(1 \pm \beta\right)}\left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{v}{c}\right)^2} \quad or \quad f_2 = \frac{f_1}{\left(1 \pm \beta\right)}\left(\frac{\phi_1}{\phi_2}\right)\sqrt{1-\left(\frac{Rs}{r}\right)}$$

Note: It might also be highlighted that the form of [6.2] in the paper is only considering a frequency [f_2] received in the forward direction due to velocity [β=v/c] and makes no reference to the wavelength distribution associated with the angle [Θ] given in [A.7].

While it is not really the focus of this review, there is an aspect of the *Ivanov Waves* discussion that might be highlighted as it further questions the nature of any waves that might be propagating through the media of space. As has been highlighted,

most of the discussions being referenced in *website-3* relate to wave models, while the Cordus model appears to be more orientated towards explanations, or conjectures, that align to a particule model. This said, it is assumed that some aspect of the particule model is oscillating with a frequency [f], which is then described as propagating outwards in the form of *'flux lines'* that form the fabric density. While we might assume that these flux lines represent energy, in some form, being propagated as waves, the details of any associated causal mechanisms are unclear in terms of how they facilitate all the required interactions between particles. However, if we assume that these flux lines propagate a frequency through the wave media, described as a fabric density, with velocity [c] that is now assumed to be a variable of [ϕ], then we might still consider the implied Doppler effect in terms of wave mechanics. While most references discussing the Doppler effect invariably simplify the equation in [A.7] to just the forward and backward wavelengths defined by (1±β), the full derivation is detailed in the Ivanov Waves discussion referenced above. However, Ivanov also proposed an alternative set of transforms, which can be compared with the Lorentz transforms below.

[A.8]
$$Ivanov: x' = \frac{x - vt}{1 - \beta^2}; \quad y' = \frac{y}{\sqrt{1 - \beta^2}}; \quad z' = \frac{z}{\sqrt{1 - \beta^2}}; \quad t' = t$$

$$Lorentz: x' = \frac{x - vt}{\sqrt{1 - \beta^2}}; \quad y' = y; \quad z' = z; \quad t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1 - \beta^2}}$$

One obvious difference in these two sets of transforms is in respect to time dilation that only occurs in the Lorentz transforms. We might illustrate this by changing the form of the Ivanov transforms, such that spatial length [xyz] is now expressed in terms of wavelength [λ] at time [t=0] and where time [t] is considered in terms of frequency at offset [x=0].

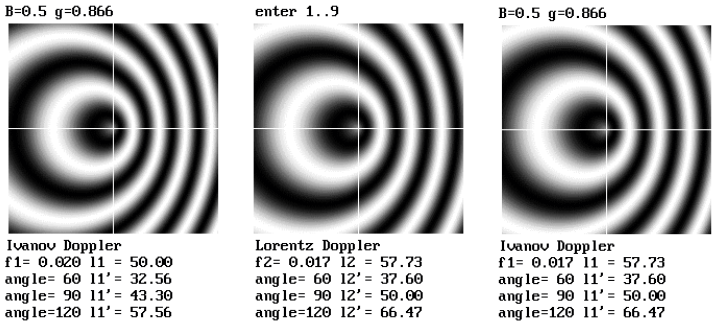
[A.9]
$$Ivanov: \lambda_x' = \frac{\lambda_x}{g^2}; \quad \lambda_y' = \frac{\lambda_y}{g}; \quad \lambda_z' = \frac{\lambda_z}{g}; \quad f' = f; \quad where \quad g = \sqrt{1 - \beta^2}$$

The reduced form of the Ivanov transforms in [A.9] do not infer any time dilation, such that frequencies [f=f'] are equal. However, we might attempt to convert the Ivanov transforms into the Lorentz transforms by multiplying each term by the [g] factor defined in [A.9] above, such that time dilation might be shown in the form below.

[A.10]
$$\lambda_x' = g\left(\frac{\lambda_x}{g^2}\right) = \frac{\lambda_x}{g}; \quad \lambda_y' = g\left(\frac{\lambda_y}{g}\right) = \lambda_y; \quad \lambda_z' = g\left(\frac{\lambda_z}{g}\right) = \lambda_z; \quad f' = g(f) = gf$$

At face value, the results in [A.10] might be seen to align to the Lorentz transforms, where the transverse wavelengths [yz] are now unaffected, while the frequency [f'], i.e. the reciprocal of time, would be slowed by [g]. It might be highlighted that time in either a wave or Cordus model might be correlated to frequency. However, time dilation still requires a causal mechanism to explain why frequency changes. While the Ivanov transforms do not need to account for time dilation, when describing the Doppler effect on sound waves, the introduction of an additional [g] factor appears to be a relativistic requirement, although this also requires a causal mechanism.

While the Ivanov transforms make no reference to time dilation, which is not required for sound waves, a previous discussion entitled *Doppler Effects and Other Transforms* raised an issue in terms of the following simulations.



The first simulation left reflects the normal Doppler effect on sound waves propagating through a wave media as a result of the wave source having a velocity [β=0.5c] with respect to the wave media. The second simulation in the middle revises the results, based on the Lorentz transforms, by applying a time dilation factor [g] to the original source frequency [f1=0.020], such that it becomes [f2=0.017]. The third simulation on the right then questions whether the Lorentz simulation actually exists within the wave media, if the effect of time dilation only takes place within the local frame of the moving source, before any wave is transmitted into the media. In the case of the Lorentz simulation in the middle diagram, the frequency [f1=0.020] is reduced to [f2=0.017] due to time dilation prior to any waves being transmitted into the media, such that the following question was tabled.

How is the middle Lorentz simulation different from the Ivanov simulation right?

In both cases, the wave source has a relative velocity [β=0.5c] with respect to the wave media, where the source is transmitting waves with frequency [f2=0.017], as measured by a stationary observer. While this frequency has been physically changed in the Ivanov case and caused by time dilation in the Lorentz case, it is unclear why the Doppler effect propagating through the media would differ. It can be seen that the wavelength results displayed below each simulation are identical and it might be assumed that a stationary observer would not directly be aware of how or why the frequency [f2] had change prior to wave transmission.

So, why are the two simulations different and who would see the Lorentz simulation?

If you compare the results under each simulation, we see the calculations of the wavelength [λ=c/f]. In the case of the Ivanov transforms, left and right, the calculation is based on [f1=0.020] and [f2=0.017] that corresponds to the wavelengths [λ1=43.3] and [λ2=50.0] respectively. These wavelengths are then reduced when observed at an angle [Θ=90^{o}] to [λ1=43.3] and [λ2=50.0] respectively, such that there is a transverse wavelength contraction as predicted by Ivanov. However, in the case of the Lorentz transforms, the wavelength at angle [Θ=90^{o}] is showed also to be [λ2=50.0], but is assumed to correspond to the source frequency [f1=0.020] prior to time dilation, not [f2-0.017]. Therefore, the claim that there is no transverse wavelength contraction might be seen as somewhat misleading as the source wavelength transmitted into the media in the Lorentz simulation is [λ2=57.73], which reduces to [λ2=50.0] at [Θ=90^{o}].

1.1.5.2 *Comments*

This outline review relates to a paper entitled '*Effect of Matter Distribution on Relativistic Time Dilation*', which attempts to further discuss the issue of causal mechanisms within the Cordus model. While the Lorentz transforms might be considered applicable to either a wave or particule model, especially in the context of relativity, it is difficult to discussed the scope of the various Doppler effects outlined outside of a wave model description. However, while the Cordus model makes reference to some form of frequency oscillation process within its particule model, which then propagates outwards into the fabric density, it appears to avoid any direct causal explanation based on known wave mechanics. So, having outlined some of the main issues raised in the paper, the final commentary simply jumps ahead to the findings of the paper in section (5.1), which are possibly reflected in the following paraphrased summary.

> *It is proposed, on theoretical grounds, that the conventional formulation of the Lorentz transformation is incomplete and needs the inclusion of a fabric density [φ] variable. General relativity is predicated on the speed of light [c] in a 'perfect' vacuum, see note below, being a universal constant. However, the Cordus model proposes that the fabric is relativistic in terms of exhibiting Lorentz effects, but assumes that the fabric density is fundamentally anisotropic and that this affects the speed of light.*

It appears that the fabric density of the Cordus model is possibly quite different in concept to that described under the heading *Wave Media*. However, the wave models discussed in terms of the *WSM* or *WMM* models, both allude to the fabric density being affected by the concentration of energy associated with a standing wave structure, such that the wave propagation velocity [c] in this region might also be affected. Likewise, the discussion entitled '*Nature of Light*' outlines some of the perceived issues associated with the wave-particle model of quantum theory, but then raises the issue of the variable particle density of space in the discussion '*The Nature of Contradictions*'.

> *Note: In the latter reference, it is highlighted that the upper limit of the speed of light [c=1] is predicated on a perfect vacuum, even though this is essentially a conceptual state that is never really achieved. For example, it has been estimated that different regions of interstellar space have between 1-1000 atoms/cm^3, which increases to something in the order of 10^9 atoms/cm^3 in the Sun's corona or the 10^{16} atoms/cm^3 in the Sun's photosphere.*

It is generally accepted that the speed of light [c] falls when propagating through different media, e.g. glass or water, although the actual causal mechanisms are explained in different ways depending on whether the description is based on an EM wave or discrete photon. However, the general point being highlighted is that the '*optical density*' of the fabric changes the speed of light [c] and causes refraction, which the particle density outlined in the note above might also affect. Whether this suggestion leads to the next conclusion of the Cordus model might still be debated.

> *It is radical to propose the fabric density as a new cosmological variable, but it is logically congruent with gravitational time-dilation. Gravitational field strength is then a proxy variable for fabric density. In principle this means that fabric density becomes the common cause of relativistic velocity effects and gravitational effects, hence may provide a means to explain the correspondence of inertial and gravitational mass.*

One of the general concerns raised by this review of the Cordus model is the lack of causal mechanisms that supports the particule model. So while the fabric density ratio [ϕ_1/ϕ_2] might be a reasonable conjecture, the explanation of its inclusion in the extended form of the Lorentz transforms only appears to consider the issue of time dilation in terms of a change to the emitted frequency of a particule with little reference to length contraction or how the velocity [v] of matter particules is affected by the fabric density. However, the Cordus model also makes the following assumption.

> *It is necessary to abandon the cosmological principle with its assumption of homogeneity across the temporal phases and spatial dimensions of the universe. In its place we propose the concept of variable fabric density. We have shown how the fabric density would affect the Lorentz transformation and we have provided a derivation from a particle basis. Fabric density is expected to show temporal variation with the evolution epoch of the universe, and spatial variation across aggregations of matter.*

While the idea of a variable fabric density appears to be a reasonable conjecture based on the known variable particule density of space, it is unclear that the Cordus model has *'shown'* how a variable fabric density would affect the Lorentz transforms in terms of a causal description, especially if only based on the particule model, i.e. it remains conjecture.

> *If the Cordus conjecture is correct, then several cosmological phenomena will need reinterpretation. The fabric effect is covert in that it causes remote particles to change frequency and velocity in ways that are non-obvious to observers.*

Aspects of this statement might also be supported by some of the wave models reviewed in as much as there may be some overlap between the description of the fabric density and fabric of space as a media for wave propagation. There is also the issue as to why the Ivanov transforms apply to sound waves, but then appear to be subject to a time dilation factor as described by the Lorentz transforms. We might attempt to summarise this issue in terms of the next question.

What is the fundamental difference between sound waves and matter waves?

One idea forwarded in previous discussions is the obvious fact that matter waves are not a construct of sound waves propagating through the medium of air. In this respect, all objects made of matter waves, including human observers, are assumed to be immersed in the media of matter waves, such that it may cause the relativistic perception summarised in terms of the *Lorentz transforms* and the description of various *Doppler effects*. However, while it may be impossible for any observer to step outside the perception of space-time, this does not mean that it is impossible to imagine the perception of a truly stationary observer. Moving onto the next statement:

> *A philosophical contribution is providing an explanation for relativity based on a deeper physical realism. Specifically, the Cordus conjecture proposes physical structures at the sub-particle level, and offers a set of principles to govern the deeper mechanics. Curiously, these mechanisms are deterministic, but there are hints that at a coarser resolution the effects manifest as stochastic behaviours. This is consistent with wave function of QM. Hence, we see possibilities for a deeper theoretical compatibility between the Cordus Theory and both quantum mechanics and general relativity.*

In part, this statement highlights one of the main issues raised in the outline review, i.e. causal mechanisms. While the Cordus model makes the claim to seek a description of some fundamental physical realism, the model appears to be rooted in the semantics of a particule model, which like *pre-war quantum mechanics*, makes little reference to wave mechanics. This bias towards the semantics of particles might be highlighted in the next statement.

We set out to prospect for a relativistic formulation from a particle perspective. We achieved this by deriving the Lorentz transformation using the Cordus Theory. We find that the fabric density, hence distribution of matter, is an essential component of the Lorentz formulation under these assumptions.

So, while the Cordus model makes some interesting proposals that might lead to new insights, it is not clear that the most fundamental causal mechanisms underpinning the universe can be based on a model that appears constrained by the semantics of particles.

1.1.6 Emergent Time

This is another commentary review of a paper *e*ntitled '*Time: An Emergent Property of Matter*' included as part of the description of the *Cordus Conjecture*. This paper specifically discusses the issue of time, although an issue associated with time was initially considered in terms of *relativistic effects*, i.e. time dilation, that was formulated as an extension of the Lorentz transforms. However, the Cordus model assumes that fundamental time is an emergent property of matter linked to the frequency oscillations described in terms of the particule model. As this model has been outlined, albeit very briefly, the reader can follow the link to this *outline review* or directly access the papers in the *Cordus Reference* section. The basic idea is that time exists on multiple levels, i.e.

1. Particule frequency of oscillation
2. Within assemblies of particules
3. And organic cellular life

The first 11 pages of this paper essentially provide an overview of the Cordus model, such that this review will start at section 4.2, which discusses the frequency oscillation within the particules. The following paraphrased statement might be seen as a basic description of the first level of time in the Cordus model.

> *Level-1: Fundamental Time*
> *The fundamental tick of time is the frequency of the particule, which is identified as the cycle of re-energisation of the two reactive ends. As such, fundamental time, at the level of the individual particule is the frequency of the re-energisation cycles of its two reactive ends, which may differ in each particule type and possibly aligns to the QM perspective of time. In this context, particules with greater masses or energies have higher frequencies, which might be correlated to* $E=mc^2=hf$*. By a similar argument, if time is correlated to frequency, then time will tick faster in-line with frequency. As such, there is no universal time in the Cordus model, but rather a unique time for each particule.*

However, as has been highlighted on a number of occasions, the Cordus model seems to cite the oscillations within the particule as a fundamental cause, whereas other models would argue that this can only be an effect of some more fundamental mechanism. For example, the *WSE* requirement model makes an argument that *energy* is the fundamental *'substance'* of the universe that propagates with velocity [c] through the fabric of space by means of wave mechanisms. Alternatively, the *OST* model makes an argument that space is analogous to a superfluid that isolates angular momentum into fundamental units called rotars. While these models may be wrong, they do at least attempt to provide a description of the most fundamental causal mechanisms at work, which the Cordus model appears not to explain. However, we will continue with the next paraphrased statement.

> *Linking time to the re-energisation cycles is important because the particule is only available to interact with other particules when it is energised. When a reactive end of particule [A] is energised it issues discrete forces, which are propagated outwards with the speed of light [c], which may now be a variable rather than a universal constant. This discrete force carries the electro-magneto-gravitational field as well as the strong and bonding forces, which are therefore also discrete.*

Again, this appears to be another statement of effect without any specific description of the causal mechanisms. While it is possible that the details of the causal mechanisms being sought have been overlooked within this outline review, a general search of all the papers has found no obvious reference to such mechanisms. However, again, we will attempt to pursue the Cordus description of fundamental time based on the next paraphrased statement.

> *The fields and forces inform neighbouring particules, e.g. [B], about the state of particule [A], such that particule [B] might move in response to the fields from [A]. Of course, particule [B] will also be emitting its own fields, which will interact with particule [A]. In this way, all particules interact with the external environment, i.e. as presumably defined by the fabric density, when a reactive end is energised and provides a means of 'communication' between particules. Therefore, in the Cordus model, time is assumed to be a fundamental attribute of matter, based on its frequency, as opposed to being an external dimension or imposed variable.*

So, according to the Cordus model, the first level of time is associated with the particule or more specifically the frequency associated with the particule type, although we have questioned the causal mechanism that supports this assumption. However, as indicated, different particule types do not necessarily have the same frequency, but which bond together as atoms and then in ever larger structures, e.g. molecules, compounds and cells, such that they might be described as an *'assembly'*. As such, we might introduce the next level of Cordus time as follows:

> *Level-2: Assembly Time*
> *While fundamental time may be correlated with the frequency of each type of particule, a different rate of time may also exist when the particules are bound into some form of assembly. However, assembly time will also depend on the nature of the interaction between the assembled particules and hence on the nature of the bonds between particules, which are described in terms of being either 'coherent' and 'decoherent'.*

At this point, some initial introduction of the terms: *coherent* and *decoheren*t bonding is required. According to the Cordus model, at small scales, possibly below the molecular level, time is internally coherent because it is based on a single frequency associated with relatively few particule types within an atom. Therefore, in order to maintain coherent time within a larger assembly, e.g. atoms, it must retain common frequency cycle of re-energisation of the particules, such that it might be described as a coherent domain of matter. However, some larger coherent assemblies may exist in the form of a superfluid for example, such that the maintenance of coherent time depends on the nature of the assembly. At this point, the Cordus model makes the following paraphrased statement concerning the '*arrow of time'*.

> *Within a coherent domain of particules, the arrow of time does not exist, at least in principle, because it is assumed that the particule state can be reversed. However, this reversibility is only possible in simple structures in which the coherence of frequency can be maintained.*

The description of the reversibility of the particule *'state'* seems to be adopting a somewhat abstract description, as per *quantum states*, where the physical process between the initial and final state is unobserved and unexplained. If we assume that the state of the particule is subject to physical effects, then reversing these effects would require the causal mechanisms to be exactly reversed. While this is possible, it may still be unlikely, although probability may depend on the complexity of the system being described. However, the Cordus model possibly recognises the limits of trying to reverse the '*arrow of time'* as the external environment, defined by the fabric density, would be full of chaotic perturbations even for simple systems, such that we might turn our attention to the definition of a decoherent system introduce in terms of the following statement.

> *Larger or macroscopic systems become increasingly decoherent as the frequency homogeneity of the system cannot be maintained. However, the Cordus model assumes that larger systems may still exist as a structural tree of coherent and uncoherent domains, although the overall level of synchronous interactions between all particule becomes increasingly impossible.*

So, within the Cordus model, single particules are coherent based on their internal frequency. However, the property of coherence can quickly be lost as particules are *'assembled'* into ever-larger structural systems, such that they become decoherent overall. As such, decoherent or assembly time is defined as follows:

> *Decoherent assembly time is the tick of interactions within an aggregate body of coherent and decoherent sub-bodies. This tick of time is much slower than the fundamental time associated with individual particules. Decoherent assembly time is also irreversible, hence the arrow of time arises at this level. This is because the interaction between sub-assemblies becomes practically impossible due to the complexity of interaction between all the particules mediated through the fabric density. As a result, the idea of entropy is associated with assembly time.*

This form of decoherence also introduces a time delay between the interactions of two or more domains, irrespective of whether individual subdomains are coherent. While the primary causal mechanism behind this process is attributed to the frequency differences between the various domains, the spatial separation between these domains also adds another time delay due to the finite propagation speed of [c] of any interaction. Again, due to the complexity of larger systems, it becomes increasingly impossible to reverse the overall state, such that the '*arrow of time*' becomes a physical reality. However, at this point, the Cordus model makes another clarification about the nature of the *'fabric density'*.

> *The fabric density is not made up of particles, but rather it is a transmission medium for photons that propagate through the fabric density. The Cordus conjecture thus affirms electromagnetic (EM) theory and its concept of a medium, while also providing a physical interpretation of the electric and magnetic constants of free space, which are otherwise ontologically challenging to EM theory. However, it is highlighted that while the fabric density supports a relativistic description, the speed of light [c] is not necessarily constant as it depends on the fabric density.*

See discussion *Relativistic Factors* for the issues raised against this description. Up until this point, it has been suggested that the main structural mechanism between particules is some form of atomic or molecular bonding, although it is clear that other forms of interaction have to be explained, e.g. electromagnetic and gravitational (EMG) forces. In the Cordus model, any particule [A] may experience an interaction, described as either a field or a force, from other [B] particules within some defined past *light cone* [ct]. As such, the space between particules is described in terms of the fabric density, which supports another level of time called *'fabric time'*, although it is qualified as a subtype of decoherent assembly time as follows:

> *Fabric time is the mutual interconnectedness of matter particules spread over three-dimensional space. This occurs via the fabric, comprising discrete field-forces for EMG interaction, such that timed events are subject to propagation delays that infer a time difference.*

At this level, time is assumed to tick more slowly due to the many delays between the interactions between particules as well as the frequency difference between coherent and decoherent domains. This is also a definition of the macroscopic level of physical time at which empirical observations might take place. However, at this point, the Cordus asserts that it can explain why time dilation occurs based on the following description.

The Cordus theory of time assumes that the external environment, i.e. the fabric density, can affect the frequency of a particule, which then provides a causal explanation of time-dilation. Basically, the proposed mechanism is based on the assumption that a greater fabric density causes the frequency of a particule to slow down, hence time will run slower. As a consequence, a higher fabric density makes it more difficult for a particule to emit its own discrete forces, such that emissions are retarded and energisation of reactive ends is delayed and frequency lengthen.

It is highlighted that the various *wave models* previously reviewed appear to struggle to provide a clear causal explanation of time dilation other than supporting the mathematical assumptions inherent in the *Lorentz transforms*. While the discussion of *Ivanov Waves* leading towards a description of *standing wave compression* may provide a causal mechanism for length contraction, the Ivanov transforms refute the notion of time dilation. However, both *LaFreniere* and *Ivanov* provide an alternative explanation as to why the *Michelson-Morley experiment* produced a null result, albeit based on different transforms. As an overly simplistic summary, the idea of length contraction also requires time dilation, if the speed of light [c] is to be maintained as a universal constant, in all frames of reference, as per the postulate of *special relativity*. However, this issue becomes more complicated in *general relativity* as the measure of length is expanded in a gravitational field due to the assumption of space-time curvature, even though time dilation is still assumed. Therefore, while it is unclear whether the Cordus model provides a coherent causal description of time dilation for both special and general relativity, the idea that the fabric density might play a role in time dilation is possibly worth pursuing, although for the moment we shall return to the final level of time.

Organic-Life Time:
Within the hierarchy of the particule model, an individual cell consists of the aggregation of discrete fields being emitted by individual coherent particules, e.g. electrons and atoms, which exist within a larger decoherent assembly of molecules and cellular organelles. Therefore, time taken to accomplish any interaction at this level takes longer.

Basically, the description above is again alluding to the fact that larger and evermore complex structures of particules, e.g. living cells, require more time to interact on a macroscopic scale. Whether this requires the rate of time to be a linear function of physical scale is unclear at this point, although this may be a requirement of length contraction that is compatible with the mathematics of the Lorentz transforms. However, extending this idea to '*cognitive time*', i.e. as perceived by humans, is possibly pushing this discussion of fundamental physics too far at this stage, such that this review will not pursue this level of speculation.

So, what might be summarised about the notion of time outlined in this paper?

In terms of section-7.2, it lists eight contributions to the physics of time, although it might be highlighted that all these contributions exist within a '*conjecture*' that has little mathematical formulation or empirical evidence to support the Cordus model. However, having highlighted this concern, we might attempt to summarise and comment on the scope of these contributions.

First, time is fundamentally the frequency cycle of the particule, such that it is not a dimension, nor continuous, such that there is no universal time. The Cordus model is predicated on a NLHV solution, where frequency is a physical effect that acts as a measure of time rather than being a mathematical abstraction quantified as an 'intrinsic' variable as in QM.

In terms of a comparison with earlier wave models, the concept of frequency and wavelength also have an obvious correlation with the concept of time and distance, although possibly subject to some qualification. In most of the wave models reviewed, everything is made of waves of some description, such that everything is immersed within a wave media and all frames of reference are relative and subject to perceptual distortions, both Doppler and relativistic. However, while we may choose to measure all frequency relative to some fundamental frequency [f_0], this is not necessarily a convenient approach, as it is difficult not to return to the concept that any frequency [f] is quantified as an oscillation count in some unit measure of time. While the Cordus model appears to make little reference to the idea of wavelength, it is a measure of spatial separation compounded by the relationship [$\lambda=c/f$], such that it is a function of frequency [f] and propagation velocity [c], where the latter may be a variable rather than a universal constant. As has been highlighted on several occasions through this review, the Cordus conjecture appears to rest on the assumption that the particule model is a description of the most fundamental causal mechanism in the universe, which while possibly highlighting a new line of thought does not seen to be anchored in empirical physical realism any more than quantum theory.

> *Second, time depends on the level of assembled matter anchored to fundamental time driven by the frequency of particule re-energisation. However, the nature of assembly time is subject to both coherent and decoherent assemblies of particules across many orders of scale, i.e. atomic, molecular and cellular, which ultimately underpin the structure of all macroscopic objects.*

It is known that the heart-rate of mammals is often reflected in lifespan, such that the length of this time might also be subjective. In this context, the human perception of time might also be subjective and correlated to our state of mind. However, the Cordus model is clearly making a more profound distinction about the nature of time, first driven by the frequency associated with each particule type and then in various scales of assembly. Of course, one of the important issues associated with time is its relative dilation in a given frame of reference subject to a relative velocity or gravitational field. However, whether the Cordus model really provides a substantive description of the causal mechanism at work has been questioned.

> *Third, Cordus provides an explanation of where and how irreversibility, entropy, and the arrow-of-time arise, which occur at the boundary between coherent and decoherent domains. In this respect, coherent domains are also a potential explanation of why time-symmetry is assumed possible at the quantum level.*

The assumption of the irreversibility of time within a coherent domain has been questioned as it was unclear what causal mechanisms were being forwarded to explain the reversal of a final state backwards towards some previous initial state. While this process might be perform by the *mathematical operators* describing quantum transitions, causal mechanisms are often far from obvious.

> *Fourth, an explanation is proposed by which time, as measured by atomic clocks, is scaled to the world at large. In this context, it is assumed that time, as perceived by human cognitive processes, is consistent with time measured by atomic clocks and other instruments. However, the frequency of the particule is still the root cause of time, although its rate might be modified by the scale of particule assembly and the scope of the coherent and decoherent domains.*

To be honest, it is not clear how this '*contribution*' adds much insight over what has also been stated in terms of assembly time and coherent and decoherent domains. The contribution that is possibly more important is a description of the actual causal mechanisms rather than a restatement of the assumptions surrounding the frequency of a conceptual particule.

> *Fifth, a seamless connection is provided between the various physical levels of time and the human perception of time. This solves another ontological problem concerning how our human perception of time connects to the physics of time. In the Cordus model, time starts out as a reversal property of the frequency of a particules, while at a macroscopic level, time becomes irreversible and compatible with the human perception of time and the concept of entropy.*

Again, this contribution is possibly based more on assumptions of the Cordus model. While the frequency associated with individual particules in coherent domains may be faster than the aggregate frequency associated with assembly time and decoherent domains, it is unclear that it actually quantifies time itself. Clearly, any process involving larger assemblies of particules will also involve many interactions across the space that separates them, i.e. signal delays defined by propagation time [ct]. In this context, the net rate within some larger assembly will involved many factors that are not directly related to the original particule frequency.

> *Sixth, contributes some answers to philosophical questions about how the perception of the NOW arises, whether time is a dimension, whether it is infinitely divisible, whether the many-worlds theory is necessary, and whether it is possible to conceive of an atemporal situation.*

It might be debated that this statement is primarily based on speculative conjecture and, as such, it is not really forwarding any solid answers to the questions cited irrespective of whether they are philosophical or scientific in scope. The issue of the '*infinitely divisible'* nature of time is often answer by quantum mechanics in terms of *Planck time*, although this is predicated on the speed of light [c] as a universal constant and *Planck length* that is primarily derived from the universal constants [c,h,G] - see *Planck Scale* for more details. The *Many-Worlds* idea is not really a theory, but one of a number of *quantum interpretations* that seek to provide some rationale for what happens between the *initial and final state* of a quantum system. The issue of whether science can explain anything without reference to time, i.e. atemporal, is questionable.

> *Seventh, the Cordus model seeks a reconciliation of multiple different forms of time into one single coherent framework. This integrates the apparently conflicting nature of the different times suggested by quantum mechanics, electromagnetic theory, and relativity. This model argues that time is all of particle-based vs. spacetime, relative vs. absolute, local vs. universal, but not simultaneously as it depends on the level of assembly being considered.*

There are indeed many different descriptions of time, see '*The Idea of Time*' for details based on classical mechanics, classical thermodynamics, special relativity, quantum mechanics and later quantum field theory. However, whether time can be anchored to some fundamental frequency of a particule type has been questioned plus it is unclear how time might actually be aggregated within the concept of assembly time, i.e. is it a linear function of scale. Therefore, without further details of the causal mechanisms underpinning the various levels of time assumed by the Cordus model, it is possibly premature to suggest that it offers a '*tangible reconciliation*' of the various ideas about time.

> *Eighth, there is a possibility that the Cordus model might provide a single framework with an ontologically meaningful explanation for a wide variety of problematic phenomena, e.g. wave-particle duality, entanglement, charge-parity (CP) violation, force unification, asymmetrical baryogenesis and time.*

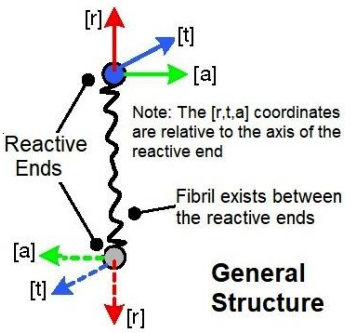
However, despite the possibilities highlighted above, it is accepted that the Cordus model is based on conjecture subject to no empirical verification. However, while the many issues highlighted against mainstream science are real problems, it is unclear that the explanation forwarded by the Cordus model can be described as being based on physical realism, if they are not

underpinned by causal mechanisms. So, while the Cordus conjecture asserts that it delivers a new theory for time, which may unify the different perspectives of QM, SR and GR within a deeper understanding of reality, this review has questioned this claim. However, this section of the review will give the last word to the authors of the Cordus model, which readers may judge for themselves.

> *The Cordus time theory addresses the ontology of time at the fundamental level and explains where and how the arrow-of-time arises and describes how time might operate at the cosmological level. The successes with the Cordus conjecture show that non-local hidden-variable solutions have merit, despite their rejection by orthodox physics. Specifically, the wider Cordus theory shows that it is possible to envisage and design a NLHV solution that circumvents the Bell-type inequalities and has high explanatory power across many physical phenomena. In particular, we have shown that questions about time can be answered at the next deeper level of physics and we have given an example of what that physics might look like and its implications for time.*

1.1.7 Closing Comments

In the *Summary of Assumptions*, associated with the review of the *LaFreniere Wave Model*, reference was first made to the Cordus Conjecture. One of the reasons for referencing the Cordus model was because problems were perceived with the explanation being provided by the wave model regarding the causal mechanism of time dilation. In this context, time dilation was quantified in terms of the mathematical assumptions of the *Lorentz transforms*, but which then left open questions as discussed in respect to the issues raised in *Ivanov Waves*. Therefore, the idea that the Cordus Conjecture might provide an alternative perspective to some of the problematic issues was an attractive idea, which was characterised in the following statement.



> *"Cordus is an audacious idea, and it produces a radical re-conceptualisation of fundamental physics. It is an unorthodox idea, one that cuts across conventional physics and challenges the premises on which those theories have been built. It is likely to be controversial. However, it is not deliberately confrontational: it is simply a process of taking a creative idea and running it through to its logical conclusions."*

However, as pointed out from the start of this review, the Cordus model quickly appears to adopt a more assertive position regarding the scope and authority of its many assumptions, e.g.

> *"It is in those conclusions that, if Cordus is correct, there are causalities for existing principles of conventional physics. For example, Cordus invalidates the 'particle' premise of quantum mechanics, refutes superposition, redefines the principle of locality, denies the existence of 'virtual particles', refutes the concept of interference of light, asserts that Bell's theorem is wrong, re-introduces a modified concept of the aether, and reconceptualises the fundamental forces. Cordus explains why quantum mechanics, which seems to apply at the level of individual particles, does not scale up to macroscopic bodies: something that QM itself has been unable to explain. Furthermore, Cordus proposes a set of new principles for the next deeper level of physics."*

While it is accepted that this review of the Cordus Conjecture is only an outline of its actual details, it has made some attempt to consider the following aspects, i.e. *Basic Concepts*, *Photon Particule*, *Matter Particule*, *Locality and Superluminal*, *Relativistic Factors*, *Doppler Effects* and *Emergent Time*. However, even the initial review of the various particule models began to question how its speculative structure could be said to described a *'physical realism'* when many of its assumptions did not appear to be supported by any obvious causal mechanisms.

> *Note: One issue raised earlier in the review was the lack of any physical description of the reactive ends, i.e. do they have a physical structure that explains their frequency? Where does the energy come from and how does it propagate through the fabric density? Other issues were raised against the physical nature of the fibril that connects the reactive end and the assumption that it supports some form of superluminal signalling. Likewise, there was ambiguity in the physical description of the fabric density being a construct of frequency-force emissions from the reactive ends of a particule, which then are assumed to explain all the fundamental* force or field interactions*, i.e. electromagnetic, gravitational and strong nuclear. One specific concern related to the idea that the duality of the reactive ends in the particule model could help explain the observations surrounding the* double-slit experiment*, which has more recently been extended to three slits that might present a challenge to the Cordus model.*

While this commentary possibly does not have much more to say about the Cordus Conjecture, it might add a few words about the methodology of science in terms of the three main developments of the 20th century, i.e. *relativity*, *quantum mechanics* and *cosmology*. These theories form the foundations of modern science, although even after 100 years of research and development, many still question the scope of the empirical evidence that supports the many assumptions that underpin this collective '*worldview*'.

So, what are the perceived problems?

From a general perspective, modern science has forwarded a description of the fundamental workings of the universe, both large and small, which most people usually accept based on the perception that the supporting weight of evidence is overwhelming. However, anybody who takes the trouble to investigate some of the details and assumptions associated with any of these major theories begins to realise that there are still many open issues – see *Scope of Outstanding Problems* for a summary. For, in many ways, the 20th century introduced a schism into the methodology of science, which might be described in terms of an ontological or epistemological preference. In this context, we shall define '*ontology*' as the study of what exists and the nature of what exists, while '*epistemology*' is possibly more orientated to the study of knowledge that is more abstract in scope. As such, we often need to consider two perceptions of reality, first, a physical reality that requires cause and effect and, second, what might be described as a quantum reality that is verified on the basis of a probabilistic outcome. However, while website-3 clearly has a preference for an ontological approach, the apparent evidence in support of mainstream science does indeed appear overwhelming, such that any questioning of its conclusions may appear to be a waste of time.

> *Note: The Mysearch website has attempted to pursue its own 'Duty of Inquiry' into many aspects of the standard model, which can be reviewed via the following links - see Relativity: Closing Remarks, Quantum Theory: Part-1 and Part-2, and Cosmology: Part-1, Part-2 and Part-3. While this review may indeed be a 'waste of time' and does not pretend to have the weight of authority to seriously challenge mainstream science, the fact still remains that the current major theories often contradict each other and, in so doing, fail to provide a single coherent model.*

So, in the pursuit of causal mechanisms, the Cordus Conjecture shares a common goal with many who question the details of the standard model. However, there are subtle distinctions in the semantics implied by a conjecture, hypothesis and theory that are possibly worth highlighting. While not necessarily definitive in scope, a conjecture might be described as a proposition that lacks the credibility of verification by any known means, which if possible, might elevate it to a hypothesis, while also lacking the creditability of mathematical formalism that might be associated with a theory. This said, the problem that this review has highlighted is not that a conjecture is any less speculative than a hypothesis or theory, but rather in that it does not appear to provide any deeper insights into the causal mechanisms that might then help better explain the nature of physical realism. This said, the Cordus Conjecture does open up the debate as to whether the fundamental universe still requires causal mechanisms, which if absent, suggests that science still has much to learn.

1.1.8 Cordus References

The Cordus Conjecture appears to support its *own website*, see link for details. However, this website does not appear to support an obvious repository of published papers by which people might work their way into the detail of the many ideas being presented. For This reason, the following *'repository'* of papers has been collated within the Mysearch website for consistency of access, although it needs to be highlighted that the list below may have been extended and updated over time. The following paper may be the most obvious starting point for many.

- *Cordus Conjecture: Overview*

However, as far as it is known, the following list of papers appears to represent the main body of work that has been published via the *Vixra Archive*, which is an alternative electronic e-print archive to the arXiv service operated by Cornell University.

- *Cordus Conjecture: Part 1.1 Quis es tu photon?*
- *Cordus Conjecture: Part 1.2 Quo vadis, photon?*
- *Cordus Conjecture: Part 1.3 Explanation of fringes*

- *Cordus optics: Part 2.1 Frequency*
- *Cordus optics: Part 2.2 Surface interactions*
- *Cordus optics: Part 2.3 Refraction*

- *Cordus matter: Part 3.1 Wider Locality*
- *Cordus matter: Part 3.2 Matter Particuloids*
- *Cordus matter: Part 3.3 Energy cycles within Matter*
- *Cordus matter: Part 3.4 Special states of Matter*
- *Cordus matter: Part 3.5 Schrodinger's Cat*

- *Cordus in extremis: Part 4.1 Electromagnetism*
- *Cordus in extremis: Part 4.2 Fabric of the Universe*
- *Cordus in extremis: Part 4.3 Gravitation, Mass and Time*
- *Cordus in extremis: Part 4.4 Quarks*

- *Effect of Matter Distribution on Relativistic Time Dilation*
- *Time: An Emergent Property of Matter*

Referencing the Cordus website, as defined above, the timeline of posting seems to run from 2011 through to 2017. It is not known whether the lack of any additional postings in the last 2 years suggests that development has stopped.