Hidden Aspects of Time

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Seeing, contrary to popular wisdom, isn't believing. It's where belief stops, because it isn't needed anymore.

Terry Pratchett

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Part 4. Can The Mind Objectively Travel in Time?

PREFACE

If we accept at least a superficially dualist metaphysics with regard to the mind-body problem then it seems that there are other aspects of reality that also reflect this dualistic nature. An example that immediately comes to mind is the relationship between colour and the wavelength of light impinging on the retina. Light's wavelength is an objective fact, measurable and open to analysis by the probe of science. By contrast the experience of seeing colour is very much a subjective one. And during life these two aspects are correlated. However, no one has yet derived a procedure for giving a totally colour blind subject the gift of imagining red for example, which is a first-person experience. This formed the basis of the *knowledge argument* compiled by Frank Jackson in support of a dualistic metaphysics.

The part of reality that is the common theme for this work is time, hence the title. Like colour, time appears to have a dualistic nature where the objective aspect is that of a coordinate in the geometry of the space-time manifold as envisaged by Einstein and Minkowski. During life in the physical world however, this is correlated with the experience of time as duration. There is a unique point, which constitutes your location in space-time, where your present is defined by your position along the temporal line. At that instant you do not normally experience being at any other space-time point, either past, future or elsewhere, and the subject has a sense of before and after. In other words subsequent to being at one point in time, we are at a different point. This imparts chronological order of events from past to future. Positions in the space-time manifold are so ordered because we, as conscious minds, appear to *move* in a way that is consistent with our sense of before and after.

On 6th April 1922, when Henri Bergson and Albert Einstein met at the Société française de philosophie in Paris, there began a heated exchange as to the nature of time. What both parties failed to realise was that each was defending an entirely distinct concept. Einstein was said to have won the exchange. However, in the views expressed here both of their assertions had merit. Einstein defended the objective/geometric character of time

whereas Bergson was more concerned with its subjective nature as experienced duration.

In the title of this work the words, *Hidden aspects*, refers to properties that may be regarded as post-Newtonian, which is to say that the absolute, inexorable nature of time is completely lost. In general relativity, time has a plasticity that was not appreciated before the late nineteenth century, and this opened up the possibility that in principle real time could be manipulated in the same way that time in a movie can. For example speeding up, slowing down and even running backwards. If we could control the position of our consciousness along the timeline of our bodies then such experiences would be real without onlookers having any inkling that something strange was happening. But such a scenario is highly subjective and is not within the domain of relativity theory.

Opposed to this are objective effects where time is both location and velocity dependent as has been empirically established by rigorous tests of general relativity. It is a little like regarding time as an escalator whose speed can be varied by external controls. Observers on the escalator would see the speed change while remaining still relative to the steps on which they stand, and this by analogy, represents the objective effects as predicted by general relativity. However, if someone decided to start walking up or down the escalator while it is travelling then the analogy is representative of the conscious point of contact with the body's timeline moving contrary to our normal experience of time. Therefore we arrive at two aspects of non-Newtonian behaviour in a temporal context. Newton did not consider either of these as real possibilities, time was regarded as absolute and immutable. If we consider our present to simply be where we are in time at a specific instant, this points to our dualistic nature. Hence we may regard the mind-body problem to be inseparable from the philosophy of time. Just as time can be modified by high velocities or the presence of large masses, then there may be ways to modify the relationship between objective time and our experience of it by the analogy of walking up or down the escalator. To a limited degree this is already accepted in psychology. However, more extreme modifications may be possible via improved understanding of the relationship between mind and body. This particular topic is the main focus in part 4.

This work is largely intended as a companion to a previous publication *The Disembodied Mind: An Exploration of Consciousness in the Physical Universe* (TDM) (2020), which was intended to promote a non-physicalist view of mind and employs a pragmatic approach based on our

understanding of modern physics rather than more traditional philosophical arguments. The work presented here is compiled from a collection of five essays, which with one exception, were inspired by TDM. The one exception being chapter 1 in this work, *Is mind-body physicalism really compatible with modern physics?*, a previous iteration of which was rejected for publication by the British Journal for the Philosophy of Science, and was compiled before TDM. Therefore *The Disembodied Mind* essentially became an extended version of the original paper where the present article was rewritten after TDM was published.

Related to this, there is a long-standing issue within physics, which has come to be known as the information paradox. Throughout most of physics it is accepted that information is preserved in principle by all physical processes. However, in recent decades it has come to the attention of theoreticians that there may exist extreme conditions where this breaks down, hence forming what is known as a Cauchy horizon, which is a future directed null cone (see Fig. 1, section2, chapter 5 for a clear illustration of a null cone) initiated either by a space-time singularity or an initial closed timelike curve (CTC). In chapters 2 and 3, constituting part 2 of this text, we address the former, which is the inescapable formation of a singularity once a sufficiently large mass collapses inside its own event horizon. However, although the Penrose singularity theorem is not contested, part 2 tentatively suggests that no mass can cross its event horizon. Moreover, it is found that a core region inside a collapsing star constitutes a cavity with most of the consumed mass confined to a thin layer just above its critical radius. As this core grows it eventually consumes all of the star's mass forming a thin shell. In this work we refer to this as the *hollow shell* model, which is a singularity free alternative to the traditional black hole hypothesis. Such a solution, if proven, would resolve the information paradox in the context of gravitational collapse.

In part 3 we address the possible formation of closed timelike curves, where the question being asked relates to physical time travel. It is now well established that CTCs also form Cauchy horizons leading to a region of unpredictability to its future. In chapter 4 we clarify a theorem originally proven by Stephen Hawking, which we refer to as the *classical causality theorem*. This states that the formation of closed timelike curves requires the presence of exotic matter, which by definition has negative mass density. Most physicists today do not subscribe to the existence of such matter. Therefore general relativity appears sufficiently constrained that the physical world does not admit CTCs. Whether exotic matter

existed in the early universe however, is still an open question, and even if it did then it is unlikely to have any bearing in the present universe.

In the final part, having tentatively ruled out time travel as a physical possibility, we address the question of whether our nonmaterial minds alone can undergo such temporal journeys. In other words although the analogous escalator cannot be reversed, there may not be anything preventing the traveller from walking against the direction of travel. This leads us into the more contentious world of psychical research where we address the phenomena of experienced temporal anomalies otherwise known as time-slips. As the relevant body of metadata grows it is hoped that details common throughout this data set can be interrogated to improve our understanding of the mind and, more importantly, its relationship with the brain/body. That way it may be hoped that sufficient control of this phenomena will become possible under laboratory conditions, allowing us to understand and control the conditions that trigger the phenomena. Once this stage is reached it would be interesting to ponder the benefits to humanity as a whole.

With one exception this work consists of a collection of research papers. The exception is chapter 4, which is better described as a tutorial article intended to clarify previous results. However, when it comes to accessibility by readers, chapter 4 is arguably the most difficult of the topics covered. As long as the reader accepts its core message that physical time machines require negative mass density fields, then this chapter can be safely skipped by a more general reader. A similar approach may be taken with chapters 2 and 3. However, it should be borne in mind that their conclusions, amounting to the hollow shell model of gravitational collapse, are only tentative.

A central thesis of this work is chapter 1, which summarises TDM, and this is the reason it is placed first, its content is fairly well known within philosophy of mind circles. However, for more general readers the ideas are not necessarily complicated, they are just less familiar. Given its technical nature in terms of the physics content, section 2 of chapter 1 may be skim read without losing its essential message. Something similar may be said of the final chapter, which addresses anomalous temporal experiences. The style of this chapter was compiled with the more general reader in mind, and consequently more technical content is kept to a minimum.

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JCA
University of Keele
May, 2022.

PART 1

LOCALISATION OF CONSCIOUSNESS

INTRODUCTION

Things change over time. At least that is how reality appears from our perspective. However, when discussing time itself confusion sometimes arises, particularly if we equate physical time with change. This is the kind of confusion that led to the heated exchange between Bergson and Einstein in 1922. Hence we are faced with the question of how change itself can change. In the four-dimensional world we accept that history is fixed, irrespective of how well we know or accept it. Therefore in the four-dimensional context the world by definition, does not change. As is demonstrated in the article below however, when dealing with conscious agents this idea may be challenged.

When considering objects in a four-dimensional context, philosophers sometimes find it useful to dismantle them into temporal parts (Jarvis Thomson, 1983). But Jarvis Thomson seems to be no supporter of temporal parts. With any object consisting of parts, difficulties arise when we attach to it an identity that is meant to persist over time. One of the best-known examples is the *Ship of Theseus*, considered by Chisholm (1976), in which gradually over time each wooden component is replaced by a metal one. Eventually the entire ship is metal. The question is should it still have the same identity as the original? Moreover if the wooden components are preserved intact, subsequently allowing the original ship to be reconstructed, then what identity should we confer on the rebuilt vessel?

Mark Heller's (1990) *Temporal Parts of Four-dimensional Objects* is intended partly as a response to Jarvis Thomson. While acknowledging a continuant interpretation of four-dimensional objects Heller's view is that such theories face severe difficulties. But there are also difficulties with temporal parts.

The temporal parts or stages idea was developed further by Theodore Sider (1996), in what became *stage theory*. This approach is also supported by Paul Tappenden (2019), which is opposed to the continuant idea dubbed *worm theory*, the worms in this case being the space-time world lines of material objects. The analogy of worms can be taken further by considering them as segmented, where the segments are time slices or

stages. When dealing with persons, these ideas are used in an attempt to shoehorn conscious agents into the material world by suggesting that the person of a living body at time, t_0, is not the same person of that body at the later time of t_1. According to Chisholm however, people are special in that they do not have temporal parts (stages). And he uses the unity of consciousness to further his argument, which is justified by the example of a person having the single experience of hearing *bobwhite* spoken. This is a compound experience consisting of hearing the words *bob* and *white* spoken in rapid succession. However, Heller counters with the assertion that when the subject hears *white* he has a brain state corresponding with having just heard the word *bob*. This is then followed by the example of a subject created *ex nihilo* with the identical brain state as having just heard the word *bob*. But he did not hear the word *bob* because he did not exist at that point. The complete experience of having heard the words *bobwhite* is therefore a construction in this example.

In the work below we consider a similar example of a person watching a digital clock increment (Tappenden, 2020). Aside from the clock state, the brain state constitutes memories of past reading plus expectations of future readings. All of this can be represented as a physical state. And this state perdures timelessly rather than endures because the person viewing a particular reading of the clock occupies a small region of space-time that, by definition, does not change. However, we also use the concept of metaphysical state, which does change because it is different when the person *experiences* seeing that clock reading as opposed to seeing any other reading. Here we use the concept of metaphysical state to challenge arguments of the *bobwhite* type described above, and to show that Chisholm's assertion that conscious agents do not have temporal stages is essentially correct because they are localised in time. In addition we also see that conscious agents are transtemporal. The picture we arrive at therefore is one where a conscious agent is always localised at one point in space-time, but from its perspective the position of that point changes. This is the *localisation of consciousness*, which is how we experience the changing world that we do.

References

Chisholm RM, (1976), *Identity through Time*, Ch 3, *Person and Object*, Open Court.

Heller M, (1990), *Temporal Parts of Four-dimensional Objects*, Ch 1, *The Ontology of Physical Objects*, Cambridge University Press.

Jarvis Thomson J, (1983), *Parthood and Identity across Time*, Journal of Philosophy, **80**, 201.

Sider T, (1996), *All the World's a Stage*, Australasian Journal of Philosophy, **74**, 433.

Tappenden P, (2019), *Everettian theory as pure wave mechanics plus a no-collapse probability postulate*, Synthese, https://doi.org/10.1007/s11229-019-02467-4.

Tappenden P, (2020), Private communication (same one as in the article below).

CHAPTER ONE

IS MIND-BODY PHYSICALISM REALLY COMPATIBLE WITH MODERN PHYSICS?

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Abstract

If we take seriously literal interpretations of quantum theory and general relativity then the answer to the question posed in the title is no. This article highlights where incompatibilities arise by considering our experience in the context of modern physics. Implied nonmaterial minds possess properties that no physical entities do by being both transtemporal and localised in the configuration space. The principle of localisation (PL) is proposed, and is used to show that there is no need to resort to the Everett interpretation to show that minds exist outside of physics, post relativity physics is enough. However, in this regime, there is no free will, minds are destined to experience a pre-determined but unknown future. Free will is restored when we reinstate pure wave theories in line with Everett.

Keywords: Configuration space, dualism, physicalism, quantum mechanics, relativity, timelessness.

1. Introduction

There has been a longstanding philosophical problem in reconciling the consequences of modern physical theories with our everyday experience of the world around us. This apparent inconsistency can be addressed by considering the conflicting viewpoints as independent postulates in order to see what lessons can be drawn. These postulates can be stated as follows

P I **Eternalism: Physical reality consists solely of a timeless wave function over a universal configuration space.**

This asserts the underlying static nature of material reality of which physical time is just one variable. The second postulate is equally important and addresses the subjective nature of our experience, this reads:

P II **Experience: Our conscious dynamic experience of the world is real.**

A likely cause of this inconsistency is the physicalist position that is tacitly assumed, where the experience leading to the second postulate is claimed to be an illusion. Elucidating the contrasting properties of minds and the material of the universe they find themselves in provides an important first step in extricating ourselves from this difficulty. The universal wave function, which encapsulates the material universe, has the properties of being timeless and distributed over the classical configuration space (C-space). By contrast minds are localised and dynamic within C-space, as we experience ourselves to be. This localisation is deduced directly from our common experience of a single classical configuration at any instant. This is the principle of localisation (PL), and is an idea that evolved from *localisation of consciousness* in the Hilbert space of quantum theory (Zeh, 1970, p74).

A significant first step in this direction was due to Albert and Loewer (1988), which had the aim of reconciling Everett's interpretation of quantum mechanics (Everett, 1957) with everyday experience. This has been supported by subsequent work with respect to the new dualism, for example (Bitbol, 1990; Squires, 1993; Hemmo and Pitwosky, 2003). Despite these authors' agreement on dualism, their respective interpretations of minds do differ. For example Squires' approach introduces the concept of a universal mind in contrast to the *many minds* of Albert and Loewer. However, in this work it is not my purpose to discuss the configuration of minds and how they may relate to each other or to the physical world, it is only to show their independent existence. I do this by appealing, not just to the Everett interpretation but also to modern physics as a whole.

The work of these authors, being written in the context of the Everett interpretation, provided reasons for others, possibly with physicalist leanings, to attempt a refutation of Everett, examples include (Byrne and

Hall, 1999; Adler, 2014). In contrast, others, for example (Lockwood, 1996; Deutsch, 1996; Saunders, 1998; Greaves, 2004; Lewis, 2007) instead try to maintain a physicalist position in the face of Everett. In what follows I show that this is not possible. Moreover, it is shown that mind-body physicalism is untenable in all post-relativity physics as interpreted at face value.

There are two key concepts, already mentioned, that need to be addressed in order to see the distinctness of minds and the physical world. These are (i) the timelessness and extended distribution of the wave function and material objects it encapsulates, and (ii) the localisation and movement of minds. In the following section I discuss timelessness by showing how physical time emerges from an essentially static reality. This is done by summarising the *problem of time* in the context quantum gravity, and then to show how classical[1] relativity can also be considered as a timeless system. Provided a reader, unfamiliar with the physics, accepts an eternalist's interpretation of time (e.g. B-theory (McTaggart, 1908)), then this section can be safely skipped without compromising the message.

Physicists tend to picture the physical world in terms of world lines in space-time that are branched in the Everett interpretation, which philosophers call *worm* theory. However, an alternative view called *stage* theory (Sider, 1996; Tappenden, 2017; 2019) is introduced in section 3 in which the worms may be considered segmented. These segments or stages as they are called represent local features in C-space. Timelessness provides the groundwork for section 4 on consciousness and the principle of its localisation. Before concluding I include three more sections: section 5 on Papineau's physicalist criterion (Papineau, 2001) and where it fails in the face of PL, section 6 dedicated to PL as applied to Parfittian examples (Parfit, 1984) and section 7 revisits stage theory where we see some of the most powerful arguments favouring a purely physical metaphysics, without denying postulate *P I*. Here I show that there is still a residue of a nonmaterial conscious entity.

2. Timelessness

Here I provide a brief overview of modern physics, by which I mean physics post-special relativity. Before relativity the state of physics was

[1] Here the word "classical" is used to indicate that we are not considering quantum mechanics.

such that the scientific community could not easily decide between presentism and eternalism, a debate dating back to Heraclitus and Parmenides *c*. 500 B.C. Generally due to the way language had evolved, time was tense dependent, so the way people thought about time could, more easily be represented by A-theory, which is more consistent with Bergson's (1910) position. From a Newtonian viewpoint the ontology of time was not considered to have the same status as physical space. Essentially everything happened in $\mathbb{R}^3$ which represented the whole of physical reality in the present. The past did not exist, it was only remembered, and the future had not happened yet therefore that did not exist either. This is how Saunders (2002) for example, defines *presentism*[2]. Given the causal relationships of events in this scheme and the causal closure of physics, it is easy to see how this opened the door to physicalist views. Later I show that mind-body physicalism today is really nothing more than a relic from the pre-relativity paradigm.

Much of the confusion about time is between physical time and its phenomenal counterpart (Bergson, 1910). In April 1922 Albert Einstein famously disagreed with the philosopher Henri Bergson over the nature of time. Einstein's position was reflected in his theories of relativity, whereas Bergson pointed out that the cold objectivity of Einstein's view could not account for time as experienced duration. Moreover in general relativity both past and future exist timelessly suggesting an unknown but predetermined future, which Bergson could not accept. In Bergson's view the future must be open, and this is addressed by adopting the literal interpretation of quantum mechanics. One possible solution to this impasse was that neither Einstein nor Bergson considered that they were defending entirely distinct concepts. Einstein's view of extended objective spatialised time, contrasted Bergson's inner phenomenal time that we experience as duration. This view of time mirrors our dualistic nature as proposed here.

Considering quantum mechanics, many philosophers attempt to preserve physicalism even in the context pure wave theories. For example Ismael (2003) points out the tendency of Everettians to invoke nonmaterial *homunculi* in order to solve the measurement problem. But as we will see

[2] There is an alternative version of A-theory known as the "growing block". This is where the past and present exist but the future does not. This version of A-theory, which strictly is a hybrid between eternalism and presentism, still requiring a privileged present, is not discussed in this work; therefore here, the terms 'A-theory' and 'presentism' are interchangeable.

they do this with good reason. Before delving into those reasons however, we need to consider pure wave theories in a wider context. These interpretations emerged as a result of efforts to describe the universe as a whole within a quantum context–all observers are internal to the system. When considering this, then as remarked by Deutsch (1996), the Everett interpretation is the only interpretation of quantum mechanics. That wider context is canonical quantum gravity (CQG), which appeared ten years after Everett. Described as its most disturbing feature, timelessness in the objective world is manifest when we express the short form of the Wheeler DeWitt equation (DeWitt, 1967; Zeh, 2007 and references therein)

$$H\Psi = 0 \tag{1}$$

and realise that no time variable is present in the arguments of the universal wave function, Ψ. A central question to be addressed is: given the timeless nature of physical reality how is it that we experience change? We are able to give a partial answer here, for further details see (Austin, 2020[a], mainly chapter 10).

The Wheeler DeWitt equation can be compared with the standard Schrodinger equation

$$i\hbar\frac{\partial\psi}{\partial t} = H\psi \tag{2}$$

where ψ is the wave function for a particular microscopic system being analysed. Here we see an obvious time dependence of ψ. The form of Schrodinger's equation, (2), would be typically used in a laboratory setting to analyse the behaviour of a particular experiment. When a WKB ansatz is inserted into an expanded form of equation (1) the Tomonaga-Schwinger equation, is obtained (Zeh, 2007, p190). Using this and taking χ as the pre-exponential factor in the WKB form we obtain

$$i\frac{d\chi}{d\tau} = H_{matter}\chi\,. \tag{3}$$

In units where $\hbar = 1$ the similarity in form between (3) and (2) is striking. Here the time parameter, τ is what Zeh calls many fingered time (or what relativists call proper time). But taken in a wider context it is nothing more than a real valued parameter on a Bohmian trajectory through C-space.

This provides a rudimentary but effective idea of how physical time emerges from a timeless universe. Moreover, a simple way of seeing the timelessness of CQG is to eliminate the time dependence of ψ in (2) ($\partial\psi/\partial t = 0$), and see that it immediately reduces to the form of equation (1).

A question prompted by this conclusion is: if time does not exist at a fundamental level then is there something else to replace it? There is, it is the configuration space itself, also called the universal C-space. Unlike time with topology $\mathbb{R}$, C-space is for all practical purposes infinite-dimensional. It is in C-space, *C*, that the Everettian *multiverse* resides in the form of a branching wave function. The topology of physical reality can then be represented by $C \times X$, where *X* is the topology of the base space (most likely S^3 or $\mathbb{R}^3$). This product space may also be called space-C, where C-space, "C", replaces "time" in space-time (Austin, 2020[a], section 6.5.4). What we think of as time is reduced to a single parameterised path with topology $\mathbb{R} \subset C$, which is no more than an ordered sequence of configurations. For further details of emergent time see (Barbour, 1999; Zeh, 2007), and for more general treatments of CQG see (Rovelli, 2003; Thiemann, 2007).

To summarise, physical time is just the C-space path of the entire universal base space, *X*, and all of its matter contents through its own configuration space. Moreover it is possible to isolate a particular path in C-space, to obtain a structure with topology $\mathbb{R} \times X$. This is what we perceive as classical space-time and time is just another coordinate in the geometry. We no longer have the presentism described by Saunders where time is just something ontologically distinct from space. This is how timelessness manifests itself in classical relativity–time is within physics.

I have, admittedly on a very basic level, shown how the classical block space-time of general relativity is derived from the Wheeler DeWitt equation. The perdurance of physical time has inescapable consequences for conscious minds. Time in eternalism is tenseless. As a consequence we can say that *past events exist* (deliberate present tense). In classical relativity both past and future events exist, they are just elsewhere in C-space. We can illustrate this by a simple thought experiment, involving the relativity of simultaneity, which has become known as the Andromeda paradox (Rietdijk, 1966; Putnam, 1967; Penrose, 1989, p201).

Consider Alice and Bob, walking along a street in opposite directions. The constellation Andromeda just happens to be on the horizon in the direction that Alice is walking. On a planet in the Andromeda Galaxy (M31), 2.4million light years away, there is an event, E_A, simultaneous to Alice when she passes Bob. Similarly we may consider an event, E_B, at the same location on that distant planet simultaneous to Bob when he passes Alice. Intuitively E_A and E_B are the same event. Relativity denies this; actually E_B occurs approximately nine days earlier than E_A assuming a relative velocity between Alice and Bob of 3 ms^{-1}. We can consider a third event, E_0, exactly half way between E_B to E_A, which will be repeated many times in both a backward and forward time sense for Charlie who walks in a circle just across the street from Alice and Bob as they pass each other. Despite this being beyond direct experience, due to the spacelike separation between events here and in M31, this thought experiment indicates the perdurance of E_0 in support of eternalism.

Another way to see how time emerges from timelessness, at a microscopic scale, is to include a clock in a closed quantum system that is in a static global quantum state. The clock in this case is just a subsystem possessing an associated time variable, correlated with the rest of the system. Page and Wooters (1983), with later refinements by Gambini *et al* (2009), have shown the possibility of creating a static entangled state with internal *dynamics*. An experiment by Moreva *et al* (2014) shows a static quantum state of two entangled photons when passing through birefringent plates that rotate the polarisation of individual photons. In one mode one of the photons was seen to evolve with respect to the other (the clock), that is their polarisations are correlated, while in another mode the collective state of the photon pair was observed to be static.

One may ask if presentism can be dislodged entirely or whether it can represent the truth based on a hidden inertial frame that defines a universal present. In this way the universe may consist of a single three-dimensional space evolving dynamically where the models of a four-dimensional block space-time, or a higher dimensional space-C, are entirely illusory. The only classical way I can think of to dispel such an idea would be to obtain direct evidence by, for example creating closed timelike loops. However, this approach seems unlikely to succeed (Hawking, 1992; Flannagan and Wald, 1996; Austin, 2020[b]). More direct evidence for the eternalist's view however, does present itself via the empirically known existence of macroscopic-Bell states whose quantum volumes exceed the space-time extent of the known universe by many orders of magnitude (Iskhakov *et*

al, 2012; Kanseri *et al*, 2013), for more detail see (Austin, 2020[a], section 6.6).

Although we can now see how internal dynamics can emerge from microscopic static systems, there is still something missing because there is no observer to experience the implied dynamic processes. Moreva's experiment shows two variables that are correlated in an entangled system. It is like laying two rulers side-by-side and saying that their respective scales are correlated. Although we have a system that is physically complete, there is still no *pointer*. It is like staring at a clock face with no hands. However, we are able to identify ourselves as pointers localised at a specific point in time for every instant. This is the principle of localisation. In the light of time being within the physics, a question that may be asked is: in what sense does the pointer move? Does it even need to move and if not can it be that we are a collection of static pointers along the world lines of our own bodies?

3. Stage Theory

Before moving on to discuss minds and localisation of consciousness, it is worth considering an alternative to the way we have so far described timeless reality. Timelessness is variously referred to as eternalism, four-dimensionalism (in a non-quantum sense) or perdurantism (as opposed to endurantism as considered by presentists). However, there are two recognised ways to describe particular objects in the timeless world: *worm* theory and *stage* theory. From a physicist's perspective (particularly in the context of relativity) timeless objects are often described as world lines possibly with past and/or future endpoints. It is also common for western philosophers to call world lines *space-time worms*, hence the designation worm theory. However, by continuing with a common analogy worms may be segmented where each segment is a *stage*. Therefore worm theorists consider world lines as fundamental objects whereas for stage theorists, time slices through a worm are treated as separate individual objects temporally related to each other, and when it comes to us, each instant of our lives is considered as a separate person.

Our description so far has been in the language of worm theory. However, a number of contemporary philosophers nowadays write in a way that is more consistent with stage theory, attributed to Theodore Sider (Sider, 1996), see also (Tappenden, 2019). Extending this idea to a pure wave interpretation of quantum theory, worms are viewed more like branched

dendritic structures with each branch being divided into individual stages. This does not constitute any proposed change to the physics of what is being described. However, it does open the door to analytical philosophers with a physicalist bias to construct more powerful arguments in support of their theses. As we will see below one such author is Hilary Greaves (Greaves, 2004) who appears to use stage theory without reference to Sider (Tappenden, 2019, footnote 3). In stage theory persons are not transtemporal with a world line from birth to death constituting a whole life, instead each instant within that life is treated as a separate person. This is due possibly to each stage having a distinct physical/brain state having consequences that allow physicalists to construct models supporting mind-brain identity, ostensibly containing all of the ingredients required for mentality within each brain state. These issues will be addressed further in section 7.

4. Nonmaterial Minds and the Principle of Their Localisation (Pl)

The principle of localisation is the theory that, at each instant, your mind contacts the physical world at one point in C-space–the focal point of consciousness. Therefore, you perceive your mind to be localised at one point in time at each instant. As an example, suppose you are meeting friends at a restaurant. You are a few minutes late. As you enter you accidentally stub your toe on the doorframe, it hurts. Resisting the temptation to let out an expletive, you proceed with a slight limp to the reserved table where your friends are already seated. Over a drink while waiting to order, you relate your recent experience to your friends. At this point, what can we say about the event when you stub your toe? This is an event in your past, you have memory of it, in addition, the state of your nervous system and the tissue neighbouring the impact point is such that you are still feeling its effects. These effects are with you now. Taking a presentist's view of time this event no longer exists. However, as we have already seen, it is eternalism that is favoured in the current scientific paradigm. Therefore the event where you stub your toe on the doorframe exists, it is just not where you are now. Even accepting eternalism, our common experience tells us that we only experience one instant at a time. That is in classical physics we really are localised in time, it is just that, unlike specific events, our locality moves with respect to our own phenomenal time–only minds change their configuration and state, this is a possible source of dynamic experience. In presentism, due to the *non-existence* of the past and future, minds are confined to the present, i.e.

localised, but the present is privileged. Whereas for the eternalist there is no privileged present and no such constraint exists–the present is just where you are. In what follows we present further support for such a view while also considering alternatives.

To relate this to physicalism, at the point where you experience stubbing your toe on the doorframe you, your mind, is at that point. Where you experience being seated with your friends, the event in question still exists. So the question that physicalists must answer is: what is the difference between an event when you experience it, and the same event when you refer to it later? For any eternalist this should be regarded as a legitimate question. In modern physics, the physicalist view implies that your mind could take the form of a localised physical disturbance, say a soliton or other type of localised wavepacket that moves along your world line in space-time in relation to phenomenal duration. The problem is that space-time is by definition static–physical time is internal to the physics. So no such disturbance can exist. Does this mean that we must deny our own existence? Obviously not but, if we identify ourselves as localised minds, we must take the bold step of denying our own physical existence, and regarding our bodies and brains as structures to which we are temporally associated.

Our material bodies (and brains) are, unlike our minds, distributed over time. To use Parfitian language, our bodies are objects extended over time, with features that vary along with many overlapping connections (causal relations). All of the body's features and connections collectively constitute a personal-identity-over-time. But because this structure is extended in time it is legitimate, given our common experience of localisation, to treat it as purely physical. This is precisely what Parfit does. However, in the light of PL it is difficult to see how physicalism can be maintained except possibly with the application of stage theory. A comment by Acton (1960) that in my view nicely summarises one motivation for physicalism (materialism), is quoted as

> The strength of the case of materialism is a result of the obscurities in the notion of a wholly incorporeal existence. This is held to be non-spatial and hence incapable of movement. But then its mode of operation on and with material bodies seems inexplicable. (Acton, 1960, p195)

A key phrase here is *…obscurities in the notion of a wholly incorporeal existence.* Yes there are obscurities. However, the extension of physical bodies over time coupled with the localisation of minds is anything but

obscure–the difference is manifest. With regard to the second sentence it is difficult to be sure what is meant by *non-spatial*. Focal points of consciousness are certainly localised in time (or in C-space), and our brains occupy small but well-defined regions of the base space to which our minds are associated. And it would appear that minds move in a more general space than just the base space. The last sentence asserts the inexplicability of the effects on material bodies by minds. When we come to discuss Papineau's criterion it will be seen that this point is wholly irrelevant.

One of the strongest proponents of physicalism in the context of modern physics, specifically of the Everett interpretation, is Michael J Lockwood. In his (1996) article he attributes minds as branching entities just like features of the wave function. From someone presupposing physicalism this is to be expected. He describes your multimind (Mind) as being distributed across a local region of the multiverse (a subset of C-space) containing copies of you. Every copy has its own mind each of which is a branch of your Mind. He describes a *superpositional* dimension orthogonal to time over which various mental states are distributed. Together with time this forms an *experiential* manifold, within which each individual mind, including yours, occupies a vertical line (its own time). From each point you can look back via the faculty of memory, along your own timeline. Lockwood uses the analogy of *tunnel vision*. You can also look at other locations in base space to points in and on your past light cone via sensory input still within your own branch. Also, as Deutsch (1996) points out, you can gain input indirectly from neighbouring timelines via interference. All this describes the physics perfectly. However, when it comes to the interpretation of minds in the context of experience related to modern physics then Lockwood's description is incomplete. But even Lockwood, when he refers to *tunnel vision*, alludes to PL–who or what is looking along the tunnel?

Let us consider the *tea/coffee* example that Deutsch (1996) relates near the beginning of his supportive reply to Lockwood. As he was drafting his article he was experiencing drinking tea. Through his firm grasp of quantum theory he could also perceive a neighbouring timeline where he is drinking coffee. He did not experience drinking coffee at that point. That was the experience of a separate individual who has the same name, identical DNA and near identical biography. In addition there will be a branch point in his near past, to the past of which both David Deutsch's (the tea drinking version and the coffee drinking version) followed

identical paths through C-space. I myself am on Deutsch's tea-branch because that is what is described in the copy of his article I have in front of me as I write. There will be many versions of the tea-branch, all subtly different, but I refer to them singly for reasons of clarity. There will be copies of me (physically) writing this article now but with the words *tea* and *coffee* switched, because those copies are referring to the article written by the coffee drinking David Deutsch. But those copies are not me because, in this life, I was not in that part of C-space. And when you read this article I will no longer be at the point where I am writing these words, I will have moved on because, although I am localised in C-space, I am moving through it along my own timeline as perceived with respect to my own phenomenal time.

Lockwood's view of minds fails PL. This is because, in his view, minds are subsystems of brains, which are static and distributed across extended subsets of C-space in the form of branching timelines. The reason given by Lockwood for this view is that he follows the principle of *supervenience of the mental on the physical*. He effectively presupposes physicalism. This is unconvincing; we cannot use physicalism to prove physicalism. However, I can offer a weaker form of the supervenience principle that does not demolish the consistency between eternalism and PL. Consider a body of water held in a container. We can say that the shape of the water supervenes on the shape of the container. This is not the same as saying that the water supervenes on the container. Here supervenience relates only to its shape. I can easily pour the water away, in which case the water and the container continue to exist separately. Similarly we can say that mental states supervene on brain states; referred to as local supervenience (Austin, 2020[a], p292). This makes sense because the state of a particular mind can supervene on the instantaneous state of a brain at the corresponding point of its Bohmian trajectory. But it makes no sense to say that localised minds supervene on brains extended in C-space. Let us see how this further relates to the measurement problem.

The measurement problem with respect to a two state quantum system, typically the spin-state of an electron along a predefined *x*-axis, is often used when discussing the minds of interacting observers. A clear analogy, used by Peter Lewis (2007), is one of a forked road with each fork leading to different destinations. Consider Saunder's (1998) argument regarding the measurement of the spin state of an electron emerging from a Stern-Gerlach apparatus. The electron is prepared in the state