Eternity and time in Science: What Role do the Theories of Relativity Play in the Formation of a Coherent Model of eternity?

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2013

Contents

List of Abbreviations

AA – Absolute Atemporality

EA – External-Atemporality

GTR – General Theory of Relativity

Mst – Minkowski Spacetime

NM – Newtonian Mechanics

PE – Presentist Eternity

PR – Principle of Relativity

QM – Quantum Mechanics

S&K – Stump and Kretzmann

STR- Special Theory of Relativity

TA – Tensed Atemporality

TE – Transcendent Eternity

§1 Overview

Historically models of eternity have been grounded in divine attributes rather than the intrinsic structure of space-time. I examine the topology of Minkowski spacetime in comparison to the Euclidean space of Newtonian Mechanics, before highlighting five common approaches to eternity. Both atemporal and temporal models of eternity are examined to establish what they tell us about the nature of eternity outside the divine attributes, before being evaluated for their coherence with the Special Theory of Relativity.

I argue that the most coherent models of eternity in light of the Special Theory of Relativity are those that appeal to metaphysical rather than physical time as it remains unaffected by the conventionality and relativity of simultaneity. I conclude that the special Theory of Relativity has a valid role to play in establishing the coherence of eternity. However, due to the discontinuity of concepts of time between the Special Theory of Relativity, the General theory of Relativity and Quantum Mechanics, it cannot singlehandedly be used to establish which models of eternity cohere with scientific models of time, but must be use alongside the General theory of Relativity and Quantum Mechanics.

§2 Background information for the Thesis

There are almost as many models of god as there are believers in Him[1] and the same can be said for models of eternity. A major reason for diverse notions of eternity within Christian philosophical theology is that the philosophical theologian has tended to start with God's attributes and then formulate a model of eternity in which they are possible. In the fourth to fourteenth centuries, when scholars were heavily influenced by Neo-Platonism, divine timelessness was the dominant theory. As the doctrine of divine immutability lost its appeal there was a rise in the everlasting model of God[2]. This has meant we have approached the issue with a theological prejudice[3] making our model of eternity fit our doctrinal requirements, rather than establishing a coherent model of eternity from which we can examine which divine attributes are compossible. This has led to eternity becoming little

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[1] J. N. Findlay, 'Time and Eternity', *The Review of Metaphysics*, 32 (1978), 3–14 <doi:10.2307/20127140>.

[2] Garrett J. DeWeese, *God and the Nature of Time*, illustrated edition (Ashgate Publishing Limited, 2004). Pp.2-3

[3] This terminology is borrowed from Tim Maudlin who refers to our need to formulate our fundamental ontology without philosophical prejudice. cf. Tim Maudlin, *The Metaphysics Within Physics* (OUP Oxford, 2009).

more than a litany of faith secondary to divine attributes[4]. Thus if we wish to make the claim "God is eternal" more than this 'it must have some explicable meaning which we can understand'[5] and it must 'comport well with modern physics or it will not be taken seriously'[6]. It is within this framework that I will examine whether the theories of relativity have a role to play in forming a coherent model of eternity.

§2.1 Models of Time

Our understanding of eternity is influenced by our understanding of time, and bound up in the notion that if God created the universe then he must have either created time, or be a slave to it. If we claim God has an eternal mode of existence then there must be genuine metaphysical truths about eternity because otherwise eternity cannot be understood as a real feature of the universe. In order to understand the relationship between time and eternity, it is necessary to understand what we mean by "time". Aristotle famously lamented 'what, then, is time? I know well enough what it is, provided that nobody asks me; but if I am asked what it is and try to explain, I am baffled'[7]. Brading[8] seems to simplify the matter when she states that 'there is no "every day" concept of time that we can make use of philosophically that is independent of the scientific concept: time as investigated by physics *just is* time as investigated by philosophy'[9]. However, Besnard argues that there is no concept of time that works across all three fundamental physical theories[10][11].

There are three major metaphysical views of time: Presentism, Possibilism, and Eternalism. Possibilism is the view that only the "now" is real; it stands like a knife edge on the division between the past and the future, and as such is constantly changing. This theory of dynamic time states that both the future and the past are equally unreal. In applying the same ontological status to the past and future, presentism is unable to encapsulate the asymmetries we perceive between them. Presentism is in direct contrast with Eternalism, which states that the present has

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[4] James F. Harris, 'An Empirical Understanding of Eternality', *International Journal for Philosophy of Religion*, 22 (1987), 165–183 <doi:10.1007/BF00136015>.
[5] Harris, 'An Empirical Understanding of Eternality'. P.166
[6] DeWeese, *God and the Nature of Time*. P.15
[7] Augustine and R. S Pine-Coffin, *Confessions* (Harmondsworth, Middlesex, England; New York, N.Y., U.S.A.: Penguin Books, 1961). Book XI, 14
[8] Katherine Brading, 'Physically Locating the Present: a Case of Reading Physics as a Contribution to Philosophy', 2012 <http://philsci-archive.pitt.edu/9429/> [accessed 15 November 2012].
[9] Brading, 'Physically Locating the Present'. P.2 (original emphasis)
[10] Fabien Besnard, 'Time of Philosophers, Time of Physicists, Time of Mathematicians', *arXiv:1104.4551*, 2011 <http://arxiv.org/abs/1104.4551> [accessed 30 November 2012]. P.18
[11] Special theory of Relativity, General Theory of Relativity, and Quantum Mechanics

no special ontological status; saying something is occurring "now" is no more significant than saying that it is occurring "here". Eternalism claims that past, present and future are all equally real and the "passage" of time is only an illusion, seeming to correlate with the STR claim that "now" is relative to the observer[12]. Possibilism sits in the middle, claiming that whilst the past (and "now") is "real", the future is only possible. On this model time is dynamic and what is actual grows as the future "unfolds".

Two terms that need clarification are static and dynamic time. Static time states all moments of time co-exist, and with no ontological difference between the past, present and future. The "passage" of time is nothing more than a feature of our psychology. The dynamic theory of time states that the present (and past) have a different ontological status to the future. Because the present (and past) are real, unlike the future, this means that the "passage" of time is a real feature of the world.

McTaggart[13] argued that there were two possible ways to discuss the positions of things in time; the A-Series and B-series. The A-series orders positions in time on the basis of their having the property of being two days future, one day future, present, one day past etc. As such A-series relations are constantly changing. Alternatively the B-series states that positions in time can be ordered according to their relative positions (x days later than, simultaneous with, x days earlier than), these relationships are static and hold no matter when in time you are speaking. McTaggart argues that the B-series alone cannot constitute a proper time series as there is no genuine change involved. Genuine change only occurs with the A-series, as the relationships of the B-series are fixed, whereas A-series relationships are constantly changing. However McTaggart believes that the A-series is inherently contradictory as it requires something to be able to hold all of the properties (being two days future, one day future, present etc.). This leads to McTaggart's claim that time cannot be real as you cannot have time without real change (A-series) but the A-series is contradictory. Therefore all time (including both A and B-series) must be unreal and any appearances of temporal order is simply illusionary.

The final issue is whether time as exists independent of events/objects within it. This is known as the debate between reductionism (with respect to time) and Platonism (with respect to time). Reductionism states that time does not exist

[12] This claim will be examined in more detail in §3.3

[13] J. Ellis McTaggart, 'The Unreality of Time', *Mind*, 17 (1908), 457–474 <doi:10.2307/2248314>.

independently of the events that occur within it, meaning all talk about time can be reduced to relationships between events/objects. Platonism states that time is like an empty container into which events can be placed, but that exists independently of what (if anything) is placed within it.

DeWeese suggested a different approach to understanding time, by sub-dividing "time" into four different types. Rather than viewing these models in contrast to the earlier models, it is more helpful to view them as different ways we apply the concept of "time". Physical (clock/measured) time refers to the laws of nature that allow for the measurement of time (i.e. are regular). This metric is dependent upon the laws of nature in a given temporal world and so is relative to a reference frame[14]. Cosmic (universal) time may or may not exist, however if it does exist, it is the standard by which all events in the universe could be located and referenced. Einstein argued that cosmic time did not exist, as time is entirely dependent on the reference frame[15], and there is no privileged reference frame that shows the "ultimate" order. Personal (psychological) time is our conscious experience of (the passage of) time. Personal time cannot be global as it appears to differ from person to person. Nevertheless we all arrive at the end of a lecture at the same time irrespective of whether the lecture has passed "fast" or "slowly". DeWeese highlights metaphysical time as a category of time that is fundamental to any other kind of time. Metaphysical time is a succession of moments through which concrete objects can be said to persist. It is not the same as physical time, as there could be concrete objects that are not physical, DeWeese argues that metaphysical time would be equivalent to "God's time".

§2.2 Models of Eternity

For the purposes of this essay eternity will not be understood as identical with sempiternity. Sempiternity simply means "existing at all times"[16], and whilst there has been much discussion as to the relationship between sempiternity and

[14] The relativity of the measurement of time will be examined in more detail in §4.2. For now it is simply worth noting that there is a question of the extent to which the measurement of time relates to the nature of time particularly regarding STR.

[15] the combination of your space-time location and world line [temporal history]

[16] This seems to be the accepted definition of sempiternity, and is provided by Kneale and others, however it does deviate from Boethius' concept of sempiternity as 'the perpetual running resulting from the flowing, tireless now' (cf. Stump and Kretzmann, 'Eternity' P.431) which for the purposes of this essay I would consider to be akin to J. Harris' argument for eternity as the specious present, and as such would be viewed as transcendent eternity, rather than sempiternity.

eternity[17], it cannot be resolved without a clear definition of eternity. Secondly there is a distinction between atemporal and temporal models of eternity. Atemporal eternity can be understood in three ways: tensed-atemporality (TA posits that there is no temporal succession and eternity is entirely without extension or temporal location; absolute-atemporality (AA) posits that there is no temporal succession, but eternity is extended in some "special" way[18]; external-atemporality (EA) posits that eternity exists "outside" time in a way that is not encompassed in either TA or AA. Temporal eternity on the other hand can refer to the view that eternity is an unlimited "now" within which there may be temporal succession presentist-eternity (PE)[19]; the other model being examined is transcendent-eternity (TE) which refers to the view that eternity is not within *our* time however it still contains temporal succession.

§3 Scientific Theories about Time and the Nature of Reality

'True revolutions in science involve more than spectacular discoveries and rapid advances in understanding. They also change the concepts on which the subject is based'[20]. There are four key scientific theories that have changed how we view space and time: Newtonian mechanics (NM), the Special Theory of Relativity (STR), the General Theory of Relativity (GTR), and quantum mechanics (QM). The scope of this thesis does not allow for an examination all of these theories. However, as NM produces a model of time that is the departure point for modern theories, and to a large extent mirrors our common sense understanding it will be examined in §3.1. QM with its varieties of interpretations would require more space than can be provided, therefore only the theories of relativity remain. It is true to say that GTR has superseded STR in many respects, it is able to account for the impact of bodies within spacetime on the structure of spacetime and it is perhaps one of the best confirmed theories of the twentieth century[21]. Equally it is true that if GTR is correct then STR cannot be, however it is not invalid as 'just as Newtonian mechanics are a first approximation and accurate for non-relativistic velocities and non-astronomical distances, so STR is an accurate approximation for isolated or

[17] M. Kneale, 'Eternity and Sempiternity', *Proceedings of the Aristotelian Society*, 69 (1968), 223–238 <doi:10.2307/4544777>.

[18] This use of the term differs from Padgett whose use of it is more in line with my definition of TA. He takes absolute-atemporality to mean there is no duration in the life of x, and it cannot be said to have extension or location in *any* time.

[19] Within this view I include authors such as J. Harris who argue that eternity can be understood as a specious present (and thus it is not without temporal succession and so isn't atemporal)

[20] Paul Davies, 'Introduction', in *Physics and Philosophy*, by Werner Heisenberg (Penguin, 1989). P.vii

[21] DeWeese, *God and the Nature of Time*. P.75

medium-sized objects moving at uniform velocities or low accelerations' [22]. Therefore given STR is most often cited in discussions of eternity, I will focus my discussion on the role of STR.

§3.1 Newtonian Time and Space

Everything that you need to know about Newton's theories on time and space are contained within his first and second laws of motion [23]. The first law states: 'Everybody (sic) preserves in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon'[24]. Although never explicitly discussed by Newton, the first law pre-supposes the existence of space with a geometric structure of Euclidean geometry called E^3. This geometry requires space to have topology, affine structure and metrical structure. These can all be likened to the three instruments used in Euclidean geometry: pencil, straightedge and compass.

The most fundamental aspect of space geometry is its topology, which provides the distinction between a single line in space and pair of disconnected lines. In order to distinguish between these within 3D space 'the points in the space must have some geometrical organization'[25]. This geometry is known as "rubber-sheet geometry" as it allows for lines for be distorted: straight lines can become curves and vice versa, however intersecting lines will still intersect after transformation and a figure that is inside another will remain so after the transformation. Equally the geometry does not allow for the space to be "torn" or "pasted" such that a continuous line becomes several disconnected lines, or disconnected curves become a continuous curve.

The affine structure of space is akin to the straightedge within Euclidean geometry. In order to be able to draw straight lines, there must be something that is different between a straight line and another kind of line within absolute space. The affine structure means that 'every pair of points are end points of exactly one straight line and every finite line can be continued indefinitely in either direction'[26].

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[22] DeWeese, *God and the Nature of Time*. P.76
[23] Tim Maudlin, *Philosophy of Physics: Space and Time* (Princeton: Princeton University Press, 2012). P.4
[24] Isaac Newton, *THE MATHEMATICAL PRINCIPLES OF NATURAL PHILOSOPHY (Illustrated and Extended with The History of the Ancient Physics and The History of the Ancient Logics and Metaphysics)*, Kindle edition. Loc. 1001
[25] Maudlin, *Philosophy of Physics*. P.6
[26] Maudlin, *Philosophy of Physics*. P.7

Finally it may have been noted that the affine structure is provided not by a ruler but a straightedge, therefore something else must provide the metric for space. This is provided by the compass as the circle is 'the locus of points all equidistant from a given centre'[27]. In addition to attributing the E^3 structure to his absolute space Newton held both that space existed at all times, and that '*identically the same points* of space persist through time'[28]. This belief explains how we are to understand the "state of rest" in the first law. An object is at rest so long as it occupies the same points of space over a given period of time.

However the above geometry alone does not define what it means for an object to be in "uniform motion". Uniform motion is making a claim about *how long* it takes for an object to complete that motion. Whilst the state of rest requires a metric to space, uniform motion requires a metric of *time*. Thus without understanding the metrical nature of time it is impossible to understand the concept of uniform motion and thus Newton's first law.

Unlike the three dimensions of absolute space, absolute time has only 'a single, ordered sequence of instants that forms the totality of history'[29]. However just as absolute space has a metric that means it is possible to compare distance between points; the metric of absolute time allows us to compare lapsed time between instants. This enables us to say that the duration between I_1 and I_2 is the same as the duration between I_2 and I_3, but less than the duration between I_1 and I_3. In turn this means that we are then able to define absolute motion as 'a motion that covers the same amount of space in the same time'[30].

The precise features of space and time are not explicitly discussed by Newton, however it is necessary that space has an E^3 geometry and time has a metric. It is also important to make a distinction between absolute and relative time:

> Absolute, true and mathematical time, of itself, and from its own nature flows equably without regard to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means

[27] Maudlin, *Philosophy of Physics*. P.7
[28] Maudlin, *Philosophy of Physics*. P.10
[29] Maudlin, *Philosophy of Physics*. P.11
[30] Maudlin, *Philosophy of Physics*. P.11

> of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year[31].

Newton was a Platonist with respect to absolute time, and he equates relative time with measured time. The strength in the Newtonian model of time is even though neither absolute space nor absolute time are directly observable, the intuition of absolute time can be established from the fact that we are continually trying to make watches and clocks more accurate. Without absolute time the question has to be raised in respect to what do we want them to be "equal" or "constant"?

Newton's second law of motion provides us with the strongest evidence for absolute motion (and thus for absolute time and space). The second law of motion states that: 'the alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed'[32]. The first law of motion provides us with an intuitive "proof" about the existence of absolute time and space, even if absolute motion isn't observable, the forces acting upon the bodies in absolute motion are. Newton argues that absolute and relative motions are distinguished by the 'forces impressed upon bodies to generate motion. True motion is neither generated nor altered, but by some force […] moved; but relative motion may be generated or moved without any force'[33]. This is because for relative motion to be noted the body being observed doesn't have to move, instead the bodies it is being compared to may move instead.

To illustrate his point Newton uses two examples that highlight 'the forces of receding from the axis of circular motion'[34] as they cannot be understood in terms of relative motion. The first experiment involves hanging a bucket filled with water by a twisted rope, and then letting the rope unwind thus spinning the bucket. As the rope unwinds the water changes from being flat, to gradually receding from the centre of the bucket and then up the sides, before becoming flat once again when the bucket stops spinning. This simple experiment disproves the relationist thesis proposed by Aristotle and Descartes that whilst there are many relative motions as a body can be compared to numerous other bodies, 'the important physical motion of a body is its motion with respect to the body that immediately encloses it'[35]. According to the relativist account both when the bucket is still and when the

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[31] Newton. Loc.873
[32] Newton. Loc.1009
[33] Newton. Loc.946
[34] Newton. Loc.946
[35] Maudlin, *Philosophy of Physics*. P.22

bucket and water are spinning together the water is at rest in relation to the bucket. However the fact the water moves out from the centre and up the sides of the bucket would appear to suggest that the water can't be considered truly at rest in both instances, only the first.

The second example provides the clearest demonstration of absolute motion in the absence of relative motions:

> If two globes, kept at a given distance one from the other by means of a cord that connects them, were revolved about their common centre of gravity, we might, from the tension of the cord, discover the endeavour of the globes to recede from the axis of their motion […] even in an immense vacuum, where there was nothing external or sensible with which the globes could be compared

The strength of this example lies in the fact that spinning is a motion, and as we have seen, in order to understand motion there needs to be *something* an object is moving *in relation to*. This point is relevant to our enquiry, because even though there is no longer a belief in absolute space and so therefore no belief in absolute motion, both the bucket and the globe experiments cannot be explained in terms of the *relative* motion of bodies. This means that even in STR the globes would show a tension that would show whether or not a force is being applied. Thus 'even in Relativity, there is an *absolute* fact about whether or not the globes are rotating about their absolute centre of gravity'[36].

§3.2 Galilean Relativity: Moving Towards Spacetime

Although absolute time and space are empirically unobservable, it is possible to remove the unobservability by changing the ontology of space and time. Whilst Newton defended the claim that it was possible to observe the absolute *rotation* of a system through absolute space, Galileo argued that it was impossible to detect uniform motion *in a straight line* through absolute space. Galileo's proof lies in the results of experiments undertaken below decks on a ship:

> Shut yourself up with some friend in the main cabin […] and have with you there some flies, butterflies, and other small flying animals. Have a large

[36] Maudlin, *Philosophy of Physics*. P.23

> bowl of water with some fish in it; hang up a bottle that empties drop by drop into a wide vessel beneath it[37]

Whether the ship is at a standstill or moving at a constant speed there is no difference in the experimental results and therefore no empirically observable difference in the two states of motion:

> The little animals fly with equal speed to all sides of the cabin. The fish swim indifferently in all directions; the drops fall into the vessel beneath; and in throwing something to your friend, you need throw it no more strongly in one direction than another the distances being equal; jumping with your feet together, you pass equal spaces in every direction[38]

The claim that the outcome of the experiments, whether under motion or at rest, are the same is called Galilean relativity. Because the bodies don't move in relation to each other, there is no way to establish the different states of motion. At the moment of writing this I 'might be at absolute rest […] or moving at one million miles per hour through absolute space in the direction from earth to Alpha Centuri'[39]. However there is no way to establish which of these situations is true as absolute motion, in a straight line, cannot be established experimentally even though 'whether a body is rotating or not, in some absolute sense, appears to have observable consequences'[40].

To move away from this contradiction we need to look at space and time in terms of Galilean space-time[41]. Whereas Newtonian space and time refer to two different *kinds* of things[42] , Galilean space-time posits: 'an event is essentially a place-in-space-at-a-time […] a space-time point, which occurs only once, and, ideally has no spatial extension and takes up no time'[43].

Galilean space-time maintains Newtonian absolute time and so allows for a well-defined metric. This means that Galilean space-time can be "foliated" into simultaneity slices. This foliation means that it is possible to tell *objectively* which

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[37] Galileo, *Dialogue concerning the Two Chief World Systems* cited in Maudlin, *Philosophy of Physics*. Pp.49-50

[38]Galileo, *Dialogue concerning the Two Chief World Systems* cited in Maudlin, *Philosophy of Physics*. P.50

[39] Maudlin, *Philosophy of Physics*. P.52

[40] Maudlin, *Philosophy of Physics*. P.54

[41] I use "space-time" to refer to the Galilean model and "spacetime" to refer to the Minkowski spacetime of STR.

[42] Absolute space with infinitely many points and absolute time with infinitely many instants where the infinite space points persist through time.

[43] Maudlin, *Philosophy of Physics*. P.60

events occurred at the same time (i.e. had a lapsed time of zero) the regular metric ensures that the elapsed between the space-time slice t=1 and t=2 is the same as the space-time slice t=n and t=n+1. Whilst Galilean space-time maintains the spatial geometry of E^3, it becomes specific to each simultaneity slice, due to the fact that points in space do not persist through time. Therefore 'indicating that the events on the slice t=0 have the structure of E^3 tells us nothing, in itself, about the geometry of events on t=1'[44]. Due to difficulties in explaining the observable phenomena of electromagnetism and light the Newtonian structure was replaced by STR. However before examining time within STR it is worthwhile to note how geometry and co-ordinates are used in the discussion of space and time.

§3.2.1 Arithmetic, Geometry and Coordinates

Whilst neither Newtonian nor Galilean accounts of the geometry of space and time require discussion of co-ordinates, they are required for STR. Maudlin does not use equations to describe absolute space and time because Newton didn't. Newton presented his theory using Euclidean geometry because motion in space is geometrical. The physical world is not made up of numbers but "physical magnitudes" and so geometry is more readily linked to the structure of the physical world than arithmetic. Even Einstein noted the difficulties in separating the "object of study" from the mathematical representation of physical reality. A clear example of this is that in many text books the geometry of Euclidean space is referred to not as E^3 but R^3. R^3 whilst representing the same physical space has a specific mathematic meaning. It expresses elements of Euclidean space as a 'set of ordered triples of real numbers'[45] that whilst being mathematical objects of R^3 are not physical elements of E^3.

The reason for the involvement of elements in R^3 that do not correlate to points in E^3 is due to the fact that R^3 is a coordinate system that represents E^3. The coordinates are used to encode the geometrical structure of E^3, which in the case of Euclidean geometry involves Cartesian coordinates – every point has an x and y coordinate. The topology of the coordinate system *must* mesh with the topology of space it is describing. Therefore in dealing with Newtonian space it must have both an affine, metrical, and differential structure.

Once a compatible coordinate system has been established it is possible to state the laws for that space in an algebraic form, however, as already noted one must be

[44] Maudlin, *Philosophy of Physics*. P.61
[45] Maudlin, *Philosophy of Physics*. P.25

sure not to confuse the mathematical representation with physical reality. It is also possible to classify the type of coordinate system in relation to the geometrical structure of the space it is being used to describe. Such characterization however, does depend upon 'the space itself, independently of all coordinates, having a certain geometrical structure'[46].

The requirement for an underlying geometrical structure also applies to being able to characterize a coordinate system as "inertial" or "non-inertial". So far we have only assigned two numbers (or spatial coordinates) to our spatial "lines" (x, y). In E^3 a single event will have three spatial coordinates (x, y, z) and one time coordinate (t) giving a four figure coordinate for each event (t, x, y, z). The time coordinate relates to the time elapsed between events, therefore all events on a single simultaneity slice have the same time coordinate even though their spatial coordinates will differ. The spatial coordinates will only be comparable within a single simultaneity slice, as Galilean space-time does not hold to Newtonian absolute space.

§3.3 Special Relativity Spacetime

Einstein begins his discussion of STR with a basic example from which the implications of STR can be examined:

> I stand at the window of a railway carriage which is travelling uniformly, and drop a stone on the embankment […] I see the stone descend in a straight line. A pedestrian […] notices that the stone falls to earth in a parabolic curve[47]

The question then becomes which of these observations is correct? This is where the concept of reference comes into play, as depending on whether one takes the carriage or the embankment as the "rigid body of reference"[48], depends on the answer one will get. Although the concept of a coordinate system or reference frame is not a fundamental concept to STR, but derivative on the objective geometrical structure of space[49], the response is dependent on what the system of coordinates is "attached" to[50]. This shows that 'there is no such thing as an independently existing trajectory […], but only a trajectory relative to a particular

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[46] Maudlin, *Philosophy of Physics*. P.32
[47] Albert Einstein, *Relativity: The Special and the General Theory*, trans. by Robert W. Lawson, Kindle Edition (London: Routledge, 2001). Loc.163
[48] Einstein uses "rigid body of reference" interchangeably with "system of coordinates"
[49] See §3.3.2
[50] I.e. the embankment or the train

body of reference'[51]. In addition in order to arrive at a complete picture it is necessary to include an account of how this relates to time. In this instance, time is introduced by each observer (the one on the train and the one on the embankment) determining 'the position on his own reference-body accompanied by the stone at each tick of the clock he is holding in his hand'[52].

The Principle of Relativity (PR) refers to relativity with respect to non-relativistic coordinate systems. It is possible to reformulate the first law in terms of PR, resulting in:

> If a mass m is moving uniformly in a straight line with respect to a co-ordinate system K, then it will also be moving in a straight line relative to a second co-ordinate system K'

This implies that if K is understood in terms of a Galilean coordinate system, K' must be too in order that natural phenomena adhere to the same laws in K and K'. PR (in the restricted sense) refers to this trans-coordinate correlation. If restricted PR does not hold it leads to a situation where the laws that govern natural phenomena in coordinate systems that are moving relative to each other, such as the carriage and the embankment, will not be the same. For example if we understand the embankment coordinate system at rest (K), and the carriage coordinate system moving relative to it (K_0) then it appears that less simple laws would apply to natural phenomena in K than in K_0 'due to the fact that the carriage would be in motion (i.e. "really") with respect to K_0'[53]. The movement of one system in relation to another can be viewed as analogous to the Earth's rotation around the sun, and yet 'the most careful observations have never revealed such anisotropic properties in terrestrial physical space'. It seems reasonable to hold to the validity of PR until one tries to reconcile it with the constancy of the speed of light[54]. If a ray of light propagated along the embankment is travelling with a velocity of c[55] and PR states the speed of light must be the same irrespective of our

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[51] Einstein. Loc.171
[52] Einstein. Loc.181
[53] Einstein. Loc.225
[54] Note: this is not the same as saying that light has a terminal velocity; it is simply the claim that light travels at the same speed in a vacuum irrespective of the speed of the object propagating it or the direction in which it is propagated.
[55] Approximately 300,000km/second in a vacuum, for the purposes of this example it is expedient to imagine that the air directly above the embankment has been removed and so the light ray is travelling in a vacuum.

rigid body of reference[56], then a ray of light propagated in the carriage must be travelling at the same speed. However if the ray of light in the carriage travelling in the direction of the light is given speed (*v*) and the velocity of light relative to the embankment has speed (*w)* then the velocity of the ray of light from the reference of the carriage is *w*=*c*-*v*. But this means from the reference point of the carriage the light is travelling at less than c, and therefore the speed of light is not constant.

§3.3.1 Introducing Time into Spacetime

If two lightning bolts hit either end of the embankment (at A and B) can my assertion that the two events were simultaneous be said to make sense? Within physics simultaneity 'does not exist for the physicist until he has the possibility of discussing whether or not it is fulfilled in an actual case'[57]. This means that any definition of simultaneity must also provide the method for establishing if it true. This leads to an apparent logical circularity requiring that we are able to measure time before we can say whether or not two events are simultaneous, but this is not necessarily the case[58]. However if we assume that the velocity of light travels from A to M at the same rate it travels from B to M it is possible to define a method of establishing simultaneity. An observer is placed at the mid-point of $\overline{AB}$ (M), with an arrangement of mirrors such that A and B are visually observable at the same time. 'If the observer perceives the two flashes of lightning at the same time, then they are simultaneous'[59]. 'In reality it assumes absolutely nothing about light'[60] it only provides a conception that can be empirically fulfilled.

This leads to a definition of time within physics. If clocks of identical construction are placed at A, M and B of the embankment (coordinate system), then the time of an event correlates to the reading[61] given by the clock in the immediate spatial vicinity of the event. This provides us with absolute simultaneity from the point of the embankment. However, in order to examine the impact a moving body of reference has on simultaneity, it is necessary to return to the double lightning strike on the embankment as viewed from the carriage. If an observer was positioned in the carriage moving in the direction of $\overline{AB}$ such that at the time of the

[56] Due to the fact that both coordinate systems must be Galilean and therefore the laws of natural phenomenon must be the same in both reference frames.
[57] Einstein. Loc.293
[58] This is known as the conventionality of one-way velocity (examined in more detail in §4.2)
[59] Einstein. Loc.302
[60] Einstein. Loc.302
[61] Position of the hands

lightning strike they were at M, they would not perceive the events at A and B as simultaneous. The reason for the lack of simultaneity is due to the fact that they are moving towards the light source at B and so the light from B has less far to travel, therefore it will reach them before the flash from A. This means that 'every reference body […] has its own particular time; unless we are told the reference-body to which the statement of time refers; there is no meaning in a statement of the time of the event'[62][63].

§3.3.2 Finding the Geometrical Structure of Minkowski Spacetime

So far time in STR has been defined time in terms of clocks, and as seen in §2.1 measured time is only one (non-fundamental) kind of time, dependent on the structure of the spacetime it is being used to measure. This understanding appears to be derivative of the underlying nature of spacetime rather than a fundamental element of it. In fact it would be fair to say that '"clock" is evidently not the sort of term that should appear in a fundamental physical law […] nature does not have to settle whether any given mechanism counts as a "clock" in order to determine how it should behave'[64].

However, it is possible to view the "clock" not as measuring the passage of absolute time, but as measuring something else. What is being measured must be an absolute "thing" as if two identical, accurate clocks are placed side by side they measure *something* off at the same rate. What they are measuring is not the passage of absolute time, but their passage (or trajectory) through spacetime. Therefore much as an odometer on two cars driving side by side will tick over at the same rate, but will show a different reading if one car takes a different route to the end point, the same is true of two clocks travelling though Mst. This is called the Clock hypothesis:

> Clock Hypothesis: The amount of time that an accurate clock shows to have elapsed between two events is proportional to the Interval along the clocks trajectory between those events, or, in short, clocks measure the Interval along their trajectories[65]

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[62] Einstein. Loc.347

[63] The need for a reference frame in order to make sense of judgements about time can be seen to be mirrored in Nelson's work on internal and external questions. This link will be examined in more detail in§5.2

[64] Maudlin, *Philosophy of Physics*. P.106

[65] Maudlin, *Philosophy of Physics*. P.76 (capitalization occurs in original)

It is this hypothesis that can account for the famous twin paradox without recourse to any mention of the speed of light, or the passage of time being slower/faster:

> Two twins, with identically constructed clocks, begin in a situation where they are side by side in rocket ships and subject to no forces. Twin A briefly turns on his engines, then turns them off. The twins drift apart. After a while, twin A again fires his engines, but in the opposite direction. He eventually drifts back twin B, who has never fired his engines. Twin A fires his engines a third time, coming back to relative rest with respect to twin B. When the twins compare their clocks, they find that twin B's clock has run off more time than twin A's. Furthermore, twin B appears to be biologically older than twin A.[66]

Whilst it may appear from a space-time diagram of the situation[67] that there is a paradox as Twin B's line "appears" to be longer, the reason the twins' clocks register different times is due to the fact that the 'clocks measure the Interval along their world-lines [trajectory through Mst], and B's world line between *o* [point of origin] and *q* [end point] is longer than A's. Period. There is nothing more to say'[68]. Having established that "clocks" measure their trajectory rather than absolute space, in order to understand how the temporal metric works within Mst the Clock Hypothesis needs to be combined with The Law of Light and the Relativistic Law of inertia. These additional laws expand on the behaviour of light in a vacuum: '*the trajectory of light in a vacuum is independent of the physical state of its source*'[69].

If one bears in mind that there is no physical structure in a vacuum except the structure of Mst itself, this implies that: the trajectory of light rays are determined solely by the geometry of Mst. This means that if a light is emitted at *P* then the structure of MSt should define where the light emitted will go (no matter the direction it is emitted in), the points where light might go from *P* is called the *future light-cone* of *P*. Likewise the points in space from which it is possible that light emitted might reach *P* is called the *backward light-cone* of *P*. This rule that every event in MSt must have both a forward and backward light-cone replaces the foliation Galilean space-time:

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[66] Maudlin, *Philosophy of Physics*. P.77
[67] See Appendix A
[68] Maudlin, *Philosophy of Physics*. P.79 (capitalization occurs in original)
[69] Maudlin, *Philosophy of Physics*. P.68 (original emphasis)

> Law of Light: The trajectory of a light ray emitted from an event (in a vacuum) is a straight line on the future light cone of that event.[70]

As Mst has the same underlying affine structure as E^3 it is possible to restate Newton's first law of motion so that it applies to Minkowski rather than Galilean spacetime:

> Relativistic Law of Inertia: The trajectory of any physical entity subject to no external influence is a straight line in Minkowski space-time[71]

These three laws establish what observable behaviour can be expected from physical items due to the (unobservable) geometrical structure of Mst. Therefore just the temporal metric of E^3 was explained through the compass, the temporal metric of MSt (and relativity of simultaneity) can be understood through the Clock Hypothesis. In order to understand the relativity of simultaneity, we need a collection of ideal clocks. If the following experiment were to be performed in E^3 it would be enough that the collection of clocks started and ended in the same simultaneity slices as each other to know that they would display the same amount of elapsed space. However in MSt it is more important to know the trajectory the clock took between the two points.

The twin paradox shows the importance of trajectory, so it is necessary for the collection of cocks to be co-moving. In order for the clocks to be co-moving they must be on inertial trajectories neither moving closer together nor further apart from each other. One clock is nominated as the master-clock from which all others are synchronised; it is also used to establish that the collection of clocks is co-moving[72]. Having established a collection of co-moving clocks it is necessary to calibrate and synchronise them. The clocks are calibrated by stating that the master-clock emits a light ray every minute, this then gives us a unit of measurement with which to work. If we take it that the round trip of the light ray takes 2 minutes, then the co-moving clocks would have to adjust their reading so that on receiving the light ray they showed I minute later than the time signature (the time it was released from the master clock) of the light ray. Once this is done the clocks are calibrated (each is "ticking at the same rate").

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[70] Maudlin, *Philosophy of Physics*. P.75

[71] Maudlin, *Philosophy of Physics*. P.75

[72] In order to establish whether a clock is co-moving to the master-clock an observer sends out light rays from the master-clock towards the target clock. If the round trip (i.e. to the target clock and back) takes the same amount of time for each measurement then the clocks are co-moving, if the round trip time increases/decreases the target clock is moving away from/towards the master-clock.

It is the final step that synchronizes the clocks that leads to "problems" with simultaneity. In synchronizing the clocks there is no absolute foliation, therefore establishing simultaneity is dependent on convention[73]. Whilst there is no singular way to establish simultaneity, some conventions are simpler than others. For example synchronizing the master clock and target clock means only that I have to ensure that (given the two minute round trip time) if the master-clock reads 12:00 when the first light ray is emitted, the target clock will read 12:01 when it receives the ray, and the master-clock will read 12:02 when the signal returns. If every clock is adjusted to this convention then it is possible to say that two events are simultaneous. However, given the arbitrary choice of master clock, as well as the convention for synchronising the clocks it would be more correct to say that they occur on '*equal t-slices*' [74] rather than simultaneity slices. This is particularly important given the fact that if we opt for a different master/target clock the t-slices will be different.

The most obvious way to show the lack of an objective account for simultaneity in Mst is by choosing to calibrate the co-moving collection from a different master-clock (master-clock^{m}). Master-clock^{m} is moving away from the master-clock and will be calibrated with target-clock^{m}. It is equally valid to pick master-clock^{m} as the calibrating clock given our initial choice was arbitrary. Having chosen master-clock^{m} establishing and synchronising a collection of co-moving clocks is the same. Both collections would enable a *t-coordinate* to be assigned to any event in Mst. So far nothing complex has happened due to this taking place in Mst. The geometry of Mst comes into play if observer^{m} tried to correlate his t-slices with observer^{o} (the original observer). If simultaneity was a genuine feature of Mst as it is in Galilean space-time only one of the collections of t-slices would be correct. This is not the case for Mst. If we compared timings for observer^{o} and observer^{m} of event *x* the

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[73] The conventionality of simultaneity has been much debated and has yet to be definitively settled one way or another (see: Allen Janis, 'Conventionality of Simultaneity', in *The Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta, Fall 2010, 2010 <http://plato.stanford.edu/archives/fall2010/entries/spacetime-convensimul/> [accessed 7 November 2012].;David Malament, 'Causal Theories of Time and the Conventionality of Simultaneity', *Noûs*, 11 (1977), 293–300 <doi:10.2307/2214766>; Sahotra Sarkar and John Stachel, 'Did Malament Prove the Non-Conventionality of Simultaneity in the Special Theory of Relativity?', *Philosophy of Science*, 66 (1999), 208–220 <doi:10.2307/188643>; Adolf Grünbaum, 'David Malament and the Conventionality of Simultaneity: A Reply', 2001 <http://philsci-archive.pitt.edu/184/> [accessed 27 September 2013]; John A. Winnie, 'Special Relativity Without One-Way Velocity Assumptions: Part I', *Philosophy of Science*, 37 (1970), 81–99 <doi:10.2307/186029>.) . A complete analysis of the debate would be outside the scope of this thesis, however §4.2 will examine the possible consequences of the conventionality of simultaneity.

[74] Maudlin, *Philosophy of Physics*. P.90

equal t-slices would not correlate. It would appear that observer^{m}'s clock would be "running slow" from the perspective of observer^{o}. Yet the symmetry of the situation means observer^{o}'s clock would appear to be "running slow" from the perspective of observer^{m}. Because there is no foliation in Mst, there is no "correct" time for *x*, it is entirely dependent upon the (arbitrary) choice of a master-clock (coordinate system).

This phenomenon is known as "time dilation" and is based in the choice of coordinates, and it shows that 'the key claim of Relativity is the *nonexistence* of simultaneity as a real physical relation among events'[75]. It is this lack of the objectivity of simultaneity that brings STR into debates about the nature of eternity. The key thing to note is that light, in and of itself has no speed, because without absolute space and time there is no way to establish an absolute velocity. Light only has an absolute speed in relation to a *particular coordinate system*.

§4 Scientific Theories about Time and the Nature of Eternity

Science has nothing to say about the concept of eternity, science only provides us with models of time that accurately describe the effects of spacetime ontology on observable phenomena within given parameters. Theology on the other hand gives us explanations of eternity that satisfy some or all of our doctrinal requirements regarding divine attributes. So how do scientific theories of time contribute to coherent theological/philosophical models of eternity? The answer lies in all models of eternity being grounded in theories about the nature and reality of time, either implicitly or explicitly. These assumptions can be held up against STR spacetime to see if they stay coherent. Whilst there are many scientific models of time, it is STR that is most often called in to validate or expand or theories of eternity. There are two major issues that arise from STR: the relativity of simultaneity and the conventionality of simultaneity. In §5 and §6 I will examine each model of eternity from §2.2 against these challenges to see if any are able to cohere with STR.

§4.1 Relativity of Simultaneity

Simultaneity can be understood as a structure that may or may not be intrinsic to spacetime that can be used to organize events[76]. If simultaneity can be defined entirely in terms of the structure of spacetime it can be understood as an absolute

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[75] Maudlin, *Philosophy of Physics*. P.92

[76] Domenico Giulini, 'Uniqueness of Simultaneity', *The British Journal for the Philosophy of Science*, 52 (2001), 651–670 <doi:10.2307/3541912>.

relation. However in STR it is no longer possible to definitively state that two events occurred simultaneously: 'every reference-body […] has its own particular time; unless we are told the reference-body to which the statement of time refers, there is no meaning in a statement of the time of an event'[77]. Thus there is 'no absolute fact to whether two spatially separated events are simultaneous'[78]. This leads to an incompatibility between STR and presentism, summed up in the incompatibility of the following premises:

(P1) All and only things that exist now are real

(P2) Special relativity is a complete account of spatiotemporal structure [79]

If STR is "taken seriously" and viewed as a complete account of spatiotemporal structure it rules out (P1). (P1) becomes incoherent due to the following argument: in STR an event E_1 is "now" relative to itself and there is no way, intrinsic to the geometry of Mst, to establish which events distant to E_1 are "now" relative to it. The problem of a "correct" way to establish a simultaneity slice is summed up in the conventionality of simultaneity (see §4.2). Instead we are dependent on the relativity of simultaneity, where choice of a "preferred plane of simultaneity" is not due to the fundamental ontology of MSt.

Attempts to maintain both (P1) and (P2) lead to extreme solipsism. This is because if there is no determinate way to establish which events are "now" relative to E_1 then there no other events that are determinately real relative to E_1. Therefore nothing is real relative to E_1 except E_1, and yet due to the fact that every event E_n is real relative to itself it leads to pluralistic extreme solipsism. The preferred Scientific and philosophical option at this point is to reject presentism (P1) outright and adopt a "block universe" (eternalist) theory of time.

§4.2 Conventionality of Simultaneity

Simultaneity does not exist for the physicist until 'he has the possibility of discovering whether or not it is fulfilled in an actual case'[80]. This is evidenced in

[77] Einstein. Loc.347

[78] John D. Norton, 'Special Theory of Relativity: Relativity of Simultaneity', *Lecture Notes: Einstein for Everyone* <http://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/Special_relativity_rel_sim/index.html> [accessed 28 May 2013].

[79] Katherine Brading, 'Presentism as an Empirical Hypothesis', 2012 <http://philsci-archive.pitt.edu/9428/> [accessed 30 November 2012]. P.1

[80] Einstein. Loc.293

the clock hypothesis[81] where it is assumed that the speed of the light ray travelling from the master clock to the target clock is the same as when it travels from the target clock back to the master clock. The very notion of simultaneity is established on an (unverifiable) convention that the speed of light is constant.

The speed of light is empirically unverifiable because in order to establish the speed of light between the master clock and the target clock we need to know both the distance between them and the time it takes for the light to travel. However in order to establish the amount of time it takes light to travel between the two clocks they need to be synchronised, 'but to synchronize the clocks the one-velocity (sic) of light should be known beforehand'[82]. The importance of this is that not only is the one-way speed of light a convention but 'the conventionality […] implies conventionality of the simultaneity of events as well'[83]. The fact that relativity is shown to be conventional and frame dependent means there is nothing in the objective structure of Mst that corresponds to absolute simultaneity[84]. There is no absolute or objective measure of simultaneity (relativity of simultaneity), which implies that simultaneity is only a matter of convention. The reverse is also true, there being no objective measure of simultaneity means that 'different observers […] are not forced […] to share the same class of simultaneous events, which means simultaneity is not absolute and is therefore relative'[85]. The crux of the matter is that in the case of three-dimensional space simultaneity as convention would not be possible due to the existence of an objective measure of which events are simultaneous.

§4.3 The Current State of Affairs

As can be seen from §2.2 there is a wide diversity in how eternity is understood. The above divisions are not necessarily mutually exclusive; however they represent a divergence in beliefs about the ontological status of eternity. Whilst much of the literature that deals with eternity in a way that is, at some level, distinct from the divine attributes dates back to the 1970's, the modern work of scholars such as Brading [86], Le Poidevin [87] and Besnard [88], has provided rigorous work linking

[81] see §3.3.2
[82] Vesselin Petkov, 'Conventionality of Simultaneity and Reality', 2008 <http://philsci-archive.pitt.edu/3986/> [accessed 28 September 2013].P.2
[83] Petkov. P.3
[84] Petkov. §2
[85] Petkov. P.5
[86] Brading, 'Presentism as an Empirical Hypothesis'; Brading, 'Physically Locating the Present'.
[87] Robin Le Poidevin, 'The Experience and Perception of Time', in *The Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta, Fall 2011, 2011

philosophical and scientific discussions of time. The fact that this development has occurred alongside a drive to bring new perspectives to bear on the traditional problems of philosophy of religion[89], means that whilst there isn't necessarily a large body of literature on role of science in understanding eternity, there are collective bodies of work looking both at the role of science in our understanding of time, and applying scientific understanding to philosophy of religion.

This evaluation is not exhaustive of existing arguments for eternity; however it provides a broad spectrum of the current approaches to eternity. Although I have aimed to avoid models in which the concept of God is not entirely separable from eternity, on occasions this isn't possible. Where this is the case I have adopted a convention of replacing "God" with "E-entity". This allows for the discussion of models of eternity that require a "life" or "being" without imposing the metaphysical baggage of "God" on to the discussion. The E-entity may or may not have the attributes associated with the Judeo-Christian God, but it is possibly safer to understand it as a non-physical, conscious being.

§5 Atemporal Eternity

Atemporality means that there is no way to order time, there can be no *before* or *after* in an atemporal eternity. This applies not only to events within eternity, but also to temporal-eternal relations as any ordering of events brings eternity into a temporal series and thus reduces it to endless temporality (sempiternity). Atemporality equates to the traditional view of timelessness. Both Absolute and Tensed Atemporality provide ways in which we can understand the relationship between eternal and temporal events in light of the lack of succession within atemporality. External-Atemporality provides a different model of atemporal eternity that spans the atemporal/temporal divide.

<http://plato.stanford.edu/archives/fall2011/entriesime-experience/> [accessed 19 November 2012]; Robin Le Poidevin, *Travels in Four Dimensions: The Enigmas of Space and Time* (Clarendon Press, 2003); Robin Le Poidevin, *The Images of Time: An Essay on Temporal Representation* (OUP Oxford, 2009).

[88] Besnard.

[89] Yujin Nagasawa, ed., *Scientific Approaches to the Philosophy of Religion* (Houndmills, Basingstoke, Hampshire; New York, N.Y.: Palgrave Macmillan, 2012); *New Waves in Philosophy of Religion*, New Waves in Philosophy (Basingstoke [England] ; New York: Palgrave Macmillan, 2009).

§5.1 Absolute-Atemporality

Stump and Kretzmann's (S&K) conception of eternity is based on Boethius' assertion that eternity is 'the complete possession all at once of illimitable life'[90]. They argue that this definition can be broken down into four claims. The first claim is that something cannot be eternal if it does not have life, meaning numbers, necessary truths etc. can only be considered atemporal not eternal. The second claim implicit in Boethius' definition is that the life held by the E-entity cannot be limited. On the stronger interpretation of this claim it is impossible for there to be either a beginning or an end to the life. The third claim is about duration, S&K argue that the kind of duration required by "illimitable life" is a special kind of duration; 'beginningless, endless, infinite duration'[91]. Although duration is a necessary attribute of anything that is to be called "life" it is necessary to understand this special kind of duration before examining the fourth claim "the complete possession all at once". A temporal life cannot be said to be possessed all at once because it is sequential, likewise it cannot be completely possessed because at any instant some events are past and some future and therefore not within the possession of the temporal entity. Thus the E-entity's "life" must have atemporality as well as duration.

S&K argue at this point that it is "evident" that although there is no temporal sequence 'it does not rule out the attribution of presentness or simultaneity to the life and relationships'[92] of an E-entity. This needs a little unpacking but can be tied into the requirement of the E-entity having "life" and consequently "existing". The problem with attaching "life" to the definition of eternity is that unless that life consists only of a single event, it must have a "present" existence. As the only existence it has is present ("all at once") the only relationship that can obtain between events in its life is one of simultaneity. For S&K, this present cannot be the present that we are familiar with in the temporal sense as that is a durationless instant[93]. As AA provides a view of eternity as a limitless duration the temporal understanding of the present does not work and cannot be extended without bringing concepts of temporal succession to bear upon it. Therefore this eternal

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[90] Anicius Manlius Severinus Boethius, *The Consolation of Philosophy*, trans. by H. R. JAMES, Kindle Edition, 2012. Book V, pr. VI

[91] Stump and Kretzmann. P.433

[92] Stump and Kretzmann. P.434

[93] It should be noted that Stump and Kretzmann unquestioningly adopt the presentist understanding of time where "now" is the knife edge instant between the past and present.

present is one in which all events occur E-simultaneously: the events exist or occur 'at one and the same eternal present'[94].

The problem is that whilst events within eternity and events within time can be understood as being simultaneous when they occur/exist at one and the same *time* (co-occur in time)or the same *eternal present* (co-occur in eternity);the same cannot be said when one event is eternal and the other is temporal (ET-simultaneity). The problem with ET-simultaneity is that there is nothing in which the events can co-occur. They cannot co-occur in time as that would reduce eternity to time, and they cannot co-occur in eternity as this would reduce time to eternity. S&K's version of AA highlights the dependence of models of eternity on our understanding of time. Their model of AA is dependent on the both the notion of absolute simultaneity and understanding time in terms of the presentist model. In order for there to be absolute simultaneity S&K adopt Newtonian absolute time[95].

However AA, as S&K conceive it, requires that duration without temporal extension is far more than "empty time". They argue that analysis of the concept of time shows that our experience of duration is illusionary, given that nothing is real except the present, so nothing can endure. Genuine duration must involve atemporal duration as only then is it possible for something to be fully realized in an existence where no part of it has either gone out of existence or is yet to come into existence. Eternity is the only way in which duration can be fully realized. The rest of their argument for eternity as the "possession of illimitable life all at once" is based on this understanding of eternity. The issue for S&K is that they are committed to presentist metaphysics, because they require an absolute present; without which they would have to accept some form of relativity and seemingly lose any possibility of simultaneity. They require simultaneity because they are committed to preserving free will in face of omniscience, and this commitment stems from creating a model of eternity around divine attributes.

There is perhaps another way to understand absolute atemporality, although it requires an E-entity to perceive our temporal existence. Sutherland[96] is talking specifically about omniscience, but I feel that his description can be used to

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[94] Stump and Kretzmann. P.435

[95] For a detailed examination of what is required by Newtonian time see §3.1. The implications of a non-Newtonian view of spacetime on this version of AA will be discussed in §5.1.1

[96] Stewart R. Sutherland, 'God, Time and Eternity', *Proceedings of the Aristotelian Society*, 79 (1978), 103–121 <doi:10.2307/4544936>.

understand how eternality differs as of mode of existence from temporality. Sutherland argues not only is foreknowledge impossible from an atemporal perspective, but so is the temporal ordering of experience. From a temporal perspective part of the way in which we distinguish between our knowledge of the past and present is that we know the latter with more certainty. Our temporal knowledge is based on distinctions between past, present, and future, but if our E-entity is said to know everything, then there cannot be these gradations of certainty in knowledge. If everything is immediately distinct and clear, then Sutherland argues that 'remembering' and direct experience cannot be distinguished, and in this way it would seem that whilst there could be duration in an atemporal existence, the atemporality stems from a feature of the *experience* of eternality rather than something which is intrinsic to eternity itself.

Sutherland's understanding of eternality provides us with a model that ties into Brading's argument[97] that "now" is not an actual feature of time rather it is a psychological one. It would also seem that this could be attached to Nelson's model to start building up a more detailed picture of atemporality as a mode of existence. The question that still remains is how an atemporal eternity can be said to relate to our temporal universe, of which it would seem that a spacetime framework is a fundamental and inseparable aspect.

§5.1.1 Absolute-Atemporality and Special Theory of Relativity

S&K employ STR as a purely heuristic device in order to explain the difficulties of defining ET-Simultaneity. However this does not mean that their version of AA is impervious to the challenges of the relativity and conventionality of simultaneity. Whilst S&K don't explicitly adopt a particular model of time, their motivation for understanding eternity as an atemporal duration is based on dissatisfaction with the conception of "now" found in presentism.

S&K argue that our experience of the (specious) present is illusionary, and that given the impossibility of true duration in temporality, it can only be understood from an atemporal perspective. Therefore in order to experience life "all at once" the E-entity must be atemporal. I would argue that there is nothing contradictory between STR and understanding "now" as specious with regards our *experience* of time. However there is no correlate between the structure of Mst and a fixed

[97] Brading, 'Physically Locating the Present'.

"now", so it could be argued that the requirement for an absolute eternal "now" forces eternity to be atemporal in the face of STR.

The second requirement for S&K's conception of AA is that "life" is experienced simultaneously and simultaneity is problematic with STR due to the conventionality thesis. Additional simultaneity difficulties arise due to the fact that whilst eternity is atemporal, the "world" they want experienced as "all at once" is temporal and does have its simultaneity relations affected by STR. In their discussion of eternity they claim that absolute time is not ruled out by STR as 'every conscious temporal observer has an undeniable, indispensable sense of the absolute present'[98]. Not only does Harris argue against the absolute now (on the basis of our experience) but also this notion of the absolute present deviates from the Newtonian view of the present as absolute. On S&K's interpretation the absolute present is reduced to an aspect of our psychological experience of time. If we reduce time to psychological time, then there are no metaphysical truths to be discovered about either the nature of eternity or time because time isn't real. If time is merely an aspect of our psychological experience then eternity understood as atemporality is simply a duration of time which contains no conscious being.

Sutherland's version of AA explicitly reduces the present to a matter of psychological time. Psychological atemporality is not affected by the topology of Mst as it isn't an objective feature of reality. I feel the crux of the matter for both models is that they reduce atemporal duration/ "now" to a feature of psychological time upon which our scientific view of time has no bearing. This in turn prevents eternity being a real ontological feature of reality, and therefore it would appear that AA is a psychological feature of a temporal mode of existence. This would mean that further questions need to be raised about the effects of STR on sempiternally existing objects/events.

§5.2 Tensed-Atemporality

A second model of eternity that also adheres to atemporality as excluding succession is Tensed-Atemporality (TA). TA is developed by Nelson[99] as a model of eternity that is 'without extension of any sort'[100]. Nelson's model is unique in that he goes to great lengths to establish how it may be possible to understand what it is

[98] Stump and Kretzmann. P.440
[99] Although the terminology of tenses-atemporality is my own, Nelson calls his model Strong-timelessness.
[100] Nelson. P.11

for something to exist alongside, but temporally unrelated to our universe. In order understand what might be said of something temporally unrelated to us Nelson examines the kinds of questions it would be possible to ask about temporal relations in our universe (Alpha) and between that of an identical but temporally unrelated universe (Beta).

Beta is not physically, temporally or spatially related to Alfa. No temporal framework encompasses both Alpha and Beta, and nothing of Alpha can be said to be before, after or simultaneous with anything on Beta (and vice versa). No duration on Alpha is longer or shorter than a duration on Beta nor is there a common *now* to Alpha and Beta.

Nelson argues that there are three kinds of questions that can be asked about temporal relations on Alpha and Beta pseudo, internal and external. Pseudo questions of time try to relate events from different universes within a singular temporal sequence and are meaningless: I.e. did the car crash on Alpha happen before or after the president was elected on Beta? (From Alpha) What time is it *now* in Beta (or vice versa)? All these questions invoke trans-universal or absolute temporal relations between the universes. Any such question must be rejected as they have no correct answers. Thus TA can be seen to deny the existence of a cosmic time that spans both universes.

Internal questions of time are questions that must be raised and answered within the same temporal universe: Is Alpha-Fred Still Alive? This can only be raised and answered on Alpha (or on Beta if about Beta-Fred) otherwise it becomes a pseudo question. Internal questions are about a single frame of reference, and are located in the same temporal reference frame that they refer to. Internal questions could therefore refer to cosmic time within an individual universe, as there is nothing which prevents this from being the case. However whilst this would allow for cosmic time along the lines outlined by DeWeese, it would not be possible to allow for a metaphysical time that was basic to *all* other kinds of time as this would imply that there is some time of trans-universal measurement of time.

External questions of time can be asked in or outside a temporal reference frame: I.e. did the car crash in New York and the election of Cameron happen at the same time? As both the events occur in the same temporal reference frame the question can be asked by those on Alpha and Beta. The ability to pose and answer external questions would appear to imply that there is an intra-universe cosmic time that allows for genuine simultaneity to take place, whether this cosmic time is to be

understood in terms of absolute time, or as some kind of privileged reference frame is not clear. The clearest way to understand this is to allow for both universes to have physical time that is also cosmic time *for that universe*. However this does not mean that external questions would not be valid if STR holds, only that there would then be questions as to what extent it is possible to say that the two events are simultaneous due to the lack of absolute simultaneity.

Moving beyond the kinds of questions we can ask about a temporally unrelated universe, Nelson argues that when we claim "Beta exists" we are not making a claim about Beta's existence in our past or future, it is used in a logically tenseless sense. Importantly when we say Beta EXISTS[101] we are not even locating it within its own internal temporal reference frame as the claim that Beta *is* 'rules out a universal frame of temporal reference within which one might use a tensed statement locating [it's] existence'[102]. To say that something tenselessly exists is not to claim it exists sempiternally or even that the statement is always true. Rather that they 'neither express nor imply any *temporal* relation between these statements and the actions, events, or things referred to in them or described by them'[103]. Thus to say that eternity EXISTS, is not to make any claim about eternity's pre-existence to our temporal universe or about its ongoing existence in the future. By not implying any temporal relation between the statement/knowledge of what exists and the object existing, this kind of timelessness (atemporality) can be understood as correlating to the traditional model of timelessness (or as Nelson terms it Weak –Timelessness).

However TA is making a stronger claim than weak timelessness. What TA provides is a model whereby not only is eternity not temporally related to our temporal system, but 'it does not itself lie in *any* temporal system and is not itself temporally ordered or located at all'[104]. Furthermore, whilst the Alpha-Beta relationship provides an initial route to enable understanding 'a reality temporally unrelated to Alpha'[105] without the complications of strong timelessness, it does not mirror the temporal-eternity relationship fully. In order to mirror the temporal-eternal relationship an omniscient, omnipotent realtor of Alpha and Beta is introduced, however for the purposes of this thesis the E-entity will suffice to fulfill this role.

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[101] capitalization indicates a tenseless verb
[102] Nelson. P.6
[103] Nelson. P.7
[104] Nelson. P.10
[105] Nelson. P.10

The E-entity is not located temporally, physically or spatially within either Alpha or Beta; in saying the E-entity exists, exists is to be understood tenselessly and without any connotations of its existing at any time in either Alpha or Beta. The fact that the E-entity is not located in either temporal reference frame means that only external questions can be answered about Alpha or Beta from the E-entity's perspective. Further even if the E-entity was understood to have created both universes and have knowledge of events in them, the knowledge could not be collated into a single temporally ordered sequence even in a 'uniquely divine frame of temporal reference'[106].

It is the E-entity that provides the TA model for eternity as 'without extension of any sort'[107]. This is in contrast to AA which requires duration, even if it is a "special sort". This is where TA and AA diverge as TA highlights the "otherness" of eternity in comparison to time, without any extension or duration it leads to an eternity that is of 'neither infinitely long nor instantaneously short duration'[108]. The main advantage of TA is that it avoids the confusion inherent in AA of trying to establish how atemporal duration can be understood. However in terms of illuminating our understanding of eternity it is only able to provide a *via negativa* account once we move from Alpha-Beta to Alpha-E-entity. Although as mentioned in §5.1 this may be augmented by combining it with other understandings of eternity such as that provided by Sutherland.

§5.2.1 Tensed-Atemporality and Special Theory of Relativity

TA is perhaps the model of eternity most naturally suited to a relativistic understanding of time. The inability to raise internal questions from outside the reference frame a particular world has a clear correlation with the relativity of simultaneity, as does the denial of any divine reference frame. The conventionality of simultaneity, equally, isn't an issue either due to the fact that times are world (reference frame) relative. The only difficulty stems from the fact that given eternity is not temporally or spatially related to Alpha there are philosophical questions about the precise nature of TA eternity and theological questions about the relationship between eternity and Alpha. However with respect to the relationship between TA and STR there do not appear to be any conflicts.

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[106] Nelson. P.9
[107] Nelson. P.11
[108] Nelson. P.12

§5.3 External-Atemporality

The concept of eternity as entirely "outside" time is s what springs to mind most readily in discussions of atemporality. One way to understand atemporality is from a reductionist perspective. As already noted[109] Reductionists hold there can be no time outside the relationships between events in time. The reasons for holding a reductionist account of time are twofold. Firstly it would seem that by definition time is 'a system of temporal relations among things and events'[110], and therefore the concept of time existing without events is incoherent. Secondly, there is no reason for us posit "empty" time, and even if there were 'we would not have any way of knowing about either its existence or its length'[111]. On this understanding of time, it is possible to argue that eternity was atemporal before there existed any events within it, and that at the moment of creation (or the first event) eternity then becomes temporal. For the purposes of this section I will only be concerned with how we might understand the atemporal aspect of this model of eternity.

One way to understand EA is provided by Zimmerman[112]. Whilst Zimmerman does not address the question of External-Atemporality (EA) directly, he examines how it may be possible to understand God's existence prior to time. Firstly, it is necessary to highlight some of Zimmerman's assumptions. Time without change is examined from an A-theorist position, which as discussed in §2.1 holds that there 'is an objectively distinguished present'[113]. Due to this the relativity of simultaneity cannot be held to be true as the "simultaneity" discussed in STR is 'something other than *real* simultaneity'[114] and so accepting the relativity of simultaneity would be to claim that 'what *exists* is relative to reference frame'[115].

The crux of this debate is whether it is possible to understand a first moment of time such that:

> (A1*) If a time *t* is such that (1) there is *no* temporally non-trivial property or relation P such that something ceased to have or began to have it before *t*,

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[109] See §2.1
[110] Ned Markosian, 'Time', in *The Stanford Encyclopedia of Philosophy*, ed. by Edward N. Zalta, Winter 2010, 2010 <http://plato.stanford.edu/archives/win2010/entriesime/> [accessed 6 November 2012]. §2
[111] Markosian. §2
[112] D. W. Zimmerman, 'God Inside Time and before Creation', in *God and Time: Essays on the Divine Nature*, by Gregory E. Ganssle and David M. Woodruff, Kindle Edition (Oxford University Press, USA, 2001).
[113] Zimmerman. Loc.1306
[114] Zimmerman. Loc.1306
[115] Zimmerman. Loc.1306

> and (2) *nothing* came into being or passed away before *t*, then *t* is the first instant of time[116]

If time is understood as necessitating change, then in order for eternity to be atemporal there must be a first instant of time as otherwise eternity can only be understood in as temporal/sempiternal. However if time can be understood as having a beginning then this posits a "period" of atemporality prior to the first instant of time. This is the view that 'if there were no creatures, there would be neither time, nor place, and consequently no actual space'[117]. This "time" before time is only possible if time does not require change, if this is the case then it is possible to understand atemporal eternity as the 'neither infinite nor finite […] period of time during which no changes occurred'[118].

If one takes a relationist approach to time viewing times as either (1) sets of simultaneous events where events are understood as 'particular things, usually spatially located and non-repeatable'[119]; or (2) abstract proposition-like entities that are 'a complete, momentary state-of-the-whole-world'[120], then it is possible to understand eternity as something other than a reduction to sempiternal temporality. On a relationist approach, times can only be understood as sets of events, given that in the "time" before creation there was only a single event or state-of-the-world because there are no changes, there is only one time before creation.

Although it may seem that such an event must be temporally extended, given that it is a single event, and times are not 'distinct from the events happening "at" them'[121], any division of the event into temporally ordered successive parts would produce "times" that contain 'the same partless event, and nothing more. So there is really only the one time before creation after all'[122]. Because there is no way to introduce distinctions into part times in this "dead time" it must be viewed as entirely atemporal. In order for a period of time to have parts and be extended there must be 'different parts for each "place" in them at which an event could occur'[123], if this is not possible, if there is only one "place" for events to occur and

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[116] Zimmerman. Loc.1343-1351
[117] Leibniz cited from the *Leibniz-Clarke Correspondence* in Zimmerman. Loc.1383
[118] Zimmerman. Loc.1391-1398
[119] Zimmerman. Loc.1488
[120] Zimmerman. Loc.1488
[121] Zimmerman. Loc.1488
[122] Zimmerman. Loc.1510
[123] Zimmerman. Loc.1526

if, consequently, it is impossible for there to be non-simultaneous events 'then the "period" is but an instant'[124]. Whilst this may appear to reduce eternity to a finite time, Zimmerman argues that it is possible to deny the finitude of pre-creation time. He argues that just because these "times" must be able to be understood as instants in our ordinary and scientific contexts does not mean that they have to do so in *every* context. It would seem plausible to claim that as the pre-creation time contains only one event, in what will become an instant in post-creation time, it need not necessarily belong to the same category as post-creation instants. This is because in this 'pre-creation, pre-laws-of-nature period, there is temporal duration but no way of dividing up into periods with lengths'[125]. It is important to note that this model of EA is entirely dependent on a reductionist account of time, if time in terms of Platonism (with respect to time), then it is not possible to posit "pre-creation" atemporality.

§5.3.1 External-Atemporality and Special Theory of Relativity

The reductionist approach to time espoused in EA should theoretically give rise to time with a topology that is dependent 'on contingent facts about the relations among things and events in the world'[126]. Yet STR has a global topology that that means that 'having picked out the future light-cone at any one event, there is a unique way to determine the future light-cone at any other event'[127]. The relativism of STR comes not from the events themselves but from the choice of reference frame, what reductionism requires is something far more fundamental. Reductionism says that the very fabric of spacetime should be affected by the events and objects within it.

There are two points to note here: firstly the pre-creation atemporality of EA consists of only one event. This means the extent of the effect on the topology of time is questionable, and it *would* correlate to that fact that post creation (when there are more objects and events) the nature of time changes. Secondly, whilst the topology of STR is similar in structure to the topology of Euclidean space (see §3.3.2) and so not affected by the objects and events in it, the topology of GTR (which replaces STR at the cosmological level much as STR replaces Newtonian mechanics at astronomical distances[128]) *is* affected by the objects within it. This

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[124] Zimmerman. Loc.1535
[125] Zimmerman. Loc.1558
[126] Markosian. §3
[127] Maudlin, *Philosophy of Physics*.P.155
[128] DeWeese, *God and the Nature of Time*. P.76

means that there is 'no unique or objective notion of "the geometry of space"'[129]. Therefore whilst STR would potentially rule EA as incoherent, I would maintain that on a wider scientific understanding all is not lost.

§6 Temporal eternity

Whilst the challenge to atemporal models of eternity is to adequately capture the nature of timeless "duration", the challenge faced by temporal models is to capture eternity without descending into sempiternity. The most common ways that this is achieved are by placing eternity "outside" our time but enabling temporal succession within it, or by placing eternity "in" our time but claiming that succession is experienced as an extended "now". In addition, understanding eternity as truly temporal as opposed to sempiternal often requires the introduction of an E-entity.

§6.1 Transcendent-Eternity

One way to understand temporal eternity is to claim that the temporal succession in eternity is not the same as temporal succession in temporality. Just as an object that is omnispatial (omnipresent) is both nowhere and everywhere, so it is possible to formulate a model of eternity that is omnitemporal at no time and every time. Given the breadth of definitions applied to omnitemporality in the proceeding discussion of DeWeese's omnitemporality[130], I will use the term Transcendent-Eternity (TE).

As already mentioned, analogies can be made between TE and omnispatiality. If an omnispatial object is taken to be neither occupying space nor limited by 'spatial points which define its surface' [131] yet nevertheless present to space, a transcendently eternal object can be viewed as one which is not located in physical time but present to all times. However the key distinction between an omnispatial and a transcendently-eternal object it that an object in TE will be temporally limited by the present instant. This limitation occurs because of DeWeese's

[129] Maudlin, *Philosophy of Physics*. P.128
[130] DeWeese, *God and the Nature of Time*; Garrett J. DeWeese, 'Atemporal, Sempiternal, or Omnitemporal: God's Temporal Mode of Being', in *God and Time: Essays on the Divine Nature*, by Gregory E. Ganssle and David M. Woodruff, Kindle Edition (Oxford University Press, USA, 2001).
[131] DeWeese, *God and the Nature of Time*. P.240

adoption of a presentist view of time[132], although given DeWeese's definition of TE it isn't technically a limitation.

DeWeese defines an omnitemporal being as 'one that is present to every *actual* moment of time, without thereby being located in *physical* time'[133]. This definition highlights two key features of TE: *which* times it is co-present with, and *what kind* of time is being discussed. The limit of TE by the present instant doesn't restrict the *omni*temporality of TE, due to the fact that it is being b=discussed in terms of a presentist framework, this means that the present instant is the only time that is real. Claiming that TE should be present to unreal times would be like claiming that an omnispatial object should be present at locations that don't exist, it is not the limit in the sense of restricting what is possible, rather it simply delineates that the limits are those of possibility.

The requirement of co-presence to physical time prevents TE from becoming sempiternity. What it distinguishes TE is that it is located within *metaphysical* time whereas the temporality of creation is located in *physical* time. Whereas physical time is dependent on there being regular physical laws that provide a temporal metric, metaphysical time does not require regular physical laws. Rather 'the flow and direction of metaphysical time grounds the ordering relations of physical time'[134]. This means that even if our world had no regular physical laws providing the temporal metric it would still 'undergo a succession of moments (flow) with a determinate order (direction)'[135] that was grounded in metaphysical time. It is also important to note that due to the topology of presentist time 'the "now" of metaphysical time coincides with the "now" of any possible physical time' [136] meaning that TE is 'temporally present at every present moment of any possible physical time'[137].

TE has two key features, it has temporal properties (or succession) in relation to metaphysical time and it is present to all actual moments of any temporal world. In order for metaphysical time to exist i.e. for there to be metaphysical temporality,

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[132] DeWeese's argument for adopting the presentist model of time is based on causality and it is outlined and defended in *God and the Nature of Time* Ch.2 and 3. However due to the constraints of space in this thesis it cannot be examined here and so during discussions of TE it will be assumed that a presentist model of time is correct.
[133] DeWeese, *God and the Nature of Time*. P.240 (emphasis added)
[134] DeWeese, 'Atemporal, Sempiternal, or Omnitemporal'. Loc.905
[135] DeWeese, 'Atemporal, Sempiternal, or Omnitemporal'. Loc.905
[136] DeWeese, *God and the Nature of Time*. P.252
[137] DeWeese, *God and the Nature of Time*. P.252

there must be a causal relation occurring. In order for there to be a causal relation occurring in metaphysical time, there must be an E-entity in TE, and it is the 'causal states of mental states in [the E-entity that] […] grounds the flow and direction of metaphysical time'[138]. However even without a metric to metaphysical time, it would still be possible for events within metaphysical time to be ordered in a one-to-one relation with events in physical time. Such a relationship however would not provide the ability to define durations in metaphysical time due to the fact that without an intrinsic metric there would be no quantitative temporal relations within TE[139].

The second key feature of TE is that it is present to all times. This can be understood as the claim that for every temporal time t_t that is present in a temporal world *W*, it is also present within metaphysical time t_m such that there is no time earlier or later than t_t that is actual at t_m. What this means is that there is a simultaneity relationship between t_m and t_t (i.e. between metaphysical and physical time) such that 'to be present at [temporal] time [t_t] is to be present at metaphysical time [t_m] and vice versa'[140]. Thus the temporality of TE is provided in the fact that there exists temporal succession with metaphysical time as a result of the conscious activity of the E-entity. This allows there to be temporal relations between TE and our temporal world, and the eternality of TE is provided through the fact that it is not subject to physical time. In other words 'there are intervals within [eternity] […], but those intervals have no specific or intrinsic temporal measure'[141] hence eternity is both "timeless" and "temporal".

§6.1.1 Transcendent-Eternity and Special Theory of Relativity

TE makes a distinction between measured time and metaphysical or cosmic time; it is also dependent upon an A-Theory view of time[142]. In distinguishing between metaphysical and measured time TE, avoids the problem associated with other A-theories that require the selection of a particular frame of reference and thus alignment with a particular "now"[143]. In separating measured time from

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[138] DeWeese, *God and the Nature of Time*. P.253

[139] Quantitative temporal relations are those in which duration can be meaningfully discussed such as an event last 5 metaphysical seconds or 3 metaphysical years etc.

[140] DeWeese, *God and the Nature of Time*. P.254

[141] Alan G Padgett, 'God and Time: Relative Timelessness Reconsidered', in *Science and religion in dialogue*, ed. by Melville Y. Stewart, 2 vols. (Malden, MA: Wiley-Blackwell, 2010), II, 884–892. P.885

[142] That the A-theory or dynamic time is the only correct model of time is endorsed by both Alan G Padgett, *God, Eternity, and the Nature of Time* (Eugene, OR: Wipf and Stock Publishers, 2001). (especially Ch.5) and DeWeese, *God and the Nature of Time*. (Ch.2)

[143] William Lane Craig, 'God and Real Time', *Religious Studies*, 26 (1990), 335–347.

metaphysical time, TE in fact avoids many issues of STR. This is because the conventionality and relativity occur with respect to measured time, and in separating the two DeWeese and Padgett are able to deny the applicability of the conventionality of simultaneity. However Maudlin cautions against placing too great an emphasis on conventionality when:

> The fact that Lorentz coordinates, with their relations to the behaviour of light and clocks […] the fact that all light emitted from an event propagates along a vacuum […] the existence of co-moving clocks as we have defined them, is not a convention. The postulation of Minkowski space-time is a physical thesis, not a convention[144]

In opposition to the position set out in §4.2, and with respect to TE, Craig[145] argues against simultaneity as entirely relative[146]. Craig takes issue with Einstein's definition of simultaneity being dependent upon the times recorded by synchronised clocks, and the conventionality of the one-way speed of light. Craig's argument against relativity and conventionality of simultaneity is based on the fact that the measurements of the two synchronized clocks (for example at the end of the twin paradox) are incorrect. What the clocks fail to accurately measure is "true" or metaphysical time, and what STR represents is a theory not about the ontology of time, but about the behaviour of physical objects. For Craig, Einstein's positivism in denying the role of the aether in defining the 'correct' reference frame highlights the fact that the relativity of STR is based on measured and not metaphysical time.

The question is what does this mean for the role of STR in defining the coherence of TE? The point of whether or not we accept Craig's argument is to some extent moot. This is because the simultaneity deals with the empirical results of measured time, what TE deals with in positing metaphysical time is some "greater" time that isn't subject to the whims of reference frames, but which *is* unobservable. From a scientific standpoint it is initially tempting to argue that what TE is in fact trying to do is to select a preferential reference frame. However it is also possible to argue that the expansion of the universe, the detection of anisotropy[147] or even GTR all point towards the existence of some kind of cosmic time. Whilst STR, whether conventional or not applies to measured time, there is no reason to believe that *if*

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[144] Maudlin, *Philosophy of Physics*. P.96

[145] Craig.

[146] Whilst I stated in §4.2 that I was siding with Petkov on the conventionality of simultaneity, I feel that as this non-conventionality thesis is proposed specifically in support of metaphysical time it is worth examining

[147] the property of being directionally dependent

there exists some form of metaphysical time it would necessarily be subject to STR. Therefore given our inability to disprove metaphysical time it would seem fair to claim that TE coheres with STR.

§6.2 Presentist-Eternity

I have already examined one model that tries to explain eternity in terms of experience "all at once". However Presentist Eternity (PE) faces a different challenge to AA, rather than the difficulty of successionless duration PE has to explain how an instantaneous mode of being can be temporal.

There are three key notions of the "present" explored by Harris absolute, time-lag and specious. Our common understanding of the present in the West is based on the Newtonian vision of the now as a knife edge that separates the past and the future[148], or as a line that is disappearing as fast as it is appearing[149]. The absolute present is our pre-philosophical notion of the present. However this conception of an instantaneous present is not mirrored in our everyday language, where it is used to mean an extended "now" i.e. she is *running* the race. J.L. Austin points to the fact that the present has no univocal meaning; it can range from the present moment, to the present century. In this sense "present" can be viewed as indexical and as devoid of meaning as "this" or "that". Sense-data theorists speak of the time-lag present, by which they mean the experienced present is never at the same "now" as the causal stimulus. Harris argues that our experience of the "present" (aside from phenomenological) is not of the absolute now. It is not filled with discrete individual sensation but with a "flow"[150], our "present" experience must always contain 'some semblance of future and past; that is […] must have a duration which is both "rearward and forward looking"'[151]. However within the specious present there is able to be ordering and structuring of thought and experience into a temporal "before" and "after" even though the present is a rolling instant. There are several key arguments examined by Harris that point to the need to understand "present" as something far more fluid than a knife-edge. If

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[148] James F. Harris, 'An Empirical Understanding of Eternality', *International Journal for Philosophy of Religion*, 22 (1987), 165–183 <doi:10.2307/40018834>. P.168

[149] Nelson. P.13

[150] This is contrary to Brading's analysis of our experience of the present in her paper 'Physically Locating the Present: a Case of Reading Physics as a Contribution to Philosophy', where she analyses our *experience* of time by examining what elements of our experience can be said to correlate to elements of Minkowski spacetime. She concludes that 'there is nothing within the structure of Minkowski spacetime that could be correlated with the "now"' (P.12-13)

[151] William James cited in Harris, 'An Empirical Understanding of Eternality'. P.174

we are able to do this it would seem to offer a unique way to understand temporal eternity that does not reduce it to an unextended instant or sempiternity.

In looking outside the Newtonian view of time it is possible for PE to provide a model of the present that comports with our experience of reality, and so provide a 'revised empiricist account which is rich enough to give us a *conceptual* understanding of eternity'[152]. Whilst it is possible for us to discretely demark a succession of "nows" our 'successive acts of *recognition* or *apperception*'[153] do not remove our experience of events as a continuous "flowing" sensation. It is the "flowing" of the present and the way that it is addressed that separates PE from AA. AA cannot allow for temporal succession within the present, whereas for PE the 'semblance of future and past'[154] that is contained within the present is the key to understanding temporal eternity. Because this model is based on the *experience* of the present PE requires an E-entity.

PE proposes a model of eternity in which eternity can be viewed as analogous to our temporal experience of the specious present. The specious present is the time duration during which perceptions are considered to be in the present, and it highlights the fact that rather than being directly perceived time is "reconstructed" by the brain. William James and Alfred Whitehead disagree on the length of the specious present in human, with Whitehead arguing it only lasts for 0.5 seconds whereas James argues it lasts between 6 and 12 seconds. This variation highlights that fact that the specious present is affected by contingent factors. The influence of contingent factors supports Harris' claim that the limit placed on the length of the specious present is arbitrary and thus if we can imagine a human with a specious present of twelve seconds why not thirteen, if thirteen why not fourteen etc.

If the specious present is to be understood as being in direct relation to the ability to discern discrete events, which in turn is dependent upon our stimulus threshold[155], then there is no reason why an eternal specious present could not contain all of spacetime. The specious present allows for us to integrate our experience and overcome the fact that 'stimuli are temporary and changing'[156],

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[152] Harris, 'An Empirical Understanding of Eternality'. P.172
[153] Harris, 'An Empirical Understanding of Eternality'. P.173
[154] Harris, 'An Empirical Understanding of Eternality'. P.174
[155] Stimulus threshold is the level or strength that a stimulus must have in order to register in our consciousness
[156] Harris, 'An Empirical Understanding of Eternality'. P.174

without which our experience would be chaotic. It is the role of consciousness to place order and structure onto the "flow" and it is this structure that creates the temporal succession within the specious present.

I think that there are two ways to move forward with eternity as the specious present. Either eternity must be rooted in metaphysical time, in which case PE can be argued to work alongside TE whereby TE explains the eternal-temporal relation and PE simply adds to our conceptual understanding of eternality; or PE is to be understood as sempiternity within which the experience of the passage of time by the E-entity is analogous to our own temporal experience, and as such eternity is not an entirely different mode of being but an extended mode of temporal being.

§6.2.1 Presentist-Eternity and Special Theory of Relativity

The impact of STR on PE depends on whether one understands it to be located within metaphysical or physical time. If we take it to be located in metaphysical time, and maintain that an eternalist view of time is correct, it would seem quite plausible for an E-entity to be able to have a specious present that could include spacetime in its entirety. As with TE there are question as to the nature of the interaction between metaphysical and physical time, but these concerns do not lie within the scope of this thesis.

Perhaps the greater challenge lies in understanding PE as located within physical time. The question then becomes one of how it is possible to understand a stimulus threshold that is able to encapsulate all of spacetime. The initial assumption is that although the relativity of simultaneity allows for spacetime to be divided into infinitely many foliations, the amount of information that could potentially be received by an E-entity must be limited by the constancy of the speed of light. It would seem that even with a zero stimulus threshold the amount of information that *could* be known is limited by the speed of light. Interestingly, however, Maudlin notes that whilst the speed of light is constant in all Lorentz coordinate systems it 'is *not* constant in other coordinate systems that could be defined in Minkowski space-time'[157]. This means that potentially, given the correct coordinate system, even an E-entity within physical space could receive stimulus from the entirety of Mst that could be perceived as a specious present.

[157] Maudlin, *Philosophy of Physics*. P.96

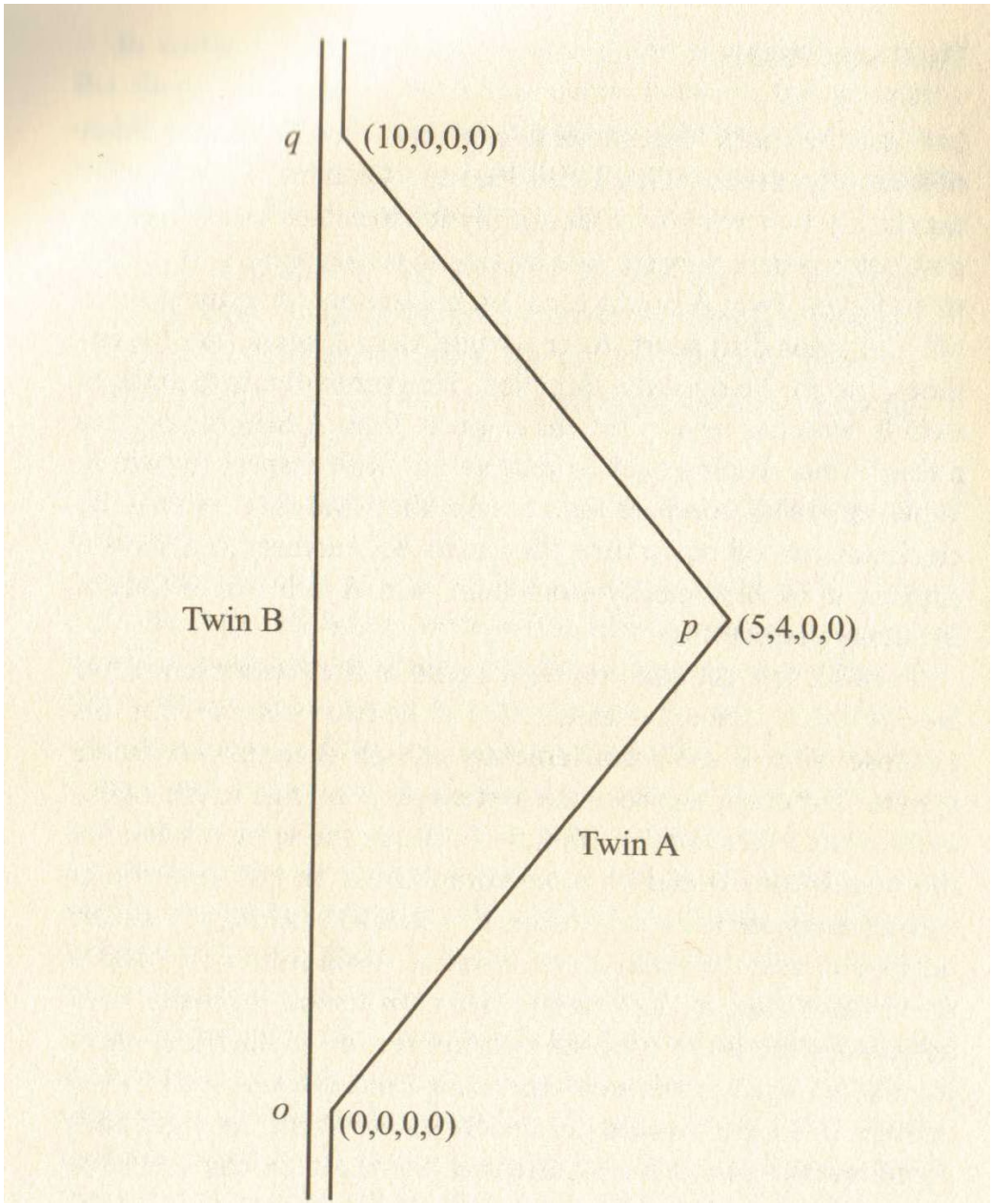
§7 Summaries and Conclusions

STR is perhaps the most commonly used scientific model of time in discussions of philosophical theology. The relativity of simultaneity, along with the time dilation associated with objects in relative motion (the twin paradox) provides fertile ground for explaining how it might be possible to understand divine attributes such as omniscience and how eternity may be more than sempiternity.

What has been shown in the process of this thesis is that STR can and does have a role to play in understanding the extent to which philosophical models of eternity *may* provide a realistic description of the possibilities of eternal existence. Perhaps the biggest successes lie in models such as EA and TE that, through the introduction of metaphysical time, are resilient to the effects of STR without reducing eternity to a psychological aspect of experienced time. I believe that examining eternity in light of STR is valuable in establishing the metaphysical possibilities of eternity as a genuine feature of reality. I also believe that the eternalist view of time provided by STR provides a stable framework in which to examine eternity. However until there is a physical concept of time that is able to work coherently across STR, GTR and QM further research is necessary to establish which models can also stand up the challenges they provide.

Does STR have a role to play in the formation of a coherent model of eternity? Yes but other scientific theories of time also have a role to play, and if we find a model of eternity that is able to be defended in the face of GTR and QM too, the we will have found a model that is robust enough that we can knowledgably discuss the kind of divine attributes that are possible within it.

Appendix A – Two dimensional Diagram of the Twin Paradox[158]



[158] Maudlin, *Philosophy of Physics*. P.78

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