Universitat Autònoma de Barcelona

TIME AND CHANCES BEFORE THE CHANGING UNIVERSE
A METAPHYSICAL INQUIRY

Federico Viglione

Universitat Autònoma de Barcelona

Faculty of Arts and Humanities

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Tutor and Supervisor

Prof. Silvia De Bianchi

Co-Supervisor

Prof. Giuliano Torrengo

PhD Student

Federico Viglione
NIU 1536165

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– Abstract –

If the universe began, why did it begin *at all*? Why did it begin *in the way* it did? And why did it begin *when* it did? Intuitively, a satisfactory explanation of the beginning of the universe should provide an answer to each of these three questions. First, however, one must clarify what is meant, exactly, by the claim that the universe began. At this purpose, I shall distinguish between the supposition that the universe (understood as the maximal mereological sum of spatiotemporally related things) had a beginning, and the supposition that the *changing* universe had a beginning. Moreover, I shall give the necessary and sufficient conditions for the changing universe (or the world-series) to have begun. Given this, I shall argue that there is a logically and metaphysically possible way in which the changing universe may have begun, namely, by chance after a beginningless period of time without change. I call this the *Awakening Universe Hypothesis*. In order to face the question of whether the *Awakening Universe Hypothesis* states a metaphysical possibility, I consider separately the issues whether a beginningless period of time is possible and whether such a period could be changeless before the beginning of the changing universe.

The first part of the discussion on the *Awakening Universe Hypothesis* will be framed in the context of the contemporary debate on the *Kalām Cosmological Argument* (KCA). The reason for this is that, in this context, arguments for the metaphysical impossibility of a beginningless temporal series are still discussed. I show that these arguments are unsuccessful and argue that a model of explanation implementing the *Awakening Universe Hypothesis* would undermine the KCA proponents' strategies for a personal cause of (the beginning of) the universe. The possibility of time without change, instead, will be discussed in light of a longstanding debate within the contemporary philosophy of time, a debate that is somehow detached from theological concerns.

Finally, I shall present a model of explanation that implements the *Awakening Universe Hypothesis*. This model, I argue, provides a sufficient reason why the changing universe begun, and a satisfactory answer to the questions why such a beginning happened when it did and in the way it did.

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The intellectual seeds of this work are almost as old as my passion for philosophy, since the idea of working on topics related to the beginning of the universe was born when I was just a bachelor student. This, unfortunately, means that I cannot thank everyone who supported me in the effort. The list, fortunately, would virtually include all the relevant people in my life. However, few mentions are in order.

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All in all, writing this dissertation was an extremely important experience. I was able to work on topics that are for me the most exciting. This strengthened my hope to continue, in the next future, my research in the metaphysics of science.

At that time there was only darkness hidden by darkness.

Nāsadīya Sūkta

So the darkness shall be the light, and the stillness the dancing.

T. S. Elliot

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Abbreviations

AII: *Argument from the impossibility of infinities*.

AITI: *Argument from the impossibility of traversed infinities*.

AUH: *Awakening Universe Hypothesis*–The changing universe we live in might (as a matter of logical and metaphysical modality) have begun by chance, in the sense that, for a beginningless period of time before the very first event, there was a chance for this to happen.

BCF: *Backward Counters' Fact*–A certain backward counter finished when they finished (rather than earlier or later, like other backward counters did).

BTE: *Begins to exist*–*x* begins to exist at *t* iff (i) *x* exists at *t*, and the actual world includes no state of affairs in which *x* exists timelessly; (ii) *t* is either the first time at which *x* exists or is separated from any $t' < t$ at which *x* existed by an interval during which *x* does not exist, and (iii) *x*'s existing at *t* is a tensed fact.

BW: *Beginning world-series*– the world-series began if, and only if, either it has a lower bound or it is finitely extended. The world-series is beginningless if, and only if, it is *not* the case that it is finitely extended and it has no lower bound.

CCM: *Constant Chance Model*.

GR: *General Theory of Relativity*.

IA: *Inconceivability Argument*.

ICM: *Increasing Chance Model*.

IPTV: *Impossibility of a Primordial Temporal Vacuum*–there could not have been a period of time without change during which something existed before the first event.

KCA: *Kalām Cosmological Argument*.

KCAr: *Kalām Cosmological Argument revised*.

LW: *Le Poidevin's World.*

MA: *Measurability Argument*.

PII: *Principle of the Identity of Indiscernibles*– For every property P, if *x* instantiates P if, and only if, *y* instantiates P, then *x* is identical to *y*.

PSR: *Principle of Sufficient Reason*–For every fact there must be a sufficient reason why that fact is the case.

PTV: *Primordial Temporal Vacuum*.

PVPs: *Primordial Vacuum Parts*.

SA: *Sufficiency Argument*.

SSA : Second *Sufficiency Argument*.

SoN: *Spontaneity of Nothingness*–The most natural state of affairs is simply nothing.

SPII: *Strong Principle of the Identity of Indiscernibles.*

SR: *Special Theory of Relativity*.

TAS: *Temporal Agent Strategy*.

TC: *Time-Clock Relation Principle*–There is a logical (or conceptually necessary) relation between 'time' and 'a physical system which can serve as a clock' in the sense that we cannot—in a well-defined way—use either of these concepts without referring to (or presupposing) the other.

TCS: *Timeless Cause Strategy*.

TSA: *Three Steps Argument*.

TFT: Temporal half of the first thesis.

TFT*: Temporal half of the first thesis*.

UC: *The Uncompletability Claim*–We cannot traverse the infinite by starting at some point.

ULTRAM: *The Ultramundane Hypothesis*–The cause of the first event must be ultramundane, that is, outside of the world-series.

VA: *Verificationist Argument*.

WPII: *Weak Principle of the Identity of Indiscernibles.*

– Introduction –

Did the universe have a beginning? The absolute weight of this question may only be expressed by an endless series of adjectives. It is daunting, long-standing, astonishing, profound, and much more. Philosophers have been thinking about it for millennia and they used to propose purely philosophical arguments[1] in favor of or against the thesis that the cosmos must have had a beginning.[2] In fact, aside from invoking divine revelation, philosophical arguments were once considered the only viable tool when it came to investigating the origins of the universe **(**Sorabji 1984, 193**)**.

Today, however, things have changed. Contemporary metaphysicians are no longer interested in purely philosophical arguments on this topic. The orthodox view has become that whether the universe (or even time itself) began is a contingent matter that must be addressed, and eventually settled, by means of scientific research (Le Poidevin 1993, 151). The problem of the origins of the universe has acquired a further, prominent adjective: empirical.[3]

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[1] I define an argument as *purely philosophical* when it is not informed by some scientific theory. A more common distinction is that between *a priori* and *a posteriori* arguments, where *a priori* arguments are those that provide justification to some statement somehow *independently of experience* (Russell 2020, 3). However, not all purely philosophical arguments for, or against, a beginning of the universe are agreed upon as being *a priori*, in so far as some of them employ existential premises (Craig 1986, x).

[2] Although Kant famously disagreed with both answers. For a brief introduction of the Kantian position, see 1.1.2. (in particular note 30) and 1.3.2.

[3] This is particularly evident if we look at the 20th century history of the philosophy of space and time. Already during the era of logical positivism, Hans Reichenbach asserted that the hypothesis that time and the history of the universe are closed like a circle (so that there would not be a proper beginning of the universe) was excluded on *empirical grounds* (van Fraassen 1985, 174). Later, in his *Philosophical Problems of Space and Time*, Adolf Grünbaum, still for empirical reasons, decided to explicitly address the possibility excluded by Reichenbach (Grünbaum 1973, 197). More recently, during the 80s, in *The Structure of Time* William Newton Smith extensively argued that, in general, hypotheses concerning the topology of time and the history of the universe (including the hypothesis that time and the universe had a proper beginning) can be corroborated by empirical data. This conclusion has been generally accepted. See for instance Quentin Smith (1988), Robin Le Poidevin (1993) and Barry Dainton (2016).

Determining when this change of perspective happened is not an easy task. One year that could be taken as the watershed is 1917 when Einstein proposed the first relativistic model of the universe. Before then, not only philosophers but scientists as well did not think that a scientific theory could have anything to say about the origins of the universe (Kragh 2019a, 29). After the advent of Einstein's General Theory of Relativity (**GR**), though, many models that described the spatial and temporal character of the universe in its entirety started to pop out as solutions to Einstein's field equations. Einstein's own model of the universe, the first to be published, described a static, spatially closed, and *temporally infinite* universe. The model, therefore, showed that, given GR, a temporally infinite universe is physically possible, *pace* the philosophical arguments that claimed it to be impossible. Later on, other models showed that a temporally finite universe is physically possible as well (Perlov and Vilenkin 2017, 113).

Since its early stages, relativistic cosmology has enormously developed, but the lesson of those times has remained vivid: whether the universe began or not seems to be a contingent matter that depends on the distribution of matter and energy throughout the whole of space-time.[4] In particular, the standardly accepted cosmological model, the ΛCDM model[5], describes our universe as having a finite age and it also gives this age a precise value: $13.799 \pm 0.021 \times 10^9$ years.[6] Given the state of the art, it is not much of a surprise that many metaphysicians and philosophers of physics are nowadays concerned

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[4] That is the four-dimensional continuously differentiable point manifold that is postulated in GR.

[5] The model provides the simplest and more reasonable account of a wide range of observational data. For instance, the model explains the redshift observed in light from distant galaxies and the large-scale distribution of such galaxies. However, before the groundbreaking discovery of the CMB radiation in 1965, a 15-years long controversy opposed the ΛCDM model with the rival steady-state theory (Kragh 2019b, 175).

[6] The offered picture is, in its main characteristics, now familiar also to non-physicists: the radius of the whole universe is increasing over time; distant galaxies and clusters of galaxies are receding from one another not because of their relative motion within space, but because of the expansion of the metric of space-time itself. If we rewind this expansion, the further we go into the past, the smaller will become the radius of the universe, and the greater will become the density of matter. Eventually, we reach the earliest space-time singularity where the radius is 0 and the density of matter in the universe is infinite. According to some interpretations of the model, the beginning of the expansion of the 4-dimensional space-time out of this singularity can be seen as the *first event* in the universe's history: the Big Bang.

with interpreting the cosmological models themselves (be it the ΛCDM or more speculative ones) rather than discussing the origin of the universe on a purely conceptual basis.

However, by abandoning this quest, philosophers have also set aside reflections on a closely related issue: *if the universe began, how can we possibly explain its beginning?* If the universe began, there are at least three facts that seem to call for an explanation: the fact that the universe began when it did, the fact that the universe began in the way it did, and the fact that the universe began at all. We have therefore a triad of conceptual issues:

(A) If the universe began, why did it begin *at all*?

(B) If the universe began, why did it begin *in the way* it did?

(C) If the universe began, why did it begin *when* it did (rather than earlier or later)?

A satisfactory explanation of the beginning of the universe should at least provide an answer to each of these three questions.[7]

Within the history of metaphysics, there have been plenty of attempts to deal with them. Of course, for a long time, the interest was mainly theological.[8] To make the beginning of the universe depend on God's will provides a convenient answer to each of the questions: God simply *decided* to make the universe begin in a certain way and at a certain time. Contrary to what one may expect, this trend has not yet gone out of fashion. Theists like Robert Deltete, T. D. Sullivan, and especially William Lane Craig, are proposing new versions of an ancient theological argument, the *Kalām*

[7] It is easy to see how closely these three issues are related to the major one: if there is an intrinsic difficulty in explaining a beginning of the universe, this could be taken as a good reason to think that the world did not begin after all.

[8] Historically, the hypothesis that the universe is finite in space and time fitted well with the idea of a creation out of nothing, supported by many Christians. Of course, there have been exceptions. A theistic tradition has conceived God as the creator of an *infinite* universe, considering that a temporally or spatially finite universe would contradict God's omnipotence. Illustrious advocates of such and similar views were Descartes, Newton, Leibniz, Kant, and Olbers (Kragh 2019a, 33). For a classic excursus on the notion of a temporally finite universe within the Christian tradition see Sorabji 1984, ch. III. For a more recent overview see Anderson and Bockmuehl 2017.

Cosmological Argument. Their aim, once granted that the universe had a beginning, is to conclude that there is a personal (divine) cause of the universe.

Nowadays we cannot avoid looking at such theological proposals with suspicion. Within our secularized society, there is a pressing need for an alternative *non-personal* explanation, that is, an explanation of the beginning of the ever-changing universe we live in which does not appeal to the free will of some divine person.[9] Remarkably, however, the only philosophers who are still proposing alternative models for such an explanation are either theists who disagree with the advocates of the *Kalām* Cosmological Argument or those atheists who are nowadays still interested in theological quarrels.[10] Instead, those metaphysicians who are not interested in such quarrels rarely venture to explore the logical range of the alternatives. The reason, I think, is that there is a widespread belief that the amount of work done on this task is sufficient and that a complete clarification of all the possible ways in which one could, *in principle*, causally explain how the very first event happened has been reached. The list includes backward causality, causal loops, simultaneous causality, causality at temporal distance, and timeless causation. All these ways, as will be seen, entail a somewhat costly revision of the standard notion of causality (2.2.1.; 2.4.; 3.4.2.).

Notice that the very first event must not coincide with the *absolute* beginning of the universe. Often, we may find, within the old debates on the possibility of a universe with a beginning, a certain lack of caution in distinguishing between three different theses, and, sometimes, this lack of caution has been somehow inherited by the contemporary scholars (Harrington 2015, 215). The three theses are:

(i) Time had a beginning.

(ii) The existence of things in time had a beginning.

(iii) Change had a beginning.

It can be argued that these theses are one and the same thesis, that they differ at most verbally (Prior 1968, 98). *Prima facie*, however, there is nothing that indicates that these

[9] Noticeably, some cosmologists doubt there could be such an explanation for the following reason: if the laws of physics become valid at the *absolute* beginning of the universe, it may not be possible to explain the beginning of the universe by means of these laws (Perlov and Vilenkin 2017, 341).

[10] Among Craig's critics, we find Richard Sorabji, Adolf Grünbaum, Wes Morriston, John Leslie Mackie, Quentin Smith, and Graham Oppy, to name but some.

three questions are logically equivalent. One thing is to investigate the origins of time *per se*, another is to investigate the origins of the universe, understood as the maximal mereological sum of spatiotemporally related things[11], and still, another is to investigate the origin of the *changing* universe. Indeed, one may conjecture that matter came into existence after a period of absolutely empty time, or that change began after a period of time without change.

Now, questions (A), (B), and (C) arise with respect to any of the three beginnings listed above. My thesis, when it comes to (iii), is that there is an unexplored option, a way in which change may have begun that has not received any attention in the contemporary literature:

> *Awakening Universe Hypothesis* (**AUH**): The changing universe we live in might (as a matter of logical and metaphysical modality) have begun by chance, in the sense that, for a beginningless period of time before the very first event, there was a chance for this to happen.[12]

This hypothesis, I claim, can be implemented into a model of explanation for the first event that will grant a *sufficient reason* for the beginning of change. My main goal, by the end of the dissertation, is to formulate such a model.

In **Chapter 1** I first argue that one should not exclude for purely philosophical reasons the (logical and) metaphysical possibility of a beginningless period of time. Nowadays, arguments for the claim that a beginningless temporal series is indeed impossible are of course to be found in the very theological debate on the *Kalām Cosmological Argument* mentioned above. I will therefore mainly refer to this debate[13], contextualizing the arguments for a beginning of the universe (**Section 1.1.**), and discussing whether they succeed (**Section 1.2.** and **1.3.**) or whether one should, as I

[11] This standard definition is taken from Lewis, who explains that the world, or universe, we live in, includes anything that exists at some distance and direction from here, or at some time from now, so that "no long-gone ancient Romans, no long-gone pterodactyls, no long-gone primordial clouds of plasma are too far in the past, nor are the dead dark stars too far in the future, to be part of this same world" (Lewis 1986, 1).

[12] Definitions of the relevant terms are given in the course of the work.

[13] I reserve a special treatment for the first half-thesis of Kant's antinomies (1.3.2.).

claim (**Section 1.4.**), leave the door open (so to speak) for a beginningless period of time. If so, then the AUH seems to be viable at least in this respect.

In **Chapter 2** I consider more discussions within the contemporary debate on the *Kalām* Cosmological Argument. The aim of the chapter is to expose what role a model that implements the AUH may have in this debate. As said, those who propose the *Kalām* Cosmological Argument conclude that the cause of the universe is personal. I argue (**Section 2.1.**) that they would be better off if they restrict their goal to the claim that the cause of *the first event* is personal. This being settled, I clarify what is meant, in this context, by 'personal cause' (**Section 2.3.**) and highlight the two argumentative strategies adopted by the defenders of the *Kalām* Cosmological Argument to support the idea that a first event must have a personal cause (**Section 2.3.**). By the end of the chapter, it will become clear to the reader how a model that implements the AUH, such as the one proposed in Chapter 4, undermines these strategies (**Section 2.4.**).

In **Chapter 3** I leave theological concerns aside and explore the contemporary debate on the relation between time and change. I argue that a period of time without change before the first event is possible. That this possibility is granted is crucial for the availability of the AUH. First, I argue that it is possible for there to be a period of time without change or, in the terminology of the contemporary philosophy of time, a *temporal vacuum*. For this purpose, I start (**Section 3.1.**) by clarifying the notion of change that is at stake in the debate. Then, I move on (**Section 3.2**.) to consider, starting from a historical perspective, the main arguments that have been offered against temporal vacua. I conclude that none of them is effective in showing that temporal vacua are impossible. Thus, I discuss (**Section 3.3**) an *a priori* argument that Le Poidevin has recently given (2010) *in favor* of vacua's possibility. I claim that, albeit with some caveats, Le Poidevin's argument seems to be quite effective. Finally (**Section 3.4)**, I face the relatively unexplored issue of whether a temporal vacuum before the first event is possible. I contend that there is nothing special about a temporal vacuum *before the first event* that would make it impossible and point out (**Section 3.5)** that this undermines the first strategy for a personal cause of the first event.

In **Chapter 4** I propose an explanatory model for the first event that implements the AUH, that is, the idea that the changing universe we live in might have begun by chance. This model is non-personal, causal, chronometric, natural, and probabilistic

(**Section 4.1.**). I explain how the availability of such a model undermines the second strategy for a personal cause of the first event. Interestingly, it turns out (**Section 4.2.**) that, if one wants to stick to the standard theory of probability, the chances for the occurrence of the first event cannot be assumed to be constant during the beginningless temporal vacuum before the first event. In the **Concluding remarks**, I assess what perspectives my work opens for both metaphysics and future research in theoretical physics and cosmology. Specifically, I will offer some considerations on what kind of physical theory may implement the model I present.

If I had to mention one philosophy book that first inspired me in producing this dissertation, I would point to *The Structure of Time* by Newton Smith (1984), which I was reading during the days when I worked on my master thesis. Specifically, I would mention one claim: "we do not see what would count in favour of the postulation of empty time [time without change] prior to a first event. There are no facts about the world which would be explained by such a postulation" (Newton Smith 1984, 106). This entire dissertation can be seen as a reaction to this sentence, an attempt to question this indiscriminately accepted claim. I contend that *there is* a fact about the changing universe that could, *in principle*, be explained by such a postulation: the very fact that the changing universe began.

– Chapter 1 –

Philosophical arguments for a beginning of the universe

The aim of this chapter is to show that one cannot find effective purely philosophical arguments for the claim that a beginningless temporal series cannot elapse. This is crucial for the availability of the AUH. To accomplish this task, I deal with the literature where relevant purely philosophical arguments are currently still being proposed: the debate on the modern *Kalām* Cosmological Argument, and more precisely on its second premise, the claim that the universe began to exist.

In the first section, I give a brief overview of the history of the *Kalām* Cosmological Argument. In the second section, I expose and criticize the first main purely philosophical argument that should support its second premise: the *Argument from the impossibility of infinities*. In the third section, I expose and criticize the second main philosophical argument that should support this premise: the *Argument from the impossibility of traversed infinities*. By the end of the chapter, I express a judgment, informed by the debate, on whether one should exclude beginningless temporal series on the basis of purely philosophical reasons.

1.1. The *Kalām* Cosmological Argument

In this section, I introduce the modern version of the *Kalām* Cosmological Argument. First, I trace back its historical roots to the times that preceded the development of Western philosophy. I then provide a brief exposition of its history within Western and Islamic philosophy.

1.1.1. The roots of the *Kalām* Argument

It is conceivable that already at the dawn of human civilizations, people pointed at the earth under their feet and to the sky over their heads and dared to narrate to their own kind that they had an origin. Countless cultures, both ancient and modern, had developed and handed down their myths about the origin of the world.[14] Some of the stories relate that the world generated out of nothing, in a *creatio ex nihilo* process, in charge of which is typically an all-powerful supreme deity. Such is the Hebrews' god described in the Genesis, as well as the god of the Qur'an, the holy book of Islam (Richard 2017). Both these deities were able to create the earth and the sky out of nothing in a relatively small number of days just by means of thought and words. However, creation out of nothing is not a commonly observable process, so that, understandably, other stories instead propose creation metaphors that refer to familiar natural processes[15], such as mammalian birth, death and rebirth of living organisms, emergence of land out of water and so on. For instance, in North American mythology the event of the very beginning often coincides with the Great Earth Mother giving birth, either directly to people or to gods who will create people (Leeming 2010, 36).

Often in those stories, at the beginning there was chaos, a state of disorder which was later ordered and shaped into the world; sometimes by a goddess who emerged naked from mixed sky and water and divided them so she could dance lonely upon the waves[16]; sometimes by a sleeping giant who suddenly woke up within a black egg and destroyed it with an ax so that the earth and the sky would form from the pieces of the egg[17]; sometimes by two black geese who were flowing back and forth over the primordial waters, until one of them, the evil one, decided to dive down under the water and bring a rock to the surface, so that the other could turn it into the world.[18]

This is just a small set of samples from among the astonishing quantity of creation myths produced by human cultures. It is already enough, however, to give a hint on how such stories, born far away from each other in space and time, all share a central common element: it is always some being's *decision* that leads to the beginning

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[14] For more information on the types of creation myths in ancient cultures and the specific myths mentioned in these paragraphs, see Leeming 2010.

[15] Nonetheless, note that *creatio ex nihilo* stories spread far beyond the domain of the Abrahamic religions. They can be found in many cultures across the epochs and all around the globe: from ancient Egypt to the Mayans, from contemporary animistic cultures to the very early religions (Leeming 2010, 2).

[16] This myth belongs to the Pelasgians, a pre-Hellenic peoples of Greece.

[17] The first traceable written record of this myth, the myth of Pan Gu, traces back to the Three Kingdoms period of Chinese history (220–280 A.D.).

[18] This myth comes from the Caucasus.

of the world. In the case of animistic cultures this should not surprise. Animism, as defined by anthropologists (Harvey 2006), is the general tendency, especially present in primitive cultures, to interpret the behavior of natural events as the behavior of a *person*. Animistic people recognize that their own movement is dependent on their own will, and, by analogy, understand the movements of the sun, the moon, the rivers, and in general the behaviors of the natural non-human world to be dependent on some personal will. They talk about non-human souls that live within such things, about their life and personality (Wright 2010, 7). Just as "ordinary" happenings are, according to animistic people, dependent on the will of some non-human person, so must be "non-ordinary" happenings such as the coming into existence of new things, for instance of new life. From this viewpoint, it is a short step toward guessing that *all there is* must have been brought into existence in virtue of some non-human person's will.

According to some anthropologists[19], there is a historical line of connection between the attribution of personhood to the natural realm typical of animistic cultures, and the attribution of personhood to ultra-mundane deities, typical of more technologically advanced civilizations (Wright 2010, 9). In the myths of the latter cultures, when it comes to explaining how this world originated, it remains a common practice to invoke a *personal explanation*, that is, an explanation that appeals to the decisional power and action of some person. After all, how else could the world have begun? Sometimes, even *regular* beginnings have seemed hard to explain otherwise. First, there is no winter or sunrise, and then there they are: that must depend on someone's will. For most of human history (especially before the advent of the scientific revolution) personal explanations, and in particular explanations that referred to divine action, were considered a good kind of explanation for the coming into being of all sorts of things, including the universe.

The observations made so far lead to the following conclusion: often, when pushed to wonder how the universe began, people had a tendency to guess that there must have been some *personal agency*.[20] It does not surprise, then, that, looking at the

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[19] Especially according to social anthropologists who promulgate an *evolutionary theory* of the history of religions, the pioneer of which was Edward Tylor with his works *The Religion of Savages* (1866) and *Primitive Culture* (1871-1874) (Wright 2010, 7).

[20] For discussion of some accounts of supernatural personal agency, see 2.3.

history of Western and Islamic philosophy, one finds that philosophers have developed this pre-theoretical tendency into a type of argument for the existence of a personal being (God), who would act as the cause of the beginning of the world. This argument had great significance in the history of philosophy and, as already mentioned in the Introduction, has been brought back to the scene in recent times.

1.1.2. Brief history of the Kalām Argument

The *Kalām* Cosmological Argument is, discernibly, a cosmological argument, that is, a type of argument for the existence of God. *Cosmological* arguments own their name to the fact that, among their premises, they all include some contention about the universe. In particular, the *Kalām* Cosmological Argument has as its main premise the assertion that *the universe began to exist*.

In its contemporary formulation William Lane Craig presents the argument as follows:

Kalām Cosmological Argument (**KCA**)[21]

(1) Everything that begins to exist has a cause.
(2) The universe began to exist.
Therefore:
(3) The universe has a cause.
(4) If the universe has a cause, then an uncaused, personal Creator of the universe exists.
Therefore:
(5) An uncaused, personal Creator of the universe exists.[22]

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[21] In the course of the work, I use this acronym interchangeably to indicate both this version of the argument and the Kalām Cosmological Argument in its most general historical meaning.

[22] I hereby take as the reference version of the argument the one in Craig and Sinclair 2009. I connect the first three lines of the argument (page 103) with the relevant part of the last two lines (page 194). It must be noted that in his more recent writings Craig endorses a more modest version of (1), namely 'If the universe began to exist, then the universe has a cause of its beginning' (Craig 2015; Craig 2017b and 2018). However, since in this chapter I focus on premise (2) and in the next one I propose a personal reformulation of the argument (2.1.2.), the choice of the reference version does not matter much for the purposes of this work.

In fact, it is almost entirely due to the work of Craig that the debate on this argument has undergone a renaissance (Oderberg 2002, 303; Oderberg 2017b, 217). The '*kalām*' tag itself was ascribed to the argument by Craig in a book published in 1979 (*The Kalām Cosmological Argument*). The history of this word is a venerable one. '*Kalām*' (كلام) is the Arabic word corresponding to the ancient Greek '*logos*' (λόγος) and can be translated in English as 'words' or 'speech'. It was used by Muslim thinkers within the field of religious teaching in order to denote any theological thesis or theological argumentation.[23] Starting from the seventh century A.D., a movement developed in the Arab world, its aim being to objectively determine the structure of the created world as it was manifested in the Qurʾān. We may understand this movement as the Islamic *scholastic* tradition (Frank 2005, 3). By extension, '*kalām*' became its name, while its practitioners were the *mutakallimūn*.

The scope of Craig's choice of terminology is to underline the historical importance of the *kalām* movement in the development of the KCA. *Mutakallimūn*, at their time, were forcefully engaging another group of Muslims, the *Falasifa* (philosophers), who they considered heretics (also) in virtue of their inherited Aristotelian position of a past-eternal universe. In contrast to this position, the *mutakallimūn* traditionally granted premise (2) of the KCA, i.e., the claim that the universe began to exist, via arguments contending that it is *impossible* for the universe not to have begun.

However, the roots of the KCA go further back in time than the *Kalām* movement. Already John Philoponus, a Byzantine Aristotelian commentator who lived in the first half of the sixth century A.D., argued for the temporal finitude of the universe in order to support the idea that God created the universe *ex nihlo* (Sorabji 2010, 208–210). In his works *Against Aristotle* and *On the Eternity of the World against Proclus* Philoponus provided three such supporting arguments. The first two of Philoponus' arguments both aimed at demonstrating that the number of past days cannot be infinite because of the absurdities that arise when it is assumed that there is, in reality, an infinite number of things. The third argument was instead based on the principle that finite parts can never add up to an infinite whole. Or, to put it somewhat more evocatively, that an infinite cannot be traversed. This principle (together with the

[23] For a classic survey on the history of Islamic thought see De Boer 1933.

consideration that a past-eternal universe would entail that an infinite number of temporally successive things would have added up until the present moment) was used to argue that *an infinite temporal regress of events* is impossible, and therefore that the universe must have a beginning (*Contra Aristotelem*, Fr. 132).

The two argumentative strategies just pointed out became recurrent in history. The strong similarity of Philoponus' proofs for the temporal finitude of the universe with the Islamic proofs suggests that the latter have a great debt of gratitude towards this early Christian thinker (Craig 1979a, 10). Moreover, when the *Kalām* age was over, it was again Christian thinkers who took up Philoponus' proofs and kept them alive, making them central to their debates. The most relevant occurrence happened in the 13th century A.D., when Bonaventure, in the *Commentaria in II Sententiarum*, applied the KCA against Thomas Aquinas' proof for the existence of God.

Aquinas' proof instantiated another type of cosmological argument that has become known, nowadays, as the *Thomist Cosmological Argument*. In order to underline the peculiarities of the KCA, it is worth noting the difference between the two kinds of arguments. Even though many versions of the Thomist Argument have been proposed throughout history[24], the general lines of the reasoning can be summarized as follows:

Thomist Cosmological Argument **(TCA)**

(6) The universe, as the totality of all contingent things, is contingent.

(7) The existence of all contingent things is causally dependent on something else (different from the contingent thing itself).

(8) What causes the existence of a contingent thing must include a non-contingent (necessary) being.

Therefore:

(9) There must be a first non-contingent cause of the universe (which everyone calls God).[25]

[24] The argument has its roots in Plato's and Aristotle's arguments for the existence of a prime mover (Craig 1980, 195).

[25] For a similar presentation of the general lines of the TCA see Reichenbach 2019, 5.

Akin to the proponents of the KCA, the proponents of the TCA have argued in favor of premise (8) by denying that there can be an infinite series of things. However, while in the case of the KCA the focus is on the possibility of an infinite series of *temporally* successive things, in the case of the TCA the focus is rather on the possibility of an infinite series of *causally* related things (Craig 1980, 289). Such elements must not be understood as temporally successive. Indeed, according to many interpreters, in the tradition of the TCA causes and their effects have been generally understood as simultaneous.[26]

That the proponents of the TCA adopted this understanding of the temporal relations between causes and effects would explain why, while they argued for a first cause of the universe, they might have not believed that the world had a beginning or that the claim that it had could be successfully justified. In fact, Aquinas himself admitted that the finitude of the world's past cannot be demonstrated.[27] In his *Summa Theologica* he maintained that "the world has not always existed is to be held by faith alone and cannot be demonstratively proved" (I XLVI 2).[28] Moreover, in his opusculum *De Aeternitate Mundi contra Murmurantes*, he argued that it is logically possible for the universe to have been created by God out of nothing and yet to have existed for all eternity.

As said, Bonaventure rejected this view. He attempted to demonstrate the temporal finitude of the universe by making use of reasonings that closely recalled Philoponus' third argument and the similar arguments proposed by the Islamic thinkers. He observed that, if the universe had no beginning, then an infinite number of celestial revolutions would have taken place, which, according to Bonaventure, implied that the present could not have been reached (Whitrow 1978, 40).

Islamic thinkers, then, were not the first ones to propose, in the context of old theological debates, arguments for the impossibility of an infinite past, nor were they the last ones. Still, they were responsible for a great deal of reflection on the issue of why, exactly, a beginning of the universe must be caused by God. It is in this regard that

[26] This is already evident in Plato's version of the argument (Craig 1980, 7).

[27] Aquinas also proposed a temporal version of the argument, the so called 'Third Way', but this is generally interpreted as concerning the future rather than the past (Craig 1980. 187).

[28] Tr. in Whitrow 1978, 39.

Islamic theologians gave perhaps their most relevant contribution to the reflection on the KCA.

In order to infer the existence of God from the finitude of the world's past, Islamic theologians sometimes appealed to what they called '*principle of determination*' (Craig 1979a, 12). The principle stated that if something could equally be or not be at some particular time, a *temporal determinant* is needed for the possibility of being to prevail over the possibility of not being at *that* particular time. The argument of the *mutakallimūn* for the existence of God then sounded as follows: all that comes to be must have a determinant to bring it about. The world has come to be. *Ergo*, the world must have a determinant to bring it about.[29]

But why did such a determinant have to be linked with the existence of a being with personal will? In the *Kalām* context, the meaning of 'determinant' varied from occasion to occasion and from author to author. However, some general considerations can be made. The *Kalām* principle of determination may closely resemble, in some respects, the more renowned *Principle of Sufficient Reason*. In its more general form, the principle states that:

> Principle of Sufficient Reason (**PSR**): for every fact F, there must be a sufficient reason why F is the case (Melamed and Lin 2021, 1).

However, according to Craig, the most influential *mutakallimūn* such as al-Ashʿarī and al-Ghazālī rejected the use of the principle of determination as requiring a sufficient *reason* for the existence of a contingent universe (Craig 1979a, 14). In fact, the *mutakallimūn* understood God as a being who is absolutely free and therefore struggled to accept that any reason could have bound such a being to create the world at some specific time. Given this, one can see why, according to Craig's classification, the KCA must also be differentiated from a cosmological argument in which a version of the PSR is assumed, which he calls *Leibnizian Cosmological Argument* (**LCA**). This argument, differently from the KCA, concludes that *a reason* for the existence of the universe can only be given by the assumption of *a necessarily existing being* (Craig 1979a, 1980, 2009).

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[29] A complete exposition of the argument occurs within al-Ghazālī's *The Jerusalem Epistle* (*al-Risala al-Qudsiyya*), a small theological treatise of the 10th century A.D.

Instead of *a reason* for the coming into being of the universe, the *mutakallimūn* were more comfortable in speaking of an efficient *cause*. Islamic thinkers also claimed that such a cause must have existed from eternity, uncaused. Otherwise, they argued, it would in turn require a cause, and this would generate an infinite temporal regress of causes which, they believed, was established to be impossible.

An issue arose here: is a world that began in time compatible with an eternal cause of the world? If a cause immediately precedes its effect, indeed, we can explain (causally) why the effect happened when it happened rather than earlier or later: that depends on the fact that the cause is temporally located, *as a whole*, just before the time when the effect occurs. But if the cause exists since the whole eternity, we cannot recur to a similar explanation. Islamic theologians were facing here the same problem that would eventually become familiar to Christian thinkers: having established that the world was created a finite amount of time ago, they had to think of a possible explanation of why it was created precisely *a* certain amount of time ago. The orthodox solution was proposed by al-Ghazālī: God can be the eternal cause of a temporally limited world in so far as God is a *free agent who willed* from eternity that the world should come into being a certain number of years ago (Craig 1979a, 12). Thus, Islamic thinkers were able to grant that their free-willing God could be the eternal cause of a temporally finite world. But, according to al-Ghazālī, there is more: God *must* be the eternal cause of a temporally finite world. In al-Ghazālī's view, indeed, when two different events are equally possible the realization of one of them *must* be the result of the action of a personal agent who is able to act freely, that is, who can choose between equally possible alternatives even if there is no reason in favor of one rather than the other (Craig 1979a, 151). Such is a hungry person who is able to choose between two equally good apples, and such would be God, who was able to choose when to create the world without needing a reason. For the *mutakallimūn*, then, to demand a determinant for the beginning of the world meant to demand a freely acting personal agent who chose to create the world.

Eventually, however, theological concerns became less pressing. Even among those who were still absorbed in theological debates, the interest in defending or criticizing the KCA decreased **(**Craig and Sinclair 2009, 102**)**. However, the proofs for the finitude of the past in themselves continued to be discussed. This becomes evident if we consider the *Critique of Pure Reason*. Here Kant reckoned the metaphysical argument for the impossibility of traversing the infinite as part of the first antinomy of pure reason[30], and therefore as a recurrent argument to which reason gives rise when applied in the discipline that Kant named rational cosmology, that is, the discipline concerned with the arguments about the nature of the world (Grier 2018, 7). Kant's original presentation of the proof was, as Sorabji puts it, one of its last echoes: after Kant, the discussion of the philosophical arguments for the finitude of the past was (when there was any discussion at all) focused on the Kantian version of the argument for a long period (Sorabji 1984, 203).

Craig's numerous writings have undoubtedly played a central role in the contemporary resurgence and enrichment of the discussion on both the philosophical proofs for the finitude of the past and the KCA in general (Reichenbach 2019, 14). However, two more factors that are thought to have contributed: the publication of extensive studies on the medieval history of the philosophical arguments[31] and, perhaps more relevantly, the establishment of the aforementioned ΛCDM model as the standard model of cosmology. Indeed, at least two of the arguments that Craig gives to support premise (2) of the KCA are based on the empirical evidence for the Big Bang (as well as more speculative models). However, despite the widespread consensus among metaphysicians on the absence of decisive purely philosophical arguments for a

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[30] An antinomy of pure reason is, in Kant's understanding, a pair of apparently compelling proofs, thesis and antithesis, for two opposite claims about the world. The first antinomy, in particular, specifically regards the issue whether the universe has past temporal (first half) or spatial (second half) boundaries. According to Kant, in each antinomy both the thesis and the antithesis share the assumption that space and time are something existing independently from the human mind. The reason why Kant thought that both proofs are only apparently compelling is that the conflict that each of the antinomies exhibits is solvable with the help of his transcendental idealism (Falkenburg 2013, 67), the doctrine according to which space and time do not exist independently of the human mind but are rather the formal features of the way in which we perceive objects, properties, and relations. In other terms, the transcendental idealists believe that what is perceived in space and time is a mere "appearance" of the things in itself (Stang 2018, 1). Kant thought that once transcendental idealism is adopted, the conflicts exhibited by the antinomies disappear.

[31] Key studies include Behler 1965, H. A. Davidson 1987 and Dales 1990. It is also worth mentioning the translations of the texts of Philoponus and his contemporaries undertaken in the late 80s under the leadership of Richard Sorabji. See, for instance, Wildberg 1987.

universe that had a beginning (Introduction), Craig's primary strategy for advocating premise (2) is precisely to propose not one, but *two* such arguments. These arguments are both drawn from Philoponus' proofs of a world that necessarily begins: Craig argues, as I will show, that an actually infinite number of things is impossible, and that, even if it were possible, there could not be an actually infinite number of temporally successive past events, since this would entail a traversal of the infinite.

Within this chapter, I focus on these two arguments. I will label them the *Argument from the impossibility of infinities* (**AII**) and the *Argument from the impossibility of traversed infinities* (**AITI**). I must warn the reader, though, that it is not my intention to give an exhaustive account of the evolution of the contemporary debate on the arguments, let alone on the KCA in general. Craig's decades-long production on the topic has generated much material that has been soon superseded by the critics and revisited by Craig himself. Rather, my attempt is to take into consideration all those criticisms and responses that seem to me the most compelling.

I contend that neither of the two arguments defended by Craig is sound. In general, we may say that an argument is sound if, and only if, it is valid and its premises are true.[32] As for the first part of the definition, an argument is valid only if it is such that its conclusion is logically entailed by its premises. *Prima facie*, it looks safe to judge both the KCA and Craig's philosophical arguments in favor of premise (2) as valid.[33] Nonetheless, my contention is that one is not justified in considering all their premises true.

1.2. On the possibility of infinites

In the first subsection, I examine the AII and contend that it is not sound. In the second subsection, I show that those who wish to justify the AII, are anyway committed to a

[32] I follow here the standard account of what a sound argument is. Craig himself explicitly adopts this definition (Craig 2010c, 2).

[33] For a formalization of the KCA and the philosophical *arguments for a beginning* see Appendix 1. Of course, these arguments can be considered valid only under the assumption that they do not commit the so-called *fallacy of equivocation,* that is, that they do not surreptitiously assign different meanings to different instances of the same term. But if we grant a unique (plausible) interpretation to each term, we must consider the arguments for a beginning as instances of valid logical forms of reasoning.

specific dynamic view of time. This will lead to the discussion of the AITI in the next section.

1.2.1. Infinities in the world

The first purely philosophical argument in favor of the second premise of the KCA concludes that the past cannot be infinite on the basis of the idea that, *in reality*, there cannot be something infinite. The argument looks as follows (Craig and Sinclair 2009, 103):

> Argument from the impossibility of infinities (AII):
>
> (10) An actual infinite cannot exist.
> (11) An infinite temporal regress of events is an actual infinite.
> Therefore:
> (12) An infinite temporal regress of events cannot exist.

The first thing that catches the eye is that the AII's conclusion *prima facie* appears to have a different meaning from premise (2) of the KCA, which claims that the universe began to exist. If this is the case, then the AII cannot directly justify what it is supposed to justify. Keeping this in mind, let us start by clarifying the terms of premise (10). First, the actual infinite. Here, it may feel like we are already in a world of trouble.

For a long time, the concept of infinity was widely felt by philosophers to be incredibly hard to manage, if not impossible. Descartes, for instance, wrote that "it is in the nature of the infinite that I, who am finite and limited, should be unable to comprehend it" (*Meditationes De Prima Philosophia*, III)[34] while Hume, talking of the "limited" human mind, said that it "can never attain a full and adequate conception of infinity" (*Treatise of Human Nature*, 26).

One of the main reasons for this historically diffused sense of unease when dealing with the infinite is that, as Adrian William Moore points out, there is a tension between two intuitions of the infinite: the *metaphysical* and the *mathematical* (Moore 2019, 2). According to the metaphysical intuition, the concept of infinity should be somehow linked with concepts such as endlessness, unlimitedness, boundlessness,

[34] Tr. in Bennett 1974, 130.

immeasurability, incompleteness, and so on. The infinite is that which is such that, given any determinate part of it, there is always more. According to the second intuition, historically linked with theology, the infinite is that which is complete, absolute, universal, and self-sufficient: a complete whole, unity, or totality.

The tension between these two conceptions of infinity has led philosophers to develop an attitude of suspicion towards one or the other. Aristotle famously distinguished what he called "the potential infinite" from "the actual infinite" and admitted the reality of the first kind of infinite (that goes hand in hand with the metaphysical intuition) while rejecting the possibility of the second (that goes hand in hand with the mathematical intuition). For Aristotle, to distinguish between the two concepts it is crucial to make use of temporal notions: the actual infinite is that which infinitude is given at some time, while the potential infinite is given over time (Moore 2019, 38). In the *Physics* he argued that infinitely large or small magnitudes, which would be actual infinities, cannot exist at any time (*Physics*, 204b 1–206a 8). However, he believed that it is *always* possible to divide a magnitude or to add to a given magnitude a smaller one. If we were to perpetuate this process without ever stopping, this would generate *an unending series of magnitudes*: at any time there would be only a finite quantity or number of magnitudes thus generated, but *the endlessness* of such series allows it to be called potentially infinite (Mendell 2004, 15).

Over two and a half millennia, a large number of thinkers followed the lead of Aristotle in rejecting the idea that there could be an infinite quantity (or number) of things (Moore 2019, 37). To quote just two of the most important of them, Leibniz claimed that the idea of an infinite *number* is absurd since "an infinite cannot be a true whole" (*New Essays*, II. XVII)[35], while Kant thought that a determinate yet infinite quantity is self-contradictory (*The Critique of Pure Reason*, B555). To see why the idea of an infinite number may seem to lead to a contradiction, consider the following question that arises when supposing that the number of all the natural numbers is a determinate infinite number: if there are infinitely many natural numbers, how many odd numbers are there? For a long time, it was not clear how to deal with this kind of questions (Moore 2019, 6). It seemed highly counterintuitive to claim that there are two different infinities, the first double than the second. However, the alternative is to grant

[35] Tr. in Remnant and Bennett 1996, 64.

that there is the same number of natural numbers and odd numbers. Since natural numbers are all the odd and even numbers combined, here is where the impression of a contradiction arises.

It was only thanks to the development of the modern set theory by Gottlob Frege, Georg Cantor and others that the idea of an infinite number became the subject of precise mathematical treatment. That was, without doubt, a real turning point in the history of the concept of infinity. The legacy of their work is the Zermelo-Fraenkel axiomatic set theory (ZF), within which consistent definitions of an infinite number and an infinite set are given. Specifically, according to ZF, it is precisely the aforementioned (apparently) contradictory feature of infinities that defines an infinite set: a set S is infinite if, and only if, it has an (infinite) proper subset[36] that is equivalent to S. This amounts to say that an infinite set has the same number of elements of a proper subset.

Let us see in more detail what this means. Within set theory, the number of the elements of a set is expressed by a *cardinal number,* or cardinality, where the cardinal numbers are defined as a generalization of natural numbers. For instance, if we say that a set has four elements, the number four expresses the cardinality of the set. Two sets are said to have the *same number* of elements (i.e., to be equivalent) if, and only if, there is a one-to-one correspondence between them, that is, if each element of one set corresponds to one and only one element of the other set, and vice versa. In this case, we can say that the two sets have the same cardinality. For instance, if two sets have both four elements, their cardinality is four. When it comes to sets with an infinity of elements such as the set of all odd numbers or the set of all natural numbers, it can be proven that also between these sets there is a one-to-one correspondence. They have therefore the same number of elements, and this number is labeled $\aleph_0$ (aleph null).[37] This is the first *transfinite* (or infinite) cardinal number.

Now that the concepts of infinite set and infinite number have been clarified, we can introduce Craig's conception of an actual infinite. This crucially differs from Aristotle's: while for Aristotle an actual infinite was an infinite quantity of things that is

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[36] If A is a proper subset of B, then all elements of A belong to in B while at least one element of B does not belong to A.

[37] Transfinite cardinal numbers are, in general, represented using the symbol ℵ (aleph) followed by a subscript.

given at some time *simultaneously*, in Craig's understanding temporality or even simultaneity are not necessary features of actual infinities. Instead, an actual infinite is just any *multitude* that possesses an infinite number of elements. A multitude, here, must be understood as any grouping of things, be it a mathematical grouping, i.e., a set, or a non-mathematical grouping. A mathematical multitude is a mathematical object, i.e., an object studied by pure mathematics. Numbers, sets, and functions are examples of such objects. All the objects that are not studied by pure mathematics are non-mathematical objects. From here on I will refer to non-mathematical multitudes as '*collections*'.

Like in ZF a set S is infinite if, and only if, there is an (infinite) proper subset that is in one-to-one correspondence with S, so, more generally, a multitude is actually infinite if, and only if, a part of it can be put in one-to-one correspondence with the whole (Reichenbach 2019, 18). Such a multitude, as said, could be either a set (Craig and Sinclair 2009, 105) or a collection. I am going to show that Craig admits the possibility of actually infinite sets but denies that of actually infinite collections. Harking back to Aristotle, he claims that there can be at most a *potentially infinite* collection[38], which, in Craig's understanding, is a collection with a finite number of members that "increases perpetually but never attain infinity" (Craig and Sinclair 2009, 105).[39]

We can now investigate the meaning of the second part of premise (10) of the AIR: what does Craig mean when he says that an actually infinite multitude "cannot exist"? For Craig, *in this context*[40], "to exist" means, for a multitude, "to be instantiated in the mind-independent world" (Craig 1979a, 69; Craig and Sinclair 2009, 105). Craig does not explicitly state the meaning of this expression. A plausible way to interpret it is as follows: something is instantiated in the mind-independent world if, and only if, it is a *mind-independent* thing, where something is mind-dependent if it is temporally located at a time in virtue of some mental activity that takes place at that time (Falguera, Martínez-Vidal and Rosen 2021, 11). Since infinite sets are actual infinities, in order to

[38] Notice that within ZF there are no such things as potentially infinite sets, so that any potentially infinite multitude must be a potentially infinite collection.

[39] For further discussion on the potential infinite, see 1.2.2.

[40] For an analysis of the concept of existence employed in the KCA, see 2.1.1.

grant (10) Craig must deny that infinite *sets* can be instantiated in the mind-independent world, or, in other words, that they are mind-independent entities located in time. There are mainly two ways in which this can be done. The first is to deny the mathematical legitimacy of the notion of an infinite set altogether so that one could claim that there are no such things as infinite sets. But given the success of ZF, this path is not advisable. The second is to claim that the acceptance of the mathematical legitimacy of infinite sets does not entail an ontological commitment to such objects. This is the natural path to go for those who, like Craig[41], claim that all mathematical objects and relations are mind-dependent (Craig and Sinclair 2009, 107). The thesis that mathematical objects are instead mind-independent is part of a view labeled '*platonism about mathematics*' (Linnebo 2018, 1). Craig rejects this view altogether. However, he does not propose any argument. He just claims that adopting a platonist view would beg the question against "the plethora of alternatives" (Craig and Sinclair 2009, 108).

I do not believe that pointing out that there is a big number of alternatives is a good way to establish that the onus of the proof is on a certain theory. However, what Craig cares about is denying that the "extratheoretical correlates" of infinite sets, that is, actually infinite collections, can be instantiated in the mind-independent world. Since the AII can be easily reformulated in terms of collections, I will leave issues concerning the ontology of mathematical objects aside and focus on the possibility of actually infinite collections.

What kind of possibility is at stake? A metaphysical possibility, says Craig, not a logical one (Craig and Sinclair 2009, 105–106).[42] We can adopt here the common conception of a logical possibility: something being free from inconsistency guarantees that it represents a logical possibility. Metaphysical possibility is widely considered stronger than logical possibility: whenever something is metaphysically possible, it is logically possible, whereas the converse does not hold.[43] A classic example of something that is logically possible but not metaphysically possible comes from Kripke

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[41] Craig writes: "The realm of abstract objects is not for me a realm of Platonic existents, but a realm of thought and imagination" (Craig in Craig and Smith 1993, 96).

[42] In his articles and books, Craig also refers to this kind of possibility as ''real possibility" or "broadly logical possibility". I interpret Craig to take the claim that sets and in general mathematical objects *cannot* exist as involving the same kind of modality.

[43] It must be said that this picture is not entirely uncontroversial (Hale 2013, 115).

(1980): gold not having atomic number 79. In a possible-worlds theoretic model, we can say that there are logically possible worlds in which gold has a different atomic number, since denying it does not imply any inconsistency. But there is no metaphysically possible world in which gold fails to have the atomic number 79. A way of accounting for this is to say that having the atomic number 79 is an *essential property* of gold, a property without which gold would not be gold. The same goes, for instance, for water being H_2O. On this account[44], metaphysical possibilities can be understood as logical possibilities that are also allowed by the natures of all of the things that could have existed (Vaidya 2017, 2).

We can now see that Craig's recurrence to some stronger-than-logical modality seems to be a required move. Indeed, the internal consistency of axiomatic set theory allows us to argue that, just as infinite sets, actual infinite collections entail no inconsistency either (Rundle 2004, 170). However, it remains an option to claim that the "nature" of existing (in Craig's sense) collections does not allow them to possess an infinite number of elements. This is exactly Craig's strategy. He claims that the very feature that defines infinite sets within set theory, having an equivalent proper subset, would give rise to absurd consequences if actual infinities were to be instantiated in the mind-independent world.

Consider an infinite stamp collection where every stamp is marked with one and only one natural number. There is stamp '1', stamp '2', stamp '3', and so on. Suppose that the collection contains only red stamps and black stamps and that for every red stamp there is a black stamp, and vice versa. The black stamps are marked with odd numbers, the red ones with even numbers. It is easy to see that, just as there are as many odd numbers as odd numbers and even numbers combined, so there would be as many black stamps as black stamps and red stamps combined, and vice versa. This is, at least, counterintuitive.

If then we start to remove or add stamps to the collection, the consequences become even more counterintuitive. Notice that all the natural numbers and only the natural numbers have been used to mark the stamps. What happens if we find a new

[44] Those who claim that entities have essential properties are metaphysical essentialists. See for instance Lowe 2008a and 2008b and Hale 2013.

stamp for our collection? Do we need to mark it with a non-natural number? No. We can take the stamp with ‘1’ on it, erase the number, and write ‘2’; then take the stamp that had ‘2’ on it, erase the number, and write ‘3’; and so on. This way, the sign ‘1’ is free to be assigned to the new stamp. Moreover, if there were an infinite number of people, each one taking care of a stamp, the whole operation would take a finite amount of time. Moreover, when then it comes to taking stamps away from the collection, things become even weirder. Suppose we remove all the red stamps. Since there are as many black stamps as black and red stamps combined, this will leave the collection with the same number of stamps as before. Instead, if we remove all the stamps except three, we will be left with only three stamps. And if we remove all the stamps, we will be left with no stamps. In all cases, we have removed a fixed number of stamps ($\aleph_0$) from a fixed number of stamps ($\aleph_0$), but we get different results.[45]

From this kind of consequences, Craig draws the overall conclusion that, whereas actual infinities can have a, so to speak, *ideal* existence, an actually infinite collection of stamps, books, rooms[46], or whatever is a mind-independent thing, is a

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[45] There seems to be the shadow of a contradiction here. However, in transfinite arithmetic subtraction and division among transfinite numbers do not give definite results, so that no contradiction arises. Noting this, Craig claims that if infinite collections were to exist, something should prevent the simultaneous removal of infinite elements (Craig and Sinclair 2009: 108). I do not believe so. In the case of infinite collections, how many elements will remain in the collection just depends on *which* (rather than *how many*) elements are taken away from it. Let me propose a thought experiment to make this concept more accessible. Suppose that my stamps are positioned on the ground, forming three lines that start from a wind rose: two infinite lines going west and north-west, and one line of three stamps going north. Moreover, suppose that, if I stay on the center of the wind rose watching north-west, my sight is able to catch all the stamps at once. If I now turn my sight on the north, I will only be able to see the stamps on the north and north-west lines. An infinity of stamps went out of my field of vision, and still I see infinite stamps. But, if instead of turning north, I turn north-east, only the three-stamps line will remain within my field of vision. An infinity of stamps went out of my field of vision, and still I see three stamps. In both cases the same number of stamps goes out vision ($\aleph_0$), but how many stamps I can still see is just different. We can explain this difference by pointing out the fact that, depending on how I turn, different stamps go out of my field of vision.

[46] The most often-quoted thought experiment that illustrates the counterintuitive properties of an infinite collection is the so-called Hilbert's paradox of the Grand Hotel. The thought experiment was first introduced by the mathematician David Hilbert in 1924 when arguing that the actual infinite had no play in empirical sciences. In the thought experiment it is shown that a fully occupied hotel with infinitely

metaphysical impossibility (Reichenbach 2019, 16). Just as having atomic number 79 is an essential property of gold, so an essential property of a collection of black and red stamps would be, for instance, having a certain number of black stamps that is different from the number of black and red stamps combined.

Craig's position is not a standard one. Critics generally answered that finite and infinite collections just behave somewhat differently, and that the results of mathematics allow us to understand the weird behavior of the latter ones. As Jordan Sobel has rightly noted, the existence of an actually infinite collection is incompatible with the following two intuitively plausible claims:

(i) There are no more things in a multitude M than there are in a multitude M* if there is a one-to-one correspondence of their members.

(ii) If M* is a proper sub-multitude of M, there are more things in M than there are in M*.

According to Sobel (Sobel 2004, 186), the choice that we inherited from Cantor is to maintain (i) while denying that (ii) holds for infinite multitudes (be they set or collections). Instead, as Smith pointed out (Smith in Craig and Smith 1993, 84), Craig aims at establishing that both (i) and (ii) *must* (metaphysically) hold for all collections. His implicit claim is that we cannot give up (ii) because it expresses an *essential property of collections*.

Who is right, Craig or his opponents? Does (ii) express an essential property of collections? A defense of a positive or negative answer is missing in the literature. In this respect, Craig believes that arguments for metaphysical possibilities and impossibilities, compared to those for logical ones, must be "more subjective" and "less certain", in the sense that they must rely somehow more directly on intuitions (Craig and Sinclair 2009, 106): if assuming that something does not have a certain property generates counterintuitive consequences, then that thing must have that property essentially. This explains why the first sighting of paradoxical consequence is sufficient to make Craig cry wolf. However, in the literature we find many arguments for claims of the form 'for every *x* such that *x* is F, then *x* is essentially P'. These arguments rely

many rooms could still welcome additional guests (even infinitely many). Moreover, the operation could be repeated *ad infinitum* (Kragh 2019a, 33).

on assumptions that can in turn be justified. To mention only one of the best known, Nathan Salmon has defended the claim that a given artifact is essentially originally made of the material of which it was actually originally made (Salmon 1981).

To sum up, we can interpret (10), the claim that an actual infinite cannot exist, as equivalent to the following claim: all multitudes that possess infinite elements cannot be mind-independent. Craig attempts to justify (10) by arguing that

(i) If such a multitude is a set, then it cannot be mind-independent in so far as it is a mathematical object.

(ii) If such a multitude is a collection, then it cannot possess infinite elements.

As seen both these claims are questionable, so that, in general, the AII lacks strength. However, I will show that even if, for the sake of argument, we decide to go along with (10), there are other problems with the argument.

This leads to premise (11), the claim that an infinite temporal regress of events is an actual infinite. The expression that appears in (11) which still needs clarification is "infinite temporal regress of events". First, the events. The question "what is an event?" has been extensively confronted over the last few decades (Casati and Varzi 2008, 35; 2020, 1), and numerous accounts are available in the literature.[47] Fortunately, here it will not be necessary to choose one. It will suffice to stick to the *relatively* standard and intuitive conception of events as *happenings in time that entail changes*. Examples of events are the foundation of Rome or the Moon Landing, a bolt of lightning or a serenade, a death or a wedding, and so on. According to this general understanding of what an event is, any event has a finitely extended temporal duration. Moreover, we can take events as (almost) always extending from a specific durationless instant[48] (its beginning) up to a different durationless instant (its end), where the beginning of any event is temporally before its end, and both instants may or may not belong to the event

[47] For a comprehensive list, see Meyer 2013, 7.

[48] In this work, I make a widespread use of the concept of a *durationless instant*. However, one may think, as it happens, that nothing is truly durationless, so that there are neither instants nor things that obtain instantaneously. I believe that none of the arguments in this work would be *decisively* undermined by a critique based exclusively on this view. For matters of simplicity, however, I shall leave this side of the discourse for future investigation.

itself.[49] If an event occurs at the very beginning or at the end of time (given that such a thing is possible), then, if time has no first or last instant, the event would not have a proper beginning or end. But still, it would be finitely extended (3.1.2.).

Now, just like the Moon Landing is an event, so it can be considered that an event is also the entire complex of whatever happened in the universe simultaneously with the Moon Landing, including the Moon Landing itself. Let us call this kind of events *maximally complex* events (Smith in Craig and Smith 1993, 78). We can now specify what Craig means by "*temporal regress* of events": a series of distinct and non-overlapping past maximally complex events (from now on simply 'past events') that includes *all* past events. I name it the 'world-series'.[50] What Craig means by "*infinite* temporal regress of events" is that the world-series, according to (11), has no first event: any event of the series has a temporally preceding event (Craig in Craig and Smith 1993, 78; Craig and Sinclair 2009, 115). In these terms, we can interpret (11) as demanding that if the world-series has no first event, then it possesses an infinite number of events.

This premise can be easily granted. We can conceive the world-series as having a one-to-one correspondence relation with a *set* that is linearly ordered and discrete (also named a sequence). A linearly ordered set is a set ordered by a total order relation. A relation $\leq$ is a total order on a set S if, for all x, y and z in S, the following holds:

> **Total order**: if $x \leq y$ and $y \leq x$ then $x = y$ (antisymmetry); if $x \leq y$ and $y \leq z$ then $x \leq z$ (transitivity); $x \leq y$ or $y \leq x$ (connexity).

---

[49] The definition of 'beginning of an event' could be made more precise through the mathematical concept of a lower bound introduced in 1.3.1. This, however, is not necessary for the purposes of this work.

[50] To this definition one may object that, according to the Special Theory of Relativity (**SR**), given the relativity of simultaneity, it is not possible to define a maximal complex of *absolutely* simultaneous events. However, we can recover this characterization of the world-series thanks to the introduction of a preferred foliation, as it is done in many cosmological models. In any case, since we are dealing with purely philosophical arguments for logical or metaphysical modal claims (rather than physical) we do not need to endorse preliminarily any particular physical theory (it may be logically possible while physically impossible for two events to be absolutely simultaneous). For the prospects of a physical theory that were to implement the Awakening Universe Hypothesis, see the Concluding Remarks.

Antisymmetry, transitivity and connexity allow to diagram the set as a line of elements *each* following, or preceding, other elements.[51] A *discrete* ordered set can be informally defined as follows:

> **Discrete set**: a set is discrete when it is composed of isolated elements.[52]

Instead, a non-discrete ordered set

> **Non-discrete ordered set**: an ordered set such that among any two elements that belong to it there is at least a third element.

Notice that assuming that the world-series is discrete does not bind one to the claim that the series of temporal items at which the events occur (that is, the series of times, which may be instants or periods) is discrete as well. The events of the world-series may be isolated elements even if the times at which they happen are such that between any two of them there is always a third one.

Now, it can be shown that any sequence that has no first element (i.e., no element that is not preceded by any other element) is bounded to possess $\aleph_0$ elements. Therefore, if the world-series without a first event is in one-to-one correspondence with a sequence that has no first element, then it is bounded to have $\aleph_0$ events. Given these definitions, we can now reformulate the AII somewhat more precisely.

> Argument from the impossibility of infinities* (**AII***)
>
> (10)* For any multitude, if it possesses an infinite number of members, then it is not (metaphysically) possible for it to be instantiated in the mind-independent world.
>
> (11)* If a particular multitude, the world-series, has no first element, then it possesses an infinite number of elements.

---

[51] This could be checked by thinking about how dropping any of the three properties of the total order relation would allow to make room for cases of ordered sets such that they cannot be diagrammed as a line of elements. For instance, connexity grants that no element is disconnected by all the others as it would be, for instance in a branching diagram.

[52] More formally, a set S is discrete in a larger topological space X if every point $x \in S$ has a neighborhood U such that $S \cap U = \{x\}$. For the definitions of topological space and neighborhood see Krantz 1999, 63.

Therefore:

(12)* If the world-series has no first element, then it is not (metaphysically) possible for it to be instantiated in the mind-independent world.

The argument so construed has a valid form (Appendix 1). However, is the conclusion strong enough to establish at least that there was a first event? Craig thinks it is (Craig 1979a, 99). Nonetheless, I will argue that, even if the AII were to be successful, it would neither establish that there must have been a first event, nor that the world-series must have a first event. It would only establish that *if* the world-series has no first event, then it cannot be instantiated in the mind-independent world. This is compatible with the world-series not being instantiated in the mind-independent world *and* not having a first event. For instance, the world-series may be just a mathematical object: an *ordered set*.[53] Nothing said so far excludes this possibility, and we have seen that, in order to justify (10)*, Craig himself argues that all mathematical objects cannot be instantiated in the mind-independent world. Surely, if a (temporally) ordered set that contains *all* past (non-overlapping) events has a first element, then *there was* a first event. But maybe such a set just does not have a first element after all, and (12)* seems to be compatible with this possibility.

If we want to deduce from the AII that the world-series cannot have a first event, we must grant that such series is instantiated in the mind-independent world. Here one may think that all that is needed is to make sure that the world-series is not interpreted as a mathematical object but as a "real" series of past events that have taken place in space and time. However, things are not that simple. There is still a further reason to be cautious in proclaiming that the world-series, *as a whole*, is instantiated in the mind-independent world: presentism.

Presentism has been proposed in the context of the long-standing debate on whether the present moment is not only semantically special[54], but somewhat

[53] The term 'temporal regress' itself has a *conceptual* connotation: it refers to the fact that the world-series is to be understood as a hypothetical *enumeration* of the past events starting from the present (Craig 2009, 116).

[54] The present moment is the only moment that we can describe without the use of definite descriptions (Meyer 2013, 99). Moreover, as Prior has famously shown, sentences that make reference to the present moment are not translatable into tenseless sentences without loss of meaning (Prior, 1959).

metaphysically, or objectively, special. Following Ulrich Meyer, we can characterize presentism as the ontological view that nothing exists that is not present (Meyer 2013, 88). If presentism is a necessary truth, it comes natural to infer that the (non-mathematical) world-series of all *past* events cannot exist, because nothing is present in such series. But if the world-series cannot exist, in the sense of being instantiated in the mind-independent world[55], then we could not deduce the absence of a first event from (12)*. Again, if the consequent of the conditional is false, the antecedent can be either true or false. Given this, if we want to deduce from (12)* that there was no first event, we better grant, in general, that past things exist.

Craig tries to break free from this constraint. He points out that even if past things do not exist, we can still enumerate them. That is, we can form *a conceptual collection* of all past events. And if there was no first event, then the number of all past events within this conceptual collection must be infinite. Since according to (10)* an infinite collection cannot be instantiated in the mind-independent world, we must conclude that there was a first event (Craig and Sinclair 2009, 116). It is unclear to me how this conceptual collection should be understood. In any case, again, the conclusion does not seem to follow the premises. Even if we concede that there may be a non-mathematical grouping of things that is a *conceptual* collection[56], all we can conclude is that an infinite conceptual collection cannot be instantiated in the mind-independent world. But this seems trivial, in so far as a conceptual collection must be a *mental* collection, so that it is hard to see how it can be *mind*-independent *per se*. Moreover, we can plausibly reject the premise according to which if there was no first event, then the number of all past events within the conceptual collection must be infinite. Indeed, there are good reasons to think that a mental collection of things cannot be infinite primarily

[55] Here, one may wonder whether the concept of existence used by the presentist is inclusive of Craig's sense of existence. In fact, it is a matter of dispute whether 'exists' in the presentist claim should be interpreted as 'exist at some time' (so that the presentist substantial tenet would be that everything that exists at some time exists at the present time only) or, in a wider sense, as existence *simpliciter* (Meyer 2013, 90). Either way, if the world-series and its elements exist in Craig's sense, that is, if they are instantiated in the mind-independent world, then they exist both simpliciter and in time.

[56] Again, if we are talking about a set, it can be infinite *and* not instantiated in the mind-independent world, so that maybe there was no first event.

because of the limits of the mind, rather than because of absurdities connected with the idea of an actual infinite.[57]

To conclude: the AII is a valid argument, but one of its premises is unjustified and its conclusion is too weak to support the claim that there was a first event.

1.2.2. Dynamic time and potential infinities

Before getting to the second important philosophical argument for the impossibility of an infinite past, it is worth considering a further criticism of the AII. This will allow us to see how those who wish to justify the AII are committed to a specific dynamic view of time.

The criticism has been proposed by Wes Morriston, one of the theologians who oppose the KCA, and it goes as follows: if the AII were effective in establishing that there cannot be an infinite series of past events (since actual infinities are metaphysical impossibilities), then a parallel reasoning must lead to the conclusion that there cannot be an infinite, endless, series of future events (since such a series would be an actual infinite as well) (Morriston 2010, 443). Craig and those who propose the KCA firmly deny this, their point being that an endless series of future events is not an actual infinite, but merely a potential infinite (which is possible) (Morriston 2010, 439).

It is not easy to envision what it could mean, for the endless series of future events, to be potentially rather than actually infinite. If we consider this series as a whole, surely, we must say that it is actually infinite, in so far as it possesses an infinite number of members (a sequence with a first but not last member must have an infinite number of members). It seems then that something else must be said to be potentially infinite. We have seen that Craig defines a potentially infinite collection as “a collection that increases perpetually but never attains infinity”. Elsewhere, he defines it as “a collection that is increasing toward infinity as a limit but never gets there” (Craig 2008, 116). From these vague definitions it would seem that, when we attempt to outline *what* can be potentially infinite, we must look for something that can *increase*. However, strictly speaking, *a determinate* finite collection cannot increase, at least if we follow

[57] In this respect, Jonathan Bennett attributed to Kant the thesis that an infinite past would entail sentient beings that are infinitely memory-laden and indicated this as a possible reason to reject the infinite past (Bennett 1974, 124).

the Cantorian teaching according to which the identity of a specific multitude is underdetermined by the members that belong to it.

Maybe we could say that *each stage* of the endless series of future events is potentially infinite, where a stage can be defined as a subseries of the whole series that contains the first n events of the series, with n being any natural number.[58] However, if the endless series of future events, as an actual infinite, cannot exist (as the proponents of the KCA claim), then how can the stages which constitute the series *all* exist? The same question goes for whatever ultimately constitutes the stages themselves, since all the events that ultimately constitute all the stages are the same that constitute the endless series (Morriston 2010, 445).

One way to avoid this problem is to adopt a specific kind of dynamic view of temporal reality[59], according to which *facts about what exists* change over time, so that there exists something that sometimes does not exist. Such a view is named *temporaryism*, while its negation, the thesis that always everything always exists, is named *permanentism* (Williamson 2013, 4; Correia, Rosenkranz 2018, 42; Correia, Rosenkranz 2020, 2005). More precisely, we must adopt a view according to which there is a changing fact about *what time is the edge of becoming*. At this time, and before this time, things exist. After this time, nothing exists. The temporaryist view according to which what exists increases over time, the edge of becoming being the present moment, is called the *Growing Block Theory* (Correia, Rosenkranz 2018, 42). Notice that the notion expressed by the verb 'to exist' must be, following Giuliano Torrengo's terminology, the notion of simple existence, that is, the notion of *being part of the ontology*, rather than the notion of *being temporally located* (Torrengo 2012, 127).[60]

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[58] The necessary and sufficient condition for a stage to be potentially infinite would be precisely to be a stage of an endless series.

[59] Dynamic views of temporal reality are, in general, views according to which what facts there are changes over time (Correia, Rosenkranz 2018, 11).

[60] While Torrengo takes this notion to be tenseless, in the sense that it does not contain *in itself* (as a predicate) any temporal reference, Correia and Rosenkranz take it to be tensed (Correia, Rosenkranz 2020, 2004). I shall remain neutral on this issue, for the only thing that matters here is to note how they all agree that this is the relevant notion of existence when it comes to the temporaryism/permanentism dispute.

If the edge of becoming is the present time, and if the not (yet) existing series of future events will be endless, then a world-series with a finite number of events would be a good candidate to be called potentially infinite. Indeed, at every moment such a series would be finite and, in a sense, increasing (Morriston 2010, 446). And still, we could say that what ultimately constitutes the potentially infinite series, exists. This setting not only seems to be more in line with Craig's definition, in that it recovers the "increasing" feature of the potential infinite, but also with Aristotle's original account (Sorabji 1984, 211). Consider Moore's illustration of a potentially infinite series as Aristotle would understand it:

> Imagine a clock, for example, endlessly ticking. Its ticking is potentially, but never actually, infinite. It is as if the ticking is in a constant state of becoming but never actually is, in its entirety. It never achieves full being. Spread over time, it exists in the way that a day exists. But, in contrast to the case of a day, there is no time at which it has completely run its course or by which it can be said to have been actualized.
>
> (Moore 2019, 37)

Here, the potentially infinite series of ticks is composed of all the *past* ticks up to the present, rather than some future ticks. Moreover, the ticking (or, more precisely, what ultimately constitute it) exist, just like "a day exist".[61]

However, even if we adopt the Growing Block Theory, it remains true that, at every moment, whatever constitutes the future series of events does not yet exist. It turns out, then, that the proponents of the KCA, since they wish to exclude the possibility of a beginningless world-series of past events while allowing an endless series of future events, must argue that future things do not exist. We have seen, moreover, that in order to infer that there was no first event from the conclusion of the AII, they must grant the existence of past things. All things considered, then, it turns out that the proponents of the AII, apart from facing the problem of justifying the claim that an actually infinite collection is metaphysically impossible, are also committed to a very

[61] Notice, again, that in Aristotle's view if such a series of ticking has no beginning that would not make it an actual infinite series, while in Craig's view it would (1.2.1.).

specific dynamic view of time: the Growing Block Theory. No other theory seems to be able to grant the ontological distinction between past and future things that they require.

Craig and Sinclair try to account for the ontological difference between past and future by appealing to the reality of temporal becoming (Craig and Sinclair 2009, 116). Assuming that by "temporal becoming is real" one means that temporaryism is true, my claim is that the only temporaryist view that seems to be available for those proposing the AII is the Growing Block Theory. Other temporaryist views that do not assume the existence of past things and the non-existence of future things (like presentism), as we have just seen, will not do. In fact, assuming the Growing Block Theory is also crucial in order to justify one premise of the second important philosophical argument for the impossibility of an infinite past: *the Argument from the impossibility of traversed infinities.*

1.3. On the possibility of an infinite past

As seen (1.2.1.), the AII is not a good argument for the claim that there was a first event. But what if we did have a good argument for the claim that there was *no* first event? Would that be enough to entail that the world-series did not begin? In subsection 1.3.1. I establish the necessary and sufficient conditions for the world-series to have begun. In doing this, I incidentally show the truth of three statements. The first one is fairly agreeable: even if there was no first event, this does not grant that the world-series is beginningless. The second and the third statements are somehow more problematic. I claim that, even if we take the world-series to be infinitely extended into the past, this still does not grant that it is beginningless. In fact, it does not even grant that there was no first event.

Establishing the necessary and sufficient conditions for the world-series to have begun is important, since the aim of this chapter is to show that one cannot find effective purely philosophical arguments for the claim that a *beginningless* temporal series cannot elapse. Moreover, this will prepare the discussion of the *Argument from the impossibility of traversed infinities* in subsections 1.3.2. and 1.3.3.

1.3.1. Infinitely far beginnings

What does the verb ‘to begin’ generally mean? Suppose one says that it begins to rain. Normally, we take this to imply that at a certain time there was no rain, and at a certain later time there was rain (Newton Smith 1984, 94). According to this common understanding of ‘to begin’, one can say that, if there was a time before the world-series when there was no world-series, then the world-series began. However, this cannot be taken as a necessary condition for the world-series to have begun, for it is at least logically possible for time itself to have begun together with the world-series.

There is a second meaning that is commonly attached to beginnings. One may also say, for instance, that the sequence of natural numbers has a beginning. In this case, what we are saying is that such a series has a first element. According to this second understanding of beginnings, one can say that, if the world-series has a first event, then it has a beginning. Moreover, one could apply this second common understanding of beginnings together with the first one, and claim that the world-series began if, and only if, either there was a time before the world-series when there was no world-series, or the world-series has a first event. However, again, things are not that simple.

Recall that the world-series is a series of maximally complex, distinct, and non-overlapping past events that includes all past events. It goes up to the present moment so that it has a last element: a maximally complex event that ends at the present moment. Recall also that each event has a finite temporal duration, and it begins and ends at precise moments (1.2.1.). Finally, the world-series is linear and discrete (it can be put in one-to-one correspondence with a linear discrete ordered set).

Now, let us suppose that the world series has no first event. Is this sufficient to establish that it is beginningless? In the previous subsection, I have shown that, if the world-series has no first event, then it must have $\aleph_0$ elements. What about its temporal duration? Suppose, for instance, that each of the $\aleph_0$ events has the same temporal length: one temporal unit. To answer the question “what is the temporal duration of the whole world-series?”, one must sum up all the singular values. In mathematics, this is expressed as the divergent series ‘$\sum_{n=1}^{\infty} 1$’ or ‘1+1+1+1+...’. That a series is divergent means that the sequence of partial sums {1; 2; 3; 4;...} fails to converge to a finite limit, which, strictly speaking, entails that the series does not have a sum. However, one can surely say that it goes to infinity (Hardy 1949). I, therefore, define the world-series as having an *infinite* temporal length if the sum of all the values of all the events' temporal durations can be expressed as a *divergent* series.

However, the fact that there are $\aleph_0$ events within the world-series does not grant that the sum of their temporal lengths can be expressed as a divergent series. Suppose, for instance, that the last event has a temporal duration of half temporal unit, and that each other event has half of the temporal duration of the following one. The sum of all the temporal lengths could be expressed as '$\sum_{n=1}^{\infty}\left(\frac{1}{2}\right)^n$' or '$\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+\ldots$'. This is a convergent series, the result of the sum being one. In general, if the sum can be expressed as a convergent series, the overall temporal length of the world-series is finite. In such a setting, we could build the world-series as *not* extending beyond whichever finite period of time ago, say thirteen billion years ago (just as well as five seconds ago). I take the world-series as having a *finite* temporal length if the sum of all the events' temporal durations can be expressed as a *convergent* series.

The intuition here suggests that, if the world-series is finitely extended, then it has a beginning. It does not matter whether there was no time before the world-series when there was no world-series, or even whether there was no first event: if the changing universe is going on since a finite amount of time, we shall not say that it is beginningless. This seems reasonable: as cosmologists often do, in the context of the ΛCDM model one can say that time has begun even if the *finite* history of the universe has no first time (since one cannot take the initial singularity to be part of the spacetime manifold) (Harrington 2015, 227). Just as time is said to have begun by virtue of its finite extension even if there was no first instant, so the world-series may have begun by virtue of its finite extension even if there was no first event.

Can one therefore take the finite extension of the world-series as a necessary and sufficient condition for it to have begun? To say it otherwise: can one take the world-series to be beginningless if, and only if, it is infinitely extended into the past? I must argue for a negative answer. Consider the case where the world-series has a first event. The simpler sub-case is, without doubt, a world-series with a finite number of events. Such a series would necessarily be finitely extended (since the events are finitely extended and in a finite number). In this case, the world-series surely began with the first event. Things become less trivial if we allow there to be $\aleph_0$ events within a first-event-world-series. Given that the world-series is linear and discrete and has a last element, for there to be $\aleph_0$ events it must be possible to build a sequence with $\aleph_0$ elements that has both a first and a last element. This is not a common setting, but it can be done. Consider the set of all integers: one way of imposing an order on it is the standard one $\{\ldots; -3; -2; -1; 0; 1; 2; \ldots\}$. Another non-standard way of ordering them is as follows: $\{0; 1; 2; \ldots; \ldots; -3; -2; -1\}$ (Moore 2019, 122).[62] The second linear ordering is still discrete: all the elements that belong to it are isolated (1.2.1.). The same would not hold, for instance, if we ordered the set as follows: $\{\ldots, -3; -2; -1; 1; 2; \ldots; 0\}$, for in this case there would be at least one element between the element '0' and any other element of the set, so that '0' would not be isolated.

Now, suppose that the world-series has a one-to-one correspondence with the second ordering introduced just above. That is, each number of the ordering corresponds to a finitely extended event. If we suppose that the sum of their respective temporal lengths is expressible as a convergent series, the world-series is finitely extended. If it is expressible as a divergent series, the world-series is infinitely extended. And still, in both cases the world-series would have *a first event*, corresponding to the element '0' of the second ordering introduced above. Given that the world-series began if it has a first element, one can say that, in both cases, the world-series began.

Of course, that an infinitely extended world-series may have a first element is highly counterintuitive: how infinite time could have elapsed *between* two events? However, in the next subsection I try to show that the possibility of the traversal of an infinite temporal sequence does not depend on whether the series has a proper start, that is, a first element.

Once we admit the possibility of infinitely distant periods or events, then we must realize that a no-first-event-world-series that is infinitely extended into the past may have begun as well. Consider, indeed, the following possibility: before the history of the changing universe that the infinitely extended world-series represents, a period of time without change elapsed. If a time when there was no event (i.e., no world-series) is logically and metaphysically possible (as I argue in Chapter 3), then such a period of time may have elapsed before a no-first-event-world-series, its end being infinitely far

[62] Notice that, technically, the integers are not well-ordered in either way (Moore 2019, 123).

apart from any event. Since in this case one can say that there was a time before the world-series when there was no world series, according to the first common understanding of ‘to begin’, one must say that the world-series began.[63]

To sum up, neither that there was a time before the world-series when there was no world-series, nor that there was a first event, nor that the world-series is finitely extended, are, by themselves, necessary and sufficient conditions for the world-series to have begun. However, the mathematical notion of a lower bound allows us to state such conditions. Consider a subset S* of a sequence S. An element x that belongs to S is a lower bound of S* if, and only if, for every y that belongs to S*, $x \leq y$ (the concept of upper bound can be defined conversely). For instance, the lower bounds of the subset of the sequence of all the integrals that contains all the numbers greater or equal than 3 will be all those integrals that are lower or equal to 3. Given this, one can define the necessary and sufficient conditions for the world-series to have begun:

> **BW**: the world-series began if, and only if, either it has a lower bound or it is finitely extended. The world-series is beginningless if, and only if, it is *not* the case that it is finitely extended and it has no lower bound.

The reason why it is preferable to avoid calling into play infinite extension as one of the conjuncts of the condition for the beginningless world-series will become clear in Chapter 4 (4.2.1.).

Now that we have given this definition of a beginning world-series we can see that, on our definition of a beginning world-series, the AII, an argument for the necessity of a first event, if it worked, would have established that the world-series began by proving that there must be a lower bound: namely, the first event.

1.3.2. The traversal of the infinite

Not many people know that in 1972 Richard Nixon competed with a philosopher, John Hospers, for the presidential election of the United States. As a philosopher, Hospers surely wondered how he had come to his attempt to disobey the age-old precept that it is

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[63] Of course, we can postulate a period of time without change even before a finitely extended world-series. In this case, however, this would hardly change our minds about whether the world-series has a beginning.

better not to put political power in the hands of philosophers. In fact, already few years before the election, Hospers was wondering, more generally, on how did anyone get to their present at all:

> If an infinite series of events has preceded the present moment, how did we get to the present moment? How could we get to the present moment, where we obviously are now, if the present moment was preceded by an infinite series of events?
>
> (Hospers 1967)

These words are evocative of the second kind of argument against the possibility of a beginningless world, which is aimed at supporting the following, broadly stated, idea: if an actually infinite collection could exist, it would still not be possible for an infinity of events to have elapsed.

This kind of argument, as seen, has a long tradition that started with Philoponus. We have mentioned its importance for the Muslim theologians, and that Bonaventure used it against Aquinas. Moreover, during the seventeenth century, illustrious proponents were Ralph Cudworth and Richard Bentley. However, nowadays the argument enjoys a certain fame especially because, as mentioned in 1.1.2., it was instantiated in the first antinomy of pure reason. As in the previous sections, I take Craig's version of the argument as the reference version for the modern formulation of the argument. However, since Kant's version uncontentiously constitutes such a crucial historical passage of the theoretical speculation about the origin of the world, Craig's version will be interpreted in parallel with Kant's, showing that, under a certain understanding of the world-series, they amount to the very same argument.[64] Here is the passage from the *Critique*:

> For if one assumes that the world has no beginning in time, then up to every given point in time an eternity has elapsed, and hence an infinite series of states of things in the world, each following another, has passed away. But now, the infinity of a series consists in the fact that it can

[64] Craig himself considers Kant's argument as equally effective as his own in establishing the necessity of the finitude of the world's past (Craig 1979a, 110; Craig 1979b, 564; Craig 2017a, 310).

never be completed through a successive synthesis. Therefore, an infinitely elapsed world-series is impossible, so a beginning of the world is a necessary condition of its existence.

(CpR A429/B457)[65]

We may schematize Kant's argument as follows[66]:

Temporal half of the first thesis **(TFT)**

(13) The world-series has no beginning.

Therefore:

(14) Up to each point in time an infinite world-series has elapsed.

(15) The infinity of a series consists precisely in the fact that it can never be completed through successive synthesis.

Therefore:

(16) It is impossible for an infinite world-series to have elapsed.

Therefore:

(17) The world-series has a beginning.

Instead, Craig's version goes as follows (Craig and Sinclair 2009, 103):

Argument from the impossibility of traversed infinities **(AITI)**

(18) A collection formed by successive addition cannot be an actual infinite.

(19) The world-series is a collection formed by successive addition.

Therefore:

(20) The world-series cannot be an actual infinite.

First, we must ask if Kant's world-series can be defined in the same way as the world-series was defined in this Chapter. Kant refers to it as the series of 'state of things in the world' that are 'each following another'. The expression 'each following another'

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[65] Tr. in Guyer and Wood 1998, 469.

[66] For a classic text on the historical and conceptual origins of Kant's argument see Al-Az.m 1972. For more recent literature on Kant's first antinomy see Loparic 1990, Watkins 1998, Malzkorn 1999, Grier 2006, Vanzo 2005, Wood 2010 and De Bianchi 2015.

suggests that Kant has in mind that the elements of the world-series could be represented as ordered in such a way to form a line. This directly recalls a set ordered by a total order relation, that is, a *linear* ordered set (1.2.1.). Moreover, it seems that we should further characterize Kant's world-series as having a one-to-one correspondence relation with a linear *discrete* ordered set, or *sequence*. The reason for this becomes evident if one considers that the aim of Kant's argument is to conclude (17), that the world-series has a beginning, by showing first (16), that it is not possible for an infinite world-series to have elapsed up to some moment (say, the moment of today's breakfast). If the series were non-discrete, then any sub-series should be constituted by infinite elements. If one takes an infinite series to be constituted by infinite elements, then (16) would entail that, no matter how long, any fragment of the world-series could not have elapsed (whatever that means). In order to avoid this undesired consequence, the world-series must be conceived as discrete.

Regarding the elements that compose the world-series, Kant talks about "states of things in the world". This expression can be interpreted with today's metaphysical tools: a state of an object (or substance)[67] is a way in which the object is at a certain instant of time (Textor 2021). If one takes the world to be an object, the elements of the world-series could be instantaneous states of the world, each associated with a certain instant. Alternatively, one could take the state of the world at a certain instant to be *the maximally complex state* that obtains at that instant.[68] Since the world-series is discrete, adopting either of the two settings would leave two options available, both unpalatable: either every instant has an associated instantaneous state of the world, so that time is discrete as well, or there is some time among every couple of instantaneous states of the world. The latter option would surely appear absurd to Kant or any of his contemporaries, while the former would attribute a very specific topological feature to time, one of which there is no clue in our experience. In fact, the time-series may well be non-discrete.

[67] Kant holds that *matter* satisfies, in the field of appearance, the formal criterion of substance (Strawson, 2000). For the definition of substance endorsed in this work, see 2.1.2.

[68] The definition of a maximally complex state is to be given on the lines of that of a maximally complex event (1.2.1.; Chapter 4).

The argument, therefore, can be best understood in its intent if one conceives Kant's world-series, just as before, not as a sequence of states, but of events that have a certain temporal duration. Each of these events begins and ends at a precise moment, so that Kant's world-series (just as before) can be built as extending "up to each point in time". If one then assumes that Kant's world-series is constituted by all the *past* events, then up to which point in time it extends will depend on what moment is taken to be present (just as before).[69]

Clarified how one should understand Kant's world-series, in order to understand Kant's argument one must face two important questions:

(F) What does it mean for the world-series to have elapsed?

(G) What does it mean for a sequence to be completed through successive synthesis?

According to Jonathan Bennett, each of these questions has an obvious answer. First answer: that the world-series has elapsed simply means that it has a last element. Second answer: a sequence is completed through successive synthesis if its elements are enumerated one by one *from one terminus to the other* (Bennett 1974, 119). Bennett argues that, since such an enumeration is possible only if a sequence has two termini, then (15) would entail that "a discrete temporal series [such as the world-series] is infinite if, and only if, it is not the case that has two termini" (Bennett 1974, 120). But (16) (which here shall be read as the claim that it is impossible for the world-series to have a last element) does not follow from (15): an infinite temporal series can have a last element, just as an infinite mathematical sequence can have a last element. An infinite series of events up to the event of today's breakfast must not, in fact, have two termini: it can be open on one end and closed on the other (the event of today's breakfast being its closure). It results, then, that on Bennett's "obvious" reading of 'elapsed world-series' and 'series completed through successive synthesis', the argument is invalid.

[69] Notice that nothing in Kant's formulation forces us to adopt this setting rather than quantifying over times or possible world-series. In order to keep things simple, I must not follow this strategy. The choice, however, does not affect the effectiveness of the argument

In fact, many commentators, from Arthur Schopenhauer to Kemp Smith, have charged Kant's argument with invalidity because "we can always conceive of the end of a beginningless series" (*The World as Will and Representation*, I587).[70] Of course, Kant did not have access to the Cantorian concept of a transfinite number. Rather, his definition of the infinity of a series underwent the influence of the dominant Aristotelian conception of infinity of his period (Bennet 1974, 138). Nonetheless, a large part of the instances of this common criticism came, somehow unfairly, from the framework of the developing modern set theory. The most prominent criticism was from Russell, who, having attributed to Kant the false claim that an infinite sequence with a last element is impossible, wrote:

> The notion of infinity [...] is primarily a property of classes, and only derivatively applicable to series; classes which are infinite are given all at once by the defining property of their members, so that there is no question of "completion" or of "successive synthesis." And the word "synthesis," by suggesting the mental activity of synthesizing, introduces, more or less surreptitiously, that reference to mind by which all Kant's philosophy was infected.
>
> (Russell 1929, 126)

However, perhaps Kant would have suggested a different answer to questions (F) and (G) above. This is exactly Craig's suggestion: in trying to dismiss Russell's objection, he notes that, although an operational definition of infinity (such as Kant's) is not needed in the case of sets, it is still required for temporal series (such as the world-series), in so far as they are "sequentially instantiated in the real world". The elapsing of the world-series, then, would be nothing else but its formation by the successive addition of new events: "Since events in time, unlike events in space, exist serially [...], we do stand at one end of a series that is constantly being completed" (Craig 1979a, 558).[71] A sequence that is completed by successive synthesis, moreover, is nothing else

[70] Tr. in Janaway 2010, 524.

[71] This characterization of the world-series seems to entail some kind of time passage. This is because, in Craig's description, the world-series "is constantly being completed", which seems to be an absolute fact independent from any temporal perspective. Notice also that the successive synthesis in Kant's argument

but a sequence that has been formed by the successive addition of its elements. If we adopt Craig's interpretation, then, by adding some hidden assumptions (HA in short), Kant's argument can be translated as follows:

Temporal half of the first thesis* **(TFT*)**

(13)* The world-series has no beginning.

(HA1) The world-series has been formed by successive addition.

(HA2) If the world-series has no beginning, then it is infinite.

Therefore:

(14)* The world-series is infinite and has been formed by successive addition.

(15)* It is necessary[72] that a temporal series (a series of things temporally ordered) is infinite if and only if it cannot be formed by successive addition.

Therefore:

(16)* It is impossible that the world-series is infinite and it is formed by successive addition.

Therefore:

(17)* The world-series has a beginning.

Now, both the TFT* and Craig's argument, the AITI, instantiate valid forms (Appendix 1). Notice that (15)* entails (18) (the claim that a collection formed by successive addition cannot be an actual infinite)[73]: given that, necessarily, a temporal series with $\aleph_0$ elements cannot be formed by successive addition, it follows that a collection formed by successive addition (which can be seen as a temporal series of

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is naturally read as mind-independent on the ground of a dynamic view of time. This suggests that Russell, in pointing out the mental component in Kant's argument, was interpreting it on the ground of a static view of time (thus, perhaps, begging the questions).

[72] Notice the importance of understanding (15)* as a claim about what is true of infinite temporal series *necessarily*. Suppose that (15)* simply stated that a temporal series is infinite if and only if it cannot be formed by successive addition. Then there could be a possible world, different from the actual one, where temporal series could be formed by successive addition, and (16)* would not follow.

[73] We must here put aside matter of historical interpretation and understand, from now on, the term 'infinite' in Kant's argument by Craig's notion of an actual infinite.

successive additions) cannot have $\aleph_0$ elements. Moreover, (19) (the claim that the world-series is a collection formed by successive addition) is equivalent to (HA1), while (20), the conclusion of the AITI (the claim that the world-series cannot be an actual infinite) can be derived from (HA1) AND (15)*. Given this, if the TFT* is a sound argument, so is the AITI.

Let us have a look, then, at the TFT* premises and ask whether there can be good reasons to believe in them.[74] Premise (HA2) can easily be granted: we have seen in the previous subsection that a beginningless world-series must contain $\aleph_0$ events. As for the task of granting (HA1), it seems that some dynamic view of time is needed: given that facts about what exists change over time, we can allow events to be "actualized one after another" (Craig 1979c, 7). Again, I suggest that some version of the growing block theory would be the most natural choice here (1.2.2.). Interestingly, then, it turns out that taking on board such a dynamical view of time (with all the problems that it may bring with itself) is important for *both* of Craig's arguments for a finite past (Craig 2001, 115–163).

But the TFT*'s truly controversial premise, about which an intense debate has been generated, is (15)*: is it possible that an infinite temporal series can be formed successive addition? Craig argues that it is not. He believes that *an infinite number of successive additions is not possible*, and therefore that an infinite temporal series cannot have been formed this way (Craig and Sinclair 2009, 103). But why should we think that an infinite number of successive additions is impossible? Sometimes, the impossibility at stake is referred to, in more colorful terms, as the impossibility of counting to infinity or of traversing the infinite. To see why this terminology is appropriate, consider a set S that contains $\aleph_0$ elements. If we count *all* of its elements, one by one, then we have perpetuated an infinite number of successive additions. Similarly, if we cross an infinitely long distance, we have, again, perpetuated an infinite number of successive additions (of steps).

There is an obvious reason that immediately imposes itself and makes us think that such things are impossible: there is *never* going to be *enough* time to count all of S's elements, or to perpetuate an infinite number of steps. Here, however, a standard objection given by the critics of the TFT* is relevant: maybe it is not possible to count

[74] Except for (13)*, which is the premise that has to be denied by the *reductio ad absurdum*.

all of S’s elements in a *finite* amount of time, but nothing is *prima facie* contradictory in the hypothesis that it is possible to count them over an infinite amount of time (Smith in Craig and Smith 1993, 89). According to this objection, a scenario that Wittgenstein once described as absurd would be possible. He imagined approaching someone who is muttering softly “five, one, four, one, three… finished!”. After been asked for clarification, they explain that they have just finished reciting backward the infinite expansion of π, something that they have been doing for all of past eternity (Wittgenstein 1975, 166).

Here one must be careful. The temporal series thus generated by the Wittgenstein’s mutterer is made of infinite utterances, but, as seen, an event-series of this kind could be either finitely or infinitely extended. To say that the series cannot be completed in a finite amount of time means to exclude the possibility of completing what is called a ‘supertask’, namely the process of performing infinite number of operations in a finite amount of time, for instance by performing each successive task during half the time taken to perform its immediate predecessor. Achille’s task of reaching the tortoise is an example of a supertask. The claim of the critics of the TFT* is that, in the case of the mutterer, what allows the completion of an infinite number of successive additions is not that each addition took less time, but that an infinite amount of *equal* intervals of time has elapsed, each interval sufficient to complete one utterance.

However, (15)* is not about temporal series of successive events only, but about temporally ordered series in general, including series of temporal items such as instants or periods. As Craig noted: “if we divide time into temporal segments of equal duration […] then before the present hour could arrive, an infinite number of previous hours would have to have successively elapsed” (Craig in Craig and Smith 1993, 105). Surely, one cannot argue, against (15)*, that infinite time *can*, in fact, elapse given infinite time, for that would clearly be a circular reasoning. This consideration, however, reveals something: the given reason why an infinite temporal series *cannot* be formed by successive addition cannot be that there is not (or has not been) possibly enough time for an infinite series of equal periods of time to be formed by successive addition, for that would be a circular reasoning as well. Some different reason must be given in order to justify the claim that one cannot traverse the infinite.

A baseline for looking for this reason seems to be the following: certainly, at least, we cannot traverse the infinite by starting at some point (Craig and Sinclair 2009, 117). I will call this the *Uncompletability Claim* (**UC**). According to the critics of the KCA, UC is not enough to defend (15)*, the reason being that from UC it does not follow that an infinite temporal series cannot be formed by successive addition, but only that an infinite temporal series cannot be formed by a successive addition *that started with a first addition* (Morriston 1999, 8). The point, here, is not about the temporal extension of the series: an infinite number of successive additions could either take finite or infinite time. What is important is that there was no first addition, so that for any addition there was a previous one.

The advocates of the KCA may still appeal to UC in order to defend (15)*. All they have to do is to argue that any successive addition that forms a temporal series *must* start somewhere. For instance, Whitrow argued that, since the only way in which we can *define* the infinite set of negative integers is via a successive addition that begins with '–1', then any successive addition that formed a temporal-series in one-to-one correspondence with the set of negative integers must have started somewhere as well (Whitrow 1978, 42). And since, given UC, an infinite temporal series formed by a successive addition that starts somewhere is not possible, we must conclude that the world-series cannot be infinite.

I shall not evaluate the validity of this reasoning, which can be doubted. What must be noted is that the principle on which the reasoning is based, UC, is normally agreed upon both by the detractors of the TFT* and by its advocates. However, the necessity of UC is not to be understood as a logical necessity. This fact, in the literature, has gone largely unnoticed.[75] Consider indeed a sequence that has two termini and $\aleph_0$ elements. As seen in the previous subsection, we can build a similar sequence by

[75] This also affected the discussion about the possibility of an actual infinite. This is evident if we consider a largely discussed example of the possibility of an infinite library. While contenders and proponents of the KCA may disagree on the question whether such a library is possible, they tend to agree that, if it were possible, then all of its books would have to have come into existence at precisely the same time. This is because, they say, if the books were putted into the shelves one by one, at successive intervals, then at no moment the library would contain an infinite number of books (Oderberg 2017b, 220). But what about the moments that are infinitely far into the future from the addition of the first book?

ordering the integers in a non-standard way. But this means that we can postulate an infinite temporal-series with a first and a last element that is in one-to-one correspondence with such a sequence without falling in logical contradiction, so that it is at least *logically* possible for an infinite temporal series to be formed by a series of successive additions that starts with a first addition.

Still, as previously, one can claim that the necessity of UC is a *metaphysical* necessity (Morriston 1999, 8–10). However, just as in the case of the discussion of the AII (1.2.1), it is hard to find any argument in the literature in support of the claim that is an *essential property* of infinite temporal series that they cannot be formed by successive addition by starting with one of the members. Nonetheless, a general consideration can be made. The main reason why it seems impossible that we can count start now to count all the $\aleph_0$ integers and complete the task at some time in the future, is that $\aleph_0$ does not belong to the series of integers. Thus, one could say, it is impossible to count $\aleph_0$ numbers (Craig and Sinclair 2009, 117). Notice, though, that if we arrange the integers in the non-standard ordering $\{0;\ 1;\ 2;\ldots;\ \ldots;\ -3;\ -2;\ -1\}$, we can easily see that, even if this ordering does not contain the cardinal number $\aleph_0$, it still contains elements that are infinitely far apart (that is, elements that are separated by an infinite number of elements).

However, it remains true that, if I start counting now, in any finite number of utterances I will have counted a finite number of integers. Similarly, if I start walking now, in any finite number of steps I will have made a finite number of steps. But all this entails is that there is no *determinate* step at which the number of my steps becomes $\aleph_0$, which does not necessitate that I cannot make $\aleph_0$ steps at all. Notice, moreover, that *even if I never started my walk*, there is no determinate step at which my steps have become $\aleph_0$ in number: at whichever step, whether it is a finite or an infinite number of steps before the last step, the steps I made were already $\aleph_0$. It seems, therefore, that *if* it is possible to form a temporal series by perpetuating an infinite number of successive additions without a start, then it should be possible to form it *with* a start.[76] Such a start would simply be infinitely far behind the end of the series.

[76] Craig agrees with this. He thinks that, if it were possible for someone to have counted all the negative integers ending at zero, then it would also be possible to reverse direction and count them all starting from zero (Craig 1979c, 8).

Given the last considerations, another objection to the possibility of traversing the infinite comes to mind. In Craig words:

> Suppose we meet a man who claims to have been counting [down to 0] from eternity and is now finishing. […]. If we were to ask why the counter would not finish next year or in a hundred years, the objector would respond that prior to the present year a number of years have already elapsed, so that by the principle of correspondence, all the numbers should have been counted by now. But this reasoning backfires on the objector: for, as we have seen, on this account the counter should at any point in the past have already finished counting all the numbers, since a one-to-one correspondence exists between the years of the past and the negative numbers.
>
> (Craig 1979c, 4)

According to this reasoning, the counter cannot, at any time, have finished counting all the infinite members of a set S. This is neither because there was not possibly enough time to do it, nor because the counter must have started the count at some time. Rather, it is because, if it were possible to complete the count, then it would have always *already be completed*: whichever past time we consider, no matter how far back into past, we do not find the counter counting. This, according to Craig, reveals that it is impossible to complete the count at all.

Here, the *sufficient condition* for the counter to have *finished* counting all the negative integers, is that they have already stated infinite utterances. From this condition, however, one cannot infer that *whichever past time* we consider, no matter how far back into the past, we do not find the counter counting. Indeed, it remains possible to find the counter counting at times that are separated by *infinitely many* periods from the present moment. *Unless*, of course, the counter never started. In that case, we could not find the counter counting even infinitely back into the past, since, at any infinitely faraway time, infinite utterances had already been stated. This brings us to question the above-mentioned condition as a *sufficient* condition.

Morriston, agreeing with Sorabji (1984), argues that the counter having had infinite time to backward count all the negative integers entails that they *could* have finished counting, not that they would have finished. Indeed, the $\aleph_0$ periods of time at stake *can* be put in one-to-one correspondence with the $\aleph_0$ utterances that constitute the counting of the negatives in their standard ordering down to 0, as well as with the $\aleph_0$ utterances that constitute the counting of the negatives in their standard ordering down to '–1'. Given this, there could be a counter who would not be finished until next year or a hundred years from now, as well as a counter that would have finished now (Morriston 1999, 13; Morriston 2017, 77).

In order to highlight this point, I shall focus on a paradox that is often discussed in the debate: the Tristram Shandy Paradox. The paradox originated with Russell, and it goes as follows: Tristram Shandy, the famous fictional character, spent two years writing the history of the first two days of his life, which made him worry that, at that rate, he could never finish. Russell's suggestion is that, were Tristram Shandy to pursue his task for ever, no part of his biography would remain unwritten (Russell 1937, 358).

Notice that Russell's claim that no part of the biography would remain unwritten is not equivalent to the claim that Shandy will come to the end of his task. That for every day there is a year such that, by the end of that year, Shandy has recorded that day, does not entail that there is a year such that, for every day, by the end of that year Shandy has recorded that day (Oderberg 2017b, 222). In other words, even if Shandy's living for $\aleph_0$ years entails that he lives for $\aleph_0$ days, so that all days and years can be put in one-to-one correspondence, *the way* in which years and days are paired in the writing process (first day with first year, second day with second year, and so on) is such that, at the end of any year, there are some days that will remain unwritten. Days and years can be put in one-to-one correspondence, but they do not have to, and, in fact, they do not.

Here is the relevance of the paradox for the discussion. Consider a scenario where we find Tristram Shandy writing from an infinity of time. Let us call it 'reversed Shandy scenario'. *Prima facie,* the following conditional seems plausible: if an infinite temporal series can be formed by successive addition (that is, if (15)* is false) then, similarly to the case of Wittgenstein's mutterer, this scenario should be possible. Notice that, for this scenario to be possible, Shandy needs not to be recording his last day at the end of the last year (as seen, given that he collects 364 more unwritten days every writing year, this is impossible). What is required is that he must be recording *some* day when we find him writing. But which one?

According to Oderberg (Oderberg 2002, 311; Oderberg 2017b, 223), there is just *no possible day* that Shandy could be recording when we find him writing. If so, then we would have a solid argument in favor of $(15)^*$: if it is not possible that Shandy is recording any specific day when we find him writing, then the infinite temporal series of his writing days cannot have formed successively. And since nothing is metaphysically peculiar about the temporal series of his writing days, we should conclude that an infinite temporal series cannot be formed by successive addition at all.

The following reasoning may make us agree with Oderberg: there are two sets of days that compose the series of Shandy's writing days, namely the written days and the unwritten days.[77] Since the total set of the writing days is supposed to be infinite, so must be at least one of the two subsets. But if the written days are infinite in number, so must be the unwritten days, given that the ratio between written and unwritten days is $\frac{1}{365}$. So far, so good: just as all the $\aleph_0$ odd numbers plus the $\aleph_0$ even numbers equal in number the $\aleph_0$ integer numbers, so the $\aleph_0$ written days and $\aleph_0$ unwritten days together equal in number the $\aleph_0$ days of writing. However, dissimilarly from the case of the odd and even numbers, all of the written days must be *before* the unwritten days. Consider the standard ordering of the negative integers $\{\ldots; -3; -2; -1\}$, and suppose the series of unwritten days is in one-to-one correspondence with this sequence, where -1 corresponds to the day we find Shandy writing (day_{-1}). We may think that no specific day can be written about at day_{-1} because all the way up the days associated with the negative integers, we do not find any written day, but only unwritten days. And if the days associated with the negative integers are already infinite, it may seem that, so to speak, the written days can be "nowhen" and that the reversed Shandy's scenario is impossible.

However, this reasoning is mistaken. Consider the following non-standard discrete ordering of the integers, where all even negative integers are followed by the natural numbers which are followed by all the odd negative integers $\{\ldots; -6; -4; -2; 1; 2; 3; \ldots; \ldots; -5; -3; -1\}$. If we suppose that the $\aleph_0$ unwritten days are in one-to-one correspondence with, say, all the numbers following -6, there is still plenty of room for the written days. There is more: as a matter of fact, we could

[77] We suppose that Shandy starts writing as soon as he is born in order to simplify matters.

conclude that at day_{-1} Shandy is writing about the infinitely faraway day_{-6}, the last day of the series of days that are written about! One year before day_{-1}, he was finishing writing about day_{-8}; after one year, he will be finishing writing about day_{-2}. Of course, as long as it is granted that the unwritten days are in total $\aleph_0$, nothing restricts us to postulate *a specific* last written day and, therefore, a specific one-to-one correspondence between the unwritten days and a subsequence of the non-standard ordering above. Just as the one who counts backward the negative numbers since eternity may finish the count now or next year or in a hundred years and so on, so the last day that Shandy's writes about may be day_{-6}, day_{-372}, $day_{-9trillions}$ and so on. If this is correct, then Tristram Shandy's thought experiment is not effective to grant $(15)^*$, certainly no more effective than the thought experiment of someone counting backward the negative numbers or of Wittgenstein's mutterer.[78]

To sum up: the supporters of the TFT* claim that an infinite temporal-series cannot be formed by successive addition. It is often noted, and correctly so, that this is true only if we assume that there *must* be a finite number of successive additions (either in a finite or infinite period of time). If we allow for there to be, in principle, an infinite number of successive additions over an infinite number of periods of time, then the series can, in principle, be formed. Moreover, we have seen that there seem to be no good reasons to think that an infinite number of successive additions is logically or metaphysically impossible. In fact, over an infinite period of time one could traverse the infinite not only once, but twice, three times, or even an infinity of times. Such is the nature of the infinite, as shown by Cantor.

1.3.3. The end of the traversal: why not sooner?

There is still a last move to which those who endorse the KCA usually resort in order to oppose the traversal of the infinite: such a traversal may finish now, or at any other

[78] Different settings of the Tristram Shandy scenario, such as the one (very much discussed) provided by Robin Small (Small 1986), are therefore beside the point. Small argues that, in order to make room for both written and unwritten days, one must imagine that Shandy is *plannin*g his life in advance instead of recording it. However, in the classical setting, it is some essential property of (infinite) temporal series *in general* (rather than some peculiar assumption within the thought experiment) that would make it impossible to form, by successive addition, the infinite temporal series of Shand's writing days.1

time, but *why* did it finish when it finished? Consider, for instance, the case of the backward counter. The reason for every utterance (even the final one) taking place at the time it does lies partly in the previous utterance[79], but it seems that there is no possible explanation of the way in which the *whole series* of utterances is "shifted" in time. We may have to take this fact as a brute fact (Craig and Sinclair 2009, 123).[80]

Another way to phrase the matter is as follows: if there were more backward counters, they would all be counting since the same amount of time. And still, some could be much further behind in their count than others. This is because, as said, that any counter had infinite time to backward count all the negative integers only entails that they *could* have finished counting. Therefore, any backward counter could be finishing now, yesterday, tomorrow, one hundred years from now, one hundred years in the past, and so on.[81] If each backward counter were to finish at a different time, one may have to take the fact that each of them finishes at the time they did as a brute fact.

The possibility of rephrasing the matter in this way is important in order to avoid any ambiguous talk of "shifting". Indeed, one may argue that, to motivate the question "Why did the backward counter finish when they finished?", the series of periods of time with which the series of utterances is in one-to-one correspondence needs to be taken as real and independent from the series of utterances. That is, one may argue that in order to motivate the question above one should adopt a specific view about the

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[79] Thus, Oderberg (2017a, 124) is simply wrong when he claims that "there could be no reason at all, *not even a partial one*" of why the backward counter finished when they finished, as well as of why a beginningless universe is in a certain state at some particular moment.

[80] Morriston has recently observed that a possible way of explaining such fact would be to assume that there is another infinite series of events, the timing of which explains the shifting in time of the backward counting. For example, someone may have been suggesting the numbers to the backward counter the whole time. However, as Morriston himself immediately admits, this would just put off the problem, since it would remain open the question of why the series of suggestions is shifted in time the way it is (Morriston 2017, 78).

[81] If all the backward counters followed the standard ordering of the negatives for their count, none of them could be *infinitely* behind a counter that just finished. However, some *may* be infinitely behind if, for instance, they were just finishing counting all and only the even negatives and they still had to go through the odd negatives up to '−1'.

ontological status of temporal items (Morriston 2017, 79).[82] Morriston explains the point by means of a spatial analogy:

> Suppose that we have a bolt of cloth, and a measuring stick, calibrated in inches, that we want to use to measure a ten inch swatch of cloth. Obviously, we can line up the end of the cloth with the end of the measuring stick, or we can line it up with the one inch marker on the measuring stick, or with the two inch marker, and so on. It's completely arbitrary which we decide to do. As long as we can do simple subtraction, we'll have no trouble measuring out a ten inch swatch of cloth. Now suppose someone asks, "Why is the edge of the stick lined up with the end of the cloth? Why not the one inch mark?" This is hardly a question that "cries out" for an […] answer.
>
> (Morriston 2017, 79).

The point to be taken here is that, if the series of temporal items does not exist independently of the series of the backward counter's utterances, then the "shifting" of the latter over the former, i.e., the way in which the two series are assumed to be in one-to-one correspondence, is totally arbitrary.

Morriston's position is not original; in fact, it can be traced back to Leibniz. Within the famous exchange of letters with Samuel Clarke, Leibniz wrote:

> Suppose someone asks why God did not create everything a year sooner; and that the same person wants to infer from that that God did something for which He cannot possibly have had a reason why He did it thus rather than otherwise, we should reply that his inference would be true if time were something apart from temporal things, for it would be impossible that there should be reasons why things should have been applied to certain instants rather than to others, when their succession remained the same.
>
> (*Leibniz-Clarke Correspondence*, 3th paper)[83]

[82] For a sketched introduction of the main features of the substantivalist and relationist theories of time and for a discussion of the relevance of their debate for this work, see 3.2.1.

Leibniz did not think that time is "something apart from temporal things", quite the opposite (3.2.1.). His point here, however, is that we *must* assume such a thing in order to *motivate* the question: 'if the universe began, why did it begin *when* it did (rather than earlier or later)?'.[84] This is question (C) of the Introduction, one of the questions we started from. If Leibniz was right, then this entire work could be somehow committed to the ontological view that temporal items are real and independent from the world-series.

Luckily, however, there are various ways in which we can avoid this difficulty. A first way is to understand the temporal items referred to in question (C) as merely possible temporal items. A second way of avoiding ontological commitment was somehow suggested by Leibniz himself: we can think of the temporal items to which question (C) makes reference as existing dependently of merely *possible* events (van Fraassen 1985, 25). Finally, a third way is to understand temporal items as existing dependently of *unchanging* things in time that existed before the beginning of the universe (3.3.).

These remarks also apply to the point raised by Morriston: one must not assume that temporal items exist independently of things in time in order to motivate the question "why did the backward counter finish when they finished?". Moreover, if the backward counter thought experiment is reframed so that instead of only one backward counter there are many, some of them finishing earlier, some of them finishing later, then the fact that *a certain* backward counter finished when they finished (rather than

[83] Tr. in Morris 1956, 200.

[84] A clarification: Leibniz's claim that there is no possible reason why this universe did not begin at some time t before the time of its beginning, t_0, is inferred from the following consequence of his philosophy of time: *this* universe could not have begun at some time different from the time of its actual beginning because any such time would be ultimately identified with the time of its actual beginning. However, one may wonder whether, granted that t does differ from t_0, there would still be some possible basis left to infer Leibniz's claim. For instance, one may attempt to infer it on the basis of a temporaryist view of time. Suppose that this universe did not exist at some (independently existing) t before t_0. Then, at that time, nothing could be predicated of *this* universe. Given this, one may be tempted to argue that it does not make sense to ask why *this* universe did not begin at t. However, Arthur Prior has shown that, even if we grant a temporaryist view of time such that at t we cannot predicate anything of *this* universe, we can still coherently maintain that at t_0, the time at which the universe began to exist, it was possible that the universe began to exist at t, so that it makes perfect sense to ask, *starting from* t_0, "why *this* universe did not begin before its beginning?" (Prior 1968, 66–77).

earlier or later, like other backward counters did) cries out for an explanation *independently of what we think* of the ontological status of the temporal items at which the utterances happen. Still, it seems that we must take this fact, let us call it the Backward Counters' Fact (**BCF**), a brute fact. Is this a bad thing?

The advocates of the KCA argue that it is (Craig and Sinclair 2009, 124; Oderberg 2017b, 226). Usually, at this purpose they appeal to the PSR. Recall that the PSR, in its standard version, is the claim that for every fact there must be a sufficient reason why that fact is the case (1.1.2.). If one adopts the principle in this form, then the BCF cannot be accepted as a brute fact. The predictable reaction of critics to this move has been to argue against the acceptance of this version of the PSR. Suggestions are that some restricted version of the principle would be more reasonable to adopt; specifically, a restricted version that would allow for facts of the BCF's type to be brute facts (Oppy 2006, 59).

However, how exactly the PSR should be restricted, or whether it should be adopted at all, is *highly* controversial (Melamed and Lin 2021, 2). I shall not enter, here, in any of the details of the discussion. It will suffice to point out that, given the status of the PSR, adopting it would involve a considerable theoretical cost, one that the advocates of the KCA may not be willing to pay. Furthermore, there is another price that they should be ready to pay if they wanted to argue in favor of premise (2) of the KCA ultimately on the basis of the PSR. This cost must be paid in terms of their internal theological dialectic. As Morriston notes (Morriston 2017, 78), one of the supposed strengths usually claimed for the KCA is that it differentiates from the LCA, the cosmological argument that assumes a strong version of the PSR (1.1.2.), in so far as it is based, for what concern the justification of its first premise, on a weakened form of the PSR, namely the Causal Principle (**CP)**. In its standard formulation, CP states that everything contingent has a cause (Reichenbach 2019, 2). This principle is interpreted as a weakened form of the PSR in so far as one can safely take it to be true if, and only if, for everything contingent there is a *causal* reason for why that thing exists.

Further discussion of CP belongs to the next chapter. For the time being, suffice it to say that, since CP is limited to facts about the *existence* of contingent things, it does not entail, by itself, that there must be neither a cause nor a reason for facts like BCF. Therefore, the defender of the KCA must adopt either the PSR in the formulation presented or at least some strengthened form of CP in order to get this result, giving away one of the supposed strengths of the KCA *vis-à-vis* other cosmological arguments (Reichenbach 2019, 14).

There is one more reason why pointing out that the negation of (15)* entails brute facts may be a problematic strategy for the advocates of the KCA. Indeed, some of them have granted that, if the beginning of the universe was preceded by a period of time without change, God's deciding to end such a period at a certain time would be a sufficient reason of why it finished when it finished (Goetz 1989, 101; Craig 1991, 106; Craig 2002, 102). Indeed, if one were to grant that a beginningless period of time without change could come to an end (this is enquired in 3.4.2.) the question would arise as to why that period finished when it finished. This question closely resembles the question of why the backward counter finished when they finished: in both cases, it is hard to see how one could possibly explain why the traversal of a certain period of time finished when it finished.[85] Nonetheless, the advocates of the KCA adopt a radically different approach towards these two questions. As for the second question, as seen, they tend to argue that there is no possible answer and to underline how that may be a problem for those who believe in the possibility of the formation of an infinite temporal series by successive addition. But when it comes to the second question, as seen, they bring up the will of God as a possible source of explanation. So, the doubt arises: may not have God simply made sure, as well, that some backward counters would finish later and others sooner? It is not clear to me why we should think that such an explanation, if desirable at all, would not be viable in the case of the countdown of the negative numbers (Craig and Sinclair 2009, 124).

Be that as it may, I shall indulge no more in theological concerns. The moral to be drawn is that resorting to the highly controversial PSR in order to grant (15)* is not an advisable path for the proponents of the KCA, nor it is obvious that they can easily grant, as it may seem, that the negation of (15)* entail brute facts. I must anticipate, here, that, while the theologians' answer to one of the above questions seems to be also viable for the other one, the situation will be different in the case of my proposal for a possible causal explanation for the occurrence of the first event (4.4.2.). Indeed, while

[85] Notice that we must not be able to compare the length of all the sub-intervals of such period in order to ask why that period finished, say, one hour or one million years *ago*.

providing an answer to the question “why the period of time without change before the first event finished when it finished?”, the proposal does nothing to grant an answer for the question “why did the backward counter finish when they finished?”. This being clarified, I shall now leave behind the traversal of the infinite.

1.4. Conclusions

In this first chapter, we have encountered and analyzed the two purely philosophical arguments that are still discussed (mainly among theologians) in favor of the claim that the universe began to exist. We have seen that both arguments are in fact supporting this claim by affirming the *impossibility* of an infinite, and therefore beginningless[86], world-series. Both arguments, with the right modifications, could be easily restated as arguments for the claim that *any period of time*, whether with or without change, must have a beginning. We shall now recall the main reason why we were interested in these arguments in the first place: if they were effective, that is, if no beginningless period of time could elapse, then the AUH, which explains the beginning of change by assuming that a beginningless period of time elapsed, would not be viable.

As the analysis shows, however, both the arguments can be considered unsound, in so far as their main assumptions are unjustified. Given this, the idea of the work remains viable, at least in the relevant respect.

[86] As I hope I made clear, an infinite world-series could have a beginning. This is the case either if we understand the “infinity” in the sense of the world-series being composed of $\aleph_0$ events, for the world-series could still be finitely extended, *or* in the sense of the world-series being infinitely extended, for the world-series could still have a lower bound. However, a beginningless world-series would be infinite, both in the sense of being composed of $\aleph_0$ events, and in the sense of being infinitely extended.

– Chapter 2 –

The cause of the first event

Through this second Chapter, I tackle the first and the last premise of the *Kalām* Cosmological Argument for the existence of God. While the first section is dedicated to the first premise, the second and the third sections are dedicated to the last premise. The objective of the Chapter is not to give a comprehensive exposition of the debate on the two premises. Rather, I underline on what grounds the defenders of the KCA argue that a cause of the first event must be a personal being. This is useful because it shows the weaknesses of the theological understanding of a first event's cause and because it clarifies what role my proposal in Chapter 4 could play in the debate on the features of the first event's cause.

2.1. Does everything that begins to exist have a cause?

In Chapter 1, I have shown that the AII and the AITI are unsuccessful in supporting the claim that there was a first event. In this section, I show that this claim is weaker than premise (2) of the KCA, the claim that the universe began to exist, at least on the interpretation given by Craig and the KCA's defenders. On the basis of this consideration, and of two important criticisms that have been directed against premise (1), I propose a revision of the KCA, suggesting that the KCA's defenders would not benefit from rejecting this revision. The purpose of this section is to make more fluid the analysis – given in sections 2.2. and 2.3 – of the (for us more crucial) last premise of the KCA, which establishes that if the universe has a cause, that cause is a personal one.

2.1.1. Beginning to exist

Let us start by clarifying Craig's definition of the terms 'universe' and 'began to exist' that appear in premise (2) of the KCA. As for what concerns the second term, no unique definition is to be found in the works of Craig. His view on this matter has changed during the years as a consequence of various issues that had arisen with previous definitions (e.g., some definitions entailed the unusual consequence that something could begin to exist at different times, or that God began to exist and has a cause) (Bobier 2013). The following definition of 'begin to exist' (BTE), however, can be taken as the most updated one:

> **BTE**: *x* begins to exist at *t* iff (i) *x* exists at *t*, and the actual world includes no state of affairs in which *x* exists timelessly; (ii) *t* is either the first time at which *x* exists or is separated from any $t' < t$ at which *x* existed by an interval during which *x* does not exist, and (iii) *x*'s existing at *t* is a tensed fact.
>
> (Craig 2017a, 61)

The reason for adopting (i) is to avoid one of the above-mentioned undesired consequences: if God "enters time" at the moment of the creation of time, this entails that God began to exist.[87] Condition (ii) grants that in order for *x* to begin to exist there is no need for there to be a time prior to *t* at which *x* does not exist. This is important if we wish to grant the possibility of a scenario where something, say the universe, began to exist at the beginning of time. The reason Craig has for adopting (iii), instead, is that he thinks that nothing would truly begin to exist if it does not *enter in the ontology* (Craig 2001; Craig 2002; Craig 2010a; Craig 2017a). However, condition (iii) may be too weak to grant that what begins to exist in the sense of BTE enters the ontology.

In order to grant this, (iii) should be reformulated so that it specifies that it is *x*'s existing *simpliciter* at *t* the fact that obtains. Indeed, recall that when it comes to the existence of things at times, the verb 'to exist' may also express the notion of being temporally located (1.2.2.). But if condition (iii) were only to claim that nothing begins to exist unless *x*'s being *temporally located* at *t* is a tensed fact, this would surely not entail that nothing begins to exist unless it enters into the ontology. Moreover, (iii) should also be reformulated so that it specifies that *x*'s existing *simpliciter* at *t* is a *fundamentally* tensed fact, that is, a fact that cannot be reduced in any way to a relational tenseless fact. This is because *x* can enter the ontology at *t* only if the fact of *x*'s existing simpliciter at *t* can change over time, and the fact of *x*'s existing simpliciter at *t* can change over time only if it is not reducible to a relational tenseless fact. In what

[87] For Craig's theory of divine eternity, see 2.2.2.

follows, I therefore interpret condition (iii) as requiring that *x*'s existing *simpliciter* at *t* is a fundamentally tensed fact.

Now, the claim that there are fundamentally tensed facts about what exist simpliciter may be taken to be just another formulation of temporaryism (1.2.2.). Therefore, it turns out that temporaryism underlies both the first and the second premise of the KCA. Given that, as seen, the AII and the AITI are already based on a dynamic view of time, it may not seem like a further commitment to narrow down the definition of 'beginning to exist' in this "dynamic" way. However, one thing is to commit to a theory in order to *justify* a premise, another is to commit to a theory in the very *statement* of a premise. These are two different levels of commitments: one weaker, the other stronger. The unwanted outcome here is that, even if there was a purely philosophical argument successful in supporting the claim that there was a first event *independently* of the assumption of a dynamic view of time, it would still not support premise (2), since the thesis that there was a first event, by itself, is neutral to whether time is static or dynamic (as much as in this respect is neutral BW, the definition of a beginning world-series given in Chapter 1). Now, we may think that, if we interpret the predicate 'begin to exist' of the KCA in a more neutral, or even "non-dynamic", way, then premise (2) and the thesis that there was a first event would become equivalent. But this is not the case, and the reason lays in the understanding that the proponents of the KCA have of the term 'universe'.

By 'universe' the proponents of the KCA have in mind some kind of characterized particular that includes every *thing* that there is in space and time and can enter in a causal relation altogether (Craig and Sinclair 2009, 194). Therefore, before the coming into existence of the universe there was nothing (it was not the case that there was any *thing*). However, in the Introduction I clarified that the first event is the beginning of change, which is not necessarily the coming into existence of the universe. Couldn't there have been a period of time without change, during which something existed, before the first event? This is the idea involved in the AUH. Theologians sometimes name this scenario the hypothesis of a quiescent universe (Craig 1979a, 99; Goetz 1989; Craig 1991; Oberberg 2017). Preferring the terminology of the contemporary philosophy of time, I will refer to the period of change before the beginning of change as '*Primordial Temporal Vacuum*' (**PTV**), in reference to temporal vacua (Introduction).

One may expect Craig and the proponents of the KCA to exclude the possibility of a PTV on the basis of arguments in the style of the AII and AITI. After all, a PTV would be beginningless (4.2.1.), and therefore an infinite, temporal series of subperiods of time.[88] But things are not as straightforward. For instance, the theologian Stewart Goetz argued that Craig's adduced "proofs" for the finitude of the series of past events do not imply that the universe had a beginning. He pointed out the alternative possibility that the universe might have been unchanging since eternity, while change had a beginning. Goetz then explicitly claimed that, in this case, the only possible cause for the beginning of change is still the intervention of a personal agent which does not create the universe but exercises its causal power to start a finite sequence of events in an already existing but quiescent universe (Goetz 1989, 101). Interestingly, Oderberg (2017, 219) and Craig agree with Goetz that the AITI and the AII do not exclude the PTV. Craig writes:

> I should agree that what Goetz envisions is possible. […] Goetz is correct that my philosophical argument in behalf of (2) does not exclude the possibility that there exists a personal being who initiates the temporal series of events into a quiescent universe.
>
> (Craig 1991, 106)

Here Craig seems to be convinced by Goetz that *a personal being*, and only a personal being, could initiate the temporal series of events in a quiescent universe (1.3.3.). The position of Craig, however, has been unstable on this matter. Indeed, elsewhere he denies the possibility of a PTV (Craig 1979a, 101; Craig and Sinclair 2009, 193) (2.2.1.). The reason why he cannot easily concede this possibility is strictly theological: on a dynamic view of time, conceiving of God as existing through an extended period of time before the first event would entail that God can undergo some kind of change (Craig 2001, 236).

[88] Craig agrees with this. Concerning God's existence during a beginningless period of time without change before the first event, he writes that God would exist "through a beginningless series of longer and longer intervals. In fact we can even say that such a time must be infinite" (Craig 2001, 235).

I tackle Craig's theory of divine eternity in subsection 2.2.2. Here, I will only highlight two facts. First, the proponents of the KCA do not seem to be prompted to argue that a period of time without change before the first event is impossible in virtue of the AII and the AITI. Second, premise (2) is a wider claim than the claim that there was first event supported by the AII and the AITI.

2.1.2. The *Kalām* Argument revised

In light of the definition of 'begin to exist' given by Craig, I shall now briefly comment upon premise (1) of the KCA, the claim that everything that begins to exist (including the universe) has a cause. As seen in Chapter 1, according to the proponents of the KCA, premise (1) should follow from CP, the claim that everything contingent has a cause (Reichenbach 2019, 2). It is clear, though, that a further thesis must be combined with CP in order to validly derive (1): that whatever begins to exist is contingent. Let us call this the *Contingency Thesis* (**CT**).

This principle would be uncontroversial if we were to take '*x* begin to exist' as equivalent in meaning to '*x* is not temporally located at all times'. This is because, if something is not contingent, then, plausibly, there should be no time at which it does not exist. However, condition (iii) of BTE requires that something begins to exist only if it enters the ontology. The presupposition of temporaryism is therefore, again, crucial in order to grant the principle, for a premanentist could claim that Socrates is contingent (since he is not located at all times), and still, that he exists *simpliciter* at all times.

Once we consider CT under the presupposition of temporaryism, it becomes clear that a counterexample to CT can only be something entering the ontology while being a necessary entity. Immediately, it may occur to the reader that the case of the universe could constitute such a counterexample. After all, the arguments in support of premise (2) were intended to prove that the universe began *by necessity*. If it did, though, would we really be entitled to consider the universe as something contingent? If not, then (given that the universe began to exist) we would have something (the universe) that began to exist and which is not contingent.

Curiously, however, CT is not much discussed in the literature and the debate largely focus on CP. The defense that has been most reiterated, both by Craig and other writers[89], is that CP is intuitively obvious (Craig in Craig and Smith 1993, 57; Craig in Craig and Smith 1993, 147; Craig and Sinclair 2009, 182). In fact, Craig goes so far as to claim that no one in their right mind could sincerely deny it (Craig 1979a, 1; Craig in Craig and Smith 1993, 57; Craig and Sinclair 2009, 182). This strategy clearly lacks suasive power, for to resist it may be sufficient to deny sharing such an intuition (Morriston 2000, 156). It does not surprise, then, that many (supposedly in their right mind) have doubted that CP holds.

Aside from objections that can be raised in a Humean fashion[90], the most reiterated objection to CP was first proposed by Russell, who claimed that the case of a contingent universe may constitute a counterexample to the principle. [91] Russell, indeed, did not conceive of the universe as something that can enter into causal relations, for he contended that we derive the concept of causation from our observation of particular things, and that therefore we cannot ask about the cause of something like the universe, which is something that we cannot experience (Russell in Russell and Copleston 1964, 175).[92] This stands in clear contrast to Craig's recent claim that CP is an all-encompassing principle that applies to what is within the universe, outside the universe and to the universe itself (Craig 2010b, 77).

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[89] See for instance Pruss 2006 for an argument in favor of PSR and therefore CP.

[90] This type of objections relies on Hume's celebrated achievement of showing that the denial of CP does not involve contradiction. In his responses to Hume, Craig (1979a, 141–44) relies heavily on Anscombe's work (Anscombe 1981, 93–99).

[91] Some of the objections made nowadays strictly recall Russell's criticism (Mackie 1982, 85), while other are not identical to it but may be subsumed under the same family. Morriston, for instance, objects to Craig that "It is true that the ordinary object of everyday experience do not pop into or out of existence without causes, but it does not follow that we know this by way of an *a priori* intuition that entitles us to generalize about the way things are in situations utterly dissimilar to those of which we have experience" (Morriston 2000, 158).

[92] Some of the reiteration strictly recall Russell's criticism (Mackie 1982, 85) while other are not identical to it but may be subsumed under the same family. Morriston for instance objects to Craig that "It is true that the ordinary object of everyday experience do not pop into or out of existence without causes, but it does not follow that we know this by way of an *a priori* intuition that entitles us to generalize about the way things are in situations utterly dissimilar to those of which we have experience" (Morriston 2000, 158).

Another relevant attack on CP has more recently come from Grünbaum, who argues that far from being intuitively obvious, CP is in fact grounded on a more fundamental principle. He named this principle the *Spontaneity of Nothingness* (**SoN**), and it states that "the most natural state of affairs is simply nothing" (Grünbaum 2000, 5). In his words (Grünbaum 2000, 16): "What, other than the insidious SoN, could make psychologically compelling Craig's avowed metaphysical intuition that something cannot [spontaneously] come out of absolutely nothing […]?". Grünbaum here is basing his charged question on his previous argument that the SoN is unjustified. On the grounds of this result, he denies sharing Craig's "metaphysical intuition" in that he thinks that the case of the universe could constitute (again) a counterexample to CP: within the universe[93], the beginning of each contingent thing could be causally explained, but besides the SoN, there is just "no cogent reason" for *requiring* a cause for the existence of the (contingent) universe as a whole (rather than its non-existence). This fact (that is the fact that there exists *some* universe, which must be distinguished from the fact that there exists *this* universe) should be taken as a "logically contingent brute fact" (Grünbaum 2000, 17).

Various other important criticisms have been directed against CP and, more precisely, against premise (1). Of course, virtually all of them have inspired replies and exchanges in the context of the modern debate on the KCA. For instance, important criticisms have been based on quantum mechanical considerations (Smith in Craig and Smith 1993, 121–23, 182; Morriston 2000, 158).[94] However, an extensive excursus on the debate would be beside the scope of this work.[95] The only point to be taken here is that neither CP nor premise (1) of the KCA are "intuitively obvious", as Craig sometimes holds. However, it is worth it to briefly focus on Craig's response to Grünbaum objection, which he came to consider "the most important objection to the causal premise" (Craig 2017a, 310).

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[93] Grünbaum considers the case where the world-series has no lower bound and it is finitely extended, but I think the point can be made independently of this assumption.

[94] For a brief overview of the most recent debate on the status of causation in Quantum Mechanics see Frisch 2020, 17.

[95] For a comprehensive list of possible strategies to demise CP and corresponding answers, see Nowacki 2007, 96–100.

Craig's response is that the ambiguous SoN is *not* an implicit assumption shared by those who wish to attribute a cause to a universe with a beginning. The reason for defending a version of CP that includes the universe lays, according to Craig, in the endorsement of a dynamic view of time rather than Grünbaum's principle. According to Craig, in the case of premise (1), if we were to deny, with Grünbaum, a dynamic view of time (Craig 2017b, 60), then nothing would begin to exist in the above-mentioned sense of *entering in the ontology* (because facts about what exists would not change). Therefore:

> There would be no reason to look for a cause of the universe's beginning to exist, since on tenseless theories of time the universe did not truly begin to exist, except in the special sense that the spacetime manifold is finite in the earlier than direction.
>
> (Craig 2017b, 61)

I shall leave aside the question of whether Craig's strategy is capable of defusing Grünbaum's criticism. What I must highlight is that, on a "non-dynamic" definition of the universe's beginning, there may be still plenty of reasons to look for the cause of this beginning. Suppose, indeed, that we adopt a definition that 1) similarly to BW above, postulates that the occurrence a first event is a sufficient condition for the universe to have begun; 2) differently from BW above (1.3.1.), explicitly excludes that the universe began to exist in the sense of something entering in the ontology. If we believed, for instance, that every event has a cause, wouldn't that be a reason to look for the cause of the universe's beginning, that is, of the first event? Even if nothing ever enters or goes out of the ontology, we can still think that things like lightning flashes, eruptions, tides, falls, meals (Mellor 1999, 122) and universe's beginnings (say Big Bangs) require a cause for their occurrence.

In fact, I think that the proponents of the KCA should not be impermeable to the suggestion of revising the whole argument in terms of events rather than referring to the universe as a whole. First of all, they would be able to avoid all the above criticisms of premise (1) by adopting the following revised version of it:

(1)*: Every event has a cause.

If we assume that any event happens contingently, (1)* would still follow form CP. But, this time, the above criticisms of CP should not present a worry for the defenders of KCA (assuming that there would still be reasons to appeal to CP). Indeed, both Russell and Grünbaum's were taking the universe as a counterexample to CP. And since precisely the universe was that which was predicated as "having begun to exist" in premise (1), restricting CP in order to exclude the universe from the domain of quantification was not an option for the proponents of the KCA. However, this problem is avoided altogether if (1) is substituted by (1)*.

Second, since, both the AII and the AITI conclude to the necessity of a first event, they would be more directly relevant if premise (2) were restated as:

> (2)*: There was a first event.[96]

it then follows from (1)* and (2)* that

> (3)*: There was a first event which was caused.

Finally, premise (4) could be restated as the weaker claim:

> (4)*: If there was a first event which was caused, then there is a personal cause of the first event.

So that the whole argument looks as follows:

> Kalām Cosmological Argument revised **(KCAr)**
>
> (1)* Every event has a cause.
> (2)* There was a first event.
> Therefore:
> (3)* There was a first event which was caused.
> (4)*: If there was a first event which was caused, then there is a personal cause of the first event.
> Therefore:
> (5)* There is a personal cause of the first event.

[96] Just as the purely philosophical arguments analyzed in Chapter 1 cannot be used to justify premise (2) of the KCA, they cannot be used to justify (2)*.

Even in light of what I pointed out, the proponents of the KCA may still be reluctant to make use of KCAr. As for what concerns premise (1), in one place Craig and Sinclair clearly state that it does not entail that all events have a cause, but only all those events that constitute the coming into existence of a substance, where a substance can be understood as an essentially characterized particulars that possess a primitive unity of parts, properties, and capacities/powers (Craig and Sinclair 2009, 134, Moreland 2010, 542). The reason why they are careful in pointing this out may be that they are worried that, otherwise, (1)* would be difficult to defend from criticisms that come on the basis of considerations about Quantum Mechanics (Craig 2015). However, as mentioned just above, (1) is not impermeable to the same kind of criticisms.

Another kind of concern relates to the fact that KCAr, unlike KCA, does not presuppose a dynamic view of time. But this only means that, in switching to the KCAr, its proponents will endorse some premises that, instead of *presupposing* a dynamic view of time, would be neutral about it. This would allow them to reduce their level of commitment (and lift the burden of the proof). They will be free to appeal to a dynamic view of time in the *justification* of the premises, if they believe this is the best strategy, and to not appeal to a dynamic view, if they believe it is not.

Still another kind of concern may come from the fact that (2)* leaves space for the possibility of the PTV, while (2) does not (the coming into being of the universe would correspond to the first event). However, as seen, it is still on the grounds of a dynamic view of time that Craig denies that PTV is possible, while other proponents of the KCA generally concede this possibility. It seems therefore that, since a dynamic view must not be presupposed in the very statement of the premise, they should have no reason to reject the reformulation of premise (2) on the basis of the fact that it leaves room for the PTV.

At any rate, adopting this reformulation of the argument is useful for our purposes, since it makes easier to show what role my proposed type of explanation could have, *in general*, for the contemporary debate on the KCA. What, on the other hand, would not be very useful for our purposes is further investigation of whether there are some reasons to doubt (1)* (that every event has a cause). Instead, I must turn to premise (4)*, the conditional for which my proposed type of explanation should constitute a counterexample.

2.2. The first event has a cause

There are two concepts that need to be explored in order to face the issue of the plausibility of (4)*: the concept of causation, which has hitherto been taken for granted, and the concept of a *personal* cause. In this section I start from the former task. First, I present the main features of the standard account of causation and address the question of which of these features are available when it comes to granting that the first event has a cause. I then underline how the biggest problem for the KCA's defenders is to clarify what kind of thing exactly causes the first event. Finally, starting again from Craig's work, I highlight a category that the KCA defender may take as a good candidate for the cause of the first event, and show that they nevertheless tend to reject it.

2.2.1. Kalām Argument's causation

In general, looking for an account of causation means looking for an account of the causal relata and of the causal relation. As for what concerns the causal relation, it is standardly represented (Le Poidevin 2003, 87) as a *strict order*, where a relation $<$ is a strict order on a set S if it has the following three logical properties:

> **Strict order**: if $x < y$ then $y < x$ does not hold (**asymmetry**); if $x < y$ and $y < z$ then $x < z$ (**transitivity**); $x < x$ does not hold for any $x \in S$ (**irreflexivity**).

The question, then, is whether these standard logical properties of causal relations are available to those who allege a cause of the first event.

Prima facie, it may seem that they are not. Indeed, because of irreflexivity, whatever is the cause of the first event, it cannot be the first event itself. Moreover, it cannot be something that is also caused by the first event, because of asymmetry. It must, then, be something that *precedes* the first event in the causal chain (while it is not causally preceded by it). Here, one may be tempted to object that the first event was the very *first*, so that nothing can precede it. If this objection were to hold, we should abandon some of the standard logical properties of the causal relation in order to grant a cause of the first event.

However, this objection does not strike. We must keep in mind that the first event was the first *in time*. What the KCA's defenders want to prove is the existence of something that *causally* precedes the first event. Whatever that is, it must not precede the first event temporally.[97] That is: the cause of the first event could be *simultaneous* with or temporally *after* the first event; or, still another option, it may not be temporally related with the first event at all. Moreover, the first event was the first *event*, so that something that is not an event could precede it *both* causally and temporally. It seems therefore that, in principle, all the classical logical properties of the causal relation can be maintained by those who grant a cause of the first event.

But just what kind of thing can enter into causal relation with the first event? In the literature we find a standard account of what kind of things, in general, can enter into causal relations: causal relata are events (where events are usually understood in the sense endorsed in this work, as *happenings in time entailing changes*) (1.2.1.), and they are two in number, one in the role of the cause and the other in the role of the effect (Schaffer 2016, 1). For instance, when in *Back to the Future* the lightning strikes the DeLorean making it disappear, the cause is the event of the lightning striking the DeLorean, and the effect is the DeLorean suddenly disappearing. One thing that the causal view presupposes is *uniqueness* as to what concerns the category of the causal relata (Schaffer 2016, 3): *only* events can enter into causal relations. Moreover, the pair of events that constitute the causal relata must be, according to the standard view, actual.

Is the standard view of causal relata available to those who grant a cause of the first event? Since only one cause is postulated for the first event, there is no problem in granting that that the causal relation occurs between two relata, one in the role of cause and the other in the role of the effect. However, according to the characterization that the proponents of the KCA give to the cause of the first event, this cause cannot be an event. If they are right, then uniqueness would have to be abandoned, so that the thorny issue would arise as to what other kind of thing can be the cause of the first event.

The argument they propose for the first event's cause not being an event goes as follows: whatever caused the first event, that is, the beginning of the world-series, must be outside of the world-series (Craig and Sinclair 2009, 191). Given this, says the

[97] The modality here is logical.

theologist, either this cause was temporally before the world-series, but still within space and time, or it was outside of space and time altogether.[98] From this we can conclude that such a cause must be *changeless*, in the sense that there cannot have been any changes either in the nature or in the operation of the cause (Craig and Sinclair 2009, 193). In other words, the nature of such cause entails that there is no change at the times when the cause causes its effect. This is straightforward since all the past events and past changes belong, by definition, to the world-series, and the cause is assumed to be outside of it. But the changelessness of what caused the first event, goes on the argument, entails that this cause is also not existent in space and time, since for it to be in space and time would mean that before the world-series there was a period of time during which there was something, the cause, but no change, and, *it is assumed*, there could not have been a period of time before the first event during which there is just something unchanging.

Within this argument we find two main assumptions:

> The ultramundane hypothesis (**ULTRAM**): the cause of the first event must be ultramundane, that is, outside of the world-series.
>
> Impossibility of a Primordial Temporal Vacuum (**IPTV**): there could not have been a period of time without change during which something existed before the first event.

I shall return to both these assumptions in the course of work. As for now, It must be noticed that, on the basis of the result that the cause of the first event is timeless, Craig and other proponents of the KCA contend that the cause of the first event *cannot* be an event (Craig 2002, 102; Craig and Sinclair 2009, 192, Erasmus 2021, 198). Given this, they should adopt a non-standard concept of causation, namely one that gives up uniqueness.[99] Notice also that, if ULTRAM alone (without IPTV) is sufficient for

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[98] Strictly speaking, this does not follow. Even if what causes the first event is outside of the world-series, it could still be within space and time while not being temporally before the world-series. For instance, if there were more than one temporal dimension, it could lay in a temporal dimension different from that of the world-series. However, I shall ignore this possibility here.

[99] Notice that we could not take the cause-relatum to be an event even if we were to understand (differently from what Craig does) "outside of time" as "outside of *this* time-series" and conceive of the

establishing the changelessness of the cause of the first event, as those who propose this argument hold, then assuming ULTRAM is already sufficient for excluding the possibility of this cause being an event, since every event entails change.

It is worth asking what the situation would be like were the proponents of the KCA to abandon ULTRAM. In this case, the question of whether the cause of the first event can be an event would be closely connected with the much-discussed issue of whether causal precedence entails temporal precedence (Schaffer 2016, 3). If it does, then an event-cause would need to temporally precede the first event, which is impossible since it is the first event. If it does not, then an event-cause could be either simultaneous or *after* the first event.

Let me start by considering the case in which it is simultaneous. Since events in the world-series are *maximal complexes*, that is, complexes of *whatever* happened in the universe simultaneously with a certain particular event (1.2.1.), the event-cause of the first event would be *a part* of the first (maximally complex) event in the world-series.[100] If then we assume, as it seems reasonable, that whatever causes a maximally complex event *as a whole* also causes any part of it[101], we have that an event-cause simultaneous

cause-relatum as an event occurring in some sort of alternative time-series. This is because of the requirement of changelessness: in this alternative time series there would be no change. For an attempt of placing God in an alternative changeless time-series see Leftow 1992.

[100] One may object that this is not necessary, given that more than one event can occur in the same spatiotemporal region. Consider, for instance, the example of the simultaneous heating and rotating of a sphere. Davidson (1980, 178) claimed that it would be unnatural to say that they are the same event. But even if this is correct, the complex of whatever event happened simultaneously with, say, the rotating of the sphere would include both the heating and (trivially) the rotating of the sphere. Therefore, within the world-series both the heating and the rotating of the sphere would be subsumed under the same (maximally complex) event. This does not entail, however, that they are the same event. Also notice that, even if understood as different particular events, the heating and the rotating of the sphere could very well have the same cause, so that, in principle, nothing seems to prevent unrestricted talk of maximally complex events as causal relata.

[101] Imagine that there is an annihilation spell that brings out of existence all things in the universe at once. If we allow for there to be an event, e, that is part of a maximally complex event, E*, so that e is not caused by what causes E*, then we allow for the occurrence of situations analogous to the following: while the casting of the annihilation spell causes the disappearance of all things, the disappearance of one particular thing, say a goat, is caused by something else (say someone else's casting an all-goats-annihilation spell). Even if this does not seem to be logically impossible, it is at least counterintuitive, and

to the first event would imply an abandonment of both asymmetry and irreflexivity, for it would mean that the event-cause is also cause of itself. On the other hand, if the event-cause were temporally *after* the first event, this would imply a case of backward causation or a causal loop. In backward-causation scenarios, the effect temporally precedes (at least part of) its cause (Faye 2021, 1). Causal loops, on the other hand, are causal chains such that the last element is one of the causes of the first element (Meyer 2012, 259).[102] Standard accounts of causation, however, do not allow for these scenarios. In fact, one may even say that, on a standard account of causation, causal precedence *does* entail temporal precedence (Faye 2021, 1).[103]

Interestingly, then, it turns out that, Regardless of whether one assumes that the cause of the first event is an event or not, one must give up on some feature of the standard account of causation. Nonetheless, it seems to me that the lowest price, in terms of intuitiveness, comes from the abandonment of uniqueness. In the recent literature one finds two main arguments in defense of uniqueness. The first points out that if more than one kind of relatum could enter into causal relations, then there may be different kinds of causal relations corresponding to the different kinds of causal relata. In this case, great ambiguities would accompany any use of the verb 'to cause' in causal talks. Moreover, the situation will become even worse if we allow the cause and the effect to be different kinds of entities (Menzies 1989, 62). The second argument, on the other hand, concludes for uniqueness on the basis of the consideration that, if we deny it, then it will be necessary to postulate a mysterious harmony (Schaffer 2016, 3), so that, for instance, the event of the lightning striking the DeLorean, and the fact that the lightning struck the nine ball, have comparable effects. However, it seems that both arguments can be defused if we allow the causal relation to be something similar to the identity relation, that is, a unique relation that can relate items of different ontological category (avoiding the need of harmonizing a plurality of causal relations).

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one could argue that what causes the disappearance of all things must also cause the disappearance of each particular goat.

[102] Notice that, on a linear temporal order, there may be backward causation without there being a causal loop. On the other hand, whether causal loops entail backward causation in a circular temporal order depends on whether the transitive temporal relation is taken to be global.

[103] On a dynamic view of time the cost may be even higher. For instance, Markosian has recently argued that a dynamic theory entails that backward causation is impossible (Markosian 2020, 149).

However, the proponents of the KCA must still specify what kind of relatum causes the first event. This is the topic of the next subsection. As for now, I shall just conclude that Craig and the proponents of the KCA are able to define the causal relation by its standard logical properties, while the standard metaphysical account of causal relata seems unavailable to them. However, giving away uniqueness is not a very costly move, and the real problem lays in the difficulty of defining what kind of relatum is, exactly, the timeless cause of the first event.

2.2.2. A cause from the outside-time

That it is hard to account for the relation between a timeless first cause and a temporal world is not something that needs to be pointed out to any theologian. And of course, I do not wish, here, to enter into the longstanding dispute.[104] However, I must now briefly expose Craig's theory of divine eternity, for in it we may find a hint of the kind of relatum required by the proponents of the KCA for the first event. In *Time and Eternity* (2001) Craig defends the theological thesis that God is timeless without creation and temporal since creation. Here, talking about the AII and the AITI, Craig writes:

> Strictly speaking none of those arguments reached the conclusion, "Therefore, time began to exist." Rather what they proved is that there cannot have been an infinite number of equal temporal intervals in the past. But if we can conceive of a time which is not divisible into intervals, a sort of undifferentiated time, then the arguments are compatible with the existence of that sort of time prior to creation. God existing alone without the universe would exist in an amorphous time before the beginning of divisible time as we know it.
>
> (Craig 2001, 233)

Elsewhere, he confirms that his personal theory is that the cause of the first event lays in an undifferentiated time:

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[104] Among the theologians that have recently treated this problem we find Stump and Kretzmann (1981), Helm (1988), Yates (1990) and Leftow (1992).

> The Kalām argument strictly demonstrates only that metric time had a beginning. Perhaps the cause exists changelessly in an undifferentiated time in which temporal intervals cannot be distinguished. On this view, God existed literally before creation, but there was no moment, say, 1 hour or 1 million years before creation.
>
> (Craig and Sinclair 2009, 192)

As a first comment, I do not think that AII and the AITI aim to prove that "there cannot have been an infinite number of equal temporal intervals in the past". Rather, as I tried to show in Chapter 1, the arguments support the thesis that an infinite discrete series of events, and in general of temporal intervals, is impossible *independently of their length* (1.4.). Having said that, there is something to unpack here: what is an "undifferentiated time", exactly? In this respect, Craig comes to help with some clarification:

> In such a time, there would be no earlier and later, no enduring through successive intervals and, hence, no waiting, no temporal becoming, nothing but the eternal "now." This state would pass away as a whole, not successively, at the moment of creation, when time begins. It would be an undifferentiated "before," followed by a differentiated "after." […] such a changeless, undifferentiated state […] It seems to have the topology of a point, the traditional representation of timeless eternity. The only sense in which such a *state* can be said to be temporal is that it exists literally before God's creation of the world and the beginning of differentiated time
>
> (Craig 2001, 235, my emphasis).

From this passage we can discern three facts about the undifferentiated time: 1. That it is *temporally* before creation, that is, before the first event; 2. That it has the topology of a point, that is, it is a durationless instant; 3. That at this instant God exists in a changeless *state*.

A few words about this proposal. From the second fact, we can now see that, in arguing that the cause of the first event must not be in time, Craig meant that it must not be in "extended time", where he thinks that all events and changes happen. However, the first fact about undifferentiated time brings already with itself the suspicion of a contradiction. I am not alone in thinking this: accusations of incoherence have come from both theist and atheists.[105] We could rework, for instance, an objection from Grünbaum, who pointed out that if there is no time separating the cause of the first event from the first event, then we cannot distinguish them (Grünbaum, 1994).[106] The same can be said about the undifferentiated time: since there is no time separating this instant from the beginning of the first event, how can one distinguish the two instants?

To take care of this problem, Craig provides an analogy. He compares this undifferentiated time with the initial Big Bang singularity. According to the standard ΛCDM model, indeed, the singularity cannot be understood as an event within the history of all the events that occurred in space-time, but it is rather the boundary and source of this history and of space-time itself. On the other hand, the Big Bang, that is, the beginning of the expansion of the 4-dimensional space-time out of this singularity, could be defined unequivocally as the first event with some duration that has elapsed (Smith 1998, 135–138).[107] For Craig, then, just like the initial Big Bang singularity is the boundary of time, so it is the undifferentiated time when God exists; just like the singularity is not a part of the temporal series of events but is causally connected to it, so it is God's state at the undifferentiated time (Craig 2001, 236).

However, this analogy is not very helpful: many cosmologists think that, *within the framework of the ΛCDM model*, the concept of time lacks a meaning "before" the Big Bang, so that we cannot talk of the initial singularity as being *in time*.[108] Similarly, if we understand the undifferentiated time, that is, the instant at which God changelessly exist, as being temporally unrelated to the first instant of time, there remains an evident difficulty in attributing a temporal connotation to this undifferentiated "time".

At any rate, the fact about the undifferentiated "time" that arouses more interest here is the third one, since it suggests a category for the cause of the first event: the category of *state*. We can understand a *state* as the way in which some *particular* is at a

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[105] On the side of theism, see for instance Wielenberg 2021a; 2021b. On the side of atheism, Grünbaum has engaged Craig in a longstanding debate on topics related with this account of divine eternity and, more generally, on the plausibility of (4)*. The crucial phases of the debate happened at the end of the last century. See Craig 1992; 1994a; 1994b;1994c and Grünbaum 1989; 1991; 1994.

[106] For an attempt of response, see Loke 2017, 162.

[107] There is some empirical basis to identify this duration with 10^{-33} seconds.

[108] For instance, there is the well-known Stephen Hawking's allegation in this regard (Hawking 1988, 6).

certain instant. Being durationless, states do not entail change (3.1.1.), so the category of state seems a good candidate for a "changeless cause of the first event". However, things are not that easy. Elsewhere Craig explicitly rejects the idea that the first event can be caused by a state. He writes:

> The event of the universe's coming into being cannot be an instance of state-state causation or event-event causation, since the origination of the universe is not a state and the condition of the timeless cause is not an event. But neither can it be an instance of state-event causation, for this seems clearly impossible.
>
> (Craig 2002, 102)

Here we must distinguish the reasons why Craig thinks that a state-event causation is impossible in the case of a state *in time* from the case of a "timeless" state. As for what concerns the state-cause in time, its impossibility could be simply derived from ULTRAM and IPTV. However, Craig often presents another argument, one which is not based on IPTV. Let us call this argument the *Sufficiency Argument* (**SA**). The argument can be presented along these lines: suppose that the first event began at the instant t_0, and that it was caused by a state-cause in time. Given ULTRAM, we have that, at any instant *before* t_0, the state-cause[109] was obtaining.[110] This is because, if there had been an instant before t_0 when the state-cause did not obtain, then there would have been a change before the first event, which is impossible. Moreover, it is assumed that:

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[109] Or, at least, what was obtaining was a state qualitatively identical but numerically different from the state-cause. For discussion on whether this is possible, see 3.3.2. The SA could be reformulated in these terms if we grant that something's being in two qualitatively identical states would have or would instantiate the same causally relevant properties (3.4.2.).

[110] A reminder on the usage of some terms: 'time' has been sometimes used, through the work, as synonymous with 'temporal item' (either an instant or a period of time). For the introduction of this terminology, see 1.3.2. Moreover, I say that a cause obtains at some time if, and only if, it obtains *entirely* at that time. Thus, if a cause occurs during all instants between the instants t_0 and t_2 (included), where the instant t_1 is such that $t_0 < t_1$ and $t_1 < t_2$, I shall not say that the cause obtains at t_1, but rather that it obtains at the time (period) T with first instant t_0 and last instant t_2. Notice that (22) excludes also cases where a single instant lies between an extended event/cause and an extended event/effect, not belonging to any of them.

(21) A state-cause must be sufficient for the first event to occur.

(22) There can be no times between the time at which a sufficient cause obtains and the time at which the effect obtains.

According to the standard conception of a *sufficient* cause (Benovsky 2012, 766; Le Poidevin 2003, 227), assumption (22) excludes cases of causal action-at-temporal-distance (3.4.2.). From all this, we derive that the occurrence of the first event at t_0 is impossible (Craig 1979a, 100; Craig and Sinclair 2009, 194): since the sufficient-state-cause obtained at all the times previous to t_0, then it is necessary for the first event to have occurred before t_0 (in general, it is necessary for the first event to have occurred before any time we suppose it to have occurred). From this, we derive that the first event both began and did not begin at t_0. In light of this contradiction, the argument concludes that the cause of the event *was not* a sufficient-state-cause in time. We have thus two sets of main assumptions from which defenders of the KCA may derive that a state-cause in time is impossible: {ULTRAM; IPTV} and {ULTRAM; (21); (22)}.

Craig thinks that (21) also applies to *timeless* state-causes. This is because he thinks that, *in general*, if a cause is "not sufficient for the production of the effect, then some change must take place in order to produce the effect" (Craig 2002, 102). Moreover, Craig does not think that a changeless and timeless state of some person can be sufficient to produce the first event. About this, he writes that "it is insufficient to account for the origin of the universe by citing simply God, His timeless intention to create a world with a beginning, and His power to produce such a result." To understand what is the view that lays behind Craig's denial we must enter, in the next section, into the issue of what the KCA's proponents mean by '*personal* cause'.

2.3. Personal causes

Though this section, I deal with the concept of a *personal* cause. More specifically, I highlight the two strategies implemented by the defenders of the KCA when it comes to arguing that the cause of the first event must ultimately lie in a freely acting agent. In one strategy, it is the timelessness of the cause (at least in the sense that it is durationless at an instant that is temporally disconnected from the world-series) that leads to the conclusion that it must be personal. The other move is to conceive of the cause as necessary but not sufficient. In the first subsection, I consider the first strategy. On the basis of the agent-causation account adopted by the KCA's proponents, I approach the issue of what kind of relatum the KCA's proponents may claim to be the timeless cause of the first event. I argue that only *states* seem to provide an adequate type of relatum for a "timeless"[111] cause the first event. In the second subsection, I consider the second strategy, which I will attempt to undermine in the next two Chapters.

2.3.1. Timeless agent-causation

How are we to understand a *personal* cause? According to Morriston, personal causes are to be analyzed in terms of individual persons who freely act (Morriston 2000, 158). In order to account for what exactly a personal cause is, then, the proponents of the KCA must first account for what it means for an individual to freely act. If they could show that the cause of the first event somehow ultimately lies in an individual that freely acts, the remaining task would be to show that such an agent must be identified with a person. This latter task, of course, will require to establish under what conditions an individual endowed with free will may be called a person. However, which set of conditions any theologian is prompt to endorse is highly dependent on their theological concerns.[112] For this reason, I shall not enter in this part of the debate concerning (4)*. Rather, I must focus on the attempts to accomplish the first task, that is, to show that the cause of the first event somehow ultimately lies in an individual (an agent) who freely acts.

To this purpose, theologians usually recur to the tools of a *libertarian theory of free will*, that is, a theory according to which (at least some) agents can freely act, where an agent freely acts if, and only if, their actions are not entirely causally determined by

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[111] In what follows, I use inverted commas when referring to the atemporality of the cause of the first event when I specifically refer to Craig's proposal of a durationless cause at the temporally disconnected instant (undifferentiated time). When I otherwise do not make use of the commas, I refer to a weaker concept of timelessness which neither excludes Craig's proposal, nor entails it.

[112] Craig (2001, 79) endorses Daniel Dennett's account of personhood (Dennett 1976, 175–196): P is a person only if P is: 1) a rational being; 2) a being to who states of consciousness can be attributed; 3) capable of regarding others as beings to who states of consciousness can be attributed; 4) capable of verbal communication; 5) self-conscious.

factors beyond the agent's control (O'Connor and Franklin 2018, 15). While all libertarians agree that a free agent can act without any causal condition that necessitates them to act (Moreland 2018, 543), their opinions split up when it comes to the issue of whether agents somehow (either primitively or not) cause their own actions. Those libertarians who believe that agents somehow cause their actions belong to what one may call *the school of agent-causation* (Moreland 542, 2018). Proponents of the KCA appeal to the agent-causation school and understand an agent who freely acts as an agent who freely causes their actions.

Craig as well has defended the claim that the cause of the first event must be an individual who freely acts. His strategy can represent here, once again, the general strategy of the KCA's defenders. First, as seen, he argues that the cause must not be in space and time; given this, he argues that the cause can only be a case of agent-causation (Craig and Sinclair 2009, 192). There are three main argumentative paths the theologian may follow to implement this strategy. First, they may claim that there are only two available types of causal explanation for the first event: an explanation that appeals to agent-causation and an explanation that appeals to previous initial conditions together with physical laws. For instance, if we ask for a causal explanation of an uncontrolled chemical reaction that blew up a laboratory, we could be told about the laws governing chemical processes and the temporally previous causes that had given rise to the reaction. However, we could also be told of the (mistaken) actions that some chemist made. These seem to be two legitimate types of causal explanation of the very same phenomenon (Swinburne 1991, 38). However, says the theologist, in the case of the first event, which is caused from outside of space and time, only a causal explanation that appeals to agent-causation is available (Craig and Sinclair 2009, 193).

The second adduced reason is that the only things that can be thought of as existing timelessly are unembodied agents and abstract objects (Falguera, Martínez-Vidal, and Rosen 2021, 3). But, as it is standardly assumed, abstract objects cannot be the relata of causal relations, and therefore they cannot be the cause of the first event. The KCA defender concludes that the cause was an unembodied agent (Craig and Sinclair 2009, 193).

Lastly, the third and most relevant reason for believing that the timeless cause of the first event is a case of agent-causation closely reminds of the *mutakallimūn*'s argument for God as the cause of the beginning of the universe: since the cause of the first event is timeless, it should not entertain any temporal relation with any moment of time. Given this, it seems that it was equally possible for the first event to happen any number of years ago. The KCA's proponent therefore concludes that the *only possible way* the first event can be caused by an atemporal cause is if this cause is a *freely acting* (personal) agent, who can freely "choose", or better who timelessly and changelessly intends, to cause the world-series to begin a precise number of years ago.

Since the notion of agent-causation is so important for the justification of (4)*, I must say something more about it. A central concept, when it comes to agent-causation, is that of basic action. Some actions are done by doing other actions. For instance, I may perform the act of pushing a button by performing the act of moving my finger. Basic actions, instead, are a peculiar kind of action, in that they are not done by doing anything else (Moreland 2010, 544). For instance, on a volitionist theory of agency, actions like the volition or willing to move a finger are taken to be basic actions. Since basic actions are not done by doing anything else, this makes them an appealing candidate when it comes to state what is the second relatum of the causal relation instantiated by an agent causing an action. Basic actions (e.g., the willing to move my finger) are somehow directly caused by the agent (e.g., myself). Anything else that is done by performing a basic action (e.g., moving my finger, pushing a button, shutting down all the lights in a club and so forth) is somehow indirectly caused by the agent: if basic actions are the second link in a causal chain, anything that is done by performing a basic action is a more remote link in the causal chain. The more immediate effects of basic actions are called basic-results.

It is important to note that actions, including basic actions, are events (Danto 1965, 142; Schlosser 2019, 9): they happen in time, and they entail some change. This means that a divine basic action that would bring about the first event (e.g., God's willing to bring about the first event) should be in some temporal relation with the first event. Some considerations made above for a hypothetic event-cause of the first event (2.2.1.) are also valid here: a divine basic action could not had taken place before the first (maximally complex) event. Therefore, it must be either after or a part of it. If it is *after* the first event, the possibility of backward causation should be acknowledged, entailing the abandonment of a standard feature of causation. If it is a *part of* the first event, one may think that, similarly to above (2.2.1.), the divine basic action would have to be the cause of itself. However, this is not the case. To see why, consider that the divine basic action needs not to be conceived as the cause of the first event *as a whole*. Instead, it can be conceived as being the direct cause of some simultaneous basic result which is also a part of the first event. This basic result could be, in turn, the cause of other parts of the first event. In general, the divine basic action so conceived would be the (direct and indirect) cause of each part of the first (maximal) event *excluding itself*. The divine basic action itself would be, instead, somehow directly caused by the agent. Indeed, Craig talks of *the act of creation* as being simultaneous with the first event (Craig 1994, 327; Craig 2015). It is important to be clear here: on an agent-causation account, what causes the first event is ultimately *not* the basic action, but rather what directly causes the basic action.

Here then is the central question: how do agents cause their basic actions? The KCA's proponents cannot maintain that the divine basic action is caused by some other event standardly conceived; nor, as seen in section 2.2., they wish to grant that what ultimately caused the first event (and therefore the divine basic action) is a *state* (i.e., a state of the divine agent). Apart from these two kinds of relata, there are three main proposals that have been explored for the cause of the divine basic action. On the first main proposal, basic actions are understood to be caused directly by the agents (Bishop 1983, 71–72; O'Connor 1995, 181; O'Connor 2000, 43; Clarke 2003, 187; Moreland 2010, 548); on the other two proposals, the causal relation between the agent and the basic actions are understood to be grounded in the exercise of *causal power*, where on the second proposal such an exercise is conceived as something different from an event, while on the third it is conceived as a special kind of event (Moreland 2010, 548–549).

Within the first proposal, agents are seen as *substances* (Moreland 2010, 542) (2.1.2.). If the defenders of the KCA were to go for substance-causation, they could claim that a divine agent-substance was the cause of some divine basic action, which in turn simultaneously caused (the remaining parts of) the first event. However, on this view, it seems that one cannot maintain that the ultimate cause of the first event, that is, the agent-substance, is timeless.

To see this, one must first note that the type of substance-causation involved in agent-causation theories is what the scholastics called '*immanent* substance-causation' as opposed to '*transeunt* substance causation'. When it comes to transeunt substance-causation, a substance directly causes a change somewhat external to itself. On the other hand, when it comes to immanent substance causation, a substance causes *itself* to acquire some accidental property. In the case at stake, the divine agent-substance-cause, call it 'God', will cause God's having the property of being performing a basic action (e.g., God's having the property of willing to bring about the first event) (Clarke 2003, 207). However, since the basic action happens at a particular time, the agent-substance will have the property of being performing *that* basic action at *that* particular time. It turns out, therefore, that an absolutely timeless agent-substance-cause would be contradictory (Wielenberg 2021a).

Craig's proposal in this regard is the following: we should conceive of the agent-substance-cause, God, as existing both in time (starting from the moment when the basic action happens) *and* outside of time. As Craig puts it: "the moment of creation is, as it were, the moment at which God enters in time" (Craig and Sinclair 2009, 195). This, according to Craig, would avoid the contradiction (Craig 2001, 233). The first thing to note about this proposal is simply that it is highly puzzling, and the suspicion of incoherence is strong. However, even if we assume that there is a way to formulate it coherently, I think that it is very difficult that the property of being timeless can be conceived as an *essential* property of the substance-cause. Instead, being timeless would be an accidental property of the substance-cause, so that (and this is a somewhat original point in the context of the analysis of Craig's proposal) the agent-substance-cause, considered by itself as an *essentially* characterized particular, is not both timeless and temporal, as Craig claims. Rather, it would be neither timeless nor temporal.

The substance-causation account of agent causation is therefore problematic for the defenders of the KCA, who on the basis of ULTRAM and IPTV argue that (by itself) the cause of the first event must be timeless. If then we consider Craig's proposal of understanding the cause of the first event as "timeless", what is truly "timeless" turns out to be the *state* of the substance occurring at the instant. Moreover, it seems that, in general, we cannot take a substance-cause to exist *only* instantaneously (O'Connor 2002: 341; Clarke 2003, 2010). Indeed, there are reasons to think that a substance of this kind could not be conceived as a freely acting agent, for it is sometimes argued that any morally responsible agent must be an *enduring* entity that *persist through* time.[113] In fact, Craig himself proposes this argument (Craig 2000b, 210–211). We must at last acknowledge, then, that an agent substance-cause can hardly be conceived as timeless and that *states* appear to be better relata than substances, at least when it comes to searching for a "timeless" cause of the first event.

If the defenders of the KCA still do not wish to allow for a timeless state-cause of the first event, they can abandon substance-causation and appeal to the alternative accounts of agent-causation where basic actions are claimed to be caused by *exercises of causal power* rather than by substances. According to the first alternative account, the exercise of causal power is understood as "the exertion of a self-determination by the agent that does not entail any change in the state of the agent itself" (Moreland 549). Since the exercise of causal power does not entail any change by itself, it would not be an event. On this view, the KCA's proponents could talk of God's exercise of causal power without entailing neither that there was any change within God, nor that God must be in time. That is, God would changelessly and timelessly exist and timelessly exercise the power that causes the divine basic action. However, if God must perform its basic action at the time of the first event, it seems that he cannot exist timelessly in an absolute sense. The problem with this approach is again the ancient theological problem of an absolutely timeless divinity acting temporally, a problem that has not yet been solved after centuries of reflections, so that here I will leave it aside and consider the first alternative approach as inadequate.

According to the second alternative account, exercises of power that cause the basic actions are understood as events that *cannot* (either logically or metaphysically) be caused. This would allow the KCA's defenders to talk of God's exercise of causal power as being part of the first (maximally complex) event and as being ultimately the cause of all the remaining parts of the first event. However, on this proposal there would be no cause of the whole of the first event, so that (1)* would have to be somewhat restricted (Moreland 2010, 549), and KCAr reformulated. More importantly, on this proposal the first cause is ultimately temporal, so that the main strategy of the KCA's defenders for claiming that this cause must be a freely acting agent would lose its grounds.

[113] For the distinction between *endurantism* and *perdurantism*, see 3.2.1.

In general, then, one must conclude that, if the cause of the first event is assumed to be timeless, either in the weak sense of being durationless at the undifferentiated time (given that such a proposal is coherent at all) or in a stronger sense, it seems that *only* states provide an adequate type of causal relatum for the cause of the first event.

2.3.2. Temporal agent-causation

Given the conclusion of the previous subsection, the question arises of whether there is an alternative strategy for arguing that the cause of the first event must be a freely acting agent, i.e., a strategy which is not based on the assumption that such cause must be timeless. Here, the defenders of the KCA have some tools to formulate an argument of this kind. As seen, the SA infers a contradiction (that the first event both began and did not begin at some time) on the basis of ULTRAM, the claim that cause of the first event must be ultramundane, and (21), the claim that a state-cause of the first event must be sufficient for the first event to occur (2.2.2.). Now, the advocates of the KCA may hold that, in general, *whatever* causes the first event, it cannot be a sufficient cause of it. This is because, if that were the case, one could always propose an argument on the lines of SA, deriving a contradiction from the supposition that the first event began at some time and that it was caused by something sufficient. This, they may maintain, holds independently on whether the sufficient cause at stake is conceived to be temporal or timeless (Craig 2002, 103). However, go on the defenders of the KCA, the *only* case of causation where the cause can be consistently taken as necessary but not sufficient for the first event to occur is agent-substance causation (Craig and Sinclair 2009, 194). From all this, they conclude that the cause of the first event must be an agent-substance.

How do the KCA's defenders justify the claim that *only* agent-substance causation can do the job at hand? In fact, there are contexts other than agent-causation in which they propose necessary but not sufficient event-causes. I will say something more about this in Chapter 4 (4.4.1.). However, the idea here is that, *when it comes to the first event*, only agent-substances are available as necessary but not sufficient causes (Craig in Craig and Smith 1993). This could be inferred from (21), the assumption that agent-substances are indeed necessary but not sufficient causes, and the claim that state causation and agent-substance causation are the only two available alternatives to event-causes in the case of the first event (Craig 2002, 102), which in turn must be based on ULTRAM (since there are no events before the first event).

In the previous section I argued that agent-substance causation is problematic in the case of a timeless cause. This argumentative strategy, though, is not based on the assumption that the cause of the first event must be timeless, so that the defenders of the KCA may still conceive of the substance-cause of the first event as essentially temporal. In this case, the agent-substance could exist since a beginningless period of time, when suddenly causing the relevant basic action for the first event to happen. A commonly used analogy is that of a man sitting since a beginningless period of time who, at a certain time, freely causes his own willing to stand up (Morriston 2000, 164; Craig 2008, 154; Craig and Sinclair 2009, 194; Wielenberg 2021a, 82). In this analogy it is evident how the existence of a substance-cause at any time, however necessary, is not sufficient, by itself, for the effect to happen: the man does not stand up until he *freely* causes his basic action. Similarly, an agent-cause would not initiate the universe until they exercise their causal power at a precise moment (Craig and Sinclair 2009, 194).

Nonetheless, substance-causation remains, in general, largely controversial (Broad 1952, 215; Clarke 2003, 196–210; Steward 2012, 203; Schlosser 2019, 9). One common objection goes as follows: according to a libertarian theory of free will, no set of conditions is sufficient to cause a basic action. However, it seems that at least some necessary conditions must exist *within* the agent-substance. In this case, one still has to explain why those conditions brought about their effect when they did, where of course this task will be far more complex if the agent-substance is conceived to be changeless (Morriston 2000, 164).

2.4. Conclusions

We have thus two main argumentative strategies that have been undertaken in order to support (4)*, the claim that if the first event was caused, then there is a personal cause of the first event. The first one is based on two supposed results: that a cause of the first event must be timeless (which in turn is based on ULTRAM and IPTV) and that a timeless cause must be a personal cause. Let us call this the *Timeless Cause Strategy* (**TCS**). The second one is based on the supposed result that the cause of the first event must not be sufficient for its effect to occur and the claim that *only* agent-substance causation can provide a necessary but not sufficient cause for the first event (which in turn is based on (21) and ULTRAM). Let us call this the *Temporal Agent Strategy* (**TAS**).

Notice that, given the result of subsection 2.3.1., these two strategies are incompatible. In 2.3.1. I argued that, if the cause is timeless, then *states* are the only available candidate for the category of the cause of the first event. And while the TCS commits to a timeless cause, the TAS commits to a *substance* cause. To put it otherwise, the TAS, in light of the results of 2.3.1., commits to the claim that the cause of the first event must be temporal, which contradicts the assumption of the TCS.

So, if the conclusion of 2.3.1. holds, the defenders of the KCA must choose between one of the two argumentative strategies. Having said that, my plan goes as follows: I must show that, whichever strategy they choose, they run in troubles. First of all, in the next chapter, I undermine the TCS by arguing for the denial of one of its main grounds: IPTV, the claim that there could not have been a period of time without change before the first event. Moreover, by the end of the chapter, I must also suggest that the SA may be invalid, casting shadows on (the first assumption of) the TAS. In the model I propose in Chapter 4, I then describe a framework where a necessary but not sufficient state-cause of the first event occurred during a Primordial Temporal Vacuum. If this is coherent, it should constitute a counterexample to (21), showing that *not only* substance-causes can be necessary but not sufficient for the first event, radically undermining the TAS. Moreover, the postulated state-cause within my proposal is going to be non-personal. In this respect, my proposal should provide a counterexample to what both argumentative strategies ultimately aim to prove: that a cause of the first event would be personal (namely (4)*).

Of course, as the reader has certainly noticed, both the TCS and the TAS are based on ULTRAM, the claim that the cause of the first event must be "outside" of the world-series, so that arguing for its denial would undermine both argumentative strategies at once. In fact, this is what many writers have done: by arguing for the logical or metaphysical possibility of backward causation, causal loops and simultaneous causality, they have highlighted that it is not *necessary* for the cause of the first event to be outside the world-series (Smith 1990; Smith 1999; Le Poidevin 2003, 88).

However, as seen above, on a standard account causal precedence entails temporal precedence, which means that all the options entailing the abandonment of ULTRAM also entail a revision of the standard notion of causality (2.2.1.). Conceiving the cause to be timeless, conceded that there is a coherent way to phrase such proposal, would entail a heavy revision as well. I suggested that the less costly option is to abandon uniqueness, and to suppose that the cause of the first event temporally precedes it. I will endorse this assumption in my proposal.

– Chapter 3 –

Time without change

In this chapter, I argue for the possibility of a Primordial Temporal Vacuum (PTV), that is, a period of time without change before the first event. This is crucial for the availability of the AUH. The question of whether a PTV is possible can be faced in two steps, or better, by answering two different questions:

(H) Are temporal vacua possible?

If the answer is in the affirmative, then we may enquire:

(I) Is it possible for there to have been a temporal vacuum *before the first event*?

The final aim, to be reached by the end of the chapter, is to argue against IPTV, the claim that a PTV is impossible, defended in the context of the discussion of the last premise of the KCA (2.2.1.). Therefore, the kind of modality involved in (H) and (I) must depend on the modality involved in IPTV. Indeed, if one were to prove that a PTV is possible in terms of a modality *weaker* than that involved in IPTV, such a proof would be of little use in the context of the debate on the KCA.

Let us assume, with Craig, that metaphysical modality is stronger than logical modality and weaker than physical modality (1.2.1). The first thing that can be established is that IPTV is certainly not restricted to physical modality. It is true that Craig somewhere holds that a PTV is physically impossible.[114] However, the objective of the defenders of the KCA is certainly not to grant that, *given the laws of nature*, the

[114] He makes three hasty points on this. First, he claims that, according to the laws of thermodynamics, the universe cannot exist at a temperature of absolute zero, but he does not provide any proof. Second, he reports that matter in the early stages of the universe was anything but cold, but there is no modality involved in this claim. Third, he holds that in a lump of matter frozen at absolute zero no first event could occur, but it is highly unclear if the modality of this last claim should be interpreted as physical (Craig 1979a, 102; Craig 1991, 106).

cause of the first event must be timeless (and therefore personal).[115] Therefore, the modality employed in the TCS and IPTV must be weaker than physical.[116] However, whether it is logical or merely metaphysical is left unspecified by Craig (Craig and Sinclair 2009, 193).

In fact, while there is no active debate specifically on (I), there is a rich debate in the context of the philosophy of time that focuses on (H). Within this debate, the modality is understood as *logical*. This makes sense if one considers that the debate mainly focuses on arguments for the logical *impossibility* of temporal vacua: given that logical modality is weaker than the metaphysical one, if one established the logical impossibility of vacua, their metaphysical impossibility would follow. Indeed, as I will show (3.3.2.), the cases for rejecting the possibility of temporal vacua ultimately rely either on the very *definition* of times in relation to changes (so that it would entail contradiction to suppose time without change), or on the suggestion that it makes no sense at all to talk about temporal vacua (where a sentence making sense is taken to be a precondition for it to express a logical possibility).

It is sensible, therefore, to restrict our discussion to logical modality as well. Indeed, as far as I am aware, in the literature there is no argument to the effect that time without change is logically *but not* metaphysically *possible*. Therefore, I hereby assume that, if temporal vacua are shown to be logically possible, they can be considered metaphysically possible as well, at least in so far as there is no reason to be aware of the inference.

The general strategy of the chapter is as follows. In the first three sections I enquire into (H). Relying on some recent literature, I conclude in section 3.3. that temporal vacua are possible. Then, in the last section, I briefly enquire into (I) and argue for a positive answer.

3.1. Introduction to temporal change

There are two ways in which such a period of time without change can be conceived: either as a period during which there is simply nothing (empty time), or as a period

[115] The reasons for this are theological: defenders of the KCA do not wish to concede that the omnipotent personal God might not have been allowed by different laws of nature.

[116] In Craig's words, the PTV should be at least "doubly impossible" (Craig 1979a, 102).

during which there is something, but nothing changes. This means that, in order to establish the possibility of a temporal vacuum, one could argue for a positive answer to *either* one of the following questions:

(J) Can there be nothing for a certain period of time?

(K) Can there be only changeless things for a certain period of time?

In order to argue for a positive answer to (H), in this chapter I focus on arguing for a positive answer to (K).[117] I start, in this section, by enquiring in what sense we should interpret the expression 'changeless things'. The objective, to be reached at the end of the section, is to establish, at least roughly, what kind of change I am interested in.

3.1.1. The standard broad view of change

According to the standard *broad* conception of change, something changes if, and only if, it possesses or instantiates some property at a given time and it lacks (or it does not instantiate) that property at some later time (Mortensen 2020, 2). A case of change would be, for instance, a knife that, from sharp, becomes blunt. Changes in properties, then, always take some time. This is because, according to the standard broad view of change, changes happen from one moment to another, so that there cannot be change within a single instant.

But what kind of things, exactly, can change their properties? And what kind of properties are subject to change? Of course, not all philosophers agree on how one should answer these questions. According to a tradition that dates back at least to Aristotle (Sorabji and Kretzmann 1976, 70), the category of things that can undergo change with respect to their properties is that of substances ('*ousiai*' in Aristotle's terminology) (*Categories* 1–5, *Physics* 190a).[118] On this view, change requires a substance, or an object[119], that persists through time and changes with respect of one or more of its properties.[120] However, this position has not remained undisputed. For

[117] In fact, I believe that (J) should be answered negatively (3.4.1.).

[118] The notion of substance has been introduced in 2.3.1.

[119] In this context, I use the terms interchangeably.

[120] Aristotle named changes of substances with respect to their properties as accidental changes, as opposed to substantial changes, whereby a substance comes into, or passes out of, existence. For more discussion on substantial changes, see 3.1.2.

instance, in the contemporary literature, sometimes, *events* have been said to change as well. Take the event that is considered to have led to the formation of the Moon: the collision between the Earth and Theia. We may say that, in a distant past, when the Moon had not yet been formed, this event was changing from being very much future to being less future; later, when the Earth and Theia collided, the event changed from being future to being present; and right now, while the moon shines placidly in the sky, the event is changing from being quite a bit past to being even more past. Properties such as 'being past' or 'being present' are sometimes called *tensed properties*.

The most important advocate of the existence of fundamentally tensed properties was John Ellis McTaggart, who rejected the predominant view according to which objects are the subject of change (which he attributed to Russell) and claimed that *only* events can undergo genuine change (McTaggart 1927, 14). If we agree that events can undergo change in McTaggart's sense, then it is easy to see that the answer to question (K) must be negative, and thus the debate on (K) would already be settled: it is clearly impossible for a period of time to elapse without any event changing its tensed properties, in so far as these changes stem straightforwardly from two facts: that some time elapses and that there are some events with some tensed properties. However, this approach would beg the question. Intuitively, when we wonder whether there could be time without change, it is a different, though vague, concept of change that we have in mind (perhaps one strictly linked with perceivable consequences) (3.2.2.).

In fact, it is highly controversial that events can undergo change at all. Nowadays, many philosophers[121] follow J. J. C. Smart (1949, 485) in claiming that

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[121] McTaggart's work (1908) has become the natural starting point, if not for all of the contemporary metaphysics of time (Callender 2017, 291), at least for the already mentioned contemporary debate on whether the present time is somehow objectively special. Those who nowadays, following one of McTaggart's insights, think that present things are, indeed, special, are generally called A-theorists. Among the most prominent A-theorists of the last century we find C. D. Broad, Arthur Prior, Peter Geach, and Roderick Chisholm. Up to this century, A-theorists have come to develop a huge abundance of theories (Callender 2017, 293; Power 2021, 42–56), among which I already mentioned temporaryist approaches. Influent works in defense of A-theories include Craig 2000a, Markosian 2004, Crisp 2003, 2004 and 2005 and Forrest 2005. In particular, Zimmerman (2005) provides an illuminating discussion on what the word 'special' should mean for the A-theorists. Although the debate originated from McTaggart, A-theorists are not directly committed to McTaggart's claim that events change their tensed properties, so that this claim can nowadays be rejected by an A-theorist along with their opponents (B-theorists).

change does not pertain to events: objects such as the Earth and Theia can change, come into existence and cease to exist, but events such their collision, cannot. If we were to follow Smart in selecting objects as the primary subject of change, (K) could be restricted to the question of whether there can be a period of time during which there are only changeless *objects*. However, this would not settle the question-begging issue, because it could be claimed that objects as well have tensed properties. Suppose an apple becomes rotten for the first time. We can attribute to the apple, at that time, the property of 'never having been rotten at some past moment'. Subsequently, the apple will lose this property, and gain the property of 'having been rotten at some past moment'. Later, it will acquire the property of 'having been rotten at some past moment, at some past moment', and so on.

Meyer shows more formally how tensed properties can be attributed to objects (Meyer 2013, 108). Within the language of some tense logic system, we can stipulate that any formula $\varphi(x)$ of the language defines a property. Let H be the temporal operator meaning 'it has always been the case that …' and P be the temporal operator meaning 'it has at some moment been the case that …', while K is the property of 'being rotten'. Moreover, let time be discrete for the sake of simplicity. Then the apple, at the moment in which it acquires the property K, would also have the property defined by the formula $H\neg Kx$. At the subsequent moment, the apple will have the property defined by the formula PKx and then, at the subsequent moment, the property defined by the formula $PPKx$, and so on. The apple will continue to undergo this kind of change, at least (we can also stipulate this) as long as it exists.

In general, then, if one takes change in tensed properties to be genuine cases of change, that is, if one takes tensed properties as genuine properties, and if one takes the term 'changeless' in (K) to refer to *any* kind of change, then one begs question (K). Again, that tensed properties are genuine properties of something can be, in general, debated, at least in so far as it is not wise to adopt a broad conception of property, according to which for every predicate F true of a thing there is a property of the thing which is designated by the corresponding expression of the form 'being F'. Sydney Shoemaker gives one reason for this:

> If the term property is used in such a way, then every object will have innumerable properties that are unlikely to be mentioned in any causal explanation involving an event of which the object is a constituent.
>
> (Shoemaker 1980, 110)

The problem pointed out by Shoemaker is not that a weak criterion for what a property is would generate too many of them. After all, if there are any properties in the world, then there is arguably an infinite number of them.[122] Rather, Shoemaker wants to highlight how certain kinds of properties (as for instance tensed properties), if admitted as genuine properties, could have no role in causal explanations, which he takes to be a good enough reason to rule them out as genuine properties.[123]

In general, realists about the existence of properties usually agree that they are to be grouped into various kinds. However, almost none of the alleged kinds is accepted by all realists (Orilia -Swoyer 2020, 21). I do not want to take a position here on whether tensed properties are genuine properties rather than arbitrary ways of grouping things (or on whether genuine changes happen also to events, for that matter). All I have to note is that, if we want to avoid begging question (K), we should rule out tensed properties as properties of our interest when we wonder whether there could be a period of time during which things remain changeless. Therefore, in what follows, I shall interpret (K) so that things (be they events or properties), in order to be "changeless", must not undergo any change with respect to a certain class of properties that does not include tensed properties; and when I talk of change, I shall refer to the specific kind of change in respect to the properties that belong to such class. The issue is therefore how the properties' class at stake should be delimited.

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[122] The cardinality of the set of all properties must be the cardinality of the real numbers if we think that each value of some physical magnitudes which can vary continuously, such as gravitational field or electromagnetic field's intensity, is a distinct property. This last claim can be found plausible even by most minimalists, those who postulate, among realists about the existence of properties, the most sparsely populated domain of properties (Orilia and Swoyer 2020, 18).

[123] For Shoemaker's causal theory of properties see also Shoemaker 1984; 2002.

3.1.2. Changeless things

In order not to beg question (K), the first impulse may be to restrict it to *non-tensed properties,* where tensed properties may be defined as all those properties that cannot be expressed without the use of *temporal indexicals* (Newton Smith 1984, 16), that is, of tenses as well as temporal demonstratives such as ‘now’ and, in general, all those expressions reflecting a given temporal perspective.

Even granted this restriction, though, we can always define some non-tensed property such that something would lose it or gain it *mainly* in virtue of its temporal location. A good example of this are *Goodman properties,* that is, properties defined on the basis of the special kind of predicates famously introduced by Nelson Goodman (Goodman 1954): we can always define a certain property F such that an object gains it or lose it at a certain time if, and only if, the object had a property G before that time, and it continues to have G after that time. An example provided by Goodman goes as follows: an object has the property of being grue before *t* if, and only if, it is green before *t* and it has the property of being grue after *t* if, and only if, it is blue after *t*. Now, suppose an object is green before *t* and continues to be green after *t*. Such an object would lose the property of being grue after *t*.

Since we can define as many Goodman-like properties as we like, we can establish that, during a certain period of time, as many Goodman-like changes as we like occurred. Therefore, if we do not rule out Goodman-like properties as properties of our interest as well, the question-begging issue still remains. The problem, though, is that it is very hard to define, *exactly*, what kind of properties count as Goodman-like properties (Cohnitz and Rossberg 2020, 14)**.**[124]

Although this could be a problem for those who directly face the question of the possibility of time without change[125], for what concerns this work there may be an easy

[124] I take them to be properties that something would lose or gain *mainly* in virtue of its temporal location, the meaning of ‘mainly’ must be left unexplored.

[125] Newton Smith (1984, 17) claimed that, when we investigate the possibility of time without change, it is not necessary to provide an exact definition of Goodman changes in order to rule them out of the discussion. This, according to him, would be because those who have the most compelling reasons to deny time without change, *relationists*, will share the intuition with their contenders that Goodman changes do not count as time without change. I will introduce below the relationist position, showing,

way out. Since I am interested, in general, in the possibility of a temporal vacuum *before the first event*, it would suffice to restrict (K) to those changes that *entail* the occurrence of events.[126] Suppose, for instance, that changes in Goodman-like properties were to entail the occurrence of events. Then for there to be a temporal vacuum before *the* first event, that period of time would have to be without Goodman-like changes. On the contrary, if Goodman-like changes *do not* entail the occurrence of events, then we can establish that, during a temporal vacuum before the first event, Goodman-like changes may happen. The same holds for any other kind of change. The question, then, is what kinds of changes entail the occurrence of events?

As said (1.2.1.), there is no general consensus on what events exactly are, but we can safely assume that neither Goodman-like changes nor changes in tensed properties entail, by themselves, the occurrence of any event. Indeed, suppose that, in discrete time, an apple (or the collision between the Earth and Theia, for what matters) acquires a tensed property. For instance, suppose the apple acquires the property of 'having been rotten at some past moment, at some past moment, at some past moment'. It would be highly controversial, at the very least, to hold that there is an event corresponding to the acquisition of such tensed property by the apple. One reason, again, is that we can hardly see how such an event could enter in any causal relation (Newton Smith 1984, 16; Benovsky 2012, 765; Meyer 2013, 108), while we have seen that events are taken to be the *standard* relata of causal relations. The same seems to be true for any Goodman-like properties. The criterion of restricting (K) to changes that do not entail the occurrence of events seems, therefore, to do its job: it rules out those properties that we have seen to generate the question-begging issue.

Established what kind of change is at stake, one may wonder whether the kind of *changing things* at stake should be restricted as well. I do not think this is necessary though. The term 'thing' has been used so far as an umbrella term that can cover basically any ontological category of which something can be predicated. The main

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eventually, that they must not reject time without change (3.2.1.). Given this, it turns out that, even if Newton Smith were correct in claiming that any relationist would agree on ruling out Goodman changes, the discussion on the possibility of time without change is not directly linked, as he thought, to the debate on whether relationism is true.

[126] According to some authors, genuine changes just are events. See for instance Le Poidevin 1991, 16.

categories that are said to undergo change, as seen, are objects and sometimes events. Since for sure there cannot be a period of time without change (that is without events) during which events happen, one could think that we may simply restrict (K) to objects. However, consider a period of time during which there is only one object, say a chair, that does not undergo any change (in the relevant sense). Say, then, that an event happens: the sudden and instantaneous disappearance of the chair, while a desk appears in its place. It seems contradictory to say that the chair has changed by losing the property of existing. After all, there is no chair anymore.

In order to include this kind of changes, that Aristotle named *substantial* changes (3.1.1.), Newton Smith has suggested the following definition:

> A change occurs if, and only if, some object has at some time some property and later that object lacks that property *or* some region of space is characterizable in such and such a way […] and later the same region is not so characterizable.
>
> (Newton Smith 1984, 15)

I believe this definition is yet too weak. Consider the case, indeed, where the desk appears at the very first (period of) time. In that case, one may certainly want to say that there has been a change entailing an event (1.2.1.), at least in so far as the *creation of the universe out of nothing* is an event. I propose, then, a slightly different definition of change:

> A change occurs if, and only if, some object has at some time T some property (*or* some region of space is characterizable in such and such a way) and it is not the case that there are some times before T so that at *all* such times the object has that property (or the same region is so characterizable).

Of course, this definition can be discussed. For instance: why should we talk about changing objects at all? Is it not preferable to deal exclusively with the spatial regions that contain such objects? Whether this option is viable depends on whether one can reduce objects to spatial regions, which is not obvious at all. Nonetheless, the issue can be avoided by making use of ‘thing’ as an umbrella term. Assuming spatial regions can have or instantiate properties, if there can be a period of time during which there are only changeless (in the sense endorsed above) things, be those objects or spatial regions, then the answer to (K) is positive.

So far for what concerns how we should understand 'changeless things' in (K) in order not to not make the answer to (K) trivially negative. In the next section, however, I argue that the endorsement of an ontological view about temporal items could make the answer to (K), by contrast, trivially positive, which would leave the question-begging issue unsolved.

3.2. Time and change

After having defined what kind of change we are interested in, I come, in this section, to directly face the issue of time without change. In the next subsection, I introduce some existing theories on the relation between time and change. The objective is to establish what should not be assumed about this relation in order not to beg question (K). In subsection 3.2.2., I then examine some arguments that historically have been given against the possibility of time without change.

3.2.1. Relationism and Substantivalism

When the task is to investigate the relation between time and change, there is a widespread consensus at least on one thing: there cannot be change without time. This follows straightforwardly from the standard broad conception of change, according to which any change takes some time. Cases of pure spatial variation, on the contrary, do not count as genuine cases of change (Mortensen 2020, 2). This seems to agree with the common usage of the term 'change'. Take the variation of the knife's sharpness along its edge: we do not want to say, in noting such a variation, that "the knife is undergoing change" or "there is some change on the knife" or similar. However, before taking this as the starting point of the enquiry, one could certainly wonder what is so special about temporal variation. After all, just as a knife can be sharp at one time and blunt at another, so it can be sharp at one place and blunt at another. And yet, change is (broadly) not defined in terms of spatial variation. What makes temporal variation special?

This crucial question is strictly linked with the above-mentioned debate on whether things, either events or objects, undergo genuine change in their tensed properties. If one believes so, then they may have reasons to claim that *any* genuine change is ultimately "genuine" *because* it entails change in tensed properties, where of course mere spatial variation does not (Le Poidevin 1991, 15). Moreover, rather independently from considerations on the existence of fundamentally tensed properties, a central intuition behind the standard broad view of change is the following: something *really* undergoes change if it is somehow in relation with *incompatible* properties *as a whole*.[127] Now, in the case of time it is often maintained that, indeed, objects persist (and change) through time as a whole. By contrast, in the case of space, what enables the knife to have different properties at different places is, intuitively, that it extends through space by having different spatial parts at different places. Nonetheless, many philosophers[128] have contended to this standard view that just as objects extend through space by having different spatial parts at different locations, they may persist through time by having different temporal parts at different temporal locations.

It is interesting to note, then, that the standard broad view of change can conceivably be questioned on the basis of the acceptance of temporal parts. Nevertheless, if the standard broad view of change is taken for granted, then only *temporal* changes count as real metaphysical changes. And once it is established that for something to change some time is needed, a natural following step is to wonder whether this conceptual link is a twofold one: do we need some change for some time to pass by?[129]

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[127] This is the root of the notorious Problem of Change.

[128] Following Lewis (1986) the contemporary literature labels this position '*perdurantism*', as opposed to the view that objects persist through time as a whole by being wholly multiply located at different times, which is called *endurantism*. Among the defenders of perdurantism there are Armstrong (1980), Robinson (1982), Le Poidevin (1991); Jubien (1993) and Hudson (2001). Among the endurantists there are Thomson (1965; 1983), Forbes (1987), Oderberg (1993), van Inwagen (1990a; 1990b; 2000), Fine (2008), Shoemaker (2015) and Leonard (2018). For a complete overview of the debate, see Hawley 2020.

[129] Intuitively, by the very act of wondering if there can be time without change, we are according to time a special status. However, within the General Theory of Relativity, time is just a dimension within the 4-dimensional space-time manifold. Although considerations about logical or metaphysical possibilities precede considerations about physical possibilities, it is worth it to clarify that the question about the possibility of time without change can eventually be reformulated in the terms more familiar to physicists:

Starting from the very origins of Western philosophy, the largely prevailing tendency among thinkers has been to provide a positive answer. Take the fragments of Parmenides' well-known poem *On Nature.* In there, a philosophical argumentation leads to the paradoxical conclusion that all change is an illusion. According to the majority of the interpreters[130], a consequence of this, for Parmenides, is that *temporal relations* are illusions as well: if we disregard the data that come from the senses, through the use of reason we can discover that the world is actually an unchanging and atemporal unity. The implicit assumption, allowing Parmenides to make the inference from the illusoriness of change to the illusoriness of time, was, presumably, that there cannot be time without change (Bardon 2013, 20–23).

However, Parmenides did not explicitly claim this principle. To find explicit statements of it we must search into later works, for instance in the *Timaeus*. Here, borrowing the voice of the dialogue's protagonist, Plato narrated that:

> Time has come into being with the heavens, in order that, having been created together, they may be dissolved together, if ever their dissolution should come about (*Timaeus*, 37e 1–38c 6).[131]

That is: were all changes to stop, so that celestial motion would come to a halt, then time itself would end as well. The fact that Plato is not offering an argument here makes no exception for his period. Ancient Greek's philosophers who belonged to the most different schools of thought were largely taking for granted the *twofold* conceptual link between time and change. In fact, time was commonly *defined* in terms of a specific kind of change: motion, that is, change with regard to location. Prominent examples are Archytas, Zeno and Chrysippus, who respectively defined time as *the number of a given motion*, *the interval of motion*, and *the interval of motion of the world* (Clark 1944, 358; Sorabji 2007, 565).

"Can there be timelike variation without qualitative change?" (Le Poidevin 2010, 171). Granted that spatial variations are not genuine qualitative changes, the general question of whether there can be time without genuine qualitative change remains relevant also within the framework of General Relativity.

[130] See, among others, Kirk and Raven 1957, 274; Owen 1966 and Hoy 1994.

[131] Tr. in Sorabji 2005, 224.

However, the idea that time is conceptually dependent on change and motion has become most commonly evoked as an Aristotelian idea. Presumably referring to the passage quoted above, Aristotle accused Plato of erroneously identifying time with a specific kind of motion: celestial revolution (*Physics*, 218a 30). To this, he objected that time cannot be motion nor any other kind of change for two reasons: while change happens somewhere, time is everywhere; while change can go faster or slower, time cannot, given that ‘faster’ and ‘slower’ are defined in terms of the concept of *duration*, which is a temporal concept (*Physics*, 218b 21). Nonetheless, Aristotle still considered time to be *essentially* related to change and motion. More specifically, according to Aristotle, what we call time is *the number that we assign to changes with respect to before and after* (*Physics*, 219b 1).

In order to grasp what this meant to Aristotle, one must bear in mind that. within Aristotle’s metaphysics, all happenings of changes have a certain duration (3.1.1.), which in turn has different parts ordered by irreducible temporal relations: before and after. Now, suppose that the fixed stars take two time-units, e.g. two hours, in order to switch from a certain arrangement in the sky to another. According to some interpreters (van Fraassen 1985, 16), in this case Aristotle would say that what we name the ‘time of the fixed stars’ movement’ is not the movement of the celestial bodies in itself, but rather *the number that we assign to the duration of such a movement*, that is, the number two. The Scholastic tradition, in fact, mainly inherited Aristotle’s view in defining time as the *measure of motion* with respect to before and after.

The important thing to note about Aristotle’s proposal is that times were ultimately defined in terms of the changes happening at those times, so that no room was left for the possibility of time without change. Twenty centuries after the *Physics* was written, another very illustrious philosopher endorsed the same approach towards temporal vacua: Leibniz. In the above-mentioned correspondence with Clarke (1.3.3.), he famously claimed that “instants apart from things are nothing, […] they only consist in the successive order of things” (*Leibniz-Clarke Correspondence*, 3rd paper).[132] As seen in subsection 1.3.3., the reason why Leibniz aimed to reduce times to things in time (more precisely to *changing* things in time) was that he thought it to be a necessary move in order to solve the long-standing theological problem of why God did not

[132] Tr. in Morris 1956, 200. The next translated quote from Leibniz is at page 206.

choose another moment for creation (Sorabji 1984, 79–80). Indeed, on his account of instants, Leibniz thought that the secular theological question was "an impossible fiction" (*Leibniz-Clarke Correspondence*, 4th paper).

Mentioning Aristotle and Leibniz's positions is important for at least two reasons. The first one: as Newton Smith pointed out (Newton Smith 1984, 17), even if most thinkers have rejected the possibility of time without change, only three main types of arguments have been offered in this regard. Following Newton Smith, we may call them the *Inconceivability Argument* (**IA**), the *Measurability Argument* (**MA**) and the *Verificationist Argument* (**VA**). Remarkably, a first important instance of the IA appeared in the fourth book of Aristotle's *Physics* (the same book in which Aristotle gave his definition of time), while an often-quoted defense of the impossibility of temporal vacua based on the MA was offered precisely by Leibniz.

There is then a second reason why reporting Aristotle and Leibniz's position is important. The verificationist line of reasoning, which somehow tries to recover the intuitions behind the first two types of arguments, may be appealing for those who nowadays inherited Aristotle's and Leibniz's common philosophical programme, namely, to ultimately account for the nature of temporal items in terms of change.[133] These are *relationists* about time.[134] The classic general formulation of the relationist claim is as follows:

> **Classic relationism**: times are logical constructions out of events and their (temporal) ordering relations.

Classic relationists take *events* to be the relata of temporal relations in so far as they are a much more natural candidate to cover this role than (material) objects. To see this, it will suffice to consider that it does make sense to say that the battle of Waterloo temporally preceded a serenade, while it does not make sense, normally, to say that a

[133] Although the ways in which they accounted for what temporal items are radically differ.

[134] The idea behind relationism can be traced back to the words of many other philosophers of the distant past. An honorable mention due to the similarity with Leibniz's statement goes to his precursor Lucretius, who in *De rerum natura* claimed that "time by itself does not exist; but from things themselves there results a sense of what has already taken place, what is now going on and what is to ensue" (*De rerum natura* 1, 459–461).

knife temporally preceded an apple (Meyer 2013, 8). Among the most well-known relationists were, for instance, Russell and Whitehead, who respectively defined times as sets of overlapping events (Russell 1936) and as ordered sets of shorter and shorter events which are infinitely nesting (Whitehead in Whitehead, Lodge, Nicholson, Head, Stephen and Carr 1919).

According to the classic relationist view, then, without events, there would be no times (Benovsky 2011, 492). Notice that the classic relationist may, in principle, endorse an account of what events are, such that neither the occurrence of an event nor an event following another entail that there is some change. However, the classic relationist, in general, takes temporal relata to follow one another as some things change their properties (Meyer 2013, 15; Morganti 2016, 81). This makes classic relationists those who, in the contemporary epoch, have been more tempted to reject time without change.

Relationists, however, need not to be classic. They may prefer, for whichever reasons, a different kind of temporal relata, as for instance temporal parts of objects or states of objects.[135] If the relationist pick temporal relata that do not entail the occurrence of changes by their very own occurrence, it seems that there is no immediate reason for them to dispute the possibility of time without change (Morganti 2016, 87). There is then another way in which classic relationists can accommodate this possibility, that is, by appealing to modal considerations. Indeed, if they suppose that merely *possible* changes are sufficient for the holding of temporal relations, then the possibility of a period of time devoid of actual changes may not constitute a threat for them. I will show, however, how this second way of accounting for vacua immediately leads the relationist into troubles (3.2.2.).

It is natural to wonder why the relationist should bother at all. Has the possibility of time without change ever been seriously *defended*? Fathoming the roots of this position is not as easy as in the previous case. Aristotle himself individuates in Anaxagoras and his followers the first proposers of a similar thesis, in so much as they supposedly thought that there has been an infinite time of *rest* (no motion) before the

[135] One popular non-classic option is to take times not as logical constructions, but rather (more plausibly) as collections of events (Le Poidevin 1993, 152). For a brief discussion of temporal-parts relationism, see Meyer 2013, 20–23.

beginning of the universe (Sorabji 1984, 72). However, it was only in the 17th century, when philosophical work was made to interpret the temporal locutions within the new physical theories, that philosophical views of time were elaborated, which would allow to think of time as something separate from the motion of things (van Fraassen 1985, 21).

Here is a particularly often quoted passage from the *Geometrical Lectures* of Isaac Barrow:

> But does time not imply motion? Not at all, I reply, as far as its absolute, intrinsic nature is concerned; no more than rest; the quality of time depends on neither essentially; whether things run or stand still, whether we sleep or wake, time flows in its even tenor. […] Imagine all the stars to have remained fixed from their birth; nothing would have been lost to time: as long would that stillness have endured as has continued the flow of this motion.
>
> (*Lectiones Geometricae*, Lect. I)[136]

Here Barrow is expressing an idea that is diametrically opposite to that encountered in the *Timaeus*: were the stars actually *fixed*, together with all other things in the universe, time would still "flow in its even tenor". Notice that this "flow", according to Barrow, would go on as long as the "stillness" would last. That is: as long as there are things that stay at rest.

Some years after the publication of the Geometrical Lectures, one of Barrow's disciples accepted Barrow's view of the absolute nature of time and derived from it more extreme consequences. The disciple was Newton, and the following passage is from his eminent *General Scholium* of the *Philosophiae Naturalis Principia Mathematica*:

> Absolute, true and mathematical time, of itself, and from its own nature, flows equably without relation to anything external […]. For times and spaces are, as it were, the places as well of themselves as of all other

[136] Tr. in van Fraassen 1985, 22.

> things. All things are placed in time as to order of succession, and in space as to order of situation.
>
> (*Philosophiae Naturalis Principia Mathematica*, Gen. S.)[137]

From this quotation it can be established that Newton's absolute time was independent not only from motion, but, more in general, from "anything external". Those who nowadays inherit this insight embrace *substantivalism about time*. *Contra* relationism, substantivalism conceive times as metaphysical basic entities which exist independently of events or, in general, things in time. Somehow metaphorically, on the substantivalist view time is seen as a container in which things *in* time are placed: a container that may as well be empty. This seems to grant the possibility not only of periods of time during which nothing changes (temporal vacua), but also of empty time in general (Benovsky 2011, 491).

Whether one should pick substantivalism over relationism as their own ontological view is not a settled matter. Nowadays, in the context of modern spacetime physics, the discussion mostly focuses on the so-called *Hole Argument* (Norton 2019, 1). However, since substantivalism *entails* the possibility of time without change, one would beg the question of whether there can be time without change if they were to approach it from a substantivalist perspective. By contrast, approaching the question from a relationist perspective, as said, does not settle the matter.

I must therefore adopt some more constraints in order not to beg question (K). That is, in considering any argument *in favor* of the possibility of time without change, nothing should be assumed that is obviously objectionable by any relationists (Le Poidevin 2010, 171). In particular, any argument that directly aims to show the possibility of time without change must not assume the truth of substantivalism.

3.2.2. Why not time without change?

Try to figure all the things at once: all the flying butterflies, together with the children chasing them, and all the planets and the particles in their staggering orbits, and all the tremendously energetic phenomena of the deep sky. Now try to imagine that all those things get trapped, for some time, in a worldwide freeze. The universe would be

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[137] Tr, in Cajori 1946, 6.

immersed in total darkness and immobility, while time continues to elapse, undisturbed. At first glance, this undoubtedly feels like an odd scenario, but is it impossible?

There are at least two facts which makes it difficult to conceive of this scenario as possible. First, whenever we realize that some time is elapsing, this is always because some change is occurring. Second, we can directly measure how much time has elapsed between two events only by means of a specific kind of changes: allegedly regular movements (e.g., celestial revolutions or the motion of the clock hands). The *Inconceivability Argument* (**IA**) appeals to the first fact, the *Measurability Argument* (**MA**) appeals to the second fact, the *Verificationist Argument* (**VA**) appeals to both.

Let us start by the IA. Sometimes, those who oppose temporal vacua claim that they are *logically* impossible in so far as they are *inconceivable*. If we follow Newton Smith, we may stipulate that 'inconceivable' here must mean something different from logically inconceivable, otherwise there would be no argument here, but a mere tautology. Plausibly, the best interpretation one could give to the term is the following: something is inconceivable if, and only if, it is impossible to imagine what it would be like to experiencing it (Newton Smith 1984, 18).

Given this interpretation, as said, an early and important occurrence of the inconceivability argument can be traced back to Aristotle's *Physics*:

> If, then, when we do not mark off any alteration, […] it happens as a consequence that we do not think there was any time and if when we do perceive and mark off [an alteration], then we do say that some time has passed, then it is manifest that there is no time apart from change and alteration.
>
> (*Physics*, 218b 30)[138]

Here Aristotle is basing his reasoning on the above-mentioned consideration that if we would go through a temporal vacuum, we would certainly not notice it. Suppose, for instance, that the universe were to freeze for ten minutes tomorrow, just when a driver is going to brake their car abruptly having seen a reckless kitten crossing the road. Unluckily, the freeze would not give ten extra minutes to the driver to think about how to save the cat's life: they would have to take a decision as quickly as if the universe had

[138] Tr. in Hussey 1983, 43.

not frozen. The reason for this is that the mere awareness of experiencing that time is elapsing would entail by itself a change in the mental state of the subject, so that experiencing something during a temporal vacuum, including something *as* a temporal vacuum, is logically impossible.[139] If this is correct, goes the proponent of the IA, then temporal vacua are inconceivable, which in turn entails that they are logically impossible.

In fact, even if there is in principle no way of experiencing a temporal vacuum, this clearly does not entail, *by itself*, that a temporal vacuum is logically or even physically impossible, so that the IA is not a valid argument. The same kind of consideration can be offered in response to the alleged temporal vacua's confutation that was proposed by Leibniz in the *New Essays*:

> If there were a vacuum in time, i.e. a duration without change, it would be impossible to establish its length. It follows from this that […] we could not refute anyone who said that two successive worlds are contiguous in time so that one necessarily begins as soon as the other ceases, with no possible interval between them. We couldn't refute him, I say, because that interval is indeterminable.
>
> (New Essays II. XV)[140]

Here Leibniz is highlighting the above-mentioned fact that, since the length of every interval of time is measured through changes, there is no possible mean of determining the length of a temporal vacuum, during which, by definition, nothing changes. But Leibniz seems to take this to entail that an *extended* vacuum would necessarily have an *indeterminate* length, which in turn would entail that it cannot elapse.[141]

On such interpretation, again, the inference is not granted. First of all, it may be the case that an extended interval *must not* have an objective specific length, so that a period of time with an indeterminate length may elapse (3.3.2.). Second, if an interval, in order to elapse, *must have* an objective specific length, then how do we know that this is not the case for the vacuum in question? As in the case of Aristotle's brief

139 For a similar reconstruction of Aristotle's argument, see Le Poidevin 2003, 17–18.

140 Tr. in Remnant and Bennett 1996, 62.

141 For a similar interpretation of Leibniz's argument see Le Poidevin 2003, 24–25.

rejection of temporal vacua, where the mere impossibility of *experiencing* a vacuum was supposed to entail the impossibility of the vacuum itself, here it is suggested that the supposed impossibility of *measuring* a vacuum's length entails, by itself, that the vacuum does not have a specific length. However, it could be the case that the vacuum *does* have a specific length, independently of the alleged fact that there is no possible means to measure it.

In order to be valid, the arguments suggested by Aristotle and Leibniz's passages need a conceptual connection between the possibility of acquiring evidence about a temporal vacuum (whether about its length or about how is it to experience it) and the possibility of the vacuum's itself to be provided. This task could naturally be performed by some version of the *verificationist principle* of significance. In general terms, verificationism is the theory that allows a sentence to have a true value *if, and only if*, the sentence can be verified. Depending on the kind of possibility that is at hand and on the selected *criteria* that the verification practice should accomplish, one can generate different varieties of the theory (and of the associated principle of significance). The stronger the principle of significance is, the more sentences are ruled out as having a truth-value.

Verificationism was adopted, of course, within the tradition of logical positivism and has been subsequently brought back on the map by Michael Dummett.[142] Within this kind of framework, a stronger argument against temporal vacua, the VA, can be phrased in the following terms: as Aristotle noted, it is logical impossible to experience a temporal vacuum; moreover, there is no possible empirical observation that could support the conjecture that the universe has (or has not) been frozen for a period of time, say, this morning; for the conjecture would not entail anything with respect to what we can observe *after* the period (it does not make any difference how much the vacuum is assumed to endure). But since contingently true conjectures can be verified only if their being true makes some difference in what we can experience (now or at some later time), we ought to conclude that conjectures about temporal vacuum are in fact meaningless. Therefore, it cannot be true that is possible for a temporal vacua to elapse.

[142] See Dummett's collection of paper *Truth and Other Enigmas* (1978), in particular the papers *Truth* (1959) and *The Reality of the Past* (1969).

The VA may be particularly tempting for classic relationists. An attractive feature of the relationist programme is that within the relationism framework, is possible, in principle, to rephrase every talk about temporal items into a meaning-equivalent talk about things in time.[143] The attractiveness lies in what follows: since temporal items are somehow mysterious entities, plausibly incapable of causal interaction, being able to rephrase every talk about temporal items into a talk about things in time *that are capable of causal interaction* (such as events) is useful especially if we wish to endorse some causal theory of reference in order to account for the meaning of the terms that we use to refer to temporal items (Le Poidevin 1993, 152). However, in the case of expressions referring to temporal vacua, such as 'one year of global freeze', such a rephrasing seems problematic for the classic relationist, for, as said, they take one relatum to follow another as objects change their properties (3.2.1.). But if the verificationist argument successfully establishes that talks about vacua are meaningless, then the problem of how to translate temporal vacua's talk does not arise.

How to answer the VA? One way is to deny that the notion of a temporal vacuum is actually devoid of empirical content, claiming that there are possible situations in which the hypothesis that the universe has been frozen for some period *could* be confirmed by later observations and therefore could make some difference in what we can experience. If such a counterexample exists, the verificationist argument would fail. In 1969, Shoemaker published an influent paper that provided such a counterexample. In the paper was described a possible world, W, in which the inhabitants would have good reasons to support the hypothesis that a temporal vacuum has occurred. W is divided in three spatial regions. The observational data available to the inhabitants of W suggest them that each of the regions is sometimes subjected to a local freeze: all the processes in the region, it appears from the outside of it, come to a halt for a period of time and the region itself becomes inaccessible. When the freeze ends, every process in the region restarts as if nothing happened there (and indeed it did not) and none of the inhabitants of the region will report to have experienced or

[143] As a matter of fact, when we refer to some moment or period of time, we normally point at it by mentioning some event which occurred *at* that moment or *during* that period. For instance, I could name this very moment as the moment in which I digit the letter 'f' on the keyboard.

measured the freeze, so they rely on the testimony of the inhabitants of the other regions in order to come to believe about their own local freezes.

Through collaboration, the inhabitants of W are therefore able to find out that local freezes of different lengths for each region happen at regular intervals, and that all freezes always last exactly one year (measured from the unfrozen regions). Given the observed frequencies of the local freezes, they calculate that *global freezes* should also occur with a certain frequency: these are periods of time during which no change happens anywhere in W. Precisely, the global freezes will occur when all the three regions of W happen to be frozen simultaneously. Now, argues Shoemaker, if we suppose that the extrapolated pattern of frequencies will remain in accordance with further observations of the local freezes, we can say that the inhabitants of W are justified in holding that global freezes occur.

Shoemaker's argument has been sometimes misunderstood. For instance, Matteo Morganti has claimed that the aim of the argument is to show that, since global freezes do not logically entail that time stops, time can pass without change (Morganti 2016, 80). The same is stated by Corish, who claims that Shoemaker's argument is question begging since he assumes what he wants to prove: the possibility of changeless time. Instead, goes on Corish, Shoemaker has only proved that *if* changeless time is possible, then a situation such the one described by his thought experiment is possible (Corish 2009, 221). To my view, this is exactly the purpose of Shoemaker's argument. The structure of his paper is indeed designed to defend the logical possibility of temporal vacua, but *specifically from a verificationist attack*. And the verificationist, for the sake of their argument *does* assume the possibility of vacua. In the first part of the paper, Shoemaker writes that

> Of course, the fact that people might have good reasons for thinking that something happens does not prove that it is logically possible for that thing to happen; […] but I think that the sorts of grounds there could conceivably be for believing in the existence of changeless intervals are such that no sound argument against the possibility of such intervals can be built on a consideration of how time is measured and of how we are aware of the passage of time.
>
> (Shoemaker 1969, 368)

Shoemaker here refers to Aristotle's observations about the impossibility of being aware that there is a vacuum going on during the vacuum itself, as well as to the fact that a temporal vacuum could not be directly measured. His claim is that, being his point successful, no argument for the impossibility of vacua can be built on these premises. That is, neither with the help of a verificationist principle of significance. However, if the verificationist point is the only reasonable ground to reject the possibility of temporal vacua, then the success of Shoemaker's argument would also be conclusive for the case of such a possibility.

Shoemaker's argument suffers, however, of a series of problems, the first of which is the very nature of local freezes. In particular: which kind of evidence could be available for the happening of local freezes? Their very nature entails that all kinds of interactions with the frozen regions are impossible, so that, form the outside, these regions could not be observed to be frozen by means of any type of observational tool (Morganti 2016, 79). The inhabitants of the unfrozen regions would rather have the impression that a specific part of their universe has suddenly disappeared (Benovsky 2012, 765). Of course, they can always reconstruct the local freeze's occurrence indirectly, based on the available evidence. However, this detail is more problematic for the argument than it may seem at first sight: if the inhabitants of W have evidence for the existence of temporally invisible (frozen) regions, maybe they are not so legitimated, as Shoemaker claims, in extrapolating the periodic occurrences of global freezes from the periodic occurrences of local ones. Indeed, they cannot easily rule out, for example, that there is a fourth region in their universe which unfreezes whenever the other three are simultaneously frozen.

A serious attempt to show that Shoemaker's argument is unsound has been made by the relationist Ken Warmbrōd (2004). His contention is as follows: for the inhabitants of Shoemaker's universe, it is actually *unreasonable* to believe that there are global freezes (Warmbrōd 2004, 270). First, Warmbrōd claims that Shoemaker cannot appeal to considerations of general methodology, such as requirements of simplicity: even if the predictive functions pertaining to the global freezes-theory are in fact simpler than the predictive functions of some theory that assumes exceptions in the regularity of the local freezes, this advantage would be outweighed by the need of positing an unobservable theoretical entity such as global freezes. That is to say, mathematical simplicity would be outweighed by conceptual complexity (Benovsky 2012, 765). Moreover, the termination of the freeze would remain, for the inhabitants of W, a mystery "insoluble and unnecessary" (Warmbrōd 2004, 273)[144], so that the assumption of unobservable temporal vacua would actually have less explanatory power than a more mathematically complex theory which does not incorporate this assumption. The inhabitants of Shoemaker's universe should therefore avoid postulating temporal vacua: it is more reasonable, for them, to explain the data assuming only local freezes.

Morganti has recently responded to Warmbrōd's paper, arguing that its conclusion is questionable (Morganti 2016, 84). The author brings up two points that should represent a challenge to Warmbrōd. First, an epistemological point: appealing to pragmatic virtues, such as the theory's simplicity, is generally problematic. There is no uncontroversial way to quantify these virtues, so that Warmbrōd would not have real support for its claim that Shoemaker's inhabitants would provide a more *complicated* explanation in terms of temporal vacua than in terms of exceptions of the regularity of local freezes. Second, and more importantly, even if methodological considerations could show that the inhabitants of Shoemaker's universe are not really justified in postulating global freezes, still their universe does not seem to be internally incoherent, so that we should consider it, writes Morganti, a real possibility (Morganti 2016, 85).

I personally do not find Morganti's answer to Warmbrōd convincing. First of all, his general methodological point could be answered by invoking the fact that Shoemaker himself had to call for simplicity (Shoemaker 1969, 373). Moreover, Shoemaker's argument was not meant, as we already mentioned, to be a positive proof of vacua's logical possibility. Instead, he argued that the inhabitants of W have good reasons to postulate global freezes in order to undermine a verificationist attack, namely the VA, so that if such alleged good reasons are not that good after all, the argument would miss its purpose. Warmbrōd's criticism could be, therefore, more compelling than what Morganti thinks.

However, the days when verificationist theories of meaning were ruling unchallenged are now over. And once the verificationist principle of significance is abandoned, we do not really see any outstanding reason to think that assertions about

[144] For more discussion on how a temporal vacuum may end, see 3.4.

temporal vacua are meaningless. *Prima facie,* we seem to be able to easily grasp what we talk about when it is said that this morning the universe could have been totally frozen for some time. The onus of proof stays, therefore, on the side of those who want to show that the opposite is true and that in fact such a speech is mere nonsense.

An attempt on this direction has been made by Henrik Zinkernagel. In his paper *Did time Have a Beginning* (2008) he claimed for the validity of a principle of significance for temporal expressions that he labeled '*Time-Clock Relation Principle*' (TC):

> **TC**: there is a logical (or conceptually necessary) relation between 'time' and 'a physical system which can serve as a clock' in the sense that we cannot—in a well-defined way—use either of these concepts without referring to (or presupposing) the other.
>
> (Zinkernagel 2008, 240)

On the base of this principle, he argues that there is no possible meaning for time during Shoemaker's freezes:

> Candidates would include 'time is what a clock would have measured had the world not been frozen'. But since, by hypothesis, no clock can operate 'during' a total freeze, the only option for explicating this counterfactual definition seems to be to appeal to other (nearby) possible worlds in which no total freeze (but only, say, an almost total freeze) is taking place. However […] it is questionable whether times in different possible worlds can be identified.
>
> (Zinkernagel 2008, 242)

It is not clear, by Zinkeragel's work, what 'no clock *can* operate 'during' a total freeze' should mean in this passage. In my view, Zinkeragel's presupposition is that, within Shoemaker's thought experiment, it is *at least physically* impossible for a clock to run during a global freeze. For otherwise, according to his own principle of significance (TC), one could meaningfully talk about a total freeze during which it was *physically possible* for some event to happen.

If my interpretation is correct, then Zinkernagel erroneously understood Shoemaker's thought experiment. For the actual occurrence of a global freeze, in Shoemaker's intentions, did not require the physical impossibility of change during the freeze.[145] It must be underlined, however, that if we take the occurrence of some kind of change as allowed by the laws of nature *during an elapsing vacuum*, this, according to some authors, would require indeterminism to be true (Le Poidevin 2010, 176). By contrast, if determinism is true (and if temporal vacua are possible), then nothing during an elapsing vacuum could change.

This seems plausible. I take the term 'determinism' here to indicate the thesis that, given a specified way things are at an instant, the way things go thereafter is fixed as a matter of natural laws (Hoefer 2016, 1), while indeterminism is the negation of determinism. Now, given determinism, and given the state of the whole universe at some time in between a vacuum, we can say that, at that (vacuum) time, it was (physically) necessary for the universe to be, at some future (vacuum) time, in the very same state. That is, given determinism, then *as long the vacuum endures*, it was physically impossible for something to change.[146]

Therefore, it seems that the postulation of a temporal vacuum does not, *by itself*, require to postulate the physical impossibility of change during vacua: only determinists are committed to such a view. It is not clear why, then, in Zinkernagel's view, we should not be able to understand what 'a one-year global freeze' means. Indeed, given TC, it follows that both the meaning and the existence of time depend on the *existence* of at least a *physically possible* physical system undergoing change (Zinkernagel 2008, 241). It seems evident, therefore, that according to his own principle of significance, Zinkernagel cannot exclude that we can meaningfully talk about a temporal vacuum during which it was *physically possible* for some event to happen.

In conclusion, it seems that an effective argument for the meaninglessness of vacua is missing. However, it remains alive the wonder about their logical possibility

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[145] This point is made by Newton Smith (Newton Smith 1984, 45).

[146] Notice that this does not entail that, given determinism, nothing during a vacuum could *never* change. The laws of nature may well work so that, given the state of the universe at some time during a vacuum, the universe is physically necessitated to be in a different state at some time *after* the vacuum.

and all the arguments shaped along Shoemaker's lines do not help.[147] As Roger Teichmann underlined, even if we accept that there could be, in principle, inductive reasons to believe that sometimes temporal vacua occur, it is not a rare situation to possess inductive reasons of some incoherent conjecture. He gives the example of someone who, finding reported many times the wrong result for some complex mathematical calculation, will believe, on inductive basis, in something contradictory. Logical impossibilities are not always evident. Given that the concept of temporal vacua is a suspicious one, the onus of proof for the *logical possibility* is, this time, on the side of who wants to claim it. What is needed is a positive argument for the possibility of time without change.

3.3. Vacua's possibility: an *a priori* argument

In what follows, I will therefore leave aside epistemological concerns and continue to discuss the possibility of vacua as a purely metaphysical issue. An interesting *a priori* argument for vacua's possibility has recently been given by Le Poidevin (Le Poidevin 2010). His paper has not received great attention so far, and it is worth it, therefore, to look at the details. The argument is offered in three steps, so that it is appropriate to name it 'Three Steps Argument' (TSA). In the next section I present the argument while in section 3.3.2. I consider its criticalities.

3.3.1. Three steps towards vacua

Step one of the TSA sets out the main assumptions and concludes for the possibility of a world where there is just something unchanging. The main assumptions are borrowed entirely from Thomas Baldwin's 1996 paper *There might be nothing*, where the author offers an argument in favor of the possibility of a world in which there is no contingent object (Baldwin 1996, 232).[148] They are stated as follows:

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[147] Arguments of this kind can be found in Newton Smith (1984, 20–25).

[148] Other authors have argued that is impossible for there to be nothing (Lewis 1986, 73; Armstrong 1989, 93; Lowe 1996: 118). However, how one answers to the question "could there be nothing?" fundamentally depends on one's approach to the metaphysics of modal concepts such as that of possible world. For example, if we define, with Lewis, a possible world as a maximal mereological sum of spatiotemporally related things, then there is no empty possible world. This is because mereological sums

Main assumptions of Three Steps Argument (**TSA**)

(23) There might be a world with a finite domain of concrete objects.

(24) These concrete objects are, each of them, things that might not exists.

(25) The nonexistence of any of these things does not necessitate the existence of any other thing.

Here goes Le Poidevin's (first step) argument: given (23), there is a possible world, W, that contains a finite number of objects. Additionally, it is assumed that one and only one of these objects, let us label it 'frozen-o', is *intrinsically unchanging* for a period, i.e., unchanging in respect of all its *intrinsic properties*. Here, standardly, a property is said to be intrinsic to an object if, and only if, the instantiation of that property is independent of other objects having or lacking their properties (including the case of some object losing all its properties by ceasing to exist). Now, let us label a different object that belongs to W as 'unfrozen-o'. By premise (23), we know that there is a possible world, W_1, that is accessible from W and that contains all the objects of W, except for unfrozen-o. In accordance with (24), the subtraction of unfrozen-o does not force us to postulate the existence of any new object. Given that, by iterating the procedure of subtraction for all the objects that are not frozen-o, we end up, in a finite number of passages, with a logically possible world, let us call it **LW**, that only contains frozen-o. More importantly, it contains frozen-o *in its unchanging state*. This straightforwardly follows from the definition of 'intrinsic property' seen above: since frozen-o's intrinsic unchangelessness is independent from whatever happens to other objects, the subtraction of any those objects cannot entail that frozen-o is now undergoing some kind of intrinsic change. And given that frozen-o is the only object that exists in LW, this world as a whole must be unchanging.

Le Poidevin resorts to Baldwin's work in order to justify the three main premises. To see if they are reasonable, we must first specify under what conditions an object can be said to be *concrete*. Usually, medium-sized objects such as ravens or

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are aggregates of concrete things and we cannot have such an aggregate out of nothing. But if, for instance, we understand, with van Inwagen, a possible world as a complete specification of a way in which the collection of all individuals might be, then we can conceive of the possibility of having an empty world. A way the universe might be is to be just empty.

writing desks are taken to be paradigmatic examples of concrete objects, while things like numbers would count as abstract. However, there are just too many ways in which a number can differ from a writing desk. So again, what are the conditions under which an object can be said to be concrete? It certainly cannot be simply by not being a number, for even if there was an uncontroversial account for the nature of numbers, we demand to apply the criterion of distinction to things others than numbers. Baldwin's proposal (Baldwin 1996, 232) is that we should adopt the following characterization: an object is concrete if it fails to satisfy some version of Leibniz's *Principle of the Identity of Indiscernibles* (**PII**).[149] That is, there can be two concrete objects that share all the relevant properties so that they perfectly resemble each other, while there cannot be two such abstract objects.

The reason for this, according to Baldwin, is that concrete objects, unlike abstract ones, are always in space-time, so that one can always appeal to the property of being located at certain space-time coordinates in order to distinguish between perfectly resembling concrete objects. It must be said, however, that this is not an uncontroversial characterization of concreteness. Let me mention, on this regard, a couple of well-known points raised by Lewis. First, Lewis observed that the (distinct) unit sets of two perfectly resembling concrete objects, which we should consider as abstract entities in themselves, would be perfectly resembling (Lewis 1986, 84). Second, Lewis suggested that such unit sets would be in space-time as well, located where the individual objects are (Lewis 1986, 83). Being aware of the existence of similar problems, Le Poidevin chooses not to rely on Baldwin's definition of concreteness. Rather, he takes (24), the claim that the concrete objects are things that might not exists, to be the very *definition* of concrete objects (Le Poidevin 2010, 174). In this view, we can interpret (23) as the claim that there might be a world with a finite domain of objects that might not exist.

Premise (23) seems reasonable. In order to deny it, one must hold that there *has to be* an infinite number of concrete objects, which is a rather strong claim. One way to reach this result would be to argue that matter *must* be infinitely divisible. However, contemporary physics does not go in the direction of describing matter as infinitely divisible, so that it *might* at least be true that this is not the case (Le Poidevin 2010, 175). Or, perhaps, one could regard regions of space-time as concrete objects that might

[149] For a statement and more detailed discussion on the principle, see 3.3.2.

not exist (where ‘exist’ has to be interpreted, here, in the same way as when it is said that “abstract objects must exist”) *and* argue that space and time *must* be infinitely divisible. Both claims (especially the categorization of space-time regions as concrete objects) would be very hard to defend. Either way, it seems to me that, if the discussion were to go in this direction, it would be rather unfruitful.

Let me explain: as seen (1.2.1.), when it comes to transfinite numbers, the subtraction operation does not give definite results. This fact may ultimately explain why both Baldwin and Le Poidevin assume a *finite* domain of objects: to subtract is the aim of their arguments. However, that subtraction does not give definite results does not entail that it is impossible to subtract elements to infinite sets (or collections). Moreover, as I claimed in Chapter 1, if one has to subtract (or add) an infinite number of elements, and such a subtraction (or addition) has to happen one element at a time, then “all” is need is an infinite number of times (1.3.2.). But if such successive subtraction of infinite elements is not impossible, then a slightly different argument from the TSA could be given in order to avoid commitment to *finite* domains of concrete objects, so that the discussion may well avoid focusing on critics concerning the possibility of finite domains of concrete objects.

As for what concerns premise (25), the claim that from the non-existence of any of these concrete objects does not necessarily entail the existence of any other thing, this premise just follows from the standard characterization of the intrinsicness of a property introduced above.

So much for what concerns the justification of the main assumptions and the first step of the argument. Step two is then devoted to the task of legitimating one further assumption that has been implicitly endorsed in step one: the existence of frozen-o. Frozen-o’s postulation presupposes that there is a region of space where no intrinsic change happens for a period, or, in Shoemaker’s terms, a local freeze. But what allows such a postulation? After all, as said, local freezes can be charged of being impossible as well as global freezes.

Le Poidevin argues that, by an application of the combinatorial principle, we can easily see that “there is nothing in logic to constrain any particular temporal ordering of property instantiations” (Le Poidevin 2010, 175). Let us consider, in the case of discrete time, an object that remains unchanged with respect to all its intrinsic properties, except for the fact that it is oscillating among having an intrinsic property A and an intrinsic property B, so that it instantiates A in t_1, B in t_2 and again A in t_3. There would be no contradiction in supposing that the object, instead, could have instantiated A in t_1, again A in t_2 and B in t_3. As a matter of fact, all the properties instantiated by the object in t_1 are compatible with A, and the object, by hypothesis, instantiates the very same properties in t_2. It seems, therefore, that the logical possibility of local freezes should be granted.

In the third and final step of the TSA, Le Poidevin envisages a crucial objection to his argument. Let us concede that step one, together with step two, successfully shows that there is a logically possible world, LW, which contains just one unchanging object. The opponent of vacua's possibility can still ask: why should this world be a temporal one? Maybe, LW could exist only atemporally. Since the TSA's conclusion is that *time* without change is possible, this is a very serious objection. A reason to claim that LW is a temporal world must be found.

Where to start? The first thing that must be noticed is that, by the construction of the TSA, the structure of global freezes is determined by the structure of local freezes. In other words, one must characterize frozen-o's changelessness in the same manner both within W *and* LW. And since LW contains only frozen-o in its unchanging state, if this world is temporal ultimately depends on the structure of frozen-o's changelessness in W. Le Poidevin claims that, arguably, there are two ways in which frozen-o can be unchanging in W: either its state is the very same at all times (the object's state endures through time) or frozen-o passes through a series of qualitatively identical but numerically different states that are temporally ordered (the object's state perdures through time). Now, Le Poidevin's strategy is the following: it does not matter which of these two options the opponents of vauca's possibility will pick, they will have to admit, eventually, that LW is temporal.

Let us first consider what happens if one tries to characterize temporal changelessness in terms of enduring states. Let us label frozen-o's single state during the whole freeze as 'S' and, moreover, let us label a couple of times intermedium to the freeze as 't_2' and 't_1', where t_1 precedes t_2. What causes frozen-o's being S at t_2? A part of the causal explanation should plausibly include frozen-o's being S at t_1. However, those who think that time without change is impossible will say that t_1 and t_2, being different times, must entail different events, and surely these events cannot happen in the same spatiotemporal region of the unchanging frozen-o. Therefore, the causal explanation of why frozen-o is S at t_2 necessarily involves events that are not in the same spatiotemporal region of frozen-o or, one could say, that are *not local* to frozen-o (Dowe 2014, 23).

Le Poidevin writes that this "looks very odd" and with no further argumentation he closes the case: the opponent of vacua's possibility cannot go for the first option. But why is it odd? In fact, many theories of causation do exclude action-at-distance.[150] However, there are cases where locality is not taken as a constraint. Examples are regularity theories of causality (Humean approaches), where usually an event *x* is taken to cause an event *y* only if all *x*-type events are followed by an *y*-type event, so that the causal explanation for every *y*-type event *necessarily* involves events that are non-local to the *y*-type event. Of course, one could think that if we cut off all the causality accounts that, likewise with Humean regularity theories, do not allow for singular causation, i.e. causation between particulars, then locality should be granted. But this is not the case: there are in fact some formulations of the concept of singular causation that allow for cases where locality is violated (Dowe 2014. 24). However, even if we grant action at distance, it remains somewhat uncontroversial Le Poidevin's claim that "the dependence of a's being F at one time on a's being F at earlier time is something that is local to a" (Le Poidevin 2010, 177), so that there are reasons to think that frozen-o's changelessness should not be characterized in terms of enduring states.

Let us now consider the case where frozen-o's temporal changelessness in W is characterized in terms of *perduring* states. In this case, it is possible to distinguish between frozen-o's state S_1 at t_1 and frozen-o's state S_2 at t_2. These can play the role of the causal relata of our causal story: S_1 is (at least partly) cause of S_2. There is no need, here, to select as causal relata the relations among states and times rather than simply the states, as it was done in the previous case when the relata were of the form 'frozen-o being S at t_x'. In fact, since S_1 and S_2 are numerically different states, they already satisfy the common requirements of asymmetry and irreflexivity (2.2.1.). In this case, therefore, the causal relata are, so to speak, intrinsic to the object.

[150] Examples are Fair 1979, Dowe 2000 and Armstrong 2004.

What about the causal relation itself? Le Poideivin argues that, as long as we allow for singular causation, then causal relation should be intrinsic as well. His point is that the most common way of making causation extrinsic to relata is to reduce it to some kind of regularities (likewise with Humean regularity theories of causation). However, in doing so, singular causation gets lost. The conclusion, therefore, is that if singular causation is allowed, then the internal causal structure of an unchanging object is, in the case of perduring states, completely intrinsic to the object (Le Poidevin 2010, 177).

But, and this is the crucial point of the whole TSA, if frozen-o state of changelessness in W displays an internal causal structure, so it will frozen-o state of changelessness in LW. Or, in other terms, if local freezes have an internal causal structure, so do global freezes. But, concludes Le Poidevin, if there is a causal structure, then there is temporal structure. Therefore, describing frozen-o's changelessness in terms of perduring states, the supporter of vacua's impossibility would fall in contradiction with their thesis, and they should admit that LW is not only a world without change, but a world with time.

Contrarily to what it may seem *prima facie*, the moral of Le Poidevin's complex argument is a straightforward one: an unchanging object would have something, an internal causal structure, that it would still have were it the only existing object. And since causal structures entail time, this allows us to infer the possibility of time without change.

I personally do not think that the TSA is a conclusive argument. Surely, a flaw of TSA could be that the assumptions, however plausible, are ultimately many. There is therefore plenty of room to try to resist the argument, and this may eventually convey the discussion towards many questions that have (yet) no uncontroversial answer. Surely, however, the argument has at least three merits. First of all, it shows how those questions are connected with the metaphysical issue of the possibility of time without change. Second, the argument does not appear to be question begging: the defender of the impossibility of temporal vacua would not have any reason to refute, in principle, any of the main assumptions, nor the secondary ones. The third and more general merit, is that of underlying, once again, how, once agreed on some reasonable assumptions, it is not absurd to concede that time without change may be possible. This may seem trivial to the majority philosophers, but surely not to the majority of physicists.

3.3.2 Discerning identical ones during changeless times

Defenders of the KCA, on their side, could move an immediate criticism to the TSA: it is not clear, as Le Poidevin maintains, that the occurrence of a causal relation entails the occurrence of a temporal relation. Just think about their (problematic) claim that the cause of the first event must be timeless (2.3.1.). However, in the case of the TSA, the causal relation is assumed, in W, to occur between two states *in time*, so that one may avoid the criticism of the KCA's defenders by claiming, more cautiously, that, *at least when it comes to things in time*, the occurrence of a causal relation entails the occurrence of a temporal relation.[151]

What truly allows the inference from the occurrence of a *causal* relation between S_1 and S_2 in W to the occurrence of a *temporal* relation between S_1 and S_2 in LW is, here, the possibility of distinguishing *in LW* the two causal relata, the two states, and therefore the two times. Given this, it turns out that the most dangerous criticism to the TSA could be made on the basis of the PII (3.3.1.), which can be fully formulated as follows: for every property P, if *x* instantiates P if, and only if, *y* instantiates P, then *x* is identical to *y*.[152] On the basis of this principle, one could point out that we cannot distinguish between frozen-o's state S_1 at t_1 and frozen-o's state S_2 at t_2, because qualitatively identical but numerical different states are impossible. In fact, among Leibniz's motivations for disliking time without change there was his belief that there cannot be two numerically different items that are qualitatively identical, including times.

However, the principle thus formulated is a very general statement, and it must be specified, if not which items, at least which kind of properties are at stake. A distinction has been made at least between two versions of the principle: one stronger,

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[151] That two things are in time does not entail, by itself, that they are in a temporal relation. Think, for instance, to the case of branching time.

[152] In the symbols of a predicate logic language: $\forall P(Px \leftrightarrow Py) \rightarrow x = y$ where '=', the symbol of identity, is taken to represent a relation. That *x* is identical to *y* means, in this context, that some item is in identity relation with itself. We can indifferently label this item as '*x*' or '*y*'.

the other weaker (Quine 1976, 113; French 1989, 144; Armstrong 1989, 66; Forrest 2016, 2). According to the weak principle (**WPII**), the set of properties that needs to be considered restricts to *pure* properties, where a property is not pure if it is ultimately analyzed in terms of a relation to a *certain* particular. For example: being 200 meters apart from the Lunar Excursion Module is not a pure property, while being 200 meters from a lunar lander it is. The strong version of the principle (**SPII**), instead, restricts the principle to pure *and intrinsic* properties. WPII allows to discriminate two otherwise indistinguishable items, say two medium-sized perfectly resembling iron spheres, that possess at least one different relational extrinsic property such as being differently located with respect to a lunar rover. By contrast, SPII does not allow for such a discrimination. A bundle of pure and intrinsic properties cannot include relational extrinsic properties. Therefore, given the SPII, one cannot distinguish between two medium-sized perfectly resembling iron spheres even if they have different relational (e.g., spatio-temporal) extrinsic properties.

The availability of TSA clearly depends on the question whether the SPII is necessarily true. A positive answer would be inconsistent with Le Poidevin's (crucial) strategy in the third step: there could be no such thing as the two qualitatively identical but numerically different states of frozen-o. Luckily enough for the author's purposes, the SPII is very much vulnerable. If we ignore pseudo-properties such as *thisness*[153], there seems to be no inconsistency in the hypothesis that two numerically different things can have exactly the same intrinsic properties. This is the reason why the debate, since Leibniz, has pretty much focused on the contingent (rather the necessary) truth of the SPII, with still little fortune for those who have argued in favor of it (Armstrong 1989, 67; French 1989, 146; Forrest 2016, 4).

When it comes to evaluate the WPII, the thesis that any two particulars *must* have at least one different extrinsic property seems *prima facie* more plausible. However, Max Black (1952) has produced an effective counterexample. He considered a completely symmetrical universe that contains nothing but two exactly similar iron

[153] It has to be noted that including such properties would trivialize any version of the principle. However, a's thisness can be analyzed as *a being identical to a*, that is, as a relational property that refers to a particular. It does not count, therefore, as a pure property, and it is safely excluded by both the strong and the weak principle.

spheres at a certain distance in empty space. These two spheres would be indiscernible: not only they will have the same intrinsic properties (composition, diameter, temperature, and so on), but they will also share spatio-temporal extrinsic properties such as *being at a certain distance from an iron sphere*. If the description of this universe does not conceal a contradiction, then it is logically possible for two items to share all of their (pure) properties, and the WPII would not be a necessary truth. Against this line of thought, some have tried to defend the thesis that, in that scenario, there would not be two spheres, but only one. For example, it has been suggested that Black's universe would be better interpreted as containing only one sphere in a non-Euclidean space. However, these responses are usually vulnerable to criticisms, and the debate is still open.[154]

Would the necessity of the WPII undermine the TSA? This is not obvious. As seen, premise (24), the claim that concrete objects are things that might not exist (3.3.1.), could be justified by restricting some version of Leibniz's principle to abstract objects only. There is more than one way of doing this while granting the necessity of the WPII. More importantly, what seems to be at danger is Le Poidevin's third step strategy: according to the WPII, frozen-o could actually be in different states in the locally frozen world, since those states could clearly stay in different extrinsic relations with some changing object (maybe frozen-o in S_1 could be closer to some moving object than frozen-o in S_2). However, what could the two states possibly stand in different relation with in the globally frozen world? One may think that, according to the WPII, the two different states would "collapse" into one unique state in a possible world where all changing objects are missing, Le Poidevin explicitly answers this possible worry in a note:

> [The assumption of qualitatively identical states] is not, however, incompatible with the weaker principle that numerically distinct items are different in *some* respect, where this includes purely relational properties. In a period of time without change, successive states can stand in different relations to the first [or last] moment (if there is one).

[154] For an overview of the history of the reception of Black's counterexample and recent developments see Casati and Torrengo 2014 and Forrest 2016, 3–4.

(Le Poidevin 2010, note 3)

However, the serious objection that would come from the defender of the WPII is not so easily dismissed. For instance, Le Poidevin's answer may not be viable if the detractor is also a *conventionalist* concerning temporal metric.

Conventionalism holds that there is no objective fact of the matter as to what the ratio between the durations of two successive, non-overlapping periods of time is (Le Poidevin 2003, 6). The reason why conventionalists believe this, is that it seems impossible to know if such facts really exist. We can only evaluate whether two successive periods have the same duration by using a clock, and we can evaluate the clock accuracy in measuring time by reference to a standard clock. Finally, we can evaluate if such a standard clock is accurate by confronting how it measures times with copies of itself: the longer the copies stay in tune, the more accurate the clock (Le Poidevin 2003, 3). But nothing grants that clocks that stay in tune are truly accurate in measuring the *intrinsic* duration of times. Since we can only evaluate if two successive periods have the same length by reference to some change that *is taken* to be regular, the conventionalist concludes that whether such periods have the same length is, after all, a matter of convention.

Many conventionalists, then, would agree that the occurrence of change during a period of time is necessary for that period to have a (conventionally) determinate duration. If this is the case, a period of time without change could not have a determinate temporal duration at all, and therefore, *pace* Le Poidevin's answer, it would be impossible to grant the distinction between two qualitatively identical states during a vacuum by pointing out exactly how far each of those states is from the first or the last moment of the vacuum. Must we therefore acknowledge that, if we adopt the main claims of conventionalism about temporal metric, appealing to the WPII would allow us to resist the possibility of time without change?

This does not seem to be the case. Even if there was no *determinate* distance between each of the two qualitatively identical states and a first (or last) moment of the vacuum, still it could be *objectively* the case that one of the two states is temporally closer than the other to the beginning, or to the end, of the vacuum. To see this, consider the two states of frozen-o, S_1 and S_2, in the locally frozen world W. Suppose the local freeze, in this world, has a last instant. As seen, given WPII, we still can grant that S_1

and S_2 can be taken as different states because of the different relational properties that they have. Now, we do not need to define a temporal metric to allow the period between S_1 and the end of the local freeze to be longer than the period between S_2 and the end of the local freeze. This is because the two periods in great part overlap, their ends being simultaneous while their beginnings are not.[155] Since this fact holds independently of the temporal metric, it will still hold in LW, even if in such world we cannot define a temporal metric.

Conventionalism, therefore, does not provide a solid ground from which one can reject temporal vacua. One can agree with conventionalists that the occurrence of changes during a period of time is necessary for that period to have a (conventionally) determinate duration, and yet the duration of temporal vacua may still be somewhat *indeterminate* (may still have *some* objective length). Moreover, we may agree with conventionalists that there is no objective fact about the ratio of two successive, non-overlapping periods of time, and still claim that there is an objective fact about the ratio of two (distinct) *overlapping* periods of time during the vacuum. More precisely, if one period is entirely contained within another, the ratio between the two periods' lengths may be such that, while the individual length of each period is indeterminate, one period is longer, or shorter, than the other (i.e., ratio >1 or <1).[156]

On the other hand, it turns out that assuming that vacua can have determinate duration would make them unpopular between conventionalists. Since I wish to remain neutral on whether conventionalists are right or wrong, in formulating my proposal in

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[155] Recall that the distinction between the two states during a local freeze can be granted on other grounds.

[156] If this is correct, then it confirms, once again, that non-classic relationists can admit the possibility of temporal vacua. To see why, recall that, on the non-classic relationist view, one does not need change to build times out of relations. However, relationists still need to differentiate their relata. If a metric were needed in order to do so for (successive) *qualitatively identical* relata, then relationists would have a new kind of problem with vacua. Indeed, *prima facie* it seems that defining such metric without assuming any difference between the relata (under penalty of question begging) would require to specify times first, independently of their content. This, of course, is not an available option for the relationist. However, if a metric is not needed in order to distinguish (successive) qualitatively identical relata (for we can do it through overlapping periods with different lengths), then relationists may still grant temporal vacua.

Chapter 4, I will not assume anything that implies that the Primordial Temporal Vacuum, or parts of such a vacuum, have a determinate, or indeterminate, duration.

3.4. Time before change

If the criticalities of the TSA can be overcome as showed, then we can take it to be an effective argument. But even granted that time without change is possible, is it possible a period of time without change *before the first event*? That is, would the postulation of a Primordial Temporal Vacuum involve something additional, compared to the idea of a "regular" vacuum, which would make it unplausible? In the next brief subsection, I consider whether the fact that a PTV would have elapsed before *the very first* event, and not just any event, poses some problems for its possibility. In subsection 3.4.2. I then face the issue (crucial for this work) of how temporal vacua may, in general, end.

3.4.1. Time without things

Prima facie, the fact that the Primordial Temporal Vacuum is before *the first* event, rather than any other event, does not seem to have any relevance for the question of its logical or metaphysical possibility. Although Craig seems to disagree with this (Craig and Sinclair 2009, 192), his worry is actually directed towards a period of *empty time* before the first event. His point seems to be that, if the first event is the creation of the universe, then a temporal vacuum before the first event would be a period of time during which there is nothing (perhaps not even spatial regions). This, of course, would pose all sorts of problems.

For one thing, it would be much harder for a relationist to account for empty time than for temporal vacua in general. Indeed, if there is nothing, and if temporal relata do not exist independently of things in time, it becomes complicated to establish what could play the role of temporal relata, and perhaps only *modal* relationism (3.1.1.) remains available. Second, empty time is simply weirder than a period during which there are only changeless things. Therefore, given the constrains established in the previous sections, the burden of the proof would, *a fortiori*, lie on the side of those who were to defend it. However, no argument on the lines of the TSA could be provided in its favor, and, personally, I do not see what kind of argument could (nor am I aware of any such attempt).

But the first event, of course, must not coincide with creation. Thus, what about a period of time during which there are only changeless things? Is there something that makes it impossible for such a period to be before the first event?

3.4.2. Causality and the end of vacua

In the previous section, there has been free talk about temporal vacua having an end. This may raise some relevant questions in the reader. Can a vacuum end? Can some event/change follow a temporal vacuum? Strictly speaking, these two questions are not equivalent, for time may just come to an end with a vacuum. However, given that temporal vacua are possible, where the modality is logical, one could generally grant that it is *logically* possible for a vacuum to end by simply assuming that an event/change *can* suddenly happen uncaused right after a vacuum. There seems to be no contradiction directly entailed by this hypothesis. However, this would make the fact that a vacuum ended a *brute fact*, which, although not logically impossible, it is surely not ideal for those who wish to grant the possibility of an ending vacuum.[157]

There is then one more reason why conceding that a vacuum can end uncaused (where the modality is metaphysical) is problematic: one could think that the metaphysical principle (1)* met in Chapter 2, 'every event has a cause' (2.1.2.), is true as a matter of *metaphysical* necessity. Now, this thesis, admittedly, is odd. The epistemology of metaphysical modality is the subject of intense debate, and, after Kripke (1980), this debate has largely focused on the question whether all and only the a priori truths are necessary (Vaidya 2017, 3; Kment 2021, 3). In particular, Kripke's suggestion was that many necessary truths have the epistemic status of being *a*

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[157] It is not clear if Shoemaker could have granted that a vacuum can end uncaused. His argument, imbued with epistemological concerns as it was, was plausibly bounded to the hypothesis that local freezes are regularly caused to end by something in the non-frozen regions, which can be used, again, to argue that it is illegitimate for the inhabitants of Shoemaker's world to extrapolate the occurrence of ending-global freezes, given that, during those, there are no unfrozen regions (Shoemaker 1969, 375). I do not think the TSA suffers of a similar issue. Frozen-o's freeze in any world, be it LW or other possible worlds, may be just supposed to never end (in which case, only the beginning of the freeze would grant the numerical distinction between frozen-o's states) or to end uncaused. This surely would raise epistemological worries as well as conceptual ones, even concerning the notion of causality endorsed, but the argument seems not to be affected in its conclusion that temporal vacua are logically possible.

posteriori. Examples are statements of identity such as "Batman is Bruce Wayne" and "Water is H_2O" (1.2.1.). Now, the problem with (1)* is that, differently from these statements, it does not seem possible to establish its truth *a posteriori* (Mackie 1982, 85). However, (1)* shares this status with many metaphysical theses that are thought to be necessary if true. Moreover, it is quite dubious that neither (1)* nor many of such theses (think for instance of the PII) are *logical* necessities (3.3.2.). Given this, nothing, in principle, prevents one to defend the claim that it is metaphysically necessary for every event to have a cause.

It is therefore convenient, in the context of the debate on the possibility of time without change, to reserve some space to the question of whether a first change after a vacuum can be caused. More directly relevant for this work: if the only logically possible way in which a vacuum could end is by being followed by an uncaused event, then on the basis of the claim that it is at least metaphysically necessary for every event to have a cause, one can argue that a PTV is metaphysically impossible. Instead, if it is logically possible for something to cause an event after a vacuum, this argument would not be successful.

If we wish to assess whether something can cause an event "right after" a vacuum, we must first ask how an event may follow a vacuum "right away", that is, we have to spell out in which ways the very first event after a vacuum may be characterized. Let us suppose that an event E is the very first event after a vacuum. In order to simplify matters, let us also suppose that E happens in LW: frozen-o suddenly explodes after a (possibly indeterminately) long and lonely freeze. In 1.2.1. events have been defined as having a beginning at some particular instant. Let us name the instant at which E begins as t_0. In the case of discrete time, t_0 belongs[158] to E, while in the case of non-discrete time, t_0 may not belong to the event itself. Given this, I can see five ways in which E can be thought to happen right after the vacuum.

Let us first suppose that time is discrete. If we imagine a vacuum that endures for two of frozen-o's states, that is, the minimum numbers of states that may compose a vacuum, we can represent the first way in which E may follow the vacuum as follows:

(α) $\mathbf{A_{-1}}\ \mathbf{A_0}\ [B_1\Gamma_2]$

[158] In this context, I shall use the term loosely.

In the above schema, Greek capital letters signify frozen-o's states, square brackets indicate the states that make up E, difference between numbers in subscript text indicate numerical difference between states, difference in letters signify qualitative difference. Qualitatively identical states are also in bold. In (α), E begins with B_1.

However, one may object that, in (α), the very first event after the vacuum is not to be represented by [$B_1\Gamma_2$], for change occurs as well between A_0 and B_1. Therefore, one may be tempted to represent E following the vacuum in discrete time as follows:

(β) $\mathbf{A_{-1}}$[$\mathbf{A_0}$ B_1]

In (β), E begins with A_0. I tend to think that (β) is a valid way to represent an event right after a vacuum. According to the terminology of the work, [A_0 B_1], taken by itself, has all it takes to be called an event: it is a happening (an explosion) that takes some time, it entails change, it has both a beginning and an end. Moreover, no qualitative change occurs *during* the period during which A_{-1} and A_0 occur, so that it seems a proper vacuum.[159]

Let us now suppose that time is non-discrete, so that between any two states of frozen-o there is a third state. On this framework, t_0 may also belong to the vacuum, for there may be no first state of frozen-o within E. However, let us first consider the case in which t_0 belongs to E. Here, again, there are two ways in which one could represent E following the vacuum. If one thinks that, at t_0, it shall obtain a state that is already qualitatively different from frozen-o's states during the vacuum, they should go for a similar schema:

(γ) $\mathbf{A_{-1}}$**…**[B_0 … Γ_1]

Instead, if one thinks that the vacuum can "overflow" E, they will go from something like the following:

(δ) $\mathbf{A_{-1}}$**…**[$\mathbf{A_0}$…B_1]

[159] Nor the time at which E occurs, that is the period that goes from A_0 to B_1, is within the vacuum (if this were to matter).

I use '…' to signify infinitely many states non-discretely ordered marked by all the real numbers between the integers in the schema.

Finally, the case where t_0 belongs to the vacuum:

(ε) $\mathbf{A_{-1}}$**…** $\mathbf{A_0}$[…B_1]

On this schema, at E's beginning, t_0, A_0 obtains. However, A_0 does not belong to E. Notice that, in defining how E may follow the vacuum "right away", one must not consider the case where t_0 is between E and the vacuum. Moreover, it cannot be that there is no last state within the vacuum *and* no first state within E. That is to say, it cannot be that between the vacuum and E there is a *temporal gap*. Indeed, in such a scenario, no instant could be a proper beginning of E. In fact, the very reason why I think it is sensible to assume that any event must have a beginning (and an end), is precisely to avoid that two events (or an event and a vacuum) may temporally follow each other in such a way, for in this case one could rightly argue that two such events would not properly follow each other *temporally*. Rather, because of the temporal gap, they would belong to two disconnected timelines.[160]

Having seen how one may characterize frozen-o's explosion, it is now time to ask: can something cause it? The problems that arise when reflecting upon this question have already been encountered through this work. In fact, an argument on the lines of the SA met in Chapter 2 may be offered for a negative answer. The argument, that I label the *Second Sufficiency Argument* (**SSA**), goes as follows. Suppose E is caused and that, if so, then a sufficient cause C of E occurs during the vacuum that precedes E. According with the standard understanding of what a sufficient cause is (Benovsky 2012, 768), action at temporal distance has to be excluded. That is, premise (22) stated in Chapter 2 must be endorsed: there can be no times between the time at which a sufficient cause obtains and the time at which the effect obtains (2.2.2.). If then we further enquire in the nature of C, we realize that it must be a state of frozen-o that obtains instantaneously, for no event occurs during the vacuum. Therefore, in this case, the time at which the cause obtains will be an instant, while the time at which the effect

[160] Of course, one can say that $\frac{157}{50}$ *precedes* $\frac{1571}{500}$ in the series of rational numbers, although in between there is the gap that, in the continuous, would belong to π. However, one must not attach the exact same meaning to both numerical and temporal precedence.

obtains will be a period. Moreover, accordingly to how we characterized the vacuum before E, one must suppose that a series of states qualitatively identical to C but numerically different from it, occurred during the whole vacuum. Supposedly, then, frozen-o will have or instantiate the same causally relevant property at any of its "frozen states", so that the sufficient causal conditions for E occurred at any instant during the vacuum before E. Given that action at temporal distance is excluded, the argument goes, it is therefore impossible for E to begin when it began, at t_0, for any state of frozen-o *during* the vacuum might have already been sufficient to cause it right away, that is, before when it is assumed to begin. From this, by *reductio*, it is concluded that E cannot be caused.

Although this line of reasoning seems quite straightforward, on a careful examination one notices that the argument does not apply to all the scenarios described above. First of all, one must notice that, on scenarios (γ) and (δ), there is just no state during the vacuum that can be taken to be the external cause of E without violating (22), so that both scenarios could be excluded merely in virtue of this principle. Having said this, the SSA certainly applies to scenario (α). Here, according to (22), A_0 is taken to be the cause of [$B_1\Gamma_2$], and t_0 is the time of B_1. Moreover, in (α), the sufficient causal conditions for E were already available at the time of A_{-1}, so that, given (22), it was necessary for [$B_1\Gamma_2$] to begin at the time of A_0, that is, *before* t_0. Since there is at least one state before the cause of E that belongs to the vacuum, the same conclusion is reached on scenario (ε). However, this does not happen when one considers (β): since here there is no state that belongs to the vacuum before A_1, one cannot conclude that E must have begun *before* the time of A_0.

Authors who in the last decades have dealt with the issue of how a vacuum may end, seem not to have considered (β) as a possible scenario. Shoemaker, for instance, wrote:

> If we make the simplifying assumption that time is discrete, […] it is clear that the cause of the change that ends a total freeze cannot be, and cannot be part of, the state of the world in the immediately preceding instant. For the immediately preceding instant will have occurred during the freeze (will have been the last instant of the freeze), and since no change occurs during a total freeze the state of the world at that instant

> will be the same as its state at any other instant during the freeze, including the first one. If the state of the world at that instant were causally sufficient to produce a generically different world state in the immediately following instant, then the freeze would not have occurred at all, for then the change that ends the freeze would have begun immediately after the first instant of the freeze-and a freeze "lasting" only an instant would be no freeze at all.
>
> (Shoemaker 1969, 376)

Shoemaker here is working on the assumption that freezes, in discrete time, would have a first state, which in general must not be the case for temporal vacua. More to the point, Shoemaker claims that "the cause of the change that ends a total freeze cannot be […] the state of the world in the immediately preceding instant". This is because, if the state-cause at that instant was causally sufficient to produce a qualitatively different state in the immediately following instant, then the freeze would not have occurred at all. However, he fails to note that, since a change always occurs between at least two instants, in order for something to cause a change, it must not *straightforwardly* cause a qualitatively different state, as case (β) shows.

Newton Smith had clearly in mind Shoemaker's passage when he claimed that "admitting any case of a temporal vacuum will force us to modify certain well-entrenched beliefs about causality" (Newton Smith 1984, 28), More recently, Benovsky reiterated Shoemaker's point:

> What can cause a global freeze to come to an end? It cannot be a sufficient cause existing at the instant that immediately precedes the end of a global freeze, since this instant is qualitatively exactly identical to all of the instants that are part of the freeze, and consequently, if it contained a sufficient cause for ending the freeze, the freeze would not last more than an instant — that is, there would be no freeze.
>
> (Benovsky 2012, 766)

Here, again, the idea that a freeze may end with an event that begins at the last instant of the freeze has not been considered by the author.

However, if this is possible, then the SA given by the defenders of the KCA is invalid. Indeed, the argument, presented on the very lines of the SSA, suffers of the very same problem: together with the main premises, it takes the claim that a changeless state-cause obtained at all times previous to its effect, the first event, as sufficient to deduce a contradiction: that the first event must have begun before when it began (2.2.2.).

Of course, one may think that (β) is not logically possible after all. One reason goes as follows: if the sufficient causal conditions for the occurrence of E are still present at the first instant at which E occurs, then B_1 cannot follow Γ_0. That the modality at stake here is logical, though, is far than obvious to me. After all, causes are not usually taken to *logically* entail their effects. Perhaps, though, one could argue that (β) is *metaphysically* impossible.[161] This, together with the SSA, would lead again to the conclusion that the caused-occurrence of an event after a vacuum is impossible.

Since the SSA is strictly analogous to the SA encountered in Chapter 2, analogous are some of the remaining options for escaping this conclusion:

(i) C did not occur during the vacuum.

(ii) There is causal action at temporal distance.

(iii) C is not *sufficient* cause of E.

There is then a fourth option that has been considered in the literature:

(iv) During the vacuum, there was a change in the causally relevant properties of frozen-o.

I must say something more about each of these options.

The reader should, at this point, have already in mind at least three ways of implementing (i): simultaneous causality, backward causality or causal loops, and timeless causation. In Chapter 2, I showed that these options require a heavy revision of the standard notion of causality. Moreover, as for timeless causation, I doubted whether there is a coherent way of formulating it (2.2.1.; 2.4).

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[161] In doing so, however, one must be careful to hold that an event (metaphysically) cannot begin at a vacuum's instant, for otherwise (δ) and (ε) would be excluded as well, where (ε) is a standard way of conceiving a period of change contiguous with a vacuum. See Prior 1968, 139.

As for (ii), Shoemaker himself considered the possibility of sufficient causality at a temporal distance (Shoemaker 1969, 378). For instance, the first change that happens after a vacuum may be caused by something that happened before the vacuum. However, Shoemaker rightly noted that this kind of causality is perhaps logically impossible: the very definition of 'sufficient cause' should entail the denial of action at temporal distance. To see why, consider the following: if there were some time between the occurrence of a sufficient cause and its effect, then it seems that the cause could not be sufficient, for the would be time in which the occurrence of the effect could be *prevented* by the intervention of a third factor (Le Poidevin 2003, 227). Of course, these considerations are not conclusive, and one may find a way to treat sufficient causality at temporal distance. Still, path (ii) seems particularly hard.

Option (iv) seems to be favored by authors discussing the problem of how vacua can possibly end. The suggestion is the following: in order to allow temporal vacua to have an end, the best one can do is to take something's "having been in a state of a global freeze for a certain amount of time" as causally sufficient for some event to happen. Newton Smith named this kind of causality '*duration causality*' (Newton Smith 1984, 33). According to Shoemaker, allowing duration causality would amount to admit that change in fundamentally tensed properties has a role in causal explanations (Shoemaker 1969, 37). For this reason, he admits that his fantasy world would be even more radically different than what would seem *prima facie*, for, as seen (3.1.1.), we usually do not take change in this kind of properties to be causally efficient. However, as Benovsky rightly noted, duration causality does not necessarily *entail* change in fundamentally tensed properties (Benovsky 2012, 769). That the amount of time elapsed during a vacuum is causally responsible for the end of it can be interpreted, for instance, in terms of some temporal relation occurring between the last vacuum's state and the beginning (or the end) of it, where changes with respect to temporal relational properties is, as seen (3.2.2.), allowed during vacua.

It remains, true, however, that duration causality is, in general, not likely to be mentioned in any causal explanation. As Newton Smith (1984, 34) observed:

> We do not take seriously the suggestion that the mere passage of time is causally relevant to anything. If some object changes its state after having been in that state for some period of time, *t*, we would not think

> that its having been in that state for that period was causally sufficient for it to change. […] Duration causality […] is excluded ab initio as we cannot see how the mere passage of time could bring about a change in the state of the system.

Although Newton Smith's observation is undisputable, it is not straightforward *why* duration causality looks unpalatable. Take the case of an egg that, left in hot water for six minutes, is cooked. It is unlikely that someone would take seriously the idea that the amount of time elapsed, rather than some underlying process, is the cause of the egg being cooked. However, if we were to observe that *every time* we leave an egg in hot water for six minutes it cooks, we *could*, in principle, attempt to corroborate the hypothesis that the cause of the egg being cooked is the amount of time elapsed by checking whether the output changes by applying certain variations on the experimental set-up. This way, we could exclude that some underlying process, *rather* than the amount of time elapsed, is causally responsible for the change. It seems, therefore, that hypotheses on the causal efficiency of temporal relational properties are not impossible to corroborate. This is why Newton Smith talks of exclusion *ab initio*.

Perhaps, the best one can say, with Le Poidevin, is that (gaining or losing) temporal relational properties may be causally inefficient *because* they (more precisely, their *tropes* or instantiations) miss a precise temporal location (Le Poidevin 2007, 102). Be as it may, it seems entirely *ad hoc* to allow temporal relational properties to be causally efficient just in order to allow ending vacua, especially given that more options are on the plate. On the one hand, indeed, ways of implementing (i) are currently explored in other contexts (2.4.). On the other hand, (iii) has not received attention in the literature on time without change, and yet it *also* does not entail the postulation of *ad hoc* causally efficient temporal relational properties.

According to option (iii) the state-cause of the first event after the vacuum, C, which occurs during the vacuum, is conceived to be necessary but not sufficient for the occurrence of the first event after the vacuum, E. Since C is not sufficient for E, one may think that there are no reasons to exclude action at temporal distance, that is, to adopt (22), so that C may be either contiguous with E or not. However, I think there are reasons here why we should conceive C as contiguous with E that are independent on whether C is thought to be sufficient for E.

Suppose, for the sake of simplicity, that time is discrete, and that E follows the vacuum in the way illustrated by (α) above. Suppose that C is necessary but not sufficient cause of E and that it occurs during the vacuum. More precisely, suppose C is $\mathbf{A}_{-1}$, so that it causes E directly at some temporal distance. Since some time without change elapses between $\mathbf{A}_{-1}$ and the beginning of E, during this time the necessary but not sufficient conditions for E's beginning at the same temporal distance still obtain. More precisely, if at the time of $\mathbf{A}_{-1}$, t_{-2}, there were the necessary conditions for directly bringing about E after two instants, that is, at t_0, then at time of $\mathbf{A}_0$, t_{-1}, there were the necessary conditions for directly bringing about E at t_1. Question: is it possible at t_0 for E to begin at t_1? On the one hand, it seems it is not, since at t_0 E already began. On the other hand, given the nature of E, it seems that at t_0 is necessary for Γ_2 to occur at the time of Γ_2. But we assumed that $\mathbf{A}_0$, as well as $\mathbf{A}_{-1}$, although not necessarily, it causes its effect *directly* at temporal distance. This may be interpreted to mean that, by obtaining at t_{-1}, $\mathbf{A}_0$ *makes* it possible for E to begin at t_1 at any time between t_{-1} and t_1. If so, then it seems that assuming $\mathbf{A}_{-1}$ is necessary but not sufficient cause at temporal distance entails a contradiction: at t_0 is both possible and not possible for E to begin at t_1.

Admittedly, this argument ultimately depends on the interpretation of direct but not sufficient causes. But even if it turns out that, on some plausible interpretations, no contradiction arises, it still seems odd to concede that $\mathbf{A}_{-1}$ can be not sufficient cause at temporal distance. Since we usually do not admit causality at temporal distance, if the not sufficient causal conditions for the beginning of E obtain during the whole vacuum, what reasons there could possibly be not to conceive of the not sufficient cause of E as not contiguous with E? I shall leave this question unanswered here. Imagining a reply, intuitively, is not an easy task. This fact alone can be taken as an indication that it is worth considering what happens in the case of a contiguous, not sufficient, cause of an event after a vacuum.

This case is much more intuitive than the previous one: during the whole vacuum the necessary but not sufficient causal conditions that would *contiguously* bring about E obtained, but *only* at the last[162] vacuum's state before E they actually brought about E. My attempt in the next Chapter will be that of framing this scenario in terms of probabilities. But rather independently of the success of my attempt, we must conclude

[162] Recall that scenarios (γ) and (δ), where the vacuum has no last state, are excluded on the basis of (22).

that there are various ways in which we could conceive of something as causing an event after a vacuum, so that, in general, there seems to be nothing in the hypothesis of a PTV that makes it more unpalatable that regular vacua.

3.5. Conclusions

In this chapter, I argued that a Primordial Temporal Vacuum (PTV), that is, a period of time without change before the first event, is logically and metaphysically possible. This was crucial in order for the AUH to be viable.

If the results of this Chapter hold, then the first argumentative strategy for a personal cause of the first event, the TCS, is undermined, for as seen in the previous chapter, it is ultimately based on IPTV, the claim that a Primordial Temporal Vacuum is impossible. As for the second argumentative strategy, the TAS, it was based on two assumptions: the supposed result that the cause of the first event must not be sufficient and the claim that only agent-substance causation can provide a necessary but not sufficient cause of the first event. During this chapter, I suggested that the SA, the argument on which the first assumption is based, may be invalid. If my suggestion is correct, then the first event may just have a sufficient state-cause. In what follows, I will show that, even if we were to grant this first assumption of the TAS, we do not have to accept the second one.

One reason why the KCA's defenders may believe that *only* agent-substance causation provides a necessary but not sufficient cause of the first event, is the following: they may just not see how there could be an explanatory model of the first event given in terms of a necessary but not sufficient state-cause in time, especially one which is not personal. What else, other than personal free will, can guarantee the occurrence of a not sufficient cause in such an explanation? In the next chapter, I try to sketch one such model of explanation.

– Chapter 4 –

A new type of explanation of the first event

In this chapter, I am going to propose a new type of non-personal explanation for a (hypothetic) first event. This type of explanation is viable, at least in principle, if the considerations of Chapter 1 and 3 hold, that is, if a Primordial Temporal Vacuum is logically and metaphysically possible. My attempt, with this proposal, is to show how an explanatory model of the first event can implement the *Awakening Universe Hypothesis*. Moreover, by providing a non-personal type of explanation where a necessary but not sufficient cause of the first event is assumed to occur in time, I aim to undermine the Temporal Agent Strategy for a personal cause of the first event. First, I introduce, in the next section, the general features of the model. In section 4.2. I present the model itself.

4.1. Main explanatory features

By 'type' or 'model of explanation' of something I mean a description of the main traits that an explanation of that particular thing would have. My claim is that the model of explanation for the first event proposed in this chapter is such that it is logically and metaphysically possible for there to be an instance of this model. Such an instance would be, among other things, causal, chronometric, natural, non-personal and probabilistic.

4.1.1. A causal, natural, non-personal and chronometric explanation

Through this chapter I will understand an explanation to be causal when it aims to show the *causal dependence* of something from something else.[163] In other words, a causal explanation must entail the occurrence of some causal relation. This will include, therefore, singular causal claims such as "The flood happened because of the storm" as genuine cases of causal explanations (Steward 1997, 138; Psillos 2002, 57).

[163] For a similar broad definition of causal explanation see, for instance, Woodward 2003, 6.

The cause of the first event, within the model, is assumed to be a state-cause in time.[164] In this sense, the model is that of a *natural* explanation, for I understand any explanation to be *natural*, as opposed to supernatural, when it does not entail the existence of something that is not wholly in space and time or is itself a constituent of space or time (Clarke 2003, 210). Moreover, I propose a model of an explanation that is also non-personal, that is, that it does not appeal to the action of any person, or, in general, to any action at all (2.3.).

In Chapter 2, I acknowledged that the TCS, one of the strategies used by the KCA's defenders in order to infer a personal cause of the first event, assumed that the cause of the first event must be timeless. On this framework, the only kind of causal explanation allowed for the first event is supernatural. I suggested that the cause, if timeless, is better conceived to be a state-cause (2.4.). Hereby, I must add a few, very general, considerations on why I think that a temporal rather than a timeless state-cause of the first event has some theoretical advantages. That is, I will say something about the theoretical advantages of a natural (causal) explanation of the first event with respect to a supernatural one. Moreover, I will briefly state why I think a personal explanation of the first event is not plausible.

I already presented Russell's position that "the whole concept of cause is one we derive from our observation of particular things" (Russell in Russell and Copleston 1964, 175) (2.1.2.). This belief was the basis of Russell's belief that it does not make sense to ask about the cause of something we cannot experience. In analogy with Russell's reasoning, one may conjecture that, since the concept of causation is derived from our observation of particular things *in time*, that is, of particular things that stand in temporal relations, it does not make sense to ask whether something was caused by something from the "outside-time". Personally, I do not undertake this way of thinking, for I think it begs the question about whether timeless causes are possible (Baron and Miller, 2014). However, I agree that the main assumption may be true. In contemporary metaphysics, it is usually assumed that causal relata are things in time, namely events. This happens for a good reason: there appear to be some facts about certain types of

[164] Such state cause may be either a maximally complex state or a part of it. A maximally complex state is a complex of whatever state obtained in the universe simultaneously with a certain state. For how this conception does not suffer, in this context, from objections due to Special Relativity, see note 47.

events, that is, regularities in the ways in which they follow or precede one another, which call out for an explanation. The thunder regularly follows the lighting, the apple regularly falls from the top of the tower when released, and so on. The very concept of causation, it seems to me, is meant to grasp the idea that there is something, *in reality*, that *explains* instances of such regularities.[165]

Now, in subsection 2.2.1. I showed that, in the case of the first event, there are difficulties in causally explaining it by virtue of the occurrence of another event. This leads to the idea of a state-cause. Now, the reader should be familiar, by now, with the conception of states as occurring at particular (durationless) instants. Therefore, the occurrence of a state does not entail, by itself, any duration. Moreover, an instant, being just a temporal item, logically does *not have* to belong to some temporal order. That is to say, we can conceive of an instant, and therefore a state, as being, so to speak, outside of any temporal order. But no order and no duration just mean no time. This is what allows us to conceive of a "timeless" state-cause of the first event (2.2.2.). However, by means of this abstraction, we deprive the concept of causation, a concept originally meant to grant explanations of temporal facts, of its (allegedly fundamental) temporal connotation. This is a big theoretical step, that in my opinion could generate any sort of difficulties in framing a reliable metaphysics of causation (see also Tallant 2019, 16). I therefore tend to think that a state-cause in time of the first event is, theoretically speaking, preferable to a timeless state-cause. Given this, the onus of the proof is on the side of the theist that claims that the state-cause of the first event was timeless.

As to why a non-personal, natural, causal explanation is preferable to a personal one, this entire work aims to show that there are no grounds to think that a personal explanation is required at all. Here, I must just add a very broad remark on why I believe the onus of the proof stays on those who propose a personal explanation: our best scientific theories give us reasons to believe that persons, whatever they are, are the evolutionary product of a very long process, or series of changes. There is no available evidence that any kind of person may come to exist independently of the occurrence of such a process or series of changes, let alone independently of the occurrence of *any*

[165] Regularity theories are suitable to grasp this idea (3.3.1.), but the same is true for the supposition of causal powers. For an introduction to regularity theories of causation in contrast to the idea that there are causal powers, see Holger and Guenther 2021.

series of changes. Therefore, it seems to me that the idea of some person existing before any change happened at all, is, missing a good argument to think that the cause of the first event must be personal, implausible.[166]

As anticipated in the previous chapters, within the proposed model I also assume that the cause of the first event was necessary but not sufficient for the effect to occur. This trait of the explanation should be welcomed by the defenders of the KCA. Indeed, as seen in Chapter 2, this type of causality is recognized by some of them even outside the context of agent-causation (2.3.2.). For instance, in order to defend the first premise of the KCA from criticisms due to Quantum Mechanics,[167] both Craig and Koons suggest that quantum events do not lack (non-logical) necessary causal conditions, although these conditions are not jointly sufficient to determine the event (Craig in Craig and Smith 1993, 146, Koons 1997, 203).[168] Their position is therefore that necessary but not sufficient causes do not belong exclusively to the realm of free agency.

Nonetheless, that the cause is not sufficient to produce the first event does not entail that the explanation will provide, as a whole, a necessary but not sufficient *reason* for the first event. Rather, my claim is that it will provide a sufficient reason for it. This, I claim, is allowed by an additional key feature of the model: that of sketching a *chronometric* explanation. The details of how this works will hopefully become clear in what follows.

The term 'chronometric explanation' was introduced by Le Poidevin in 2007. He characterizes it as follows:

> Chronometric explanation appeals to the temporal location and extent of things, or to the rate of change. Often it will occur in the context of a causal explanation. Thus, a certain effect may be explained, not simply by the existence of an antecedent cause, but by the location of that cause

[166] Especially in the USA, scientists have long been defending the theory of evolution by natural selection from religious attacks (Montgomery 2012). However, I am not aware of any proper development of an evolutionary argument in the context of the debate on the KCA.

[167] The idea is that the indeterminacy of the theory entails that some quantum events are *uncaused* (Reichenbach 2017, 14).

[168] See also and Pruss 2006, 169.

> in time, or by the interval between that cause and another item, or by the rate at which some antecedent change proceeded.
>
> (Le Poidevin 2007, 117)

Le Poidevin lists three ways in which a chronometric explanation may occur in the context of causal explanations:

(i) The effect occurs at some time *because* an element of the causal chain is located n seconds before that time (e.g., the firework explodes at some time because it was lit five seconds before that time).

(ii) The effect occurs *because* the cause occurs in some temporal relation with another item (e.g., electricity flows around the system because two buttons were pressed simultaneously).

(iii) *The rate at which some antecedent change proceeded* (e.g., two traces on the Campbell-Strokes recorder the same length because the two intervals of sunshine that caused the trace were equal in duration).

The model I am going to propose does not seem, *prima facie*, to fit any of these cases. And yet, there is a clear chronometric component: the fact that a beginningless period of time elapsed before the first event is taken to be crucial in order to account for it. Differently from any of the above examples, a topological feature of time is called directly into play in the explanation.

According to Le Poidevin (2007, 119) and Torrengo (2016, 284–286), conventionalists cannot resort to chronometric explanations (or at least to those that assume objective facts about the ratio of periods). However, in 3.3.2. I noted that there are at least some such facts that conventionalists can admit, namely those about the ratio of *overlapping* periods. Specifically, if one period is entirely contained within another, the conventionalist can maintain that the first period is objectively shorter than the other. As I hope it will become clear in the next section, this is the only kind of objective facts about the ratio of periods that my model of explanation needs to assume.

4.1.2. Chance before change

As anticipated in the Introduction, the main feature of the model I propose is that of being *probabilistic*. That is to say, an explanation based on such model should allow to describe how the first event happened (how change begun) by chance. The term 'chance', as it can be guessed, is not used here to refer to the ordinary pre-theoretical concept employed in situations such as games of chance, but rather to a more theoretically charged notion of probability, namely, one that presupposes an objective interpretation of it (Eagle 2021, 3).

Hereby, I will consider as worth of the label '*probability interpretation*' all those attempts that have proposed probability-like concepts to explain the meaning of probability statements. Among the non-objective interpretations of probabilities are, just to mention the most relevant, the subjective and the logical one. On the first interpretation, probabilities are usually intended as *degrees of beliefs* (Hájek 2019, 13). It is natural to understand probabilities as subjective in a sentence such as: "I am not sure if it is snowing outside, but it probably is". In the second case, probabilities can also be seen as degrees of beliefs, but their value is assigned *a priori* by an analysis of the logical space of possibilities.[169] One can say that non-objective interpretations of probabilities, in general, locate probabilities in our heads or in logical abstractions (Hájek 2019, 20). By contrast, on objective interpretations, probability values are understood as mind-independent and located, so to speak, in the world. Probabilities are portrayed as holding independently of the beliefs of any agent.

In my model, I will propose that, at some instants before the first event, there were certain *objective* probabilities (chances) for the first event to happen in a certain period of time. These chances held quite independently from the existence of any future epistemic subject, and they allow to (probabilistically) explain the occurrence of the first event. Moreover, I suggest that the most appropriate objective interpretation of probability for the model I propose is a single-case interpretation, that is, an interpretation that allows one to make sense of probability assignments to single events independently of their belonging to some series of events. Single-case interpretations oppose to those interpretations that allow to assign probabilities to certain kinds of events only insofar as they are part of an actual or hypothetical collection of such events. Following Gillies (2000b, 126), I refer to the latter as *long-run* interpretations. The reason why a long-run interpretation is not viable for a probabilistic explanation of

[169] The most systematic study of logical probability was provided by Carnap (1950). See Donata Romizi (2009) for a historical account of the difference among the subjectivist and the logical approaches.

the first event is quite obvious: the first event is, by its very nature, unrepeatable. There can be only one.

The two types of interpretation that, nowadays, seem to better allow for single-case probabilities are the *propensity* and the *best-system* interpretation (Hájek 2019, 20–25). I shall give a rough overview of how these interpretations were first introduced. This should help to give a grasp on how, possibly, one can make sense of single-case probabilities. However, I shall not go into the matter of which interpretation is more adequate for the probabilities in my model. Rather, I shall leave this task for future work.

On a propensity interpretation, probability statements are understood as statements about propensities-like concepts (propensities, tendencies, dispositions, latencies, and so on) that are somehow associated with some kind of physical situation and that will bring to an outcome of a certain kind.[170] The basic idea behind the propensity interpretation of probability can already be found in the works of Peirce (Hájek 2019, 20). He understood probability statements of the type "*if a die is thrown from a dice box, the probability it will turn up a number divisible by three is one-third*" as meaning that "the die has a certain *would be*, [that is] a property quite analogous to any habit that a man might have" (Peirce 1910, 79–80). That is to say, the die's chance of landing 6, for instance, is an *objective property* of the die.

Pierce's analysis was in contrast to another conception of probability, the one proposed by frequentists. The *frequency interpretation* was born in the second half of the 19th century, when probability was acquiring a significant role for the empirical sciences (Romizi 2009, 101). Some frequentists, notably von Mises, identified probabilities with the *limiting* relative frequencies of certain kind of events within actual or hypothetical collection of such events (named collectives) (von Mises 1928, 12). On this account, for instance, the probability of getting a 6 by rolling a die is equal to what the limiting frequency of the outcome '6' would be if there were a very large (perhaps infinite) collection of rolls (Hájek 2019, 20).

One of the major problems frequentists have to face is the so-called "single-case problem": many kinds of events are most naturally regarded as *unrepeatable*, and therefore it seems hard to place them into proper collectives. This is not only true for the

[170] This definition is on the lines of Hájek's (2019, 22).

first event, but also for many less extraordinary events such as Italy's victory in UEFA Euro 2020. Nonetheless, it is natural to think that such events should be assigned a probability too. Aware of this problem, von Mises, on the grounds of his frequency theory, came to deny the possibility of validly introducing probabilities for single events at all (von Mises 1928, 11). By contrast, Pierce's analysis seems more suitable in order to grant objective single-case probabilities. Differently from frequency theories, it allowed to distinguish between the probability as a dispositional property, on the one hand, and an occasion that would manifest the disposition on the other (Gillies 2000b, 118). In the case of the dice box, for instance, such an occasion would be "an endless series of throws [of the die] from the dice box" (Peirce 1910, 80).

Unluckily for the frequentist, single-case probabilities may be required in order to interpret probabilities in Quantum Mechanics (Suárez, 2004; 2007; 2011; Dorato and Esfeld, 2010) or at least this was the idea that brought Karl Popper to abandon the frequentist approach, which he previously adopted in the *Logic of Scientific Discovery*, and to develop Pierce's idea into a complete propensity interpretation (Popper 1957; 1959; 1983; 1990). According to Popper's theory, the probability P of an event of a certain type, E, is the propensity, inherent to some *repeatable* initial conditions of an experimental set-up, to produce a limiting relative frequency P of E within a sequence of events (Popper 1959, 34–35). For instance, when we say that a die, when rolled, has probability $\frac{1}{6}$ of landing six, we mean that a repeatable set-up (e.g., a fair die being thrown with a certain force towards the center of a smooth table) has a propensity to produce, within a series of rolls, a limiting relative frequency of the event "landing six" equal to $\frac{1}{6}$ (Hájek 2019, 21). The late Popper, however, abandoned the requirement of repeatability and claimed that propensities are "properties of the whole physical situation" (1990, 17), where of course no *whole* physical situation is a repeatable experimental set-up. The reason was, plausibly, to retain objective probabilities for single events, for, as seen, if propensities are defined in terms of repeatable conditions, it becomes difficult to achieve this (Gillies 2000b, 126).

Popper late theory was therefore a 'single-case propensity theory'. Other such theories have been proposed by James Fetzer (1982) and David Miller (1994). Miller associates propensities with the complete state of the universe at a given time (Miller

1994; 1996), while Fetzer with the complete set of nomically and/or causally relevant conditions (Fetzer 1982, 195).

However, propensity interpretations are not the only ones that allow for single-case probabilities. Another candidate are the so-called best-system interpretations of probability pioneered by Lewis, which in turn are based on his best-system analysis of lawhood (1994). According to this proposal, the laws of nature are stated within the best deductive system that makes only true assertions about events. By 'best system' is meant, by Lewis, the system that better combines certain theoretical virtues and better fits to the data (Lewis 1994, 478). When it comes to systems that make assertions about chances of events, these systems may also assign a chance to the actual course of history, the world-series. The *fit* of a chance system is defined to be this very chance: the higher it is, the better the fit (unless there is no mention of chances, in which case the fit is perfect by stipulation). On this account, chances of single events are just what the probabilistic laws of the best system assert they are (Lewis 1994, 480). More importantly, such probabilistic laws may directly assign a chance to unrepeatable types of events as well, such as the decay of a rare atom, thus seemingly overcoming the single-case problem of frequentism (Hájek 2019, 25).

Of course, both propensity and best-system interpretations encounter problems of various kinds that still generates a lively debate.[171] However, it should be clear by this brief overview that both interpretations may represent a tool in order to make sense of single-case chances of unrepeatable events, which is what is needed in order to postulate that, before the first event, there was a chance for the unrepeatable first event to happen.

4.2. The Awakening Universe

In this section, I outline a new model of explanation for the first event. This model implements what I have called the *Awakening Universe Hypothesis* (AUH), that states that change may have begun by chance, in the sense that, before the very first event, there was a certain chance for this to happen (Introduction). In the first subsection I first set out more details about the Primordial Temporal Vacuum. In the second subsection, I

[171] In particular, the best-system interpretation has been subject of increasing interest. See Hájek 2019, 24–26 for an overview of the recent developments.

(so to speak) introduce chances in the vacuum. First, I assume these chances were constant, and highlight the troubles this brings. Then, I introduce the model I propose and face some of the critics it may meet.

4.2.1. The Primoridal Temporal Vacuum

The Primordial Temporal Vacuum, so far, has been defined as a beginningless period of time without change before the first event during which something existed. But what does it mean 'beginningless' in the case of the PTV? In a very similar way to the world-series introduced in 1.2.1., the PTV can be conceptualized as a sequence (that is a *discrete* ordered set) of distinct and non-overlapping periods of time during which there were things, none of them changing in the relevant sense. For simplicity, in order to define a *beginningless* temporal vacuum, I apply here the conditions given in subsection 1.3.1. for a beginningless world-series: a temporal vacuum is beginningless if, and only if, it is *not* the case that it is finitely extended *and* it has no lower bound.[172]

The PTV has to be beginningless. For suppose it is not: then either it has a lower bound (a first instant) or it is finitely extended. In both cases one is able to define a first period of the PTV and identify *that* as the first event (1.2.1.; 1.3.2.), so that the PTV would not be the PTV after all.

Let us label the periods that compose the PTV as *Primordial Vacuum Parts* (**PVPs**). Since the PTV has no lower bound, there are $\aleph_0$ PVPs (1.2.1.). Since it is not the case that the PTV is finitely extended, then it is not the case that the sum of all PVPs' durations is convergent. Notice that denying this does not commit to the claim that the sum of all PVPs' durations is divergent: the total duration of the PTV may be either infinite or *metaphysically indeterminate*. Leaving the latter option open is important, for it avoids commitment to objective facts about the ratio of the single (non-overlapping) PVPs, which, as seen (3.3.2.), is in turn important both in order to argue for the possibility of vacua without begging the question and to remain neutral on whether conventionalism is correct.

Yet, one can still grant that there are objective facts about the ratio between the sum of two or more immediately successive PVPs' durations and any of the components

[172] Notice that, since there is no time before the PTV, it cannot have a lower bound unless is has a first moment.

of the sum (or sum of components of the sum). Namely, the ratio, r, will be such that $r>1$ or $r=1$. To put it more simply, one can grant, for instance, that two immediately successive PVPs, T and T*, have *together* longer duration than both T and T* singularly, even though both values may be indeterminate.

What about the end of the PTV? In subsection 3.4.2., it was shown that there are various ways in which an event may be conceived to follow the PTV. I will resume them briefly. On the model, a state that occurs during the vacuum is taken as the contiguous cause of the first event. If causality at temporal distance has to be excluded, the PTV must have a last state. Even so, we have seen that, depending on whether time is conceived to be discrete or not, there a three different ways in which the PTV may end, leaving room to the awakening of the changing universe: (α) ($\mathbf{A_{-1}}$ $\mathbf{A_0}$ [$B_1\Gamma_2$]) and (β) ($\mathbf{A_{-1}}$[$\mathbf{A_0}$ B_1]) on discrete time and (ε) ($\mathbf{A_{-1}}$**…** $\mathbf{A_0}$[…B_1]) on non-discrete time. However, I must not commit to any of these ways. All that should be kept in mind, about the end of the primordial vacuum, is that it has a last moment, a last state. In (α) and (ε) this state is the cause of the first event. In (β), instead, the cause is the *penultimate* vacuum's state, while the last state belongs to the first event itself, which in this case represents, so to speak, a gentler awakening.

4.2.2. Constant and Increasing Chance Models

Before introducing my proposed model, I must first introduce a similar one, which I shall call the *Constant Chance Model* (CCM). I am going to suggest that this model is incompatible with the standard theory of probability. I suggest that my proposed model, the *Increasing Chance Model* (ICM), conveniently avoids this problem.

CCM: Suppose that there was a PTV. As seen, this can be conceptualized as a sequence of PVPs. Suppose that, at any time t_i at which any of these PVPs began, there was a chance P for the universe to awake (that is for a first event to happen) during the PVP that began at t_i and ended at some later time t_{i+n} (name it PVP_i).[173] I assume that P realizes during PVP_i if, and only if, the last instant of the PTV belongs to PVP_i. Notice that P, the chance of *a* first event to happen during PVP_i, must not be identical to the chance of *the* first event to happen during PVP_i. Rather, P is the conjunction of the

[173] Beginnings and endings of PVPs are understood as durationless instants that may or may not belong to the PVP, just like beginnings and endings of events (1.2.1.).

chances of each event that would constitute an awakening of the universe, just like the chance for the event of "me dying" is the conjunction of the chances of each event that would constitute my death. Let us name the event "awakening of the universe" as 'E_A', while the first event as 'E_0'. Since E_0 is, *ex hypothesis*, the first event to be explained, all the scenarios in which E_A actually realizes while E_0 does not, although may have had a certain chance before the occurrence of E_0, are excluded *ex hypothesis* as well. That is to say, when, in our scenario, E_A realizes, it realizes through the occurrence of E_0. Notice also that P is formally *independent* of what happens in the previous PVPs (although of course nothing happens during any of those). Moreover, that the value of P is unique means that it remains *constant* at each PVP.

Now, during PVP_i there are two possible outcomes: either E_A happens, or E_A it does not. Since these are exhaustive, given the standard formal theory of probability, Kolmogorov's axiomatization (Kolmogorov 1933), the probability of E_A *not happening* over PVP_i is $1 - P$; the probability of E_A not happening in both PVP_i and the next PVP, PVP_{i+1}, is $(1 - P)^2$; the probability of E_A not happening in all the first n PVPs after PVP_i is $(1 - P)^n$. Therefore, the probability of E_A happening over the first n PVPs is $1 - (1 - P)^n$ (Ng 2013, 40). It is easy to see that the more PVPs we consider *after* t_i, the higher the cumulative probability that, in this amount of time, E_A will happen (change will begin), where this probability approaches one as n approaches infinity. In the jargon of probability theory, let us call it '*cumulative probability*'.[174]

This situation is very similar to that of a repeatedly rolled die: the cumulative probability of getting at least one six out of the next roll is $\frac{1}{6}$, the probability of getting at least one six out of the next two rolls is $\frac{11}{36}$, and so on. This cumulative probability approaches one as the number of next rolls approaches infinity.

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[174] Technically, the term 'cumulative probability' refers to the likelihood that the value of a random variable is within a given range. Consider a random variable T which assumes the real values. The function that assigns to any real value t the probability $P(T \leq t)$ is the cumulative function: it determines, for any t, the probability that the random variable T has some value $\leq t$. This function can be defined both for discrete and continuos variables. In our case, T can be taken to range over some sequence of PVPs, so that the cumulative function could determine, for any of those PVPs, the probability of E_A happening up to that PVP.

So far so good. However, in the case of the CCM there is, so to speak, no first roll: t_i is chosen arbitrarily within the PTV, and since the PTV is beginningless, there are $\aleph_0$ PVPs in the past of t_i. What about the probability of E_A happening during any of the PVPs *before* t_i? Arguably, this probability should be one. As seen, on the CCM, the cumulative probability tends to one as the number of PVPs *after* t_i tends to infinity. Now, since infinite PVPs have *already* elapsed before t_i[175], this probability, one may conclude, must *already* be one at t_i. And since what is true at t_i is true at the beginning of any PVP, this just means that whenever we suppose E_0 happened, there is a probability one that E_0 already happened before. If probability one entails some kind of necessity, then it seems we have a contradiction: whenever we suppose E_0 happened, it *must* already have happened before. Before rejecting the CCM, however, one must be careful. Is it really the case that the probability of E_A having already happened before t_i is one? And, in that case, is one inescapably bounded to the conclusion that E_A *must* already have happened before t_i?

In reflecting upon the first question, the reader may notice that the situation is similar to that encountered in Chapter 1, when dealing with the arguments against a traversal of the infinite (1.3.2.). There, I explained why one could think that counting backward all the negative integers is impossible: because infinite ($\aleph_0$) numbers would have already been pronounced up to any time so that at any time the backward counter would have already finished their count. Similarly, it seems now that, having infinite ($\aleph_0$) PVPs elapsed up to *any* PVP's beginning, the probability that E_A already happened is one. This is certainly so if the sufficient condition for the probability to have reached one before t_i is that there are $\aleph_0$ PVPs in the past of t_i. In Chapter 1, I doubted that, in the case of the backward counter, there are reasons to accept a similar sufficient condition. All we could say, in that case, was that the backward counter *could* have finished their counting by now, not that they would or must have. If the backward counter were not finished, for instance, until next year, still they would have pronounced by now $\aleph_0$ numbers. This is not, therefore, a sufficient condition for the counting to have been completed by now. Unfortunately, we cannot avoid the contradiction entailed by the CCM by applying the same kind of consideration. The clear indicator that the backward counter is not bounded to have finished by now is that

175 For discussion of purely philosophical arguments against this possibility, see 1.3.2.

there are other numbers, rather than "-1", they could have come to pronounce in infinite time. Differently, in the case of the cumulative probability of E_A happening before t_i, there is just no value below one that this probability may take infinite PVPs to reach. Keeping P constant, for any real probability value n such that $n < 1$, one can build a finite sequence of PVPs such that the cumulative probability calculated from the beginning of the sequence to its end is greater than n. It seems therefore that, on the basis of philosophical considerations, one must concede that, on the CCM, the probability of E_A happening before t_i is one.

Surprisingly, however, if one faces the issue on the basis of the standard formal theory of probability, they are brought to deny this conclusion. An argument given by de Finetti (1974) may help to clarify why, but first I need to roughly introduce the formal theory. Let Ω be a non–empty set and F a specific set of subsets of Ω (technically, F is an algebra over Ω). The members of F are called *events*. A function is defined from F to the real numbers. This function is a *probability function* if it satisfies the Kolmogorov axioms. According to the first axiom, *non–negativity*, the probability of an event is a non-negative real number. According to the second axiom, *normalization*, the probability of Ω is one. This means that the probability that at least one of the e mutually exclusive and jointly exhaustive events will occur is one (Williamson 2007, 173). According to the third axiom, *countable additivity*, the probability that one of two mutually exclusive events occurs is the sum of their individual probabilities.[176]

Now, consider a fair lottery with each natural number appearing on exactly one ticket. Call it *de Finetti's Lottery*. That the lottery is fair means that each ticket has an equal probability of being picked. Suppose now that each ticket has some positive real-valued probability of being picked. Since any positive real-valued probability added to itself $\aleph_0$ times is larger than one, the probability that at least one of the tickets is chosen is larger than one. Therefore, there is a violation of *normalization*. Suppose instead that each ticket has probability zero of being chosen. Since zero added to itself $\aleph_0$ times is zero, the probability that at least one of the tickets is chosen is less than one (namely,

[176] This third axiom, formally $P(\bigcup_{n=1}^{\infty} A_n) = \sum_{n=1}^{\infty} P(A_n)$ where P is the probability function and A is a member of F, requires generalization to an infinite Ω and to a sigma-algebra F of subsets of Ω (Easwaran, Hájek, Mancosu, and Oppy 2021, 33).

zero), so that again we have a violation of *normalization*. It seems, therefore, that, on Kolmogorov's axioms, one cannot assign probabilities on a de Finetti's Lottery scenario. In particular, one cannot assign a probability value to the event 'picking of at least one of the tickets' (Lyon 2016, 158; Easwaran, Hájek, Mancosu, and Oppy 2021, 33).

Through a slight modification of the argument setting, one can see why, given Kolmogorov's axioms, on the CCM the probability of E_A happening before t_i cannot be one. Let us name the last PVP before t_i as PVP_{i-1}, and, in general, any PVP that is n PVPs before t_i as PVP_{i-n}. Let us name the possible temporal series where E_A happens during PVP_{i-1} as $series_{i-1}$ and, in general, any possible series where E_A happens during PVP_{i-n} as $series_{i-n}$. Since there are $\aleph_0$ PVPs before t_i, there are $\aleph_0$ such series. Now, instead of assigning to each ticket a natural number, one can assign to each ticket a different series. Assume, again, that the lottery is fair: each ticket-series has an equal probability of being picked. Since each series has an equal number of PVPs and P is constant at each PVP, one can also read this probability as the probability that a particular series actualizes. From here, the argument goes through as above, concluding that, on Kolmogorov's axiomatization, there is no probability value assignable to the event 'picking of at least one of the ticket series'. But this just means that there is no probability value for the event 'actualizing of at least one of the series' which is the same event as 'happening of E_A during PVP_{i-n} for at least one value of n'. Therefore, it seems than, on Kolmogorov's axiomatization, we cannot assign "one" to the probability of E_A having already happened before t_i.

Notice that Kolmogorov's axiomatization does not allow any *other* probability value assignments in cases such as *de Finetti's Lottery,* where probabilities should be equally distributed over infinite exclusive and jointly exhaustive events. This has been taken as a reason of discontent with Kolmogorov's axiomatization (Lyon 2016, 158), which in turn brought to the recent discussion of alternative probability theories.[177] For

[177] See Easwaran, Hájek, Mancosu, and Oppy 2021, 35 and in particular the Supplement on *God's Lottery* for an overview. For recent discussion on the opportunity of dropping *countable additivity* in favor of a restricted principle see, among others, Seidenfeld 2001, Bartha 2004, Howson 2008, Schurz and Leitgeb 2008, Bingham 2010, Easwaran 2013 and Seidenfeld, Schervish, and Kadane 2014. For an alternative approach involving a non-real-valued probability function see Wenmackers and Horsten 2013, Benci, Horsten, and Wenmackers 2012; 2018 and Wenmackers 2019.

instance, if one drops *countable additivity*, one can assign probability zero to each event and probability one to their union without contradiction. It has been noted, however, that by doing so one must also drop a desirable formal constrain of probability: *regularity* (Easwaran, Hájek, Mancosu, and Oppy 2021, 35).

Informally, the regularity constrain says that any possible event has positive probability. If a probability distribution is not regular, then an event with probability zero is not perforce impossible, and, therefore, an event with probability one is not perforce certain (or necessary) (Williamson 2007, 173). In our context, this means that, even though the probability of E_A having already happened before t_i can be taken to be one on some non-standard probability theory, this would not entail that E_A *must* already have happened before t_i. If so, then no contradiction is entailed by the CCM. However, it turns out that the CCM is incompatible with the standard formal theory of probability. Also, it turns out that, on some non-standard formal theories that allow to assign zero probability to possible events[178], the model would bound us to abandon regularity, which is a desirable constraint for the formal theory.

Although regularity is not the only formal desiderata at risk of getting lost (Benci, Horsten, and Wenmackers 2018, 510–511), it is one of particular relevance for the purpose of this work. Indeed, as I explain below, it must be assumed here that an event having probability one is sufficient for it to happen. Otherwise, the proposed model would not provide a *sufficient* reason for the occurrence of a first event. Instead of venturing into considering which non-standard formal theories that are compatible with the CCM may allow to retain regularity (if there are any)[179], I propose a different explanatory model, one that would allow to retain both the standard theory of probability, which showed its usefulness in a wide range of applications, and (among other desiderata) regularity.

ICM: The *Increasing Chance Model* is similar to the CCM under many respects, except that the chance of the universe to awake (of E_A happening) is assumed to

[178] Technically, any theory that is *finitely* additive and such that the probability function ranges over real values is bounded to this assignment when it comes to represent uniform probability distributions on infinite countable sample spaces (Benci, Horsten, and Wenmackers 2018, 513).

[179] For recent discussion on how to retain the regularity constrain on non-standard formalisms see, among others, Williamson 2007, Pruss 2013, Easwaran 2014, Lyon 2016 and Howson 2021.

increase towards the future at each PVP. Moreover, something more specific is assumed about the PVPs' order. More precisely, they are conceived to be in one-to-one correspondence with the negative integers in their standard ordering $\{\ldots;\ -3;\ -2;\ -1\}$. For brevity, I shall call this a *standard negative ordering*.

Let us call the last PVP as PVP_{-1} and, in general, any PVP that is n PVPs before PVP_{-1} as PVP_{-1-n}. Suppose that, at the beginning of PVP_{-1} the chance of E_A happening during PVP_{-1} had a certain value P. Suppose, furthermore, that, at the beginning of each PVP before PVP_{-1}, the chance of E_A happening during that PVP was lower that the chance at the beginning of the next PVP. More precisely, the chances varied so that the sum of all the values up to the last PVP can be expressed as series that converges to a value q lower than one. Moreover, I assume that the cumulative probability calculated from minus infinity up to the beginning of *any* PVP is lower than the cumulate probability calculated from the beginning of that PVP up to when E_0 began.

Let us see an example: at the beginning of PVP_{-1}, the chance of E_A happening during PVP_{-1} may have been $\frac{1}{10}$ and, at the beginning of each PVP before PVP_{-1}, the chance may have been $\frac{1}{10}$ of the chance at the beginning of the following PVP. Therefore, at the beginning of PVP_{-2}, the chance of EA happening during PVP_{-2} was $\frac{1}{100}$, the chance at the beginning of PVP_{-3} was $\frac{1}{1000}$, and so on. In this case, the total sum of all the chances' values, starting from PVP_{-1} and going backwards, can be expressed as the series '$\sum_{n=1}^{\infty}\left(\frac{1}{10}\right)^{n}$' or '$\frac{1}{10}+\frac{1}{100}+\frac{1}{1000}+\frac{1}{10000}+\ldots$'. This series equals $0,\overline{1}$.

The problems that arose with the CCM do not arise on the ICM. Since the chance at each PVP is not assumed to be constant, one is no longer justified in assuming, as in the argument above, that the ticket-series lottery is fair. Therefore, on the ICM, one can adopt Kolmogorov's axiomatization without therefore finding themself unable to represent a *uniform* probability distribution on infinite countable sample spaces. Regularity can therefore also be retained (Easwaran, Hájek, Mancosu, and Oppy 2021, 35). Moreover, since the sum of all the single chance-values converges to a value lower than one, the cumulative probability of E_A happening during *any of the PVPs* before E_0 (from now on *total* cumulative probability) must have a certain value q lower than one when E_0 began.[180] Therefore, the above-mentioned conceptual reasons to think that the CMM was contradictory do not apply here.

On the ICM, it also assumed that, had E_0 not happened at the end of PVP_{-1}, the total cumulative probability after, having reached the value q at the end of PVP_{-1}, either reaches one, eventually, or it tends to one towards the future (where the total cumulative probability is calculated for each *counterfactual* PVP after PVP_{-1}). In both cases, *given regularity*, one can say that, in a finite amount of time after the end of PVP_{-1}, E_A *had* to happen.

One may object that, in the hypothesis that the total cumulative probability would have tended to one towards plus infinity, this last claim is not true. This is because, the objection would go, at any (counterfactual) PVP finitely far away from (that is n PVPs after) PVP_{-1} the total cumulative probability is still less than one. I believe this objection can be dealt with by recalling some results of Chapter 1. There, I pointed out that it is logically possible for two elements of a sequence to be separated by $\aleph_0$ elements (1.3.1.). On this basis, I argued that an infinite temporal series (a temporal series with $\aleph_0$ elements) where two elements are separated by infinitely many events is (logically and metaphysically) possible (1.3.2.). Now, one can ask whether, on the ICM, had E_0 not happened, an infinite temporal series of PVPs could have elapsed after PVP_{-1}, such that some PVPs would have been infinitely far away in the future of PVP_{-1} (call them $PVPs_{+\infty}$). The answer, I claim, is "no": E_0 had to happen before any $PVPs_{+\infty}$ may elapse, for the total cumulative probability of E_A happening must reach one before any $PVPs_{+\infty}$. Therefore, on the ICM, a first event had to happen a finite amount of time after PVP_{-1}, or in general, after any time we suppose it to happen.

As far as I can see, there is still another, more troubling, objection that could be moved to the ICM. So far, there has been free talk of the total cumulative probability of E_A happening during any PVP. The objection, in its general terms, would go as follows: to talk about the total cumulative probability or similar concepts is unavoidable when

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180 To see this point, consider two periods PVP_1 and PVP_2 where E_A has a constant independent chance 0.1 of happening during each period. The sum of the chances is 0.2, while, by the formula $1 - (1 - P)^n$, the cumulative probability is 0.19. This is sensible considering that E_A can happen only once, so that the chance of it happening in both periods must not be counted in the computation of the cumulative probability (Ng 2013, 40).

one considers how the ICM should carry out its explanatory work. However, it seems that one cannot give an objective interpretation of these probabilities, as it should be required for the ICM (4.2.1.). Therefore, it is concluded, this kind of talk is unavailable, so that the ICM cannot carry out its explanatory work. Against this objection, I argue that even if this kind of talk were in fact unavoidable, one must not give objective interpretation to the probabilities involved.

The problem with giving an objective interpretation to the total cumulative probability of E_A happening during any PVP is that this probability seems past-oriented. As Jonathan Schaffer puts it: 'chances should only concern future events' (Schaffer 2007, 124). The idea expressed by Schaffer is that, at every instant *t*, the only outcomes which are a matter of non-trivial objective probabilities (chances) are those which occur later than *t* (Eagle 2014, 126). This claim, it must be said, is not entirely uncontroversial. Some recent arguments, indeed, have been given to undermine it (Meacham, 2005; Hoefer 2007; 2011; Cusbert 2018). However, that chances should concern the future remains a piece of common knowledge about chance, a platitude (Eagle 2014, 126–127), so that it is hard to interpret a past-oriented probability as chance.

To see why the total cumulative probability on the ICM may be past-oriented, consider again the example of the die rolls, where the cumulative probability of getting at least one six out of the next roll is lower than the cumulative probability of getting at least one six out of the next two rolls, and so on. The cumulative probability is, in this case, something that depends on how many *future* rolls one considers *from a determinate temporal location* (say from a given instant just before the first roll). However, in the case of the ICM, where the PVPs are in the standard negative ordering, there is just no time that can work as a determinate temporal location from which the total cumulative probability is future-oriented. Notice that, even if we were to suppose that there was some PVP infinitely far away in the past of the first event, call them $PVPs_{-\infty}$, things would not change. Since the PTV is beginningless, no model can provide a time from which the *total* cumulative probability is future-oriented.

I shall now say something more about why talking about total cumulative probability, or about any cumulative probability calculated from minus infinity up to any PVP, seems required for the ICM to do its work. In the Introduction, I claimed that an explanation of the of the beginning of the universe, in order to be satisfactory, should at least provide an answer to three main questions. Let us reconsider and rephrase them in terms of a first event (1.3.1.). Question (A): “if the universe began, why did it begin *at all*?”, becomes:

(L) If there was a first event, E_0, why was there *a* first event at all?

That is, why did E_A occur? Question (B), “if the universe began, why did it begin *in the way* it did?”, becomes:

(M) If there was a first event, E_0, why did *that* event happen (rather than any other event)?

Question (C), “if the universe began, why did it begin *when* it did (rather than earlier or later)?”, becomes:

(N) If there was a first event, E0, why did E0 begin at the instant it did (rather than earlier or later)?

A satisfactory explanation of the first event should provide an answer to each of these three questions. Here is a way one can attempt to answer such questions on the basis of the ICM *without* talking about the total cumulative probability.

For (L), the answer goes as follows: “*because*, some period PVP_i before the occurrence of the first event, there was an objective cause for a first event to occur during that period. Had C not realized when it did, it would have necessarily realized (earlier or later)”. This answer suggests therefore a *sufficient condition* for the occurrence of a first event.

Once (L) is answered this way, the other two questions have a straightforward answer on the ICM. To (M), one answers that E_0 was just one of the probable first events, one of the ways the universe had some chance of waking up during PVP_i. To (N), one answers that the instant when E_0 began was just one of the possible instants for E_0’s chances to realize during PVP_i. However, it is not a brute fact that E_0 happened and that it happened when it did, because to both answers one can add that a necessary but not sufficient state-cause of E_0 occurred immediately before E_0, providing therefore a temporally contiguous causal condition for E_0. Moreover, since on the ICM chance-value increases at each PVP are increasing, to the second answer one can add that it was *more probable* for E_A (and therefore E_0) to happen during that period rather than during *any* previous period.[181]

In general, then, the ICM explains the first event by giving both a sufficient and a necessary condition. However, the explanation, given as such, is, I believe, still radically unsatisfactory. Think of someone rolling a die since a very long time. Suppose that they would get a six for the first time just now. When asked for an explanation, they would point out that the objective chance of getting a six in the last throw was higher than that the objective chance at any previous throw, because the die just got loaded. Would that be a satisfactory explanation? Or would we want to know how comes they never got a six in *all* previous throws? In this context, then, question (N) must not be interpreted as being only about why E_0 happened when it happened and not at *any* other time. The question is also about why E_0 did not happen during *all* previous times. Therefore, one must also provide a reason why the first event did not occur during all PVPs *before* PVP_i.

One can accomplish this task by pointing out that the cumulative probability calculated from minus infinity up to the beginning of PVP_i is lower than the cumulative probability calculated from the beginning of PVP_i up to when E_0 began. It turns out, therefore, that talking about the cumulative probabilities calculated from minus infinity, such as the total cumulative probability, is a crucial part of the explanatory work that the ICM must carry out. And it is with this kind of cumulative probabilities that there is a problem in objectively interpret them.

My claim, however, is that there is no need, in fact, to objectively interpret them. Probabilities calculated from minus infinity come into play when it comes to *explain* why E_0 did not happen before a certain time. But these probabilities must not be located, so to speak, in the world: future-oriented chances existed before the first event happen, independently of any degree of belief, they were there, succeeding themselves in an infinite temporal series. Cumulative probabilities calculated from minus infinity are a mathematical artifact that comes into play *only* when we appeal to such chances in order to explain the first event.

To make the point more vivid let me turn again to a dice analogy. Think of someone rolling a die since eternity, so that the rolls are in the standard negative

[181] Recall that there is no specified metric during the Primordial Temporal Vacuum.

ordering, and suppose, furthermore, that the die has always been increasingly loaded, so that the chances of getting a six increased at each roll. Suppose that the first six is rolled at the next roll. One can explain why there never was a six *before* that roll by appealing to the fact that the chances were lower in the past throws, *and* to the fact that they increased *in such a manner* that if one calculates the cumulate probability of getting at least one six in all the throws before that last one, one gets a probability value that is lower than the objective chances of getting a six in the last throw. Here, there is no need to grant that these cumulative probabilities must be an objective chance as well, rather than just some kind of explanation-related concept.

4.3. Conclusions

If the model I propose is consistent and metaphysically possible, as I argued, then the last of the two strategies of the KCA's defenders for a non-personal cause of the first event is undermined. Indeed, it is shown by the logical and metaphysical possibility of the ICM or, more generally, of models similar to the ICM in the relevant aspects (Appendix 2), that a necessary but not sufficient cause of first event could be a state-cause in time, and that such a cause could not be personal. Moreover, I argued that the onus of the proof for the claim that the cause of the first event is personal is on the side of the theist (4.1.1.), so that, if no other strategy is provided, then a *non-personal explanation* of the first event is to be preferred.

As for what concerns the best chances' interpretation for the model, it is certainly hard to account for them on a propensity interpretation, given that, as seen in subsection 4.1.2., change in propensities is often associated with change in the universe, while on the ICM one has the first thing without the second one. Perhaps, however, it is possible to cling on a propensity interpretation by appealing to change in certain *nomological* conditions (Fetzer 1982, 195). Perhaps a best-system analysis is more adequate for the model. Or, perhaps, there is a third way. Within this dissertation, I shall leave the issue open. Future work will be dedicated to this issue.

– Concluding Remarks –

The *raison d'être* of this dissertation was my desire to explore the idea that the changing universe began as a matter of chance after a beginningless freeze. I expressed this idea through the *Awakening Universe Hypothesis*, the hypothesis that there is change in our universe because change had a chance to occur during a beginningless, changeless, time. The final goal of the dissertation was to show that this hypothesis is logically and metaphysically available, and that it can be implemented in an explanatory model. Moreover, I aimed at showing what role the existence of such a model may have in the contemporary debate on the *Kalām Cosmological Argument*.

As for the first task, my strategy has been two-fold. First, in Chapter 1, I tried to show that in the current literature one does not find an effective and purely philosophical argument for the impossibility of a beginningless universe, or time. Since a consistent treatment of infinities is granted by modern set theory, if no such arguments are to be found, one must grant that past-infinite beginningless time cannot be discarded on purely philosophical grounds.

Second, in Chapter 3, I discussed whether a (*per force* beginningless) Primordial Temporal Vacuum is possible. Here as well I considered the main philosophical arguments against the counterintuitive idea of time without change, finding, again, that there are no truly compelling ones. I considered then a positive argument in favor of this possibility. All commitments considered (as for instance the commitment to the denial of the strong Principle of Sufficient Reason), I found this argument effective.

If the logical and metaphysical possibility of a Primordial Temporal Vacuum is conceded, then, by means of an objective interpretation of probabilities, one can implement the *Awakening Universe Hypothesis* via an explanatory model coherent with the standard formal theory of probability. This is what I have done in Chapter 4 by proposing the *Increasing Chance Model*.

The model has at least two main pros. In subsections 2.4 and 4.3. I outlined that, if the logical and metaphysical availability of a similar model is granted, then the arguments offered by theologians in favor of a personal cause of the beginning of the universe fail. Therefore, we are left with no metaphysical reasons to think that a divine being once decided to kick off the dance of changes that permeates our world. Moreover, the *Increasing Chance Model*, and plausibly other models that may consistently implement the AUH (Appendix 2), show how one can give a sufficient reason for the fact that the universe we live in is a world with change.

Sometimes, in debates surrounding cosmology, similar facts are accounted for by appealing to consideration concerning the *possibility* of asking the relative questions.[182] Likewise, one may suggest that the sufficient reason for the fact that the universe we live in is a changing world is simply that it is physically possible for us to require such reason, since whenever we require such a reason by asking the question "why is the universe we live in a changing world?", some change is entailed at least in our mental state. Similar explanations rise obvious suspicions of circularity. Instead, models such as the ICM have the additional merit of showing how one could ground the fact that the universe we live in is a changing world without incurring in this risk.

Of course, one can always ask: "why did the chance of the ICM increase in the way it did?". I suggest that the question is outside the scope of a philosophical work. All I aimed to in this dissertation was to show the existence of an explanatory model that may allow to explain the first event by assuming a PTV and objective chances for the first event during the PTV. The reason why the chances were increasing, or, in general, changing while there was no change, could reside in the details of a physical theory that were to implement this explanatory model. The task of developing any such theory belongs, of course, to physicists.

However, a philosopher could perhaps reach some result when it comes to the issue of *which kind* of physical theory, if any, may implement the *Awakening Universe Hypothesis* or, more specifically, the *Increasing Chance Model*. This task shall be left for future work. However, some general considerations on future perspectives are in order here. I believe that such a physical theory could play a role within current research in cosmology. Let me give some reasons for this claim.

Surely, a physical theory that were to implement the *Awakening Universe Hypothesis* would have no use in explaining the very first coming into existence of

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[182] These are applications of the so-called *Weak Anthropic Principle*, which states that "our location in the universe is necessarily privileged to the extent of being compatible with our existence as observers" (Carter 1974, 293).

things, for it would assume that something had existed for a beginningless time before the beginning of change. It just so happens that the standard ΛCDM model seems instead to describe a universe the content of which came into existence a finite amount of time ago, when the 4-dimensional space-time expanded out of the initial singularity. As pointed out in 2.2.2., the beginning of this expansion, the Big Bang, can be identified with the first event. On the ΛCDM, no period of time elapsed before the Big Bang.

But how do cosmologists explain the Big Bang? Nowadays, in theoretical cosmology, one finds several speculative candidates that aim to accomplish this task. Some of such candidates allow postulating time before the Big Bang.[183] One example is the *oscillatory model* proposed by Paul Steinhart and Neil Turok (2002). This model describes the history of the universe as a sequence of expansions and contractions, such that the volume of the universe increases at each cycle (Steinhart and Turok 2002, 45). Another example are the models of *eternal inflation* (Perlov and Vilenkin 2017, 328). An eternally inflating universe is characterized by an exponential expansion which locally comes to an end, leaving space for a much lower-rate expansion. This process endlessly generates local bubble universes, such as ours. In eternal inflation models, "our" Big Bang happened at the beginning of the expansion of "our" local bubble universe (Guth 2007, 7). Thus, cosmic expansion is supposed to have somehow preceded the Big Bang.[184] Moreover, models associated with *string theory* also seem to allow the Big Bang singularity to be temporally bypassed (Zinkernagel 2008, 237).

However, none of these models implies that the history of the universe is beginningless. In fact, in 2003 Arvind Borde, Alan Guth and Alex Vilenkin (BGV) have shown that a universe that is, *on average*, expanding, must have had a past space-time boundary (Borde, Guth, and Vilenkin 2003). The theorem is based on some very general assumptions: it does not assume, for instance, that gravity is described by Einstein's field equations. However, as Sean Carroll recently noted, it only applies to

[183] Given the richness of the research field, I shall give just a few examples. These are in no way representative of some model typology. They are not, for instance, among the most accredited or complete. Their description just intuitively portraits the fact that cosmologists are, nowadays, trying to explain the Big Bang.

[184] For a criticism on the possibility of defining cosmic time before our Big Bang in eternal inflation models, see Rugh and Zinkernagel 2013.

classical spacetime and may not hold under a full theory of quantum gravity (Carroll 2021).

Aside from the issue of how far-reaching its implications are, the BGV theorem shows at least one thing: introducing cosmic time and cosmic expansion before the Big Bang in order to explain it may just shift the beginning of the expansion further back in time, leaving the latter unexplained. Interestingly, proposals are being made in this regard. The idea (to mention just one) is that space-time spontaneously emerged from "nothing" *because* there was a non-zero probability for a quantum tunneling to occur (Krauss 2012).

From this very brief overview one can see that the problem of explaining how the universe's expansion began has not been set aside from cosmological debates. Suppose now that there were good philosophical reasons to identify the beginning of the universe's expansion with the first event/change. Therefore, a physical theory that, in accordance with the empirical data, were to implement the *Awakening Universe Hypothesis* could have a role in the contemporary theoretical debate in cosmology.

This may seem, to many philosophers and physicists, far from feasible, if not impossible *in principle*. The main difficulty is that, *intuitively*, no cosmological model based on current physics (GR) can implement the idea of a Primordial Temporal Vacuum.[185] As said, the assumption of a Primordial Temporal Vacuum should play a role in explaining why the expansion of the universe began, that is, why there was a variation of the scale factor of the universe in the first place. However, cosmologists often define the cosmic time parameter through its relation with the scale factor (Rugh and Zinkernagel 2009, 5), so that a cosmological model based on GR seems unable to describe a period of time elapsing before any such variation. More generally, it seems that, *in any physical theory*, metrical variation in the time parameter is intrinsically bounded with (at least physically possible) change (Zinkernagel 2008, 240).

However, I do think that there is some wiggle room here. I shall give three suggestions. First, the supposed fact that there was a chance for change to begin at each time during Primordial Temporal Vacuum indicates that change was physically possible at those times, so that *perhaps* one could define metrical variation in the time parameter on the basis of *physically possible* changes. Moreover, no metric *has* to be defined

[185] In fact, I received this objection in personal exchanges with colleagues.

during the vacuum, so that *perhaps* one could have a theory that allows for the distinction of times during vacua without defining a temporal metric for them. Finally, although there are no events during the Primordial Temporal Vacuum, one may have (at least) one kind of variation able to provide some ground for the distinction of times during vacua: namely, chance variation.

These, of course, are just suggestions. I do not wish here to enter the debate on the nature and function of philosophical discussions of physical theories that are not (yet) well-established or even fully formulated (Butterfield and Isham 2001, 3, Weinstein and Rickles 2021, 2). Nevertheless, this dissertation should show to those metaphysicians who are not moved by interest in theological debates, that there is still some work to be done in the survey on the possible ways the universe might have begun. Carrying out this work can bring results in many branches of contemporary metaphysics such as philosophy of time, philosophy of probability, philosophy of causality, philosophy of mathematics, and so forth. Such results are worth pursuing, independently of theological interests.

– Appendix 1 –

Validity of the arguments for a beginning

Consider a specific first-order predicate language L: its vocabulary contains logical constants including '∀', '∃', '→', '↔', '¬' and '∧' (which respectively stand for 'for every', 'for some', 'if then', 'if and only if then', 'not' and 'and'); variables including 'x'; predicate letters including 'P', 'Q', 'R' and 'S' and brackets. In L, KCA can be formally represented as a logical form composed by four formulas. Three represent the assumptions that are not inferred: (1), (2) and (4). The last one represents the argument's conclusion: (5).

$\forall x(\mathrm{P}x \rightarrow \mathrm{Q}x)$; Pa; $\mathrm{Qa} \rightarrow \exists y(\mathrm{R}y)$; $\exists y(\mathrm{R}y)$[186]

Within this formalization, 'P' stands for 'began to exist', 'Q' stands for 'has a cause', 'R' stands for 'is a personal creator' and 'a' stands for 'the universe'. In general, this form is instantiated by valid arguments if, and only if, the last formula is entailed by the set of the others. Now, one way of accounting for what it means for the last formula to be entailed by the set of others is to characterize entailment in terms of the semantic notion of *logical consequence*. In order to symbolize the relation of logical consequence, it is sometimes used the symbol '∴' so that the claim that a well-formed formula of the language α is a logical consequence of a set of well-formed formulas Γ can be symbolized as 'Γ ∴ α'.

Logical consequence is defined relative to the language, and, when it comes to predicate languages, it is usually defined in terms of a notion named 'satisfaction'.[187] This allows to assign truth values to closed formulas without assigning truth values to open formulas such as Px, to which in fact it would make no sense to assign a truth value. However, if we restrict our interest to closed formulas, we can say that, whenever

[186] For a different formalization of the KCA, see Romero and Perez 2012.

[187] This way of characterizing logical consequence is based on Tarski 1936a; 1936b.

α is not an open formula and Γ does not contain open formulas, we can define logical consequence as follows:

> **Logical consequence**: $\Gamma \therefore \alpha$ in L if, and only if, for all models M of L, if all formulas in Γ are true in M, α is true in M.

Where a model is an ordered pair of a set and a function used to assign a denotation to individual constants and predicate letters of the language.

Under this definition of logical consequence, the KCA is proved valid by the fact that the last formula of its form is a logical consequence of the first three. We can show this informally. Supposing that Pa is true in a model M means to suppose that whatever a denotes in M (in this case 'the universe'), it belongs to the denotation of P in M (in this case the set of things that began to exist). Supposing that $\forall x(\mathrm{P}x \rightarrow \mathrm{Q}x)$ is true in M means to suppose that whichever denotation we assign to *x*, either it belongs to the denotation of Q in M (in this case the set of things that have a cause), or it does not belong to the denotation of P in M. Therefore, if we assign to *x* the same denotation as a, we must conclude that the denotation of a in M belongs to the denotation of Q in M, that is, Qa (which represents line '(3)' of the KCA). Lastly, to suppose that $\mathrm{Qa} \rightarrow \exists y(\mathrm{R}y \wedge \mathrm{S}y)$ is true in M means to suppose that there is a denotation of *y* such that either it belongs to the denotation of R in M (in this case the set of things that are personal creators of the universe), or the denotation of a in M does not belong to the denotation of Q in M. We must conclude that there is a denotation of *y* such that it belongs both to the denotation of R in M and to the denotation of S in M. In symbols:

> **KCA**: $\forall x(\mathrm{P}x \rightarrow \mathrm{Q}x)$; Pa; $\mathrm{Qa} \rightarrow \exists y(\mathrm{R}y \wedge \mathrm{S}y) \therefore \exists y(\mathrm{R}y \wedge \mathrm{S}y)$

If we consider specific modal predicate language L* similar to L and equipped with the usual modal operator '$\Diamond$' that stands for 'is possible' (where accessibility is reflexive, symmetric and transitive), then we can formalize the AII* and by means of a reasoning analogous to that above we can prove that the AII* is valid by showing that the last formula of its form is a logical consequence of the first two. In symbols:

> **AII***: $\forall x(\mathrm{P}x \rightarrow \neg\Diamond\mathrm{Q}x)$; $\mathrm{Ra} \rightarrow \mathrm{Pa} \therefore \mathrm{Ra} \rightarrow \neg\Diamond\mathrm{Qa}$

Where variables range over multitudes instead of any object and individual constants stand for particular multitudes, ‘P’ stands for ‘possesses an infinite number of members’, ‘Q’ stands for ‘is instantiated in the mind-independent world’, ‘R’ stands for ‘has no first element’ and ‘a’ stands for the ‘the world-series’.

The same goes for the AITI. In symbols:

AITI: $\forall x(\mathrm{P}x \rightarrow \neg\Diamond \mathrm{Q}x)$; Pa $\therefore$ $\neg\Diamond$Qa

Where variables range over collections instead of any object and individual constants stand for particular collections, ‘P’ stands for ‘is formed by successive addition’, ‘Q’ stands for ‘possesses an infinite number of members’ and ‘a’ stands for the ‘the world-series’.

As for the TFT*, if we formalize the four main assumptions and the conclusion in L* we can, once again, show that the argument is valid since the last formula is a logical consequence of the first three. In symbols:

TFT*: $\neg$Pa; Qa; $\neg\mathrm{Pa} \rightarrow \mathrm{Ra}$; $\forall x\, \neg\Diamond\neg(\mathrm{R}x \leftrightarrow \neg\Diamond \mathrm{Q}x)$ $\therefore$ Pa

Where variables range over temporal series instead of any object and individual constants stand for particular temporal series, ‘P’ stands for ‘has a beginning’, ‘Q’ stands for ‘has been formed by successive addition’, ‘R’ stands for ‘it is infinite’ and ‘a’ stands for the ‘the world-series’.

– Appendix 2 –

Oscillating Chance Model

Hereby, I present a model that implements the AUH, alternative to the ICM. The *Oscillating Chance Model* (**OCM**) is similar, under many respects, to the ICM. However, on the OCM, PVPs are conceived to be in one-to-one correspondence with the integers in their non-standard order: $\{\ldots; -6; -4; -2; 1; 2; 3; \ldots; \ldots; -5; -3; -1\}$ (1.3.2.). In those PVPs that correspond to the negative integers, E_A's chances increase towards the future in the same manner as in the ICM. Instead, in those PVPs that correspond to the positive integers, the chances symmetrically *decrease* towards the future. That is to say: E_A's chances in the PVPs that correspond to -2 and 1 are assumed to be equal (when the chances value remains constant between during two contiguous PVPs, it is called a *peak*), E_A's chances during the PVPs that correspond to -4 and 2 are assumed to be equal, those that correspond to -6 and 3 are assumed to be equal, and so on. Moreover, like in the ICM, the total cumulative probability of E_A was lower than one when E_0 happened, but is assumed to either reach one, eventually, or to tend to one towards the future had E_0 not happened when it happened.

On this model, then, the chances for the universe to awake have been increasing for an infinite period of time, then reached a peak, then decreased for an infinite period of time, and then, again, increased for an infinite period of time, until E_0 happened. Given the way the cumulative probability behaves, one can still say that it was not necessary for change to begin before when it begun, and that it was necessary for change to begin sooner or later. Plausibly, as soon as one keeps the total cumulative probability of E_A lower than one, this pattern of increasing and decreasing chances could be extended indefinitely into the past by modifying the ordering of the PVPs and by appropriately decreasing the value reached at the peak for each past cycle.

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