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The Inherent Logic in the Idea of the Multiverse

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The idea of the multiverse, likely difficult to prove in traditional scientific ways, may be bolstered by two arguments from the field of logic. This article, contextualized by the metaphorical, non-logical approaches to the multiverse and situating itself within the history of astronomy, explicates these two arguments from logic. The first argument relates to the implicit illogical vanity in the assumption that our presently-known universe is special. In other words, it may be somewhat logical to embrace the history of deanthropomorphism more fully in the light of the Big Bang and the theory of cosmic inflation. The second argument suggests resolution to the long-standing philosophical and logical mysteries associated with the anthropic principle, as well as the attendant use of Ockham's razor as a logical tool. The problem of evidence and falsifiability is briefly implicated, as well as some consequences for apologetics.

***Keywords*:** Multiverse, logic, anthropomorphism, design, apologetics, Ockham's razor.

Внутренняя логика в идее мультивселенной

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Идея мультивселенной, которую, вероятно, трудно доказать традиционными научными способами, может быть подкреплена двумя аргументами из области логики. В этой статье, где приведены метафорические, не-логические подходы к мультивселенной, рассматриваются два аргумента из логики в контексте истории астрономии. Первый аргумент связан с неявным нелогичным тщеславием в предположении, что наша ныне известная вселенная особенная. Иными словами, возможно, стоит более полно охватить историю деантропоморфизма в свете Большого взрыва и теории космической инфляции. Второй аргумент предлагает решение давних философских и логических загадок, связанных с антропным принципом, а также сопутствующее использование "бритвы Оккама" в качестве логического инструмента. В статье вкратце рассматривается проблема доказательств и опровержимости, а также некоторые последствия для апологетики.

***Ключевые слова*:** мультивселенная, логика, антропоморфизм, творение, апологетика, бритва Оккама

The extensive history of post-Copernicanism is outside the scope of this article. However, many have described how society experienced a consistent trend away from anthropomorphism after Copernicus refocused modern attention on heliocentrism in 1543. In summary, the first six features of the post-Copernican aftermath became logically deanthropormorphic: The cosmos is older than first thought, as well as bigger, non-teleological, uncentred, locally finite, and inconstant in all its regions. All six of these commonly-described features tended to make researchers realize that humanity might not be crucial to the larger picture. For the cosmos is huge compared to its investigators; secondly, it is also much older than their brief and recent arrival. Furthermore, it does not seem to have a purpose; if it has a purpose, that purpose may not be taking *homo sapiens* into account. Fourth, the human race, along with this planet's sun, solar system, and galaxy, are now demonstrably not at the centre of the cosmization process. The present species and its habitation, fifth, also has no permanence; everything, at least in the more immediate vicinity, appears to be finite, with even our sun burning itself out. And sixth, change is everywhere, not just in this local spot.

This article is about logic in the multiverse debate. The theoretical prospect of multiple universes, a seventh and perhaps climactic consequence of post-Copernican cosmization, is arguably not much more than the ultimate logical step in the overall drift away from anthropomorphism. As Dąbrowski said, "While one may consider the studies related to the concept of the Multiverse as a new revolution that can change the current paradigm in cosmology, in fact, it can rather be understood as the next step in the Copernican transit, where our habitat has gradually lost relevance as unique, special, and also tiny as compared to early science ages thought" [Dąbrowski, 2020, p. 1].

Sceptics can object that there is no direct evidence for the chaotic generation of a plethora of universes. This hesitation is understandable. Some might object, as Kitty Ferguson puts it: "If all this [multiverse generativity] is taking place, shouldn't we be able to notice it?" Ferguson then explains that the answer is negative: "The inflation happens so rapidly that the regions and sub-regions and sub-sub-regions, etc., become immediately independent of one another" [Ferguson, 2017, p. 173]. Direct evidence for a multiverse may thus forever elude scientists. And yet there are various aspects of logic that can set astronomers and physicists into this multiverse direction partly because the theoretical construction is consistent within the lengthy historical drift towards deanthropomorphism. This article will pursue these logical angles, especially two arguments. As Darwin forthrightly demurred when countering the persistence of anthropomorphism: "Man in his arrogance thinks himself a great work, worthy the interposition of a deity" [Weiner, 1995, p. 281]

Danielson summarizes the deanthropormorphic trajectory by saying one can discern "a familiar pattern in the history of cosmology, namely

the ‘pluralizing’ of a concept that initially did not admit of a plural; from earth to ‘earths’; from sun to ‘suns’; from the galaxy to ‘galaxies’; and now… from the universe to ‘universes’” [Danielson, 2001, p. 477, 478]. This trend line, where researchers notice the advisability of pluralizing, is one of many suggestive metaphors alongside the logical pathway of deanthropomorphism. The human race may have lost its last tether for supporting any form of intellectual arrogance: Not even its currently inhabited universe is necessarily a one-of, special, unique, preeminent, distinguished.

a) Various Metaphors and Poetic Ways of Describing the Multiverse

Although this article will be dealing, consequently, with these matters of logic – especially two main arguments – it may be helpful to delve first into some of the metaphorical ways of speaking that have emerged. Metaphors are not strictly logical. The multiverse debate, after all, with its extensive range of books and journal articles in the last few decades, is an idea which “clearly challenges the epistemological boundaries of science, and so enters into the grey zone where physics meets philosophy” [Alonso-Serrano, 2019, p. 20]. Some critics warn, in fact, that this metaphorical grey zone for theoretical physics is potentially “a no-man's-land between mathematics, physics and philosophy that does not truly meet the requirements of any” [Ellis, 2011, pp. 294–295]. What is the difference between metaphor and logical speculation? Some scientists argue that “the multiverse cannot be considered a scientific theory, but should at most be included in the field of metaphysics” [Alonso-Serrano, 2019, p. 19]. Prominent scholars in the field struggle to find the best term for the multiverse; Leonard Susskind, for example, says he tried “polyverse, googolplexus, polyplexus, and googolverse, without success. I eventually settled on megaverse…” [Susskind, 2006, p. 377]. Max Tegmark speaks of a hierarchy, four different levels of multiverse potentiality:

> By our universe, I mean the spherical region of space from which light has had time to reach us during the 13.7 billion years since our big bang. When talking about parallel universes, I find it useful to distinguish between four different levels: Level I (other such regions far away in space where the apparent laws of physics are the same, but where history played out differently because things started out differently), Level II (regions of space where even the apparent laws of physics are different), Level III (parallel worlds elsewhere in the so-called Hilbert space where quantum reality plays out), and Level IV (totally disconnected realities governed by different mathematical equations) [Tegmark, 2011].

Scholars have used diverse, colorful, and poetic phrases for evoking the imagery of the multiverse, the "many nuggets" [Greene, 2004, p. 320, 321]. Perhaps our universe, says Lawrence Krauss, "is rather like a tear buried in a vast multiversal ocean of possibilities" [Krauss, 2012, p. 138]. Paul Davies says that what is usually regarded as *The* universe might in fact be only a disconnected fragment of spacetime [Davies, 1986, p. 42]. Ours could be just one of a potentially infinite family [Krauss, 2012, p. 129]. There could be many embryo universes [Danielson, 2001, p. 466] or other variations on universes that sprout [Rees, 2000, p. 168–170]. We may need to envision "a great cosmic web" (Temming; Siegfried, 2019]. Perhaps universes come in pairs, Universe/anti-universe, much like matter and anti-matter [Robles-Perez, 2019].

String theorists such as Susskind speak of a Landscape, a theoretical construction within which to postulate the various strings of universe reality. The Landscape itself is not real, but the alleged universes are likely actual. He refers, thus, to "A Landscape of possibilities populated by a megaverse of actualities" [Susskind, 2006, p. 377]. This entire realm of speculation that uses metaphor opens up the bizarre possibility "that physics, at some fundamental level, is merely an environmental science" [Krauss, 2012, p. 175] since it deals only with the one universe researchers currently occupy and therefore happen to know somewhat. But investigators can imagine daughter universes emerging like a bubble from within the confines of a parent universe [Davies, 1986, p. 41] so that the entire cosmological escapade becomes a type of self-replicating infinite adventure [Krauss, 2012, p. 176] with this present one being only "one bubble in a vast cosmic fizz" or "one of many 3-D domains stacked, like pages of a book, in higher dimensional space" [Temming, Siegfried, 2019]. Stephen Weinberg refers to pocket universes [Holt, 2012, p. 159], a term first coined by Alan Guth [Susskind, 2006, p. 353]. "Each pocket has its own 'weather': its own list of elementary particles, forces, and constants of physics" [Ibid., p. 14]. "Fluctuations may spawn new domains", says Martin Rees; "Space may have a kind of lattice structure, or be knotted rather like chain-mail" [Rees, 2000, p. 158]. He also describes our present cosmos as a possible oasis in a broader landscape of other universes. [Ibid., p. 177]. Geoffrey Chew uses the deft phrase "nuclear democracy" [Polkinghorne, 2006, p. 18]. For Smolin, analogous to Darwinian terminology, we should perhaps speak of diverse *species* of universes [Danielson, 2001, p. 477, 478].

In 1956, John Wheeler had introduced the metaphorical idea of 'quantum wormholes', and by the late 1980's Stephen Hawking was making "mental excursions through these wormholes, and finding 'baby universes' at the other end" [Ferguson, 2017, p. 150]. "It's possible, declared Hawking, that our own universe began as a bulge from the side of another. It may be part of an infinite labyrinth of universes, branching off and joining one another like a never-ending honeycomb…" [Ibid., p. 152].

Logic and metaphor are not always mutually exclusive forms of rhetoric. In sum, when trying to describe this new concept of a cosmos intertwined with multiplicity and an ongoing infinite process of generativity "The prosaic word 'multiverse' fails dismally to capture this vast panoply of universes" [Ferguson, 2017, p. 227]. But the resulting variety of metaphorical language should not distract readers from the two key logical aspects of the argument which this article will elucidate.

b) The Multiverse: Not the Same As the Logical Idea of Life in Other Places in This Universe

The concept of a multiverse is not technically the same as the theorization about other life forms, communicative or non-communicative, on other habitable exoplanets or moons within our currently known universe. However, this entire topic, veritably centuries-long and including the numerous complications of the Drake Equation, is outside the scope of this article.

c) The More Radical Concept in the Logic of a Multiverse

Reflecting on the radical nature of this more modern multiverse concept, Brian Greene notes the following logic: "As these other universes would likely be forever separate from ours, it's hard to imagine how we would ever establish whether this 'multiverse' picture is true. However, as a conceptual framework, it's both rich and tantalizing… it suggests a possible shift in how we think about cosmology" [Greene, 2004, p. 320, 321]. This cosmological shift is arguably quite huge; Rees points out that "This new concept is, potentially, as drastic an enlargement of our cosmic perspective as the shift from pre-Copernican ideas… Our entire universe may be just one element – one atom, as it were – in an infinite ensemble: a cosmic archipelago. Each universe starts with its own big bang, acquires a distinctive imprint…" [Danielson, 2001, p. 465].

It could be suggested, in fact, that the logical notion of a multiverse, as a final step in the trajectory of deanthropomorphism, is even more revolutionary than the seed planted by Copernicus. Although science often likes to compare items analytically, most astronomers and physicists after Copernicus had still intuitively accepted that the universe itself could not be compared to something else. But the multiverse idea, if eventually helpful, would thus end up contravening a foundational pillar of the earlier

Copernicus. As Timothy Ferris points out "It is often said that the central problem of cosmology itself is that we have but a single universe to examine" [Ferris, 1988, p. 369]. But this rational assumption, that we do indeed have nothing to compare to this presently-known universe, is a decidedly real conundrum. Pierre Laplace, one sees in hindsight, may have been misguided when he praised Newton by saying: "Newton was not only the greatest genius that ever had existed, but also the most fortunate; inasmuch as there is but one universe, and it can therefore happen to but one man in the world's history to be the interpreter of its laws" [Burtt, 1924, p. 31]. To the contrary; in light of multiverse theory, it now seems Newton may have uncovered only a few locally significant regulations. Once the notion of a multiverse begins to percolate, in other words, the assumption that investigators have only one universe to ponder can almost sound naïve, as in the mouth of G.K. Chesterton: "The universe is a single jewel… This cosmos is indeed without peer and without price. For there cannot be another one" [Danielson, 2001, p. 349]. Is it true that there cannot be another one? The negative way to state the problem of the radical repositioning engendered by multiverse theory is to say, with Michael Heller, that physics "is wretchedly restricted to the visible horizon of our local universe…" [Heller, 2019].

But what if there actually is or was or will be another universe? Or billions and trillions or *squillions* [Barnes, Lewis, 2014], with each of them infinitely coughing up more?

d) First of Two Logical Considerations: Multiverse Within the Trend Towards Deanthropomorphism

When one places this radical concept of the multiverse within that broader context of a trend towards deanthropomorphism, the first logical consideration becomes the following question: Is it not simple human vanity which would make investigators assume that *their* Big Bang is the *only* Big Bang that has ever happened? Logic suggests commonalities.

When astrophysicists survey the incredible pools of energy that exist within the sights of the Hubble Telescope, including star factories, black holes, supernovae, inter-galactic collisions, and gravitational burps, what creates a limited intellectual concept like *The* Big Bang other than the same anthropomorphic instinct that has already been thoroughly undermined by the first six aspects of post-Copernicanism (bigger, older, non-teleological, un-centred, locally finite, inconstant)? As Jim Holt put it: "Universe-engendering explosions like the Big Bang should be a fairly routine occurrence. (As one friend of mine observed, it would be very odd if the Big Bang came with a label that said 'THIS MECHANISM OPERATED ONLY ONCE.')" [Holt, 2012, p. 84. *Capitals in original*]. Stephen Hawking

once speculated that "a sufficiently large, rotating black hole might provide a one-way passage to another universe" [Ferguson, 2017, p. 290].

If one considers this logic in the context of former religious language, the question becomes: If the Big Bang was not a *creatio ex nihilo* engendered by an ontologically different form of existence such as a Divinity – something difficult to posit logically – then the Big Bang must have been engendered by an ontologically similar form of existence such as a previous or parallel universe – something less difficult to imagine logically. Although resisting anthropomorphism is not logically required, embracing deanthropomorphism more radically is not illogical. In other words, it may be somewhat logical to embrace the history of deanthropomorphism more fully in the light of the Big Bang and the theory of cosmic inflation. The fact that various computations are possible for Einstein's field equations demonstrates the theoretical viability of the logical resolution:

One may ask the question: do we really need the vast amount of universes in the form of the multiverse? In order to answer this question let us notice that the classical cosmology (based on the Einstein field equations) selects only one solution (our universe) out of an infinite number of solutions (aleph-one number of solutions equal to the set of real numbers). On the other hand, quantum cosmology needs all the classical solutions to be present in the quantum solution which is the wave function of the universe in order to get the probability of creating one universe. Then, in classical cosmology, one needs some initial conditions as a physical law to resolve the problem of choosing "this" solution (our universe) and not "that" solution (other universe), while in quantum cosmology all the initial points (classical solutions) are present in the quantum solution, and there is no need for any initial conditions to be introduced as an extra law [Dąbrowski, 2019].

The Big Bang theory may have seemed to some of its early adopters like a perfect validation of the *creatio ex nihilo* presented within various world religions. But with the advent of multiverse conceptions, the creation story is inadvertently subsumed and neutralized. If the Big Bang was not actually a singularity, then it may represent "the lawful emergence of a new universe from a previously existing one. In that case, it would be superfluous to invoke God to explain the emergence of something from nothing" [Goldstein, 2011, p. 455]. We now inherit, consequently, a new theoretical situation: The Big Bang did indeed cause a massive and visible expansionary inflation, but – counterintuitively – "rather than inflation's being incorporated into the standard big bang theory, in this [multiverse] approach the standard big bang would be incorporated into inflation" [Greene, 2004, p. 321].

In the inflationary scenario, our universe – the one that suddenly popped into existence some 14 billion years ago – bubbled out of the spacetime of a pre-existing universe. Instead of being all of physical

reality, it's just an infinitesimal part of an ever-reproducing 'multiverse'. Although each of the bubble universes within this multiverse had a definite beginning in time, the entire self-replicating ensemble may be infinitely old. The eternity that seemed lost with the discovery of the Big Bang is thus regained [Holt, 2012, p. 84].

Andrei Linde proposed a theory in the 1980's called chaotic inflation which predicted that Big Bangs ought, in principle, to be fairly common [Ibid., p. 166]. What researchers call the universe, explains Rees – something which is basically just the aftermath of our own *local* Big Bang – "may be just one of a whole ensemble, each one maybe starting with its own Big Bang… this then demands a new word, the 'multiverse', for the entire ensemble of 'universes'…" [Rees, 2000, p. 147, 148]. "A few physicists, notably Stephen Hawking, have argued that a remarkably simple primeval state of the universe is, in fact, to be expected… An example of a singularity is the infinitely dense, infinitely compact state that marked the beginning of the big bang. Singularities are also expected to occur inside black holes and perhaps elsewhere as well" [Davies, 1986, p. 55]. The cosmos is certainly known to contain objects "that have collapsed, 'puncturing' space and cutting themselves off from the external universe" [Rees, 2000, p. 39, 40].

According to Alan Guth, "Conceivably, every time a giant star goes supernova and its remnant collapses to form a black hole it might give birth to a new universe, on the other side of space and time" [Ferris, 1988, p. 361]. This may sound speculative, but is also a merely logical consideration. For Lee Smolin, black holes might simply be "locations for new big bangs" [Danielson, 2001, p. 474]. Totally aside from documentary evidence for separate universes – something researchers admittedly do not presently possess and are perhaps unlikely to find – this type of theorizing is nevertheless operating on some fertile logical ground within the overarching trajectory away from the anthropocentric stance. After all, if it is logically possible, there are likely some intergalactic resource materials to make it doable. As Rees says, "There are many millions of black holes in our galaxy, of about ten solar masses each… Much larger black holes lurk in the centres of galaxies… The stars very close to the centre of our own galaxy are orbiting very fast, as though feeling the gravity of… a black hole with a mass of 2.5 million Suns" [Rees, 2000, p. 39, 40]. Scientists routinely acknowledge that they do not currently know what could be happening inside all these black holes, including the bigger ones at the centre of galaxies as well as all the haphazard smaller ones, but it might be irresponsible to discount the logical notion that they are potentially birthing other domains similar to, comparable to, or quite different from the one *homo sapiens* seems to have been birthed within. New universes, says David Berlinski, could be "bubbling up all the time, each emerging from its own black hole and each provided with its own set of physical laws" [Danielson, 2001, p. 497].

The bottom line, returning again to core insights of Einstein, connects the issues of logic and multiverse as follows:

> We (tacitly) assume that the actual universe is described (up to a reasonably good approximation) by a solution to Einstein's field equations, and that any other of its solutions describes a possible universe. Our measurements never single out a unique solution, but rather a class of "nearby" solutions. In this way, the actual universe is placed "in the context" of other universes. Moreover, in cosmology, this strategy has been exploited in a systematic manner and expanded to the form of a specialized field of research. The space of all solutions to Einstein's equation has even merited a special name: the ensemble of universes (or the ensemble, for short) [Heller, 2019].

Within these broad permissions granted by logic, there are of course entertaining side-trails. For example: Perhaps there are many Black Holes that explode into a sort of dud; nothing materializes; they are "dead ends", as Susskind puts it [Susskind, 2006, p. 346]. That is also a logical thought. There may be universes with completely other sets of parameters and dynamics than our own. "Each island universe can have different physical laws and fundamentals" [Scoles, 2016]. Behind the Event Horizon (EH) of a black hole, nothing can emerge. Not even light itself can escape from the gravitational pull of the black hole. But if light goes into the black hole on one end, perhaps it is logical to imagine it coming out from a sort of "white hole" on the other end [Tyson, 2016]. Just as it did for planet Earth and the human race? As John Caputo puts it, "The astrophysicists… tell us of the precariousness of our situation, that we are cosmic accidents, that if we went back to the Big Bang and started all over again, we might not get the same results, might not get this solar system or this bluish spaceship Earth, or any of its inhabitants" [Caputo, 2013, p. 229, 230].

To be sure: If there are an infinite number of universes, exploding constantly into violent superabundance like fireworks that spew out other pyrotechnics, and if scientists will never see any of these other universes, it becomes impossible to compare them. That might seem, but not necessarily, like a daunting objection to logicians. For, as Rees says, regardless of how one frames this, "the ultimate theory might permit a multiverse whose evolution is punctuated by repeated Big Bangs; the underlying physical laws, applying throughout the multiverse, may then permit diversity in the individual universes" [Rees, 2000, p. 174]. Bryson says in a colloquial manner that Big Bangs could be "going on all the time all over the place" [Bryson, 2003, p. 13]. And as Edward Tryon humbly suggests: "I offer the modest proposal that our Universe is simply one of those things that happen from time to time" [Ibid., p. 15]. There could be "a multiplicity of big bangs – a continuous production of universes" [Danielson, 2001, p. 477, 478]. In short, "what we consider to be 'everything' may be but a small constituent of a far richer reality" [Greene, 2004, p. 412].

A variation on this logical theme of multiple universes is the notion of an endless succession of universes, but emerging always from the same one that current investigators now inhabit. This specialized topic, too, is outside the scope of this article. In essence, summarizing that approach, there is only one universe, but it keeps dying and being reborn. "Some scientists, such as the late Cornell astronomer Carl Sagan, suggested that the Big Bang itself succeeded the collapse of a previous cosmos. Our present cosmos might then represent the latest stage in an unending series of collapses and expansions of an ongoing succession of universes" [Young, 2012, p. 34]. The overall picture in this variant model is an oscillating universe in which a period of expansion is followed by a reversal which comes to a halt, "to be followed by cosmic collapse into the cleansing fires of the next big bang" [Ferris, 1988, p. 219].

Many of the debates and writings about the multiverse also delve into the topic of quantum mechanics. That specialized topic, likewise, is also outside the scope of this paper. The realities of quantum mechanics, however, are often held to be theoretically consistent with the logic of a multiverse even if quantum mechanics would not itself insist on such a notion.

In sum, the first logical reason to consider the viability of a multiverse option is because it appears potentially vain to presuppose that *our* Big Bang is the *only* Big Bang that ever occurred. It is consistent with the historical trend line in the logic of deanthropomorphism to be humble about current humanity's meagre version of an originating bang. In other words, repeating the statement in the Abstract, it may be somewhat logical to embrace the history of deanthropomorphism more fully in the light of the Big Bang and the theory of cosmic inflation. Although the multiverse may sound speculative, it is actually somewhat logical to ask questions such as the following: "If general relativity tells us that any star that collapses beyond a certain point must end in a singularity, then doesn't it also tell us that any expanding universe must have begun as a singularity" [Ferguson, 2017, p. 61]? This, in fact, is the type of question Stephen Hawking used to ask: "When a black hole has finally radiated all of its mass away and disappeared, what has actually happened to everything that went into forming the black hole and everything that later fell in" [Ibid., p. 98]? The multiverse might be theoretically possible. It might not be irrational to consider it. The notion may well contain some inherent logic.

e) The Second Major Logical Consideration: Issues with the Anthropic Principle

However – perhaps more significantly – the second logical reason to give some serious attention to the apparently preposterous notion of multiple universes is because the theory addresses an otherwise mystifying

circumstance, often categorized under the phrase *the anthropic principle*: How is it that all sorts of amazing coincidences coalesced from the initial microseconds of the Big Bang to allow this present and quite particular universe to become precisely what it presently is? How did all these remarkable laws of physics get launched in just this way, to result in just this current cauldron of galaxies, stars, planets, moons and people? As Rees puts it, "Among the toughest philosophical conundrums we face in considering the origin and nature of the cosmos is this: Our universe displays an array of characteristics that are mind-numbingly improbable… The hypothesis of the multiverse – of a huge, perhaps infinite ensemble of universes – allows us to behold what looks like a tailor-made universe without concluding that it was purposely made to measure" [Danielson, 2001, p. 464]. Clarifying the impact of this anthropic principle, Jim Holt asks:

> If our universe is but one among a vast ensemble of universes in which such constants varied at random, then isn't it to be expected that some of these universes should have the right mix of constants for life to occur? And as humans, wouldn't we be bound to observe ourselves living in one of the universes whose features happened to be congenial to our existence? Doesn't this 'anthropic principle' make the apparent fine-tuning of our universe wholly unremarkable? And in that case, wouldn't the God hypothesis be unnecessary as an explanation of why we are here [Holt, 2012, p. 98]?

Philip Dowe summarizes the conversation about the anthropic principle as follows: *"The Anthropic Cosmological Principle* [1986] by physicists John Barrow and Frank Tipler, contains numerous examples of the amazing coincidences that are necessary in order for life to evolve… Had the expansion rate been slightly more rapid, stars and heavier elements would never have formed. Had it been slightly slower, the universe would have collapsed long before life could have developed" [Dowe, 2005, p. 149, 150]. Earlier already, Dowe had said, "The term 'anthropic principle' refers to the remarkable connection between the initial conditions and constants of the universe, and the fact that life has arisen in the universe. This remarkable connection requires explanation. Why is our universe fine-tuned for life? Why didn't it have any of the much more likely configurations that would not have produced life" [Ibid., p. 148]?

Everything in present-day life arguably does seem remarkably coincidental. In fact, it often seems downright miraculous, and one does not need to be religious to have that impression. As Leonard Susskind concedes, there are many "thoughtful, intelligent people who look around at the world and have a hard time believing that it was just dumb luck that made the world so accommodating to human beings" [Susskind, 2006, p. 6]. The highly improbable convergence of necessary preconditions is true not only for the cosmos as a whole, but also closer to home,

e.g. the fact that the sun is 93 million miles away, not 92 or 94, both of which would have made life as we know it impossible. History is understandably full of exclamations of amazement. But – and this is one of the logically intriguing features of the multiverse theory – "the 'Coincidence Problem' could… be solved if perhaps the value of the cosmological constant that we measure today were somehow 'anthropically' selected… That is, if somehow there were many universes… Put another way, it is not too surprising to find that we live in a universe in which we can live!" [Krauss, 2012, p. 12]. Or, as Kitty Ferguson puts it: "We don't know how many alternative universes end up producing something like 'us', but we do know it did happen once" [Ferguson, 2017, p. 252].

Historically, there are both *weak* and *strong* versions of the logical arguments regarding the anthropic principle. "The weaker version of the anthropic principle amounts to the trivial and rather obvious claim that since we are here now, the universe must have been such as to allow us to be here. The stronger versions differ from that in that they entail that because we are here, the universe had to be in a certain state, that is, they attempt explanation, not just prediction" [Dowe, 2005, p. 154]. Lying in the background of these issues in logic are still the old metaphysical arguments from Design that emerged during the Enlightenment. Everything seems to have been perfectly put together so that the human race can exist – or, the other possibility in light of multiverse theory – it merely looks like it was designed, but in essence it was just one of many options. *Homo sapiens* happens to look like the optimum configuration for this present option, simply because that species adapted to fit snugly within its parameters. As someone once said: A room filled with invited guests who have all won the Lottery would not technically be amazing; it would simply be an indication that the room is full of invited guests who have all won the Lottery.

As Krauss summarizes the logical aspects of this second argument: "A multiverse, either in the form of a landscape of universes existing in a host of extra dimensions, or in the form of a possibly infinitely replicating set of universes in a three-dimensional space as in the case of eternal inflation, changes the playing field when we think about the creation of our own universe and the conditions that may be required for that to happen" [Krauss, 2012, p. 176]. The multiverse theory, in short, becomes a remarkably different way of sidelining the God question, even if that was never the main motivation for the theory and even while the logic in the theory cites the same amazing coincidences that are often so riveting for those who advocate belief in a Designer. Susskind describes this non-metaphysical way of utilizing the anthropic principle as "the physicist's Darwinism" [Susskind, 2006, p. 11] because the same haphazard randomness in the history of biological speciation is now projected into the field of cosmic generativity. Instead of finding a proof for a God, this secular handling of the anthropic principle simply finds a proof of many possibilities due to very large numbers [Ibid., p. 346]. It is worthwhile

to read attentively of the numerous ironical twists in the following quote as Davies struggles, already four decades ago, with how to process the potential significance of the anthropic principle:

> Only in those universes where the numbers come out just right would life and observers form… Alternatively, the numerical coincidences could be regarded as evidence of design. The delicate fine-tuning in the values of the constants, necessary so that the various different branches of physics can dovetail so felicitously, might be attributed to God. It is hard to resist the impression that the present structure of the universe, apparently so sensitive to minor alterations in the numbers, has been rather carefully thought out. Such a conclusion can, of course, only be subjective. In the end it boils down a question of belief. Is it easier to believe in a cosmic designer than the multiplicity of universes necessary for the weak anthropic principle to work?.. the seemingly miraculous concurrence of numerical values that nature has assigned to her fundamental constants must remain the most compelling evidence for an element of cosmic design [Davies, 1986, p. 189].

This key question – *Is it easier to believe in a cosmic designer than the multiplicity of universes necessary for the weak anthropic principle to work* – is inevitably raised, and it contains a logical component: As Alexander Vilenkin puts it, the multiverse theory is one way which "explains the long-standing mystery of why the constants of nature appear to be fine-tuned for the emergence of life. The reason is that intelligent observers exist only in those rare bubbles in which, by pure chance, the constants happen to be just right for life to evolve. The rest of the multiverse remains barren, but no one is there to complain about that" [Vilenkin, 2011]. Ruth Gregory provides a succinct formulation of Davies' dilemma by stating it in precisely the opposite manner: "If there is only one universe, it would be pretty unlikely that it had turned out just like our own. However, if there are an infinite number of universes, it makes sense that at least one of them would contain life" [Gregory, 2018]. From a purely technical point of view, logic cannot solve all the lingering problems. It remains theoretically possible that everything that was ever made has been made for us to behold. Logic cannot win this debate, but it can clarify that there might be a relevant logical domain apart from purely evidentiary issues.

f) The Use of Ockham's Razor and Its Relation to the Logical Idea of a Multiverse

But are theoreticians simply inventing numerous invisible and unprovable entities in order to help explain what lies before our eyes?

With the conundrum of the logic thus exposed, researchers dive into one of the more curious debates in apologetics that has arisen within

the history of religion and philosophy. Religious believers can understandably ask: Are atheists, positivists, empiricists and methodological naturalists so against the simple and obvious solution – namely, that there is one amazing God who created this one extraordinary universe in the one incredible Big Bang – that they would rather postulate the existence of multiple universes, which can never be seen, demonstrated, or proven, just to get around the apparently thorny obligation of bestowing obeisance towards the Grand Designer? "No need for Plato when you have a multiverse!" [Holt, 2012, p. 207]. As Richard Swinburne says: "To posit a trillion trillion other universes to explain the life-fostering features of our universe seems slightly mad when the much simpler hypothesis of God is available" [Ibid., p. 98]. As Greene says about these paradoxes of logic, the concept of an enormous proliferation of universes is a bizarre solution "that many a detractor has found intolerably exorbitant" [Greene, 2004, p. 207, 208].

This devout hesitation sounds, on the face of it, like a legitimate bewilderment based on logic. Any innocent investigator is naturally astounded by the numerous coincidences that made this current world possible: "The gross features of the present-day universe are highly dependent upon tiny variations in the early universe… If this happened by pure chance, it was very lucky indeed; the odds against it are vanishingly small" [Ferris, 1988, p. 355]. As Davies said "To invoke an infinity of other universes just to explain one is surely carrying excess baggage to cosmic extremes…" [Davies, 1986, p. 173].

Disputants therefore often point out here the relevance of Ockham's razor – the principle of logic that, in general, rhetoricians should seek the simplest solutions and not invent a multitude of convoluted explanations. The notion of a multiverse can easily seem like an exceptionally dense and byzantine option. Sabine Hossenfelder says "Ockham's razor should shave off the multiverse. It's superfluous. Unfortunately, this argument carries little weight among many of today's theoretical physicists who value the multiverse because it excuses boundless speculation" [Hossenfelder, 2018].

However, the issue, logically, is not as clear-cut as it may appear. The notion of multiple universes is, in some ways, less complicated than the notion of a Grand Designer for a single universe. The theory of a multiverse modestly envisions more of what is already known, whereas a Grand Designer immodestly invokes a concept of something Wholly Other. Such an invocation of completely unknown substances is, logically speaking, more complicated than a merely multiplied situation or a situation potentially open to multiplicity. Jim Holt asks, in the context of his conversations with the sophisticated theist Richard Swinburne: "Is this the best that theism can do – cap off its cosmic explanation with an inexplicable being, a Supreme Brute Fact?" [Holt, 2012, p. 108]. As Dowe explains while refuting Davies:

Davies claims that explanations of fine-tuning which appeal to a designer are simpler than multi-world explanations. But in reply to Davies it could be noted that Ockham's razor refers not to how many entities of a certain kind there are, but how many kinds of entities there are. From this perspective, the multi-world hypothesis is superior because it postulates more of the same kind of thing, whereas the design argument postulates a different kind of entity [Dowe, 2005, p. 160].

Richard Dawkins sums up the logic of the situation succinctly:

> It is tempting to think (and many have succumbed) that to postulate a plethora of universes is a profligate luxury which should not be allowed. If we are going to permit the extravagance of a multiverse, so the argument runs, we might as well be hung for a sheep as a lamb and allow a God. Aren't they both equally uparsimonious ad hoc hypotheses, and equally unsatisfactory? People who think that have not had their consciousness raised by natural selection. The key difference between the genuinely extravagant God hypothesis and the apparently extravagant multiverse hypothesis is one of statistical improbability. The multiverse, for all that it is extravagant, is simple. God, or any intelligent, decision-taking calculating agent, would have to be highly improbable in the very same statistical sense as the entities he is supposed to explain. The multiverse may seem extravagant in sheer *number* of universes. But if each one of those universes is simple in its fundamental laws, we are still not postulating anything highly improbable. The very opposite has to be said of any kind of intelligence [Dawkins, 2008, p. 175, 176].

It can certainly be granted, says Rees, that a plethora of universes "may not seem an 'economical' hypothesis – indeed, nothing might seem more extravagant than invoking multiple universes – but it is a natural deduction from some (albeit speculative) theories, and opens up a new vision of our universe as just one 'atom' selected from an infinite multiverse" [Rees, 2000, p. 166]. Cosmologists and astronomers do at least agree, both transcendentalists and immanentists, that this present cosmos does seem to have been, at one point, a single heavy and miniscule atom that dynamically exploded. The Big Bang conception and its attendant cosmic inflation has had some traction everywhere, with every school of thought. Thus, although the multiverse theory may sound like pure fancy at first sight, due to the basic principles of logic the concept of a multiverse "genuinely lies within the province of science, even though it is plainly still no more than a tentative hypothesis" [Ibid., p. 167]. The theory says, not only that this currently known cosmos started out as an atom, but that there are indeed many atoms. Perhaps many of them are highly charged and volatile, ready to erupt at any time, combustible to the extreme, able to launch new universes. It sounds highly bizarre. Can this be called logic? The warnings inherent in the history of the logical principle of Ockham's razor are pertinent: "Ockham's razor is extremely important –

as without it you could literally add invisible gods and angels to any scientific theory" [Hossenfelder, 2018].

However, the multiverse concept remains simultaneously attractive in its logical simplicity. "A number of central ideas that drive much of the current activity in particle theory today appear to require a multiverse… Almost every logical possibility we can imagine regarding extending laws of physics as we know them, on small scales, into a more complete theory, suggest that, on large scales, our universe is not unique…" [Krauss, 2012, p. 126, 127]. These apparently absurd notions of a multiverse are thus the eminently logical context for volatile apologetic debates. People understandably insist on the idea that a Designer would be a convenient answer to a lot of the problems. And they rightly sense that the multiverse doctrine, regardless of its motivation, can seem like a desperate form of metaphysics which perhaps constitutes a radical evasion of the Prime Mover. In that variant oscillation model, for example, "A universe eternally repeating this cycle – expansion, contraction, bounce, expansion again – would elegantly avoid the thorny issues of origin" [Greene, 2004, p. 405].

However, appealing quickly to Ockham's razor in this particular debate about logic and the multiverse may sound more relevant than it actually is. In the era of Galileo and Kepler, many people also insisted on retaining the Ptolemaic notion of circularity in the heavens because circles are supposedly simpler than ellipses. And people also resisted "the spatial enlargement of the universe" in Copernicus' earlier day on the basis of this same Ockham's razor [Dąbrowski, 2019]. In the quantum approach, "we enlarge ontology (all universes instead of one), but reduce the number of physical laws (no need for initial conditions). It seems to be quite reasonable to do so… we enlarge whatever the size of our universe is by adding extra universes which possess different physical laws and which are real, though they may seem to be virtual once we look at them classically as one of the realisations of our hypothetical opportunities reflected in mathematical formulation of some field equations with a number of different solutions" [Ibid.]. Ockham's razor, generally a useful and even vital procedure in logic, can nevertheless be applied in a misguided manner. Circles and the small universe were incorrect ideas, despite their guileless attraction.

A saying often attributed to Einstein is "Make everything as simple as possible, but no simpler" [Bryson, 2003, p. 45]. That is a wise and cautionary remark within the field of logic. "So I'm inclined to go easy with Ockham's razor", said Rees; "a bias in favour of 'simple' cosmologies may be as short-sighted as was Galileo's infatuation with circles" [Rees, 2000, p. 173]. Max Tegmark disagrees with George Ellis in using Ockham's razor to exclude multiverse scenarios: "As a theoretical physicist", he said, "I judge the elegance and simplicity of a theory not by its ontology, but by the elegance and simplicity of its mathematical equations –

and it's quite striking to me that the mathematically simplest theories tend to give us multiverses. It's proven remarkably hard to write down a theory which produces exactly the universe we see and nothing more" [Tegmark, 2011].

Krauss insists that a multiverse is actually *more* logical than a single cosmic occurrence; he says: "I want to stress that a multiverse is *inevitable* if inflation is eternal, and eternal inflation is by far the most likely possibility in most, if not all, inflationary scenarios… the possible existence of these extra dimensions provides a huge challenge to the hope that our universe is unique" [Krauss, 2012, p. 129, 133]. The entire question of Design, once philosophers and logicians allow for a multiverse, simply disappears altogether: "…the response to [the question] why there is something rather than nothing becomes almost trite: there is something simply because if there were nothing, we wouldn't find ourselves living there!" [Ibid., p. 177]. In opposition to the idea that a single universe with a single Designer is the most obvious solution, Greene emphatically replies "It is *far* more likely – breathtakingly more likely – that the whole universe we now see arose as a statistically rare fluctuation from a normal, unsurprising, high-entropy, completely disordered configuration…" [Greene, 2004, p. 167]. In terms of the second law of thermodynamics, this currently inhabited universe as a whole is likely heading for radical entropy, but the possibility exists that local enclaves – sections of the multiverse – could infrequently demonstrate "a limited and temporary tendency for organization to increase". Life would find its home, says Norbert Weiner, "in these enclaves" [Taylor, 2007, p. 322].

g) Summary of the Two Main Logical Considerations for Taking the Multiverse Idea Seriously

In conclusion, there are at least these two major logical reasons for taking the concept of a multiverse seriously, even if it cannot presently be proven, demonstrated or observed. First, it is an organic extension of the post-Copernican trajectory along the historical pathway of deanthropomorphism and undercuts the possible vanity that would assume the currently understood Big Bang is equivalent to some hypothetical *solitary* Big Bang. Secondly, the multiverse concept provides a clean and quite possibly responsible resolution to the long-standing philosophical and logical mysteries associated with the anthropic principle, analyzed in the context of a responsible use of Ockham's razor. The two arguments operate in tandem, which is why Philip Goff's recent article against multiverse theory alleging the inverse gambler fallacy may not hold sway. His article [Goff, 2021] could abstractly be correct on the second argument, but the multiverse debate is not simply mathematics; it takes place

in the context of the known awareness of at least one Big Bang, as in the first argument.

As time goes on, evidential reasons in support of the multiverse may yet be found. This empirically and/or mathematically focused research is a highly specialized field of expertise which is outside the scope of this article. Perhaps there is evidence of a multiverse in the notion of vacuum pressure within Dark Matter, a vibrant topic among current researchers. At the time of his death, Stephen Hawking was working on mathematical and other paradigmatic arguments in favor of the multiverse. His biographer explains that "Fundamental numbers in our universe, such as the masses and charges of particles and the value of the cosmological constant, might be the result of the shape, the geometry of a labyrinth of interconnected universes" [Ferguson, 2017, p. 156]. Furthermore, the new technique of measuring gravitational waves might eventually have an impact on evidence for the multiverse theory. Investigating these gravitational waves includes, for some, the search for trace evidence of collisions between our universe and some other one, the prospect of some consequent multiversal bruising or perhaps a detectable impact on the Cosmic Microwave Background radiation [Bucklin, 2017].

Scientists generally agree, as does the writer of this article, that testability and experimentation are important to the process of genuine science. Karl Popper devised the critical notion of "falsifiability"; if a theory can in principle never be falsified, then it is not a genuinely scientific theory [Popper, 2002]. One is therefore in murky territory if proposing a multiverse theory that can *ipso facto* never be contravened. George Ellis has therefore warned that "The very nature of the scientific enterprise is at stake in the multiverse debate" [Ellis, 2008, pp. 2.33]. On the other hand, however, some of the greatest developments in the history of science included an historical hiatus between the hypothesis and the confirming evidence. Einstein's theory of general relativity, for example, proposed in 1915, became headline news only after May 29, 1919 when Eddington observed the bending of the sun's light around Mercury during a total eclipse of the sun. Other predictions of Einstein, such as the very recently discovered gravitational waves, were not finally confirmed until more than 100 years after his theory. Similarly, black holes were imagined long before they were imaged; today, black holes are almost common knowledge. People knew there were atoms more than 2,500 years before they were observed. As Barnes and Lewis say, "Unobservable entities aren't necessarily out-of-bounds for science. For example, protons and neutrons are made of subatomic particles called quarks. While they cannot be observed directly, their existence and properties are inferred from the way particles behave when smashed together" [Barnes, Lewis, 2014]. Theories about cosmic inflation, and varying speeds of inflation in diverse regions of the cosmos, were not instantly demonstrable [Siegal, 2019]. Perhaps the most famous example

of the overall interrelationship between evidence and theory is Darwinism. Charles Darwin could demonstrate that there had been massive changes within speciation, but he could not actually prove the exact means by which that happened until the advent of Mendelian genetics and the later discovery of RNA/DNA would verify "his very clever hunch" [Susskind, 2006, p. 375].

The above paragraph simply reinforces that logic would say: Never say never. It could end up becoming presumptuous to declare: "No signals from other universes have or will ever bother our telescopes" [Barnes, Lewis, 2014]. George Ellis might also go too far when he says: "…one can motivate multiverse hypotheses as plausible, but they are not observationally or experimentally testable – *and never will be*" [Ellis, 2011, p. 294–295. My emphasis]. Empirical proofs for a multiverse may yet emerge. Scholars also continue searching for evidence of wormhole connections between possible other universes and our own. Much may eventually depend on how compelling one finds the notions of mathematical consistency within fields like String Theory. As Susskind says, "…giving up on the possibility of more direct tests is certainly premature. It is true that theory and experiment usually proceed 'hand in hand', but it's not always the case" [Susskind, 2006, p. 375].

One can certainly agree that, logically, a multiverse theory might not strictly be necessary for cosmology, astronomy and physics to thrive; however, that is not the same as saying the notion is illogical. In terms of the larger history of science, investigators may be in uncharted territory; the scientific enterprise as such may never have been *required* to think so comprehensively about a potentiality that remains currently invisible to itself. As Heller puts it, "the standard philosophy of science has never previously encountered postulated entities in physics which are so distant from any empirical control" [Heller, 2019]. Given these kinds of necessary limitations, "the study of possibilities is essential for the study of the actual universe" [Ibid.]. The problem therefore might include the necessity of making "inferences beyond data" and using avant-garde mathematics, including Bayesian Probabilistic methods" [Ibid., 2019]. All these empirical research questions are outside the scope of this article.

But: As Siegfried says, "…history shows that [contemplating the multiverse] is a scientific question. It is not a metaphysical question or a meaningless question. It is a legitimate scientific question that warrants further investigation – and scientific research might someday provide the answer" [Temming, Siegfried, 2019]. The contention of logic, in other words, is not that everything has been resolved or can be resolved, but that the trajectory of multiverse research might be on a fertile course. Explorers may be getting closer, even if they have definitely not arrived. As Alonso-Serrano and Jannes say: "The key argument in string theory and some multiverse-related approaches is that the theoretical 'gap' to be

bridged is shallow, in other words: that the multiverse is a natural continuation of our best theories, general relativity and quantum field theory; that we are indeed close to finding such a 'final theory', and that consistency, elegance and uniqueness should therefore be sufficient arguments to solve the remaining problems (until the solution is eventually confirmed empirically)" [Alonso-Serrano, Jannes, 2019].

h) Concluding Comment on the Logic of Multiplicity and the Post-Copernican World View

Does our universe appear to be so incredibly special because it is unique, or does it only appear to be so incredibly special because it is one of many billions of options? Nothing might logically necessitate the theory of multiple universes (at present), but perhaps logic does not necessitate a Designer either. And yet these two alternatives are perhaps not equally hefty; thus the problem cannot be reduced to a simple need for blind faith in either direction. Perhaps due to the present lack of empirical evidence, researchers must resort to logic. As Heller puts it, "From the point of view of the philosophy of science, the question is: Could the explanatory power of a multiverse ideology compensate for the relaxation of empirical control over so many directly unobservable entities?.. With no strict empirical control at our disposal, it is logic that must be our guide" [Heller, 2019].

For this reason, this essay has concentrated on two arguments from logic. It is helpful to conclude this article on the logic of the multiverse conceptualization with these observations from Daniel Goldsmith:

> In the space of less than 500 years, the study of the universe and its parts has taken humanity from a geocentric, planet-bound consciousness to a knowledge of our place in the solar system, to the revelation that our entire galaxy is but the equivalent of a grain of sand on a vast beach of galaxies that fills the universe. It has opened us to the concept of infinity, and given us an appreciation of the scale that encompasses all that is. Could it be that, on some level, quantum cosmology is right? Could trillions of worlds not unlike our own co-exist with ours in the space-time continuum alongside trillions of probable worlds, each safely couched within its own universe? Could the theory of inflation be a true reflection of the way nature weaves ever-evolving universes together, like pearls on a string, each one part of the greater whole but also unique unto itself? Could there truly be a theory of everything so simple and so elegant that its basic concepts could be understood by a child? [Goldsmith, 2002, p. 133].

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