Universe Without a Cause: A Reply to David Lu

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Abstract

David Lu has recently argued that denying the Modified Causal Principle (MCP) – that if the universe began to exist, then it has a cause – leads to the conclusion that we likely inhabit an Omphalos universe, one that began recently with the appearance of age. Lu goes on to argue that if the universe is likely Omphalos, then independent measurements of the universe's age are unlikely to agree. I offer three families of objections. First, Lu's probabilistic reasoning faces technical challenges and, even if those challenges are overcome, cannot rule out an Omphalos universe. Second, I propose an alternative hypothesis that does so. Third, I argue – drawing on a standard argument in the foundations of statistical mechanics – that no ordinary scientific inference can be used to rule out our living in an Omphalos universe. Instead, we must either presuppose that we do not inhabit one or else be stuck in a skeptical scenario tolerable to no one.

1. Introduction

According to one version of the Kalam Cosmological Argument,

(1) If the universe began to exist, then the universe has a cause.
(2) The universe began to exist.
(3) Therefore, the universe has a cause.

Proponents of the argument typically proceed to a second stage where they attempt to show that the cause of the universe possesses various divine attributes. Hence, they conclude, God exists. Let's refer to the first premise as the Modified Causal Principle (MCP).[1] David Lu (2025) has recently offered a novel defense of the MCP. Lu argues that if the universe could have begun without a cause – so that the MCP is false – then any moment in the universe's history could have been the first. Worse, if the MCP is false, Lu argues, then it's more probable that we inhabit an *Omphalos universe*, that is, one that began recently with false memories and records of a non-existent past, than it is that the universe began in the Big Bang. And if we probably inhabit an Omphalos universe, then we probably inhabit a universe where independent measurements of the universe's age do not agree.

I don't claim to know whether the universe began or whether the universe had a cause. However, I offer three families of objections. First, it's difficult to see how Lu's claims about probability could be justified. As it stands, Lu's argument makes several errors with respect to his treatment of probability. Once these errors are correct, various technical challenges related to defining a probability distribution over possible

[1] Other versions of the Kalam Cosmological Argument – such as the version offered by William Lane Craig (2000) – make use of the Causal Principle: anything that begins to exist has a cause.

initial states of the universe remains. If these challenges are resolved, the MCP, by itself, cannot rule out that we inhabit an Omphalos universe. Moreover, contrary to Lu, the universe being Omphalos would not imply that independent measurements of the universe's age would be unlikely to agree. As I will show, these difficulties are powerful and several ways Lu might modify his argument are not helpful. Second, I offer a simple alternative hypothesis – the Maximally Extended Universe Hypothesis (MEUH) – according to which the spacetime we inhabit must be maximally extended. Roughly, spacetime is maximally extended if spacetime is as large as spacetime can possibly be; I introduce a more mathematically precise definition of 'maximally extended' below. The MEUH predicts that we do not live in an Omphalos universe. Various considerations suggest a law of nature according to which spacetime is maximally extended; in turn, various accounts of natural law suggest the law holds as a matter of metaphysical necessity. Moreover, the MEUH can be adopted by philosophers who reject the MCP. I don't know whether the MEUH is true. But the MEUH is a simple hypothesis capable of doing everything Lu claims the MCP can do and more. Without a good reason for rejecting the MEUH, we don't have a good reason to accept the MCP. Lastly, I show that a standard argument, well-known among philosophers of physics, implies that empirical evidence cannot be used to rule out the possibility that we inhabit an Omphalos universe. Unless we assume that we do not inhabit an Omphalos universe, we are mired in a skeptical scenario tolerable to no one.

1. Lu's Argument

Let's begin by defining some terms and variables. A universe is *cosmogony-friendly* just in case "independent, scientifically-valid estimates for the age of the universe generally agree with each other" (Lu 2025, p. 244). E is the statement <We live in a cosmogony-friendly universe.> C is the statement <The universe has a cause.> Lastly, B is a long conjunction representing all relevant background knowledge. Lu understands B to include that the universe began. Using these definitions, Lu offers an argument with three premises and a conclusion. Quoting from Lu (2025, pp. 243-244):

(1) Given that the universe began to exist, if the universe does not have a cause, then there is an extremely low probability that the universe is cosmogony-friendly: that is, $p(E|{\sim}C\&B) \approx 0$.
(2) Given that the universe began to exist, if the universe has a cause, then there is not an extremely low probability that the universe is cosmogony-friendly, that is: ${\sim}p(E|C\&B) \approx 0$.
(3) The principle *if the universe began to exist, then the universe has a cause* is independently motivated.[2]
(4) Therefore, by the restricted version of the Likelihood Principle, the fact that the universe is cosmogony-friendly provides strong evidence that if the universe began to exist, then the universe has a cause.

Lu intends for his argument to have the same form as Robin Collins's (2008, p. 207) fine-tuning argument. Lu's argument clearly does not have the same form, the first two premises are not equivalent to the formulas

[2] For the purposes of clarity and charity, I've suppressed Lu's use of the non-standard notation (C|B) to represent a conditional statement.

Lu offers, and Lu's argument is not logically valid. Nonetheless, any set of mutually consistent premises can be edited into a valid argument.[3] I suggest a charitable rephrasing of Lu's argument below. For now, let's discuss how Lu supports each of the argument's premises. Premises (1) and (2) take, as given, that the universe began to exist and Lu tells us that our background knowledge should include that the universe began to exist. Unfortunately, there is no consensus in physical cosmology as to whether the universe has a finite past (Afshordi & Halper 2025; Chen, Halper, & Afshordi 2025), and philosophers continue to debate the *a priori* case for a finite past. Additionally, the universe might not have a beginning even if the past is finite.[4] I think there are more interesting issues to discuss in Lu's article. Let's suppose, for the sake of argument, that we know the universe began to exist in the finite past.

By a possible state of the universe, Lu (2025, p. 242, footnote 21) means the configuration of the universe at a single instant in the universe's history. To support premise (1), Lu (2025, pp. 243, 245-250) argues that if the universe could begin uncaused, then any possible state of the universe could begin uncaused. To reach that conclusion, Lu considers numerous non-causal explanations and argues that none of them satisfactorily constrain the Initial State Of the Universe (ISOU). Without a satisfactory constraint, any instant in the universe's history could have been the ISOU. Lu argues that if every possible state of the universe has an equal probability of beginning uncaused, then there are vastly more ways for the universe to have begun recently, with the appearance of age, than to be legitimately as old as the universe appears:

> [...] because of the entropic arrow of time, it is actually *more* probable that we live in a recent Omphalos universe (e.g., one that began to exist 5 minutes ago) compared to an ancient Omphalos universe (e.g., one that began to exist 5 billion years ago) or the Big Bang universe that began some 13.8 billion years ago. Given that (1) the second law of thermodynamics implies that entropy in the universe has been increasing with the progression of time, (2) there are more possible universe states with higher entropy than lower entropy, and (3) every possible universe state has an equal probability of beginning to exist uncaused, then it follows that: if the universe began uncaused, then it is more likely that we live in a universe that began closer to our present moment than farther away from it (Lu 2025, pp. 252).

Hence, if the universe began without a cause, then the universe most likely began recently. Lu continues by arguing that if the universe began recently, then it is very unlikely that the universe is cosmogony-friendly. He writes,

> [...] the number of possible Omphalos universes where independent, scientifically-valid estimates for the age of the universe do *not* generally agree with each other ("cosmogony-unfriendly universes")

[3] To see this, suppose we are tasked with constructing a valid argument using premise P for conclusion Q. We can do so by introducing the premise <if P then Q>.

[4] For example, many (perhaps all) of the Kalam argument's most prominent defenders understand God to be in time (e.g., Craig 2001; Erasmus 2021). Since nothing can occupy more past time than there has been and Craig thinks past time is finite, God must have a finite past. Nonetheless, God is beginningless. Consequently, some past finite entities are beginningless. A successful case for the beginning of the universe must do more than show that the past is finite; a successful argument should offer convincing criteria for distinguishing past-finite beginningless entities from past-finite beginninged entities and that the universe belongs to the latter category.

> vastly outnumbers possible Omphalos universes that are cosmogony-friendly. When combined with the fact that every possible Omphalos universe has an equal probability of beginning to exist without a cause (from premise 1.2), it follows that if there is an extremely high probability that we live in an Omphalos universe that began uncaused, then there is an extremely low probability that the universe is cosmogony-friendly (Lu 2025, p. 254).

Lu describes five methods for determining the age of the universe. And then writes,

> All five of these methods assume that the universe began with the Big Bang and has left cosmological remnants (e.g., current size of the universe, cosmic background radiation, stars, etc.) which can be used to estimate the age of the universe. However, if we live in an Omphalos universe that began uncaused, then there would be no causal link between those cosmological remnants today and the Big Bang (since the Big Bang didn't occur). In other words, there would be nothing to constrain the initial features of these remnants – such that the probability they provide a coherent age of the universe is vanishingly small (Lu 2025, pp. 255-256).

Hence, for Lu, the hypothesis that the universe began without a cause does not predict that the universe is cosmogony-friendly or old.[5] In contrast, Lu argues, the hypothesis that the universe has a cause *does* predict that the universe is cosmogony-friendly and old. To defend premise (2), Lu points out that causes constrain their effects. The universe's cause might constrain the ISOU to the Big Bang state.

Despite Lu's claims to the contrary, Lu's third premise, its defense, and the restricted version of the Likelihood Principle are unnecessary for reaching his conclusion. In fact, it's generally not true that one should conclude that e is strong evidence for *h* by invoking the restricted Likelihood Principle, nor can one generally conclude from $p(e|h_1) > p(e|h_2)$ that there is "strong evidence" for h_1. Nonetheless, we can use Lu's statements to construct an argument for the conclusion that we have *some* evidence for the MCP. Evidence e is said to *favor* hypothesis h_1 over hypothesis h_2 just in case $p(e|h_1) > p(e|h_2)$. Lu's first two premises, if true, imply that E favors C over $\sim C$. According to the *positive relevance theory of evidence*, e is evidence for h just in case e raises the probability of h, that is, $p(h|e) > p(h)$. When e favors h over $\sim h$, so that $p(e|h) > p(e|\sim h)$, then it follows, by the probability calculus, that $p(h|e) > p(h)$. Consequently, if E favors C over $\sim C$ – as Lu's first two premises claim – then E is evidence for C; the universe being cosmogony-friendly is evidence that there was a cause of the universe.

[5] There is some recent evidence that the universe is not cosmogony-friendly. For example, current determinations of the Hubble parameter from more recent cosmological history, e.g., from cepheid variable stars and type 1a supernovae, disagrees with the value inferred from the Cosmic Microwave Background; this discrepancy is the so-called *Hubble tension* (Riess, et al, 2023). In combination with a cosmological model, the disagreement in the Hubble parameter can imply an inconsistency in the universe's age. For the sake of argument, I am granting that the universe is cosmogony-friendly.

Lu concludes that E evidence for the MCP and not merely evidence for C. The MCP can be written as the conditional $b \rightarrow C$, that is, if the universe began to exist, then the universe has a cause.[6] In general, showing that there is evidence for a consequent, such as C, does not suffice for showing that we have evidence for a corresponding conditional statement, such as the MCP. However, Lu's first two premises and his assumption that the beginning of the universe is included in B entail that E is evidence for the MCP. The probability of the MCP is

$$p(b \rightarrow C|B) = p(\sim b \vee C|B) = p(\sim b|B) + p(C|B) - p(\sim b\&C|B)$$

For Lu, B entails b, that is, our background knowledge includes the statement that the universe began, so that $p(\sim b|B) = p(\sim b\&C|B) = 0$, and, hence, $p(b \rightarrow C|B) = p(C|B)$. Therefore, if E raises the probability of C, E raises the probability of the MCP. So long as b is part of our background knowledge (which, again, is not something I'd otherwise concede), Lu's first two premises entail that E is evidence for the MCP.

One could object that, without constraining the hypothetical cause of the universe, the ISOU is unconstrained. In that case, cosmogony-friendliness is not evidence for there having been a cause of the universe. Lu is aware of this objection; as he puts the point, "[b]y just positing that the universe has a cause of its beginning, all we have done is push the problem back a level" (Lu 2025, p. 260). Lu replies that there is a specific, independently motivated hypothetical cause that constrains the universe's initial state. Following Robin Collins, Lu (2025, p. 261) argues that, "it would be unsurprising for God to bring about a universe whose age could be accurately and precisely determined through the scientific method by intelligent observers within the universe." Moreover, it would be unsurprising for God to bring about a universe where "intelligent beings such as ourselves generally have reliable cognitive faculties" (Lu 2025, p. 261, footnote 76). Lu concludes that we have independent reasons for thinking that God would create a cosmogony-friendly universe. Given that there's an independently motivated hypothesis in which the universe is caused to exist and that predicts cosmogony-friendliness, Lu concludes that $p(E|C\&B)$ is not low. I will return to this objection in the next section, where we'll see that Lu's reply is inadequate.

3. Some Initial Concerns About Probability

Let's turn to some immediate concerns about Lu's probabilistic arguments. Recall Lu's argument for the view that, without a cause to constrain the beginning of the universe, it's more probable that the universe is young, with the mere appearance of age, than that the universe is genuinely old. Lu reaches this conclusion on the basis of a few principles. First, without a cause to constrain the initial moment, there is a uniform probability distribution over possible initial moments. Second, the possible initial moments are possible instantaneous, three-dimensional configurations of the universe. Third, because the entropy increases over

[6] I've assumed the MCP should be understood as an ordinary conditional. Arguably, the MCP should be understood as a counterfactual conditional. But if we do understand the MCP as a counterfactual conditional, it's opaque to me how Lu's argument bears on the MCP.

time, many more recent initial moments are possible than older initial moments. Each of these principles may be questioned.

Lu uses a version of the Principle of Indifference to motivate the first principle, that is, that without a cause to constrain the initial moment, there is a uniform distribution over possible initial moments. To overcome well-known objections to the Principle of Indifference, Lu borrows a modified version from Collins. Collins (2009, p. 234) writes,

> According to the *restricted Principle of Indifference*, when we have no reason to prefer any one value of a variable p over another in some range R, we should assign equal epistemic probabilities to equal ranges of p that are in R, given that p constitutes a "natural variable." A variable is defined as "natural" if it occurs within the simplest formulation of the relevant area of physics.

Hence, on Collins's version, we should place a uniform probability distribution over the variables that appear within the simplest formulation of the relevant area of physics. When discussing the beginning of the universe, Lu thinks the natural variable is a possible instantaneous state of the universe:

> When we say that the universe began to exist, we are saying that the universe has an initial *state*. This denotes that there is a smallest, indivisible unit of time (i.e., a 'moment')[7] which can be used to objectively divide up the possibility space into individual states. Given this, the natural variable in our case would be the state of the universe at a particular moment of time, as described by the relevant area of physics (Lu 2025, p. 251).

This view is objectionable for several reasons. One cluster of reasons concerns the choice of a natural variable. Lu chooses the "state of the universe at a particular moment of time". In footnote 21, on page 242, Lu clarifies what he means by a 'state'. The state of the universe is given by a point in configuration space. For example, in classical mechanics, "states comprise the positions and momenta of all particles in the universe at that particular moment of time". But if this is what Lu means by a state, then the probability for a system to occupy *any* state is zero. Charitably, I think we should understand Lu to mean the macrostate, that is, each of Lu's "states" corresponds to an entire coarse-grained region of configuration space. And the probability that Lu is interested in is the probability that the ISOU falls within a given coarse-grained region. Understood that way, the probability is not zero; moreover, I could understand why Lu tells us that later "states" in the universe's history have higher entropy. However, even with this modification, Lu's argument remains problematic. Again, under the restricted Principle of Indifference, we place a uniform probability distribution over the possible values of the variables that appear in the simplest formulation of the relevant area of physics. For cosmology, the relevant area of physics is General Relativity. It seems doubtful that the universe's instantaneous macrostate is a natural variable for General Relativity. That theory's central equation – the Einstein Field Equation (EFE) – does not include such a variable, and solutions to that equation – that is, General Relativistic spacetimes – cannot generally be chopped into

[7] Lu refers to the smallest, indivisible units of time as 'moments', but philosophers more typically use the term 'instant'. In this article, I follow Lu's use of 'moment'.

moments. This also provides good reason to question the second and third principles, i.e., that the possible initial moments are instantaneous, three-dimensional configurations and that many more recent initial moments are possible than older initial moments.

Continuing in footnote 21, Lu writes, "Under general relativity, the space of possible states of the universe (known as superspace) contain only those universe states whose three-dimensional space-time geometries are consistent with the Einstein Field Equations."[8] There is a sense in which some General Relativistic spacetimes can be represented as trajectories through superspace – that is, as sequences of three-dimensional geometries. However, a given spacetime will not correspond to a unique superspace trajectory.

Spacetime is analogous to a loaf of bread. In a pre-relativistic conception, there's an objective fact about which events, across the entire universe, are simultaneous with which other events. In terms of the loaf, this means there is a unique best way to cut the loaf into slices, where each slice represents an instant of time. In General Relativistic spacetimes, there is no unique best way to slice the loaf. One spacetime can be cut into moments (i.e., foliated into Cauchy surfaces) in multiple ways. Each slicing corresponds to a different path through superspace – a different sequence of three-dimensional geometries – even though all such sequences correspond to one spacetime (Wheeler 1973, p. 226-7; Guilini 1995, p. 492). Since each spacetime is multiplied in superspace, one must take care in defining a probability distribution on superspace.

So far, the problem has been that the sequence of three-dimensional geometries is not unique. Set aside the uniqueness problem. Spacetimes that can be sliced into sequences of three-dimensional geometries, even if those sequences are not unique, have a mathematical property called *global hyperbolicity*. Unfortunately, not all General Relativistic spacetimes are globally hyperbolic, and, consequently, not all can be sliced into three-geometries. Without a restriction to globally hyperbolic spacetimes, superspace is simply not the configuration space for General Relativity. In simpler terms, the uniqueness problem was generated by the fact that we can "rotate" the knife used to cut spacetime into slices. The problem currently before us is that some spacetimes are not even loaves; is there a best way to cut a bagel or a pretzel? What about a fougasse? To be fair, there is a formulation of General Relativity, called the *Hamiltonian formulation*, where one only countenances globally hyperbolic spacetimes. In that framework, superspace *is* the configuration space for General Relativity. However, the restricted Principle of Indifference requires the simplest formulation of a theory; it's at least unclear – and seems intuitively incorrect to me – that the Hamiltonian formulation is the *simplest* formulation.

Let's consider another possible choice for a natural variable. Cosmologists often make the simplifying assumption that the universe is spatially homogeneous and isotropic. Spacetimes consistent with that assumption can be sliced into a sequence of three-dimensional geometries. Moreover, the assumption also entails that there exists a slicing such that, on each slice, the distribution of matter and energy is uniform. Under that assumption, the EFE reduces to the *Friedmann-Lemaitre-Robertson-Walker (FLRW) equations*; in turn, the spacetime described by the FLRW equations are called *FLRW spacetimes*. The

[8] In more precise terms, superspace is the space of three-geometries modulo diffeomorphisms (Guilini 2009).

simplest, classic models of an expanding universe are FLRW spacetimes. For this reason, the FLRW equations, and the corresponding set of spacetimes, are ubiquitous in cosmology.

FLRW spacetimes have an important feature. Suppose we slice an FLRW spacetime such that, on each slice, the distribution of matter and energy is uniform. (The geometry of FLRW spacetimes guarantees that there is a slicing of that sort.) We can imagine clocks inhabiting such a spacetime and that "ride" their universe's expansion. The time kept on such a clock is called the *cosmic time*. Each slice can be labeled by a value of the cosmic time. In some sense, the result resembles the pre-relativistic conception, where the cosmic time has taken the place of absolute time. The difference in cosmic time between the first moment and the present might be a charitable choice for a natural variable.

This proposal encounters two problems. First, the singular FLRW models traditionally used to describe the Big Bang do not include a first moment. By analogy, consider that there is no immediate next real number after 0. Hence, there is no first element of the set of real numbers greater than 0. Singular FLRW models have a similar feature; while they include a finite past, they do not include a first moment. This is troubling because, according to Lu, "[w]hen we say that the universe began to exist, we are saying that the universe has an initial state"; if that's what a beginning of the universe involves, the classical singular models of the Big Bang are beginningless.[9] Second, we can roughly think of measures (in the measure-theoretic sense) as a generalization of probability distributions, where, for example, we relax the requirement that the distribution sums to 1. While there is a measure naturally defined over the configuration space for FLRW spacetimes, namely, the Liouville measure, it is not a good choice for Lu's purposes. Several physicists have argued that the Liouville measure allows us to make judgments about typical versus atypical FLRW spacetimes (Gibbons, et al, 1987; Coule 1995; Carroll & Tam unpublished; Carroll 2023). However, because it diverges, whether the Liouville measure licenses judgments about credence is controversial. A procedure, called *regularization*, can be applied to remove the divergence. In doing so, choices have to be made that lead some to argue that the result is no longer natural or well motivated (Hawking & Page 1988; McCoy 2017; Wenmackers 2023).

Supposing that the Liouville measure does license judgments about credence, Lu might appeal to a typicality argument. Since the Liouville measure is conserved along configuration space trajectories – that is, along the Hamiltonian flow – the Liouville measure can be used to say how typical it is for spacetime to have some specific feature for some "instant" (or Cauchy surface) in the universe's history. However, while Lu assumes that any of the states along a configuration space trajectory are candidate ISOUs, typicality arguments usually assume that the relevant trajectories correspond to maximally extended spacetimes, in the sense defined below. Such arguments exclude Omphalos universes, so that the Liouville measure is likely inappropriate for Lu's purposes.

Even if these difficulties are overcome, another remains. Recall Lu's argument for concluding that, without the MCP, there is an extremely low probability that the universe is cosmogony-friendly. Without the MCP, Lu argues, nothing constrains the ISOU, and we'd probably inhabit an Omphalos universe. And, Lu claims,

[9] J. Brian Pitts (2025) has recently offered a closely related argument.

if we do inhabit an Omphalos universe, there is a low probability that the universe is cosmogony-friendly. In many Omphalos universes, the universe began too recently for there to have been any measurements at all. But a cosmogony-friendly universe is one where independent and scientifically valid measurements of the universe's age agree. To countenance cosmogony-friendliness as a datum, we must say that we know independent and scientifically valid measurements of the universe's age agree. Hence, to countenance cosmogony-friendliness as a datum, we must assume the universe is at least old enough to include such measurements. We should exclude universes from consideration where cosmological measurements haven't taken place – for example, those universes that began more recently than Edwin Hubble's measurements in the early twentieth century. With that restriction, a problem looms for Lu's argument. An Omphalos universe is a young universe with the appearance of age. A cosmogony-friendly universe is one where independent and scientifically valid estimates of the universe's age agree. For Lu, a universe has the appearance of age provided the universe is cosmogony-friendly. Hence, contra Lu, Omphalos universes – suitably restricted – *are* cosmogony-friendly.

In constructing a probability distribution appropriate for Lu's argument, we should exclude universes that are too young for cosmological measurements to have taken place. We should also include universes whose microstates differ from those of the actual universe. Some truncations of our spacetime are Omphalos universes, but so are truncations of all of the universes whose macrostates are consistent with the actual universe's macrostates. In that case, all of the universes considered include counterparts to ourselves with access to mutually consistent cosmological measurements. To include cosmogony-unfriendly universes, we need to include a broader class of universes, ones with distinct matter-energy distributions, and hence – given how matter-energy couples to spacetime – distinct spacetime structure. In the pre-relativistic context, to say that two possible spacetimes, S_1 and S_2, have the same age involves, roughly, that there is a moment m_1 in S_1 and a corresponding moment m_2 in S_2 such that there is as much time before m_1 as there is before m_2. Can that notion be updated for General Relativity? To do so, we'd need to identify corresponding spacetime structures (such as counterpart moments) across possible worlds. Unfortunately, there is an unresolved question about how to identify trans-world counterparts of spacetime structures and to use them to evaluate counterfactuals (Curiel 2015; Vassallo 2020; Jaramillo & Lam 2021).

Suppose Lu grants that Omphalos universes are cosmogony-friendly. As far as I can tell – and perhaps there's an option I cannot foresee – there are two routes Lu could take to save his argument. On the first, Lu could argue that, without a cause to constrain the universe's initial portion, the universe would most likely be young,[10] and most young universes are not cosmogony-friendly. Lu argues that our universe being cosmogony-friendly favors C over $\sim C$. Unfortunately, C does not predict cosmogony-friendliness. If the universe could be cosmogony-unfriendly (or have any other feature), then we have just as much reason to think that the universe could be caused to be cosmogony-unfriendly (or be caused to have any other feature). In other words, even if some specific version of C has independent motivation, we have no reason to think that $p(E|\sim C\&B) < p(E|C\&B)$; arguably, we have reason to think that $p(E|\sim C\&B) =$

[10] By 'young universe', I mean a spacetime truncated in the recent past, as defined in section 4, and not extended out to, e.g., the Big Bang.

$p(E|C\&B)$.[11] To put the point another way, if the universe's cause is unconstrained, the ISOU is unconstrained. To predict cosmogony-friendliness, Lu employs a more specific hypothesis – for example, that the universe was caused by a deity with specific desires – but whether there is such a hypothesis is insufficient for defending C. Now consider the second route. Lu could argue that, without the MCP, we most likely live in an Omphalos universe, where our universe's cosmogony friendliness gives it the illusory appearance of age. This presents us with an unwelcome skeptical scenario. However, as I show in the next section, there is a simple alternative hypothesis – the *Maximally Extended Universe Hypothesis* (MEUH) – that avoids the skeptical scenario.

4. The Maximally Extended Universe Hypothesis

Before continuing, let's summarize the road so far. Lu argues for the conclusion that, without the MCP, it's more probable that the universe's age is illusory than that the universe is genuinely old. Lu uses three principles to reach this conclusion, which involve a uniform probability distribution over possible initial moments. In turn, the uniform distribution is supposedly justified by the restricted Principle of Indifference. To apply that principle, Lu must choose a natural variable. A natural variable might be defined on superspace, which Lu understands as the space of possible configurations of a General Relativistic spacetime. Unfortunately, (i) some spacetimes are overrepresented in superspace, while (ii) other spacetimes are not included in superspace at all. Perhaps the natural variable could be cosmic time, a variable defined within the simplest models of an expanding universe. However, whether or how a probability distribution or measure should be defined over the set of such models remains unclear. Standard proposals are mathematically controversial and, at any rate, are unhelpful for reasoning about Omphalos universes. Supposing those difficulties are resolved, to countenance cosmogony-friendliness as a datum, the universe should be assumed old enough to include appropriate measurements of the universe's age. With this assumption, Omphalos universes turn out to be cosmogony-friendly; the probability that the universe is cosmogony-friendly, given an Omphalos universe, and the probability that the universe is cosmogony-friendly, given an old universe, are both 1. If Lu concedes that Omphalos universes are cosmogony-friendly, Lu could argue that, without a cause constraining the universe's initial state, the universe would likely be young and most young universes are not cosmogony-friendly. Lu could then argue that our universe being cosmogony-friendly favors the existence of a cause of the universe. Unfortunately, that some hypothetical causes, such as God, are more likely to bring about a cosmogony-friendly universe does not entail that cosmogony-friendliness is likely given the disjunction of possible causes. Hence, cosmogony-friendliness is not good evidence that there was a cause of the universe after all. Alternatively, Lu could argue that, without the MCP, we encounter a skeptical scenario: our universe's cosmogony friendliness gives it the illusory appearance of age. However, a simple alternative hypothesis, the MEUH, avoids that scenario.

According to the MEUH, spacetime must be maximally extended. Thus, to explicate the MEUH, I need to define 'spacetime' and 'maximally extended'. In the relativistic context, spacetime is represented as a

[11] In some sense, an even stronger point can be made. Supposing that we had evidence for one of the disjuncts in a long disjunction, the same evidence can be evidence against the long disjunction. For that reason, even if we had evidence that a deity with specific desires caused the universe, it wouldn't follow that there is evidence that the universe was caused to exist.

solution to the EFE. For example, when discussing the possibility of distinct spacetimes, I mean the possibilities represented by the diverse solutions to the EFE, or by the solutions to whatever equations replace the EFE in General Relativity's successor. Following Earman (1995, pp. 31-3) and Manchak (2017), a spacetime S is *extendible* just in case there is another spacetime S' such that S can be isometrically embedded into S'. S' is called the *extension* of S. Moreover, we say that S is *maximally extended* just in case S does not have an extension. (Some authors use 'inextendible' to refer to maximally extended spacetimes.) Intuitively, we can think of S' as a larger spacetime that includes S as a proper part.[12] In some sense, maximally extended spacetimes are as large as they can possibly be. If not maximally extended, spacetime is said to be *truncated*.

Let's slow down for a moment, take our breath, and explain in simpler terms what's at stake with maximally extended versus truncated spacetimes. One spacetime can be distinguished from another in terms of its geometrical and topological properties. Consider the cubical region of space, currently in front of me, that measures one foot on each side. If that cubical region were all that existed, then spacetime could be extended, in both space and time, to a larger region. That's because there's another possible spacetime that includes a counterpart to the cubical region, but also includes other regions.[13] In the possibility where the cubical region exists alone, by itself, spacetime is truncated. Lu's Omphalos universes are truncated spacetimes. While the cubical region or the Omphalos universes can be extended, it's not true that, for any possible finite spacetime region, there's always a further extension. There are some cases where the spacetime geometry, itself, is incompatible with a further extension. This is precisely what happens in the classical models of an expanding universe that include a Big Bang singularity; in such models, spacetime cannot be extended further into the past, because the spacetime geometry, itself, forbids such an extension.[14]

Both the MEUH and the MCP are intended to restore our everyday intuition that we do not live in an Omphalos universe. Without the MCP, Lu argues, we are subject to the widespread illusion that the universe is old. However, this is a special case of a broader problem. Omphalos universes are truncated spacetimes, but some truncated spacetimes are not Omphalos universes. Just as there is a skeptical problem posed by the possibility that the universe began five minutes ago with the appearance of age, so, too, there is

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[12] There are some technical reasons not to take this too seriously. For example, if *S* and *S'* occupy distinct possible worlds, then there is a counterpart to *S* – and not *S* itself – that is a proper part of *S'*.

[13] Previously, I mentioned that there is an unsolved issue concerning how to identify trans-world counterparts of spacetime structures when evaluating counterfactual statements in the General Relativistic context. That problem is not encountered here, because the claim is only that there are "larger" spacetimes that include a region isometric to the cubical region.

[14] Relatedly, there is an ambiguity in questions like, "could the past have been longer?" This ambiguity has come up in discussions I've had about Lu's paper, so it's worth mentioning here. Suppose General Relativity was the final theory of spacetime and that there is a Big Bang-like singularity located somewhere to my past. On one interpretation, the question concerns whether there is another spacetime, one that includes a spatiotemporal region identical to my past, but that also includes an additional region beyond the singularity. In that case, there is no such possibility, so the past could not have been longer. On a second interpretation, the question concerns whether there is another General Relativistic spacetime, with a counterpart of myself (provided such a counterpart could be identified), but does not include a spatiotemporal region identical to my past. In that case, the past may well have been longer, precisely because such a possibility could involve a different space-time geometry. With a distinct space-time geometry, there might not be a Big Bang-like singularity.

a skeptical problem posed by the possibility that the universe will end in the next hour or two feet to my left. By ruling out truncated spacetimes, the MEUH explains why we can be confident the universe won't end in the next hour or two feet to my left. In other words, the MEUH does additional explanatory work no one claims the MCP can do.

Why think that spacetime must – as a matter of metaphysical necessity – be maximally extended? Metaphysical principles are often employed to defend the view that spacetime must be maximally extended. For example, John Earman (1995, p. 32) suggests Leibnizian principles, e.g., the Principle of Sufficient Reason and the principle of plenitude, might motivate thinking that spacetime doesn't end arbitrarily and should be maximally extended.[15] If such principles are metaphysically necessary and entail that spacetime is maximally extended, then they entail the MEUH. However, there is reason to be cautious when applying the Principle of Sufficient Reason. For example, an extendible spacetime may have more than one inextendible extension (Earman 1995, p. 32; Doboszewski 2017). Perhaps a better argument can be made from physical law.

Working cosmologists and mathematical physicists often assume spacetime is maximally extended. For Robert Geroch (1970, p. 264), any non-maximally extended model is "unsatisfactory as a model of our universe", while, for Juliusz Doboszewski (2017, p. 196), " inextendibility is commonly taken to be a necessary condition for a spacetime to be physically reasonable." Suppose physicists are right to assume either a spacetime model is maximally extended or not a genuine physical possibility. This is most plausibly explained in terms of natural law, i.e., that there is a law according to which spacetime must be maximally extended.

Accounts of natural law come in two families. First, Humean accounts of laws, on which laws provide a mere summary of the distribution of local matters of particular fact, with no necessary connections between disjoint spacetime regions. The features of one spacetime region can be freely recombined with other spacetime regions. Humeans might not have a convincing case for the MEUH, because one spacetime region cannot necessitate spacetime continuing into disjoint regions. Second, anti-Humean accounts of laws, where laws govern or constrain the distribution of local matters of particular fact. For anti-Humeans, the features of one spacetime region necessitate the features of disjoint spacetime regions. Anti-Humeans may have a convincing case for the MEUH, because a spacetime region may necessitate that spacetime continues into disjoint regions.

Many anti-Humeans endorse a view I call *naive determinism*. According to naive determinism, our world can be divided into moments, where each moment determines what happens in subsequent moments. However, naive determinism is inconsistent with contemporary relativistic physics. Before relativity, it made sense to think of the world unfolding moment-by-moment, because there was thought to be an objective fact concerning which events are simultaneous. Special Relativity undermined this notion: the theory does not include objective simultaneity relations, independent of a particular reference frame. However, one

[15] In fact, the question as to whether spacetime could be truncated is a close cousin to the central issue in the Leibniz/Clarke correspondence.

could add objective simultaneity back in by privileging the simultaneity relations found in one reference frame over all others. Unfortunately, this move becomes unavailable in General Relativity. In General Relativistic spacetimes, there's no such thing as a reference frame encompassing all of spacetime, so that there are no globally defined reference frames to pick from, and the notion of simultaneity, inherited from Special Relativity, applies only at each point. (In more precise terms, reference frames and simultaneity surfaces exist only in each point's tangent space.) Some General Relativistic spacetimes – such as the FLRW spacetimes discussed previously – can be cut into three-dimensional spatial slices, but whether spacetime can be so sliced and whether those slices, should they exist, are plausible candidates for instants of absolute time, depends on the contingent, global distribution of matter and energy. This is one example of a more general fact: contemporary physical theories have features incompatible with naive determinism and require a different view about physical determination. For this reason, Emily Adlam, Eddy Chen, and Sheldon Goldstein have suggested that laws constrain spacetime "all-at-once".

On the all-at-once view of laws, instead of producing subsequent states of the universe from previous states, the laws globally constrain all of spacetime. The all-at-once view is anti-Humean because the "[l]aws constrain the world by limiting the physical possibilities and constraining the actual world to be one of them" (Chen & Goldstein 2022, p. 39). As Adlam (2022, p. 7) writes, "laws make things happen and are thus part of the objective modal structure of reality." Though Adlam insists that laws constrain physical reality because they have modal force, she remains agnostic about what, precisely, laws are. In contrast, Chen and Goldstein take their inspiration from Tim Maudlin. Like Maudlin (2007), Chen and Goldstein maintain that laws are *sui generis* and irreducible entities with modal force. Unlike Maudlin, Chen and Goldstein's laws do not produce subsequent states from previous states; instead, laws globally constrain spacetime and its contents. The MEUH can be motivated by an account of laws on which laws (i) have modal force, (ii) globally constrain spacetime, and (iii) obtain in any possible world that includes the kinds of items they govern.[16] If it's a law that spacetime must be maximally extended, then spacetime is maximally extended in every possible world that includes spacetime.

The MEUH can be true independent of whether the MCP is true. In fact, while explicating their views of laws, Adlam, Chen, and Goldstein endorse a view – *causal non-fundamentalism* – where the MCP is plausibly false, or at least inapplicable. By my lights, the most plausible form of causal non-fundamentalism, *Neo-Russellianism*, is the conjunction of two theses: (i) causation is not physically fundamental and (ii) there are real (non-fundamental) causal relations that help guide effective strategies (Blanchard 2016). For Neo-Russellians, causation has a deeper explanation in terms of our world's non-causal features. Fundamental physical theory is expressed mathematically and not in terms of causation. By itself, this fact is not a particularly good reason to deny causation in fundamental physics. In addition to the mathematics, physical theories include an interpretation. Perhaps some of the mathematical structures that appear in fundamental physics can be interpreted as causal relations. For Neo-Russellians, the mathematical structures that appear in fundamental physics do not have a plausible causal interpretation. First, causes are generally asymmetrically related to their effects, whereas the fundamental laws symmetrically relate the

[16] I take "kinds" to be as little metaphysically committing as possible. For my purposes, the items the laws constrain can differ in some important respects between possible worlds. For example, though the topology and curvature of spacetime may differ between worlds, the same laws might govern spacetime in all the worlds where spacetime exists.

goings-on in disjoint spacetime regions. Second, causes are supposed to obtain between specific, localized items, e.g., a brick breaking a window, whereas the relations that appear in the fundamental laws include widespread spacetime regions, such as an entire Cauchy surface or an entire past light cone, as relata. The all-at-once view of laws fits particularly well with Neo-Russellianism:

> […] if the 'all-at-once' view of lawhood is accepted then there probably can't be anything like causal structure at the most fundamental level, since events determined by all-at-once laws will typically depend on one another in a reciprocal fashion so there will be no asymmetrical causal relations to be found. But the absence of specifically *causal* structure need not defeat the modal structure approach to lawhood, because of course there could still be more general modal structure in the all-at-once setting (e.g. relations like metaphysical necessitation or ontological dependence), and therefore it should be a priority for proponents of modal structure to develop an account of these more general possibilities (Adlam 2022, p. 12).

Likewise, Chen and Goldstein (2022, p. 24) write, "temporally asymmetric relations such as causation and dynamic production are not constitutive of how laws govern" and that they "do not think causal fundamentalism is true." (Chen and Goldstein do say that their rejection of causal fundamentalism is logically independent of their view about laws.) If causation is merely a derivative feature of physical reality, then it's not plausible for the universe to have had a cause. Hence, Neo-Russellians have good reason to deny the MCP, while still accepting the MEUH.

To be sure, the all-at-once view of laws and Neo-Russellianism are controversial and the all-at-once view of laws is currently a minority position in philosophy of physics. I find their combination attractive, have defended it against criticisms elsewhere (Linford 2025), and I think their combination suggests a plausible case for the MEUH. However, as I have also discussed, there are other reasons for endorsing the MEUH, such as the role that the MEUH plays in avoiding skeptical scenarios. For that reason, the case for the MEUH does not stand or fall with the all-at-once view of laws.

Having discussed some considerations in favor of the MEUH, I turn to discussing reasons the MEUH is superior to the MCP. The first involves the fact that the MEUH provides a better explanation of our scientific practices than does the MCP. Prior to relativistic cosmology, the universe's origin was generally thought to lie beyond the scope of scientific inquiry. Since the beginning of time cannot be directly observed, any particular starting point would have seemed arbitrary. For example, on the Newtonian conception, space and time are a fixed stage over which matter is distributed. Time could always be imagined to extend further into the past, regardless of the matter distribution. Since we can only observe the matter distribution, the Newtonian conception entails that our observations are more or less irrelevant for determining whether time began.

Suppose that pre-relativistic physicists had discovered that all observed objects have a maximum age of fourteen billion years. One explanation might have been that time itself began fourteen billion years ago; another, that no surviving objects predate a catastrophic event that took place fourteen billion years ago; and a third, that our age estimates are systematically mistaken, and the universe is younger than it appears.

To confidently conclude that time began fourteen billion years ago, we need a strong link between the matter-energy distribution and the spacetime structure. General Relativity provides this link. In General Relativity, matter-energy tells spacetime how to bend and spacetime tells matter-energy how to move. If spacetime is maximally extended, then spacetime can have a boundary only when spacetime cannot, as a matter of physical law, be continued further. Remember: there are some spacetimes whose geometry prevents an extension. In classical, singular Big Bang models, the spacetime curvature becomes infinite in the finite past; spacetime cannot be continued beyond the singularity. Moreover, since spacetime and matter-energy are closely coupled, provided we know enough about the matter-energy distribution and General Relativity (or something like it) is a final theory of gravity, we could indirectly infer that spacetime becomes singular. Ergo, General Relativity opened the possibility that the universe's origin is a scientific matter after all.[17]

Here is one way to illustrate the difference General Relativity makes. In early studies of the Big Bang, the universe was studied using the FLRW equations. Newtonian gravity turns out to include analogous equations; in some cases, the Newtonian and relativistic equations are structurally identical. However, there is an important difference between the Newtonian and relativistic cases. In General Relativity, the gravitational field is one and the same thing as spacetime. If the gravitational field has a boundary, so, too, spacetime has a boundary. This is not so in Newtonian gravity. In Newtonian gravity, the Big Bang singularity is a single instant where the gravitational field is undefined; unlike the General Relativistic case, spacetime can be continued, without problem, beyond the singularity and infinitely into the past. Perhaps one could object that spacetime should be truncated at the instant the gravitational field becomes undefined. However, doing so is contrary to the practice generally employed in classical field theories. For example, in classical electromagnetism, the electric field is undefined at all of the points within a charged plane, but well-defined outside. We don't say that spacetime ends at charged planes. Hence, spacetime does not generally end at a singularity in a field.[18]

If the gravitational field just is spacetime, any point missing from the gravitational field is missing from spacetime. Hence, the possibility arises that we can infer, from observations of and assumptions about the matter-energy distribution, that spacetime has a boundary. Moreover, the boundary is not arbitrary, as it is in an Omphalos universe; the boundary – should one exist – is mandated by physical law.

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[17] There's good reason for thinking that we do not, and might not ever, know enough about the matter-energy distribution for inferring that spacetime has such a boundary, and that General Relativity is not a final theory of gravity. What's offered with one hand is taken away with the other.

[18] This point can be illustrated with other examples. The electric field of a single charge is singular, even though spacetime does not come to an end at the location of the charge, while, in the corresponding relativistic spacetime, i.e., Schwarzschild spacetime, a point is missing from spacetime. There are some contexts in General Relativity where the matter-energy distribution is singular, but the gravitational field, that is, the metric tensor, is non-singular. For example, a flat spacetime region can be smoothly connected to an exterior Schwarzschild region through an infinitesimally thin shell (Poisson 2004, pp. 93-94). Arguably, such cases more closely resemble the plane of charge in Maxwellian electrodynamics than does the FLRW singularity. None of the points are missing from spacetime in either the plane of charge or the thin shell.

The various singularity theorems beloved by friends of the Kalam Cosmological Argument – such as the Hawking-Penrose theorems or the Borde-Guth-Vilenkin theorem – and often utilized as part of the scientific case for the beginning of the universe, assume that spacetime is maximally extended. Because the precise definition of 'spacetime singularity' remains controversial (Earman 1995; Curiel 1999, 2021; Joshi 2014), the singularity theorems do not conclusively prove the existence of a singularity in the models to which they apply. Instead, the theorems prove geodesic incompleteness, an important (though weaker) condition for diagnosing whether the entirety of a spacetime model has a past singular boundary (Geroch 1970, pp. 263-4; Earman 1995, pp. 33-40; Penrose 2002, pp. 1154-5).[19] A *geodesic* is a trajectory that a particle follows when subject to no forces other than gravity. Spacetime is *geodesically incomplete* when at least one geodesic ends at some finite location. However, this condition is only diagnostic for singularities provided that spacetime is maximally extended; if spacetime comes to an abrupt, arbitrary boundary in (for example) the past – as in Omphalos universes – then spacetime is geodesically incomplete without being singular.

Let's turn to the second reason the MEUH is superior to the MCP, that is, the MEUH has far broader application than does the MCP. The skeptical scenarios posed by Omphalos universes involve the universe being far younger than it appears. However, as already discussed, other truncations of spacetime lead to their own skeptical scenarios. Spacetime could arbitrarily come to an end tomorrow or two feet to my left. While the MCP cannot address this issue, the MEUH can. Moreover, for the MCP to be applicable, spacetime must have a beginning. Whether spacetime began turns on whether a consistent and objective direction of time is definable throughout all of spacetime. Solutions to the EFE do not inherently include a past-to-future direction, though such a direction can sometimes be added. Some spacetimes – for example, those that are not time-orientable – have topologies precluding even the possibility of adding a past-to-future direction. The MEUH applies regardless of whether spacetime includes a past-to-future direction.

Now, the third reason the MEUH is superior to the MCP. The MEUH can do its explanatory work without assuming theism, while the MCP's ability to tell us that we do not inhabit an Omphalos universe is parasitic on theism.

One could object that, according to some philosophers, spacetime does not need to be maximally extended. If they are right, then the MEUH is false. For example, consider Misner spacetime. (This example was previously considered in (Manchak 2017).) Misner spacetime contains a globally hyperbolic region. If there is a law of nature according to which spacetime must be globally hyperbolic, then the globally hyperbolic region of Misner spacetime might be possible, but not maximally extended Misner spacetime. However, we could modify the principle that spacetime must be maximally extended. Perhaps spacetime must be maximally GH-extended, that is, spacetime must be as large as global hyperbolicity allows. In that case, we

[19] Some spacetimes include a region isometric to a region from a singular FLRW spacetime, and so are bounded to the past by a Big Bang singularity, but also include regions that are not at all bounded to the past. One example is the time reversed Oppenheimer-Snyder model (Poisson 2004, p. 90-92), where an interior FLRW region is matched to an exterior Schwarzschild region. The various singularity theorems entail that the FLRW region is singular, but do not have consequences for the exterior, which is non-singular.

can suitably modify the MEUH; so long as spacetime must be as large as it can be with respect to whatever laws constrain spacetime, we can construct a corresponding modification of the MEUH.[20]

Some readers may find the view that there is a law that spacetime must be globally hyperbolic attractive. For example, readers attracted to the Principle of Sufficient Reason may dislike the strong indeterminism that appears without global hyperbolicity. Other readers may have felt dismayed when I discussed the incompatibility between naive determinism and General Relativity. But good news: globally hyperbolic spacetimes are close siblings to the world as the naive determinist imagines it. Globally hyperbolic spacetimes can be cut into a series of three-dimensional geometries – *Cauchy surfaces* – such that the features on any one determine the features on all of the others. In that case, on an anti-Humean account of laws, any one Cauchy surface could necessitate the rest of spacetime being as large as it can possibly be.

So far, I've shown that multiple considerations favor the MEUH, that the MEUH can do the same explanatory work as the MCP, and that the MEUH can do additional explanatory work not offered by the MCP. I now turn to showing that the MEUH is not vulnerable to the objections Lu makes to views denying the MCP.

Lu summarizes three arguments, previously offered by William Lane Craig, for thinking that anything that begins to exist has a cause. First, there is an argument based on the "a priori metaphysical intuition that something cannot come into being from nothing" (Lu 2025, p. 239). This metaphysical intuition is not universally shared. Those who don't share the intuition will not find this argument convincing. Moreover, Neo-Russellians and other friends of the MEUH can endorse a closely related intuition, i.e., that everything happens for a sufficient reason. Independent of the MCP, truncated universes involve a violation of that principle by including a boundary for which there is no sufficient reason, while maximally extended universes do not. Second, one can ask why, if something can come into existence uncaused, only universes do so (Lu 2025, p. 239). Friends of the MEUH can reject that only universes come into existence uncaused. Friends of the MEUH can say that whatever comes into existence uncaused must be consistent with physical law. Arbitrary entities coming into existence at arbitrary places and times would violate physical law. Third, one could argue that our ordinary and scientific experience constantly confirms the empirical generalization that anything that begins to exist has a cause (Lu 2025, p. 239-240). Friends of the MEUH need not endorse that our scientific experience has constantly confirmed that empirical generalization. Neo-Russellians, specifically, would disagree; on their view, the principle is inconsistent with our experience in fundamental physics.

Lu argues that, for the ISOU to be constrained, the initial state must be differentiated from other states of the universe. Lu considers three ways the ISOU could be differentiated from other states of the universe. Consider the first two. First, a property of the ISOU could differentiate it from other states. Lu adopts an argument from Andrew Loke, that is, that any property the ISOU has would be had in the concrete only after the ISOU has already begun to exist. And that's too late in the explanatory chain to explain why the

[20] Whether we can identify the laws that do govern spacetime is a different story. Manchak (2017) has argued that, plausibly, we cannot.

ISOU exists. Second, Lu (2025, p. 246) considers the possibility that “a pre-existing entity [prevents] other universe states from beginning to exist uncaused”. Lu argues that if the ISOU is the first concrete item, then there couldn’t be a pre-existing item preventing other universe states from beginning to exist uncaused. MEUH proponents find neither convincing.

In reply to the first, the properties of an item are not too late in the explanatory chain to prevent that item from beginning to exist. A house cannot be, at once, white and black all over; a white-and-black-all-over house has metaphysically impossible properties. Likewise, according to the MEUH, the initial portion of the universe must be the initial portion of a maximally extended spacetime. As for the second argument, friends of the MEUH may have independent reason to think that there is a pre-existing item that prevents other universe states from beginning to exist uncaused. For example, on some anti-Humean accounts of laws, such as Chen and Goldstein’s, laws are irreducible, atemporal entities; a law could be explanatorily prior to the initial portion without anything concrete existing before the initial portion. Furthermore, on the all-at-once view of laws, features of the universe that constrain the initial portion can be metaphysically, but not temporally, prior to the initial portion. For example, a subsequent spacetime region could constrain the initial portion.

Lu considers the possibility that there is “some other non-causal explanation” for the ISOU. I don’t have space here to object to the replies Lu cites by Weaver (2018) and Loke (2023). However, one of Lu’s additional arguments for thinking that only a cause could constrain the ISOU is worth discussing.

Lu discusses the possibility that structural constraints explain why only the ISOU, and not other universe states, begins to exist uncaused. Lu argues that structural constraints dictate not only the possible ISOU, but also which universes could possibly exist. Lu then writes, “Objectors need to posit examples of explanations from structural constraints (or other forms of non-causal explanations) which specifically limit the ability of beginning to exist uncaused to only certain possible universe states.” Ironically, Lu’s MCP fails in an analogous way. Lu needs to show that the cause of the universe constrains the initial portion of the universe. The MCP doesn’t provide such a constraint, and the fact that a more specific, independently motivated hypothesis might do so is insufficient.[21] In contrast, the MEUH *does* constrain the initial portion of the universe.

In sum, there are several reasons one might endorse an important rival of the MCP, that is, the MEUH. First, the MEUH can do the explanatory work claimed for the MCP and more. Second, the MEUH is supported by metaphysical principles many philosophers endorse, such as the principle of sufficient reason. Third, the MEUH explains why profitable scientific inquiry can assume that spacetime is maximally extended. Fourth, some anti-Humean accounts of laws, such as the “all-at-once” account, plausibly support the MEUH. Fifth, while the MCP is likely either false or inapplicable on the “all-at-once” account, the MEUH could still be true. Sixth, the MEUH helps to rule out skeptical scenarios the MCP cannot rule out.

[21] To see why this is so, suppose that a hypothesis can be written as a long disjunction of mutually incompatible hypotheses, e.g., all the ways that the universe could be caused to exist. And suppose some datum was probable, given one of the disjuncts, e.g., the universe began with some feature given that the universe was created by God. In that case, it wouldn’t follow that the datum was probable given the hypothesis.

Seventh, there are a number of reasons the MEUH is superior to the MCP. Lastly, the various objections Lu offers to alternatives to the MCP do not succeed as objections to the MEUH.

5. The Return of the Boltzmann Brain

I've argued that Lu's probabilistic statements are difficult to justify and that there is a simple alternative to the MCP that has a number of advantages. Next, I show that, beginning from a position agnostic about whether we inhabit an Omphalos universe, we cannot empirically determine whether we do. Lu summarizes five methods for measuring the universe's age; can we infer therefrom that we probably live in a cosmogony-friendly universe that began in the deep past? According to a standard, widely recognized argument in the philosophical foundations of statistical mechanics, we cannot; instead, we are faced with a radical skeptical hypothesis tolerable to no one. We should presuppose – not infer – that our universe is not Omphalos.

Various macrophysical processes are temporally asymmetric. For example, released from the corner of a room, a gas expands to fill the room. Why? There are fewer ways to arrange gas atoms in the room's corner than over the entire room. Given that the atoms begin in the corner, a uniform distribution over the possible states of the gas, and the laws governing the atoms' motion, we can predict that the gas expands to fill the room. However, the laws governing the atoms' motion are time-symmetric. Just as we predict that the gas expands because there are more configurations where the gas has expanded, so, too, we can retrodict that the gas contracted into the corner. The gas contracting into the corner is improbable, but not as improbable as the gas having been in an even smaller configuration in the room's corner at earlier times. Similar arguments apply for time-asymmetric macrophysical processes generally. Supposing a uniform probability distribution over microphysical states, we can understand entropy to represent the number of microphysical states corresponding to a given macrophysical state. There are many more microphysical arrangements of gas atoms over an entire room, so the entropy increases as the gas expands. According to the *Past Hypothesis*, the observable universe was in an extremely low entropy state in the deep past; the ubiquity of time asymmetric macrophysical processes is then a consequence of an entropy gradient over the observable universe's entire history.

Without assuming the Past Hypothesis, knowledge of the past becomes impossible. Knowledge of the past depends on records of the past. Consider the physical conditions that must be fulfilled for a measuring device to form a record, such as a photographic plate. (Here, I am following Albert 2000, p. 117.) When a photograph is taken, the plate undergoes a macrophysical, time-asymmetric transition. This requires a condition among three instants of time. First, the photographic plate must be in its *ready condition*: a relatively low entropy macrostate where a clean, unexposed plate has been loaded into the camera and the shutter has been cocked. Second, the shutter's trigger is pulled, the shutter opens, the plate is exposed, and undergoes an irreversible chemical transformation. Third, the shutter is closed again, and the plate is stored with higher entropy. We can infer the intermediate image-forming stage only because of the entropy gradient between the first and third stages. Given only the third stage, the laws, and a uniform distribution over microphysical states, it is far more probable that the photographic plate fluctuated into the third stage than that the photographic plate carries a genuine record.

To be clear, given only the laws and a uniform distribution over microphysical states, the photographic plate fluctuating into the third stage is stupendously improbable. Hence, given only the laws and the uniform distribution, we shouldn't predict the plate to be in the third stage. However, given only the laws, the uniform distribution, and that the plate *is* in the third stage, the plate is far more probable to have fluctuated into that stage than to carry a genuine record.

Just as we know the plate carries a genuine record only because we know the photographic plate began in its ready condition, any record of the photographic plate's ready condition requires an even lower entropy macrostate further in the past. In turn, this information requires a second recording device, one that recorded the ready condition of the photographic plate. A past regress ensues:

> But how is it that the ready condition of this *second* device (that is, the one whose *present* condition is the *record* of that *first* device's ready condition) is established? And so on (obviously) ad infinitum. There must (in order to get all this off the ground) be something we can be in a position to *assume* about some other time – something of which we *have* no record; something which cannot be inferred from the present by means of prediction/retrodiction – the mother (as it were) of all ready conditions. And this mother must be *prior in time* to everything of which we can potentially ever *have* a record, which is to say that it can be nothing other than the initial macrocondition of the universe as a whole (Albert 2000, p. 118).

The Past Hypothesis states that the observable universe once occupied the mother of all ready conditions. Because the Past Hypothesis concerns a time before those recorded by any records, it cannot be inferred through ordinary scientific means. Nor can the Past Hypothesis be retrodicted from present observations; without already assuming the Past Hypothesis, our records – and so all of our scientific data and empirical observations – were vastly more likely to have recently fluctuated into existence than to be genuine records of past events. This is so even if all of our observations agree with one another. Instead of an ordinary scientific inference, we need to rely on something like a transcendental argument, i.e., the Past Hypothesis is a precondition for the possibility of having reliable knowledge of the past in the first place.

Without the Past Hypothesis, what's most probable is the smallest low-entropy region compatible with my present experience. My present experience can be explained by a brain-sized low-entropy region fluctuating into existence for a few seconds. All of my memories – including my memory of writing the previous sections of this paper – are probably hallucinations that fluctuated into existence with my brain. This skeptical scenario – that, given only the laws and the uniform distribution over microphysical states, my experience and memories are most likely the momentary hallucinations of a short-lived brain – is called the *Boltzmann Brain Problem*. Lu has endorsed similar considerations for Omphalos universes; for Lu's case, we end up with the *Boltzmann Universe Problem*, where the entire universe is most probably a spacetime region the size and shape of my brain that only began a moment ago. Nothing about my experience allows me to directly infer, through ordinary scientific means, that I am not a Boltzmann Brain. However, if I am a Boltzmann Brain, then all of the science I think we've discovered – and so all the science that led us to the Boltzmann Brain/Universe Problem in the first place – are illusory. In that case, the belief that I am most likely a Boltzmann Brain cannot be justified. Ergo, the case that I am a Boltzmann Brain is self-defeating (Carroll 2020). This inference – like the one for the Past Hypothesis – is not an ordinary scientific inference; instead, the argument follows from the conditions required for reasoning about the past in the first place.

While the Past Hypothesis entails that the universe is very old, we cannot make inferences about the universe's past without assuming the Past Hypothesis. Given only the laws and a uniform distribution over microphysical states, we would not expect independent measurements to agree on the universe's apparent age. However, given the laws, the uniform distribution, and that independent measurements *do* agree on the universe's age, most likely, the measurements fluctuated into existence only recently and only accidentally agree. To infer that our independent measurements of the universe's age agree *because* they genuinely tell us about the universe's past, we need to assume – not infer – the Past Hypothesis. If we do assume the Past Hypothesis, then we've already assumed that we do not inhabit an Omphalos universe. Consequently, we cannot begin from a position agnostic about whether we inhabit an Omphalos universe; instead, because we have to presuppose the Past Hypothesis, we must also presuppose that we do not inhabit an Omphalos universe.

6. Conclusion

Lu has argued that if the universe could have begun without a cause, then the universe most probably began recently, with the appearance of age, and hence, our various cosmological measurements should not mutually agree with one another. I've offered several objections. First, there were several difficulties in the way that Lu applies confirmation theory. These difficulties included that a natural variable, suitable for Lu's purposes, is difficult to identify and, for that reason, a probability distribution or measure is difficult to identify. Supposing that the difficulties in Lu's application of the restricted Principle of Indifference can be overcome, the probability that the universe is cosmogony-friendly, given an Omphalos universe, and the probability that the universe is cosmogony-friendly, given an old universe, are both 1. For that reason, Lu's argument that cosmogony-friendliness supports a cause of the universe does not succeed. I examined various ways Lu could modify his arguments, but those modifications do not help either. Furthermore, while Lu argues that a skeptical scenario cannot be overcome without the MCP, I've shown a simple alternative hypothesis, the MEUH, avoids that scenario. Moreover, the MEUH has a number of arguments in its favor; for example, the MEUH helps us to overcome skeptical scenarios the MCP cannot be used to overcome and explains why profitable scientific inquiry can often assume that spacetime is maximally extended. While I don't claim to know whether the MEUH is true, as long as the MEUH is a superior live option, we don't have a good reason to endorse the MCP. Lastly, I discussed how a well-known argument implies that we cannot begin from an agnostic position and infer whether we inhabit an Omphalos universe. Instead, we must presuppose that we do not inhabit an Omphalos universe, or else be stuck in a skeptical scenario acceptable to no one.

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8. References

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