Time: Frequency, irreversibility, and connectedness of matter

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Abstract

A novel conceptual model is described for time, one that is independent of existing theories. The cordus conjecture suggests that time consists of frequency oscillations of matter. The arrow is applied to time where irreversibility arises. The interconnectedness of matter, via its fields, creates a patchwork of temporal cause-and-effect. At its most basic level time originates with the frequency cycles of the particules of matter and photons. The rate of time is thus determined by the mass of the particule, in turn how it is assembled, from what subcomponents, and the external environment (hence also time-dilation). Thus time is locally generated, and cordus rejects the idea of an absolute clock. The forward arrow is only applied to the ticks of time when irreversibility arises. The paper explains how the irreversibility arises, in terms of the interaction between two volumes of matter and the statistically impossibility of returning all particules in the system to their original positions and states. Thus decoherence, irreversibility, entropy, cause-and-effect, and the arrow of time all arise at the same discontinuity in physics. There is a connectedness between volumes of matter that are at different geometric locations. A phenomena that occurs in one volume is communicated via photons, or massy particules, or fields, to other matter around it. This communication applies cause positional constraints on the recipient. The combination of connectedness, frequency, and irreversibility, results in temporal cause-and-effect. Thus human perceptions of time are a construct, with all the potential for illusion that implies, founded on a real physical principle of temporal causality. Time is a series of delayed irreversible interactions (temporal ratchets) between matter, not a dimension that can be traversed in both directions. Cordus provides a more basic concept of time from which quantum mechanics and general relativity emerge as different approximations. The resulting conceptual model provides a novel integration of quantum mechanics, general relativity, and the human-perception models of time.

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1 Introduction

Though intuitively familiar, time is a mystery. Time is a variable throughout physics: classical mechanics, quantum mechanics (QM), and general relativity (GR) all include it. Yet the constructs in each are very

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different. Nor are those constructs always coherent with humans' personal cognitive perception of time. For example, the idea that time runs differently depending on location, or that time may have had a beginning, is deeply puzzling to the mental model of most people. It is natural that various philosophical questions also arise.

All these approaches, physics, psychology, philosophy, have developed models for time. Yet they are poorly integrated, indeed sometimes in conflict (e.g. QM and GR). Time is still a mystery, and there is no basic model that is acceptable to all the disciplines.

The existing theories of time are well-developed, having enjoyed much attention. Yet no universal-theory of time has emerged from any of the extant approaches, despite the effort. It suggests the possibility that existing theories may be conceptually inadequate. Thus there are two lines of enquiry: to continue to refine existing theories of time, or seek a conceptual breakthrough. The latter approach involves striking out in a totally new direction: coming up with a new foundational concept.

This is the approach we take here. The purpose of this paper is to explore the concept of time through the lens of the cordus conjecture. The foundational idea is a reconceptualisation of the structure of the 'particle'. This is a radical concept without precursors, and therefore detached from the orthodox literature.

The cordus conjecture is a novel alternative theory of fundamental physics, constructed on a different concept for 'particles'. It is currently primarily a qualitative conceptual method [1]. Cordus was originally conceived as a conceptual solution for the problem of wave-particle duality [2]. It turns out to be useful, as a reconceptualising tool, for other problematic areas of fundamental physics. It should be considered a conceptual solution or extended thought-experiment rather than a validated theory, hence 'conjecture'. It is intended to be thought-provoking, and this means it is sometimes unorthodox. In this specific area it provides, as will be shown, a novel concept for time, and offers solutions to the problem of what time is and how its arrow arises.

2 Background

It turns out with cordus that the key to understanding time is to reconceptualise matter, especially 'particle'. Doing so accesses new concepts for entropy [3], coherence [4], special condensed and super-states of matter [5], and offers an explanation of why quantum mechanics does not scale up to macroscopic scales [6]. All of those concepts have some connection to the explanation for time, developed below.

What is the cordus conjecture?

The conjecture states that all 'particles', e.g. photons of light, electrons, and the protons in the nucleus of the atom, are not zero-dimensional

points, but have a specific internal structure called a 'cordus'. The term ‘particule’ is used to differentiate this important conceptual difference from the QM construct. The cordus consists of two ‘reactive ends’, which are a small finite distance apart (‘span’), and each behave like a particle in their interaction with the external environment. A ‘fibril’ joins the reactive ends, and is a persistent and dynamic structure, but does not interact with matter [7]. The reactive ends are energised (typically in turn) at a frequency [8]. The reactive ends emit one or more force lines called ‘hyperfine fibrils’ (hyff) into space, and when the reactive end is energised it sends a transient force pulse (‘hyffon’) outwards along the hyff curve [9]. This makes up the field, which is thus also discretised in 3D space. Various features of the hyff and hyffon carry the electrostatic field, magnetism, and gravitation simultaneously. Thus a unification of these forces is provided [10].

In this model the photon has a single radial hyff which it periodically extends and withdraws [7]. By comparison all massy particules have permanent hyff (including neutral particules like the neutron)[9], see Figure 1. Electric charge is carried at 1/3 charge per hyff, so stable particules like the electron are surmised to have three hyff, arranged orthogonally [11]. The hyff from multiple massy particules compete for the three hyff emission directions (HEDs), and may synchronise their emissions to access those spaces. Thus there is an element of mutual negotiation, based on shared 3D geometric timing constraints, and this explains the strong force [11].

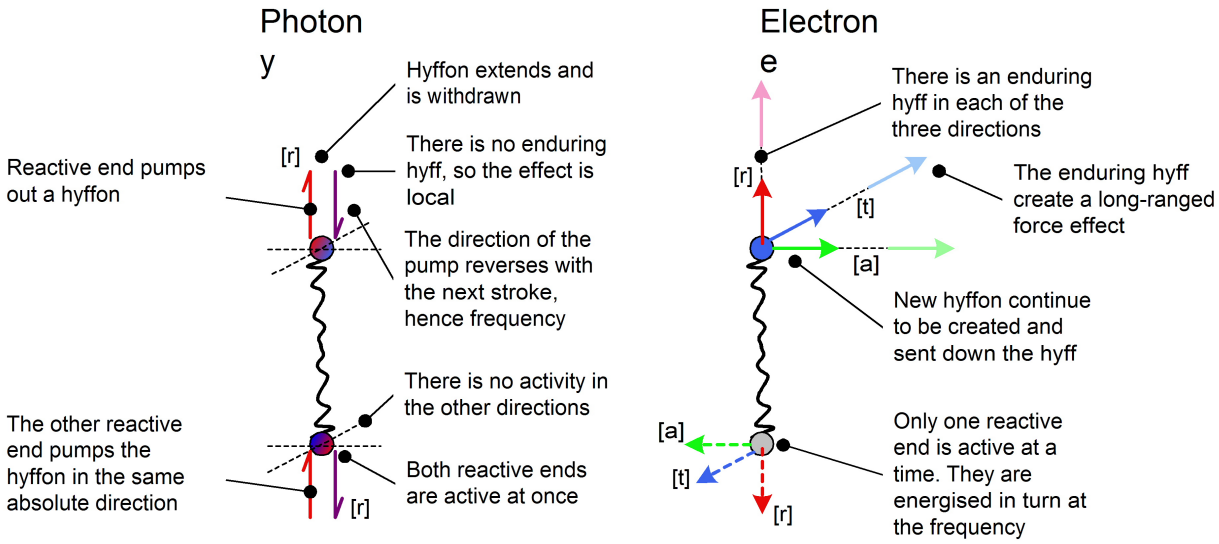

Figure 1: Models for the photon and electron, showing the different characteristics of their discrete field structures. The photon has a fibrillating pump that only shuttles energy outwards and then immediately afterwards brings it back inwards, whereas the electron consistently pushes hyffon (force fragments) outwards in a pulsating manner. Both cordi therefore have a frequency, but the difference is what they do with it. All other matter and antimatter behaves like the electron, though the hand

of the hyff is inverted for antimatter, and the direction of pumping is reversed for positive charge.

In terms of its conceptual design, cordus has high fitness[2] because it is able to explain many effects within one logically consistent framework [1]. However, cordus is a conjecture and the validity thereof is uncertain. Therefore derivatives of the idea, as here, should be considered speculative.

What is coherence?

Cordus permits a more specific definition of coherence and superposition than is possible from within the 0D point construct of QM [2]. From the cordus perspective, superposition is simply that the cordus particule is actually physically oscillating between two positions: the locations of the reactive ends at the end of their span. The cordus particle (e.g. photon cordus) collapses to one of these ends when it is grounded [5]. Likewise coherence, from the cordus perspective, is when all the particules, which may be photons, electrons, protons, and possibly atoms & molecules, etc., have synchronised frequencies and phases thereof. This also involves the sharing of hyff emission directions (HEDs).

Thus coherence is a special state of assembly where the particules provide for mutual preservation of the twin locations of each others' reactive end: when any one particule is energised at its one reactive end, the position of its other dormant reactive end is filled by the active end of another particule. Coherence is, according to cordus, best understood as an ordered complementary frequency state synchronisation (CoFS) between two or more particules [5].

For materials with a coherent structure, the effect of an externally imposed change is communicated to neighbouring internal components at the next frequency cycle. For assemblies with high purity, this may be fast indeed, hence second sound in superfluids, and rapid electron transmission across biological molecules.[3] Hence also the successes in putting molecules into geometric superposition. Thus communication within atoms and molecules is rapid, being able to take advantage of the internal frequency network.

[2] Fitness in conceptual-design sense of providing explanations that are consistent with numerous empirically observed phenomena.

[3] For a descriptive overview of quantum biology, and applications to odour reception, electron transfer in ATP, & photosynthesis, see Brooks, M., The weirdness inside us. New Scientist, 2011. 2832(1 October 2011): p. 34-37.

Cordus anticipates three mechanisms for discoherence [4]. First, a coherent material cannot accept internal shear velocity. Second, higher temperatures lead to decoherence because phonons (internal thermal vibrations) disturb the stability. Third, more complex assemblies of matter are harder to put into coherence, and the complicating factors are the number of components in the assembly, and the variety of species (simplicity and purity).

What is entropy?

Cordus explains entropy as a spatial and temporal dilution of energy [3]. Thus an atom that has surplus energy can dispense it in five main forms: electron orbital change (including bonding), electron ejection, photon ejection, electron flow (plasmons), and phonon propagation. If phonons, then another atom some distance away receive some of the energy and will likewise use what it can and dispense with the rest. That remote atom might emit a photon for example. Even if that photon was sent straight back to the original atom (which is not generally the case), there would still be less energy in the feedback loop because of the phonon dilution in the bulk, and the time required for the photon flight. Thus the individual mechanisms are all reversible (elastic), but the system as a whole is not, and we suggest this is what creates entropy.

Both photons and phonons tend to be dispersed out into the surrounding space or material (respectively), and this dilution of the original energy is the primary mechanism for thermodynamic irreversibility and entropy. The geometric and micro-structural complexity of the matter accessible to the photons and phonons introduces so many dilution paths that it is extremely unlikely that the energy fragments will spontaneously recombine. Geometric separation is another contributory factor: when the matter separates or radiates photons across space, then the dilution is further increased and the number of paths reduced by which the energy can come back together. The enormous radiative loss of photons from stars contributes to entropy, because that energy cannot realistically all be recovered after it has travelled billions of years and stopped in our eye, and even if it were reflected back it would be more billions of years to travel back. In the meantime space expands, which adds to the delay. Thus the expansion of space in the universe further contributes to entropy.

Geometric separation of matter causes the photon travelling between them to arrive late, the more so if it involves transmission through denser material. Thus the energy is not delivered at the time it might have been, but is instead postponed into the future. If that postponement is indefinite, it takes energy out of the system. This is another barrier to recombining the original energy, and thus another contribution to entropy.

Not only is the energy delayed, but so too is any information carried by the photon. Furthermore, the cordus model for transmission of discrete field force-elements (hyffons) [9, 10, 12] suggests that these too travel at the speed of light. Thus information about the strength and direction of the fields of the remote particule only arrives at the basal particule after some

time. The basal particule cannot respond to external fields until it receives them. This contributes a delay to the exchange of information between decoherent objects.

3 Time at the assembly level

Cordus offers a construct of time that depends on the number of particules and the nature of their relationship, i.e. the 'level of assembly' of matter [4]. This is an unusual approach, since time is conventionally associated with a dimension of the cosmos. Nonetheless it has the potential to better-explain certain features of time, as will become apparent.

3.1 Time at the particule level: frequency (level 1)

Time, at the level of the individual particule (e.g. electron), refers to the frequency of the re-energisation cycles of its two reactive ends. This is because the particule is only available to interact with other particules when it is energised. Particules with greater masses have higher frequencies, and therefore tick faster. Cordus provides a specific internal structure for particules, hence a physical explanation for frequency [8].

When a reactive end is energised it issues a discrete field force (hyffon). These are propagated outwards at local fabric speed c, the speed of light. The hyffon carries the electro-magnetic-gravitational field, which therefore is also discrete. These fields inform neighbouring particules, even remote ones, about the state of the basal particule. In turn, the basal particule responds to hyffons from the external environment when its reactive ends energise. Thus the periodic re-energisation of the reactive ends is a mechanism whereby the particule communicates with other particules and responds to their forces. 'Force' is not quite the right word to use, since the cordus concept suggests that the mechanism is prescribed positional relocation of reactive ends, i.e. displacement. Thus the external hyffons force the reactive end to energise in a slightly different position to that which it might have preferred. The mechanism is held to negotiation between the particules for momentary rights to the three-dimensional hyff emission directions (HEDs). Separately we have shown that HEDs explains the strong force [11], annihilation [13], and coherence [4].

3.2 Time at the level of molecular assembly (level 2)

The above applied to a single particule, e.g. a lone electron or proton. Such a particule can keep its own time. However it is more common for matter to be assembled together, i.e. bonded. That assembly may be coherent, discoherent, or a mix of the two. We take the simpler case of coherent matter first.

Time at the level of coherent matter (level 2.1)

Each coherent domain of matter has its own time: the common frequency cycle of its re-energisation. The whole of the coherent body has the same frequency, this being necessary for coherence according to the cordus definition thereof. The phase of the particules must also be complementary. Thus there is a 'global' time, but only within the assembly of matter that makes up the coherent body.

Time at the level of discoherent matter (level 2.2)

Macroscopic objects at our level are discoherent as a whole, since they lack the homogeneity of composition and are too warm to be coherent [4].

There is an assembly tree to any macroscopic object, where the sub-components may be a mixture of individually coherent and discoherent domains. Indeed at suitably small scales all matter becomes *individually* coherent, and cordus predicts this boundary is at or below the molecular level [4]. Thus electrons, protons, and atoms are always *internally* coherent, that being a necessity for their stability.[4] However as the assembly grows in size and diversity of composition, so a synchronous HED arrangement becomes impossible to negotiate by the protagonist particules, and thus discoherence arises. Thus at some intermediate level of assembly an object consists of coherent and discoherent domains. For example, even if individual molecules are indeed coherent (this is presumed but uncertain) then an aggregation of different molecules will be discoherent as a whole.

Single particules are automatically coherent. These, and any coherent domains (assemblies of multiple particules) manifest their properties at their own internal frequency. These properties are their fields (of which there are three (electrical, magnetism, and gravitation[9, 10]), the orientation thereof, and the position of the reactive ends (of which there are two). The fields themselves are discrete pulses (hyffons), and the frequency of production is very high.

However other neighbouring domains of matter of different composition, even if independently coherent, do not perceive the individual hyffons of the first domain in their discrete form.[5] Instead they perceive each other (experience each other's forces) as a continuous rain of field forces. Hence classical mechanics and discoherence arise at the same point in the assembly tree of matter. The perception of time arises at the same point. As does entropy.

[4] Bonding stability, strong-force, and coherence are simply different manifestations of the deeper synchronous HED mechanism, according to the cordus perspective.

[5] The two domains would need to have the same frequency (hence mass characteristics) for the individual hyffons to be apparent, in which case they could move into a bonded state of assembly, i.e. become one coherent body. Thus there is no problem with independent coherent domains merging to form larger domains, but it requires homogeneity of composition (to satisfy the mass and frequency requirements).

The arrow is applied to time where irreversibility arises

Decoherence causes a time delay to be inserted into the functional interaction of two or more domains – whether or not those domains are individually coherent. This because the frequencies differ, so the faster oscillating domain will have to mark more ticks before the slower responds. If there is geometric separation then the finite speed of field propagation (c, speed of light) further adds a time delay. Consequently the one domain generally has done something different before the second has fully responded. Therefore getting domains back into their initial positions becomes unlikely and statistically impossible as the number of participating domains increases. Note that even in the simplest situation of two interacting domains, there is still the perturbation of the fabric that they both feel, i.e. the rest of the particules in all the accessible universe affect the two domains. So what happens stays happened, and does not naturally self-repair.

3.3 Time at the level of organic life: chemistry (level 3)

Within our own physical bodies, which are decoherent at any level which our unaided senses can perceive, the different coherent domains run at their own times. These volumes of matter are smaller than a cell, and smaller even than organelles. We anticipate that the only coherent domains with physical bodies are at the molecular level and smaller.

Time, at the level of an individual cell, consists of the fuzzy aggregation of the frequencies of the many individual coherent particules (electrons, atoms, molecules) and decoherent sub-components (clumps of molecules, organelles). 'Fuzzy' because the discrete field hyffons are not individually distinct. Chemical transport within the cell occurs as and when the sub-components are able to interact. Thus the cell takes much longer to achieve anything (more frequency ticks) than a simple sum of the times required by the coherent subcomponents. The actions of the cell are not superluminal, as is possible within a coherent domain, i.e. entanglement is only possible within coherent systems.

The process of human thought takes time. The photosensitive chemicals in the retina need frequency cycles to react to incoming photons, frequency cycles of the electrons to transit down the nerve fibre into the cortex, more frequency cycles of the neurotransmitter molecules to interact with cells, and thus time for the brain to assign a meaning to what is seen. Thus at the level of organic life, time is based in chemistry.

3.4 Time at the cognitive level: phenomenal (level 4)

Our human perception of time is the next level up, and is a construct of the cognition. The brain does not have a global atomic/molecular clock,

but instead has a subjective counter of events and infers 'time' from that.[6] Our cognitive quantification of time is very rough, and varies with the situation. Nonetheless we perceive time as flowing. This is because it does indeed take chemical time for us to accomplish anything, even thought, and especially motion. But the perception of time for us is a cognitive construct that we overlay on chemical time, and that in turn on the frequency of matter.

We might perceive our thoughts to be effortless and instantaneous, and the resulting movement of our body to be immediate. We can perceive, and respond within, tenths of a second. But the deeper clocks of the particules of matter beat so fast as to be beyond our sensation.

We also perceive that time flows in one direction: forward. There is an obvious arrow of time, whereby cause precedes effect. This too arises from the non-linearity of the transition from particle time to chemical time.

We also perceive that time is universal: that what happens to me is also how you see things happening. So when we meet and I extend my hand and voice a greeting, I believe that you too hear those words, and the touch of the hands is real. Clearly this is the case, because when meeting we do indeed see the smile and confirmatory signs that we expect.

3.5 The connectedness of time

There is a connectedness of phenomena that are at different geometric locations. It *seems* that spacetime is continuous, because it *seems* that it is possible to coordinate the two phenomena in time. But that does not mean there is a master clock. The two phenomena are linked, because they share the same fabric.

Any communication between the two objects is a result of photons, or massy particules, or fields, and these cause positional constraints on the other, i.e. the geometric location of the reactive end is affected by the communication. Thus all force is ultimately prescribed displacement of position of the target particule.

A phenomena that occurs in one volume of matter, be that combustion, noise, motion, etc, thereby communicates that to other matter around it. Consider one volume to be my body: my speaking communicates forces to the volume of air immediately around me, which in turn propagates the dynamic displacement throughout its volume, so that the membrane in your ear is displaced, and you hear the sound.

[6] Exactly what 'events' the brain counts to infer passage of time is a wider mystery, and cordus does not specifically address this cognitive question. Nor does it explain what the biological mechanism might be for accumulating the sense of elapsed time. If 'events' include external stimuli and internal markers (perhaps physiological depletion) then there is no particular difficulty explaining why perception of time is so flexible. However, a cognitive model is beyond the present scope.

In general the phenomenon is that one volume of matter causes an effect in the second. The interactions at the most basic level all require frequency cycles, so this causes temporal causality. This is a physical reality, and is also the basis for cognitive perceptions of time.

It is not a master clock that accomplishes this, nor does it require continuity of spacetime. The piece-wise communication between volumes of matter (whether coherent or not) achieves the effect of time.

4 Discussion

4.1 Outcomes

What we have achieved here is a description of how time arises, within the cordus framework. As we noted at the outset, that conceptual model is conjectural and the results here are likewise speculative.

According to the cordus model, entropy, classical mechanics, and our perception of time all arise at the boundary between coherence and discoherence.

Thus time starts out as a frequency property of particules, and by extension of the strong force (explained via synchronous HEDs) to coherent domains too. At this level, time is the re-energisation sequence – the oscillating firing of the reactive ends. Thus it is appropriate to measure time in terms of the frequency-dependent activities of individual atoms (e.g. atomic clocks). The frequencies of the various types of particules do differ, based on their mass, but the relative difference is constant. So the ticks of one particule may be used to count those of a different type.

Time-dilation

The existence of time as a frequency effect also explains why time-dilation occurs. Acceleration, or the presence of higher gravitational fields (hyffons) slows time.

Cordus explains this as the particule's hyffons having to interact with the fabric of the vacuum, which in these cases has increased pressure density. The interaction changes the re-energisation behaviour and slows the frequency of the particule. This fabric comprises all the hyffons of all the other particules in the accessible universe, and the overall effect is somewhat like a relativistic aether [12]. For the particule, local time is the ticks of its frequency, so time really does change when the frequency does. Therefore all the process of interaction that depend on frequency, e.g. chemical reaction with a second particule, or transport of a messenger electron/atom/molecule, or emission of a photon, or nuclear decay, will be happen faster/slower relative to an external observing particule.

So there is absolute time at the particule level (or coherent domain) but it only applies locally. There is no universal time. The cosmos is filled not with one time, but a patchwork of many times.

Cause-and-effect

Thus there is both a cause-and-effect in the interaction of two or more volumes of matter, *and* a small time delay at each interaction. It is the sum of these delays that we perceive as time. Not only perceived in a cognitive sense, but also measured in an objective sense by atomic clocks and other instruments.

4.2 Arrow of time

That there is an arrow of time is a consequence of the irreversibility of most interactions between volumes of matter. It maybe helpful to think of these volumes as molecules, though the precise boundary between coherent and discoherent bodies is not known with complete confidence. Entropy, decoherence, and time emerge together at the boundary.

However we anticipate that there are several levels of arrow. One is at the subatomic level, where the arrow can perhaps be reversed. This might be possible in simple systems of only a few coherent subatomic entities, in prescribed states, and a stable external environment. If the particules can only be in a few states, then their behaviour is effectively reversible. There is still interaction at frequency cycles, i.e. time, but it no longer has an arrow pointing away from past states. So time, and the arrow-of-time are not synonymous at all levels. The self-stability of the proton may be an example. However it is impossible to fully control the external environment of the fabric and its perturbations. The decay of the free neutron is held to be an example of a stable case slipping into decoherence [14].

While reversibility seems feasible at simple levels, we never see this for macroscopic bodies. This is because such bodies are discoherent. Therefore they interact inelastically with their environment: they do not return to precisely their initial states. Inability for one body to return thereby means that all the other bodies in the accessible universe cannot either, because the fabric of background field hyffons has been changed. The cordus concept of the fabric is therefore important in explaining how irreversibility arises.

At this second level the irreversibility of cause-and-effect creates a physical arrow of time. This is not merely a cognitive perception, but a real physical flow.

In some ways there is a third level at which the one-wayness of time becomes apparent, and this is the cognitive meaning that the brain constructs for it. Proprioception, and the underlying neural systems that support it, creates a personal arrow of time. We think, then our limbs

move, then our peripheral nerves confirm the new position, likewise the eyes confirm and calibrate the proprioception. To the cognitive system, the arrow of time is the immediate and predictable sequence of cause-and-effect in the neuro-muscular-skeletal system and the immediate surrounding environment.

Cognitively we struggle to interpret events when the sensory signals conflict, like sea-sickness, echoes in a large room, or time-delay in a long-distance call. The fact that the cognition struggles in such cases is circumstantial evidence of a cognitive model for the arrow of time.

Worse, if one person was existing at a faster (or slower) pace of time, as in time-dilation, then the cognitive model fails and we perceive the situation as bizarre. That our feet age slightly differently to our head is only strange because we expect, cognitively, that time be continuous and universal.

4.3 Implications: Addressing common questions about time

What about time travel? Can bodies travel faster than the speed of light and could this result in time flowing backward? Could spacetime be folded back on itself in a loop?
Probably no to the first. The speed of light is the local speed at which hyffons (discrete force field elements) are propagated. It is not certain that a body would be able to withstand the self-inflicted onslaught of the fabric pressure were it to travel faster than c, but even if this were possible its interactions with other matter would still require frequency cycles, hence time, for both participants. Even when the interactions are reversible (which is expected to only apply to the simplest levels and even then conditionally, see above), all this means is that there is no arrow of time. In every macroscopic situation there is irreversibility, hence a forward arrow of time.

Regarding the second, the folding of spacetime is not possible, according to the cordus perspective. This is because there is no spacetime: Time, in the cordus model is *not* a dimension at all, but a patchwork of temporal ratchets at the most fundamental level of matter. Time is a series of delayed interactions between matter, not a linear scale that can be traversed in both directions. It is not sensible, in this model, to talk of folding time back on itself. We acknowledge that superfluids do show quantum vortices, which cordus explains as a coherent material folded back on itself [5], but in that case it is possible to have a void in the middle of the vortex, whereas the patchwork of time is perfused with the fabric which cannot be voided. It is not possible to connect two regions where time flows differently, because the fabric flows through both. The fabric cannot be bent, nor can time. This means that cordus also refutes the QM idea that tiny wormholes make shortcuts through spacetime. Entanglement and the superluminal transport of information is not time travel, and is readily explainable with cordus [15]. Nor is there any need in the cordus model for chronology protection (the old paradox of a time-traveller killing his grandfather), because time only flows in one direction.

Is time a real fundamental property of the universe?
Yes, it is a physical effect at the particule level, the mechanism being the frequency of the particule. Yes it is fundamental in that the existence of matter, specifically the energisation of the reactive ends, is linked to time. No, there is no master clock or universal parameter. No, in that time does not exist on its own. It is not a dimension linked to space but rather to matter.

Is time the framework in which events take place?
No, not at least in the sense of a continuous spacetime. Yes, in that individual particules negotiate their timing (frequency, energisation) with other neighbouring particules and the fabric at large. The assembly of matter, specifically its fields, and the patchwork of negotiated interaction is the framework of time. All events occur in that framework, because all events involve interactions between particules.

Can time pass at different rates for observers in different situations?
Yes, time is locally determined. But the different locations are linked together by negotiated HEDs at their boundaries. Realistically those domains are very small, and large coherent volumes, e.g. vats of superfluid, are uncommon. (Where these exist the whole volume reacts as one.)

Is time an illusion?
Yes, at least in that our cognitive construct of it emerges from deeper effects, and is fuzzy, being stitched together in the mind as an apparently smooth and continuous dimension. No, in the sense that time corresponds to the frequency oscillations of matter, and these exist while matter exists.

Are there alternative realities?
If there are many worlds or parallel universes, there is every reason to expect that –by definition- they will be inaccessible to the present one, and therefore unknowable. Those are metaphysical ideas, like religion in being beyond physics, and cordus cannot confirm or disprove them. Yet cordus can say that there is no *need* for alternative realities. Cordus refutes the QM concept of many futures (temporal superposition) and provides a model for time in which there need be only one reality in which everything that happens simply stays happened.

Is time the passage from low to high entropy?
Not quite: entropy is a related but different effect to time. The arrow of time arises at the level where discoherence results in irreversibility in the interaction between particules. While time is the frequency ticks of particules, the irreversibility of interactions contributes to the *arrow* of time. The same irreversibility creates entropy. But time and entropy are not the same effect, even if they have a common root. Irreversibility is quantified by entropy, and also drives the local ratchets for the arrow of time.

Why do the laws of physics treat the past and future the same?
This is because quantum mechanics does not include entropy, in turn because it erroneously assumes that matter is always coherent (hence reversible interactions). QM is unable to predict its own limits of applicability, and therefore is erroneously assumed to apply to all matter [4, 6]. Cordus explains why and where coherence breaks down. Likewise classical mechanics is also symmetrical regarding time, if losses are ignored. The arrow is only applied to time when irreversibility arises.

Why does the human brain not 'remember' the future?
Time is a one-way effect. There is no future that is simultaneous with the present and the past. Cordus specifically refutes the idea that an object can simultaneously be in multiple futures, i.e. temporal superposition.

Which perspective of time is correct: the absolute clock of quantum mechanics or the spacetime of general relativity?
Neither, but in some ways both are adequate for their purposes. According to cordus, time at the fundamental level is created by the local frequency of oscillation of the particule, and the arrow is driven by irreversibility. Thus time is locally generated, and cordus suggests the QM idea of an absolute clock is incorrect.[7] Also, cordus suggests that time is a patchwork at the cosmos scale, not a continuous spacetime, thereby not accepting this feature of GR either. However both QM and GR are approximately correct, at least at the level of detail that concerns them. Cordus provides a more primitive mechanics for time that accommodates the thoroughly different models of QM and GR.

Where did time come from?
To the level to which cordus can penetrate, time is a consequence of the frequency oscillations of particules. Its rate is thus determined by the mass of the particule, in turn how it is assembled and from what subcomponents. In that sense even massless particules (photon, neutrino) have frequency and therefore time. However the forward arrow of time arises where coherence lets off and decoherence starts. This discontinuity in the physics of time occurs at different levels of assembly depending on temperature and homogeneity [4]. Time therefore comes from the frequency oscillation of matter, which in turn comes from the primal photon(s) at genesis [16]. Thus time started when the universe started.

At a still deeper level we have to ask what the mechanism might be for frequency in the particule. Cordus currently explains it as dynamic energy oscillation between the field structures at the two reactive ends, but undoubtedly there is more to it than this.

Will time end, and when?
Time is part of matter, and shares the same origins and fate.

[7] If the wave-functions of QM were rewritten in terms of the de Broglie frequency for the particule, rather than probability in absolute time, then QM and cordus might be closer. A secondary effect is that cordus also suggests that the simple presence of an observer does not collapse the wave-function or influence the outcome of an experiment, unless that observer was bonded in a coherent way to the experiment – which cordus suggests is practically impossible to achieve.

Is time a dimension?
No, it is not a dimension: it is neither smooth nor infinitely sub-divisible. It is not a ratio variable. It only looks that way when viewed from a sufficiently high level of assembly, hence the approximations of the classical mechanics. The concept of spacetime is also an approximation. In the cordus view, time is more like a patchwork of cause-and-effect ratchets between sub-microscopic domains.

5 Conclusions

Applying the cordus conjecture yields a novel alternative conceptualisation of time. According to this conceptual model, time originates at several levels.

At its most basic level time originates with the frequency cycles of the particules of matter and photons. Specifically, the ticks of time are the frequency oscillations of particules. Cordus provides a specific internal structure for particules, hence a physical explanation for frequency. The rate of time is thus determined by the mass of the particule, in turn how it is assembled and from what subcomponents. The local conditions and external environment, specifically relativistic velocity, acceleration, and high gravitation, affect the energisation process of the reactive ends. This effects the frequency of the particule, and thus the local time, hence time-dilation.

Thus time is locally generated, and cordus rejects the idea of an absolute clock, or a universal one. Time therefore comes from the frequency oscillation of matter, which in turn comes from the primal photon(s) at genesis. Thus time started when the universe started, and will end with it too.

However the ticks of time are not the same as the arrow of time. The forward arrow is only applied to time when irreversibility arises. This is where coherence lets off and decoherence starts. This discontinuity in the physics of time occurs at different levels of assembly depending on temperature and homogeneity, but is well before the macroscopic or even cellular level. Cordus explains how the irreversibility arises in the time-delay that is introduced (frequency ticks required) when two volumes of matter interact. This explanation applies whether those volumes are decoherent or even independently coherent. Irreversibility arises because it is statistically impossible to return all particules in the system to their original positions and states. The fabric, which comprises the discrete field forces (hyffons) of all the other particules in the accessible universe, adds complexity to the interaction of even the simplest assembly of particules. Therefore entropy, irreversibility, discoherence, cause-and-effect, and the arrow of time all arise at the same point.

There is a connectedness of phenomena that are at different geometric locations, and this applies between macroscopic objects and at the small scale. A phenomena that occurs in one volume is communicated via photons, or massy particules, or fields, to other matter around it. This communication applies cause positional constraints on the recipient. The combination of connectedness, frequency, and irreversibility, results in temporal cause-and-effect.

It is not a master clock that accomplishes this, nor does it require continuity of spacetime. The piece-wise communication between volumes of matter (whether coherent or not) achieves the effect of time. Cordus does not accept the temporal superposition of QM, hence also refuting the alternative-realities idea of QM. It also refutes the GR idea of spacetime, instead suggesting that time is a patchwork of temporal ratchets, not a continuous dimension. Hence cordus also rejects the idea of time-travel via folded spacetime, or the wormhole idea of QM.

Cordus offers an answer to the question of whether the absolute clock of quantum mechanics or the spacetime of general relativity is correct. Neither is, but both are adequate approximations for their purposes. Cordus provides a more basic concept of time from which QM and GR emerge as different approximations.

At the level of organic life, time is based in chemistry, specifically the delay introduced by the irreversible interaction of molecules. It takes chemical time for us to accomplish anything, even thought. Human perceptions of time are a construct founded on a real physical principle of temporal causality.

The cordus model also offers explanations for various troublesome questions about time: is time-travel possible via folding of spacetime (no), is time real (yes), is time an illusion (partly), are there alternative realities (obsolete), is time the passage of entropy (not really), why are the laws of physics symmetrical, where did time come from, will it end (yes), is it a dimension (no)? The validity of the cordus model is uncertain, and the work is conjectural. Nonetheless it has high fitness in that it offers a logically consistent set of explanations for a very wide variety of physical phenomena.

To sum up, the cordus model suggests that time consists of frequency oscillations of matter. The arrow is applied to time where irreversibility arises. The interconnectedness of matter, via its fields, creates a patchwork of time and cause-and-effect. Time is a series of delayed irreversible interactions between matter, not a dimension that can be traversed in both directions. Cordus proves a novel concept for time that is independent to existing models but nonetheless conceptually integrates QM, GR, and the human perception models of time.

References

1. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Cordus Conjecture: Overview*. viXra **1104.0015**, 1-17 DOI: vixra.org/abs/1104.0015.
2. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J., *Wave-particle duality: A conceptual solution from the cordus conjecture.* Physics Essays, 2012-. **In Press**.
3. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Energy cycles within matter. Cordus matter: Part 3.3* viXra **1104.0024**, 1-7 DOI: vixra.org/abs/1104.0024.
4. Pons, D.J. (2012) *Limits of Coherence: Where and Why is the Transition to Discoherence?* vixra **1201.0043**, 1-12.
5. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Special states of matter. Cordus matter: Part 3.4* viXra **1104.0025**, 1-12 DOI: vixra.org/abs/1104.0025.
6. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Why does quantum mechanics not scale up?* viXra **1107.0019**, 1-18 DOI: vixra.org/abs/1107.0019.
7. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Quis es tu photon? Cordus Conjecture: Part 1.1* viXra **1104.0016**, 1-8 DOI: vixra.org/pdf/1104.0016.
8. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Frequency. Cordus optics: Part 2.1* viXra **1104.0019**, 1-10 DOI: vixra.org/abs/1104.0019.
9. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Electromagnetism. Cordus in extremis: Part 4.1* viXra **1104.0027**, 1-17 DOI: vixra.org/abs/1104.0027.
10. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Gravitation, Mass and Time. Cordus in extremis: Part 4.3* viXra **1104.0029**, 1-14 DOI: vixra.org/abs/1104.0029.
11. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Quarks. Cordus in extremis: Part 4.4* viXra **1104.0030**, 1-15 DOI: vixra.org/abs/1104.0030.
12. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Fabric of the universe. Cordus in extremis: Part 4.2* viXra **1104.0028**, 1-8 DOI: vixra.org/abs/1104.0028.
13. Pons, D.J. (2011) *Annihilation mechanisms: Intermediate processes in the conversion of electron and antielectron into photons* viXra **1109.0047**, 1-21 DOI: vixra.org/abs/1109.0047.
14. Pons, D.J. (2011) *Stability and decay: Mechanisms for stability and initiators of decay in the neutron*. vixra **1112.0002**, 1-17.
15. Pons, D.J., Pons, Arion. D., Pons, Ariel. M., & Pons, Aiden. J. (2011) *Wider Locality. Cordus matter: Part 3.1* viXra **1104.0022**, 1-7 DOI: vixra.org/abs/1104.0022.
16. Pons, D.J. (2011) *The preponderance of matter: Asymmetrical genesis via the antineutrino route*. vixra **1111.0035**, 1-19.