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Prolegomena to Any Future Physics-Based Metaphysics

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Philosophers of religion sometimes appeal to physics to provide support for the hypothesis that God exists. More generally, metaphysicians sometimes appeal to physics to provide support for claims about the fundamental nature of the world. But given the current state of inquiry in physics, where the two most fundamental theories are incompatible, such arguments of physics-based metaphysics are problematic. I support this line of thought by focusing on two sorts of problematic arguments, special-relativity-based arguments against presentism and Big-Bang-based arguments in favor of the existence of God. I am not arguing that physics-based metaphysics can't be done; I am just arguing that extant examples of physics-based metaphysics are flawed. I close by considering various ways that future versions of physics-based metaphysics could potentially be successful.

I. INTRODUCTION

To what extent can questions in metaphysics be answered by appealing to results in physics? Some questions in metaphysics—questions regarding necessary existence, or the nature of modality, for example—have little to do with the contingent facts about our particular universe that physics attempts to discover. However, other questions in metaphysics—questions regarding the nature of space and time, or the fundamental building-blocks of matter, for example—do potentially depend on truths learned from physics. Now, if one is a scientific anti-realist, and hence holds that the aim of science is not truth, then one will be skeptical of arguments that reach metaphysical conclusions on the basis of results from physics. But for those who are sympathetic to some version of scientific realism, physics seems to be providing information that is relevant to some traditional metaphysical debates about the nature of the universe.

Indeed, metaphysicians sometimes do appeal to results from physics to provide arguments in support of some particular metaphysical view they endorse (or to provide arguments against some particular metaphysical view they reject). For example, there are relativity-theory-based arguments against presentism, claims about the Big Bang in support of the cosmological argument, claims about fine-tuned constants in support of the teleological argument, and quantum-mechanics-based arguments in favor of indeterminism and holism.

What I want to point out in this paper is that these physics-based arguments rest on shaky foundations. The arguments in question aren't necessarily wrong-headed, but sophisticated reasoning needs to be added to give the arguments the plausibility that they intuitively (yet fallaciously) appear to have. This sort of sophisticated reasoning hasn't been provided in the literature; I will start to explore the prospects for giving it below.

But why is it that physics-based metaphysics rests on shaky foundations? The answer, in brief, is that the actual physical theories that are utilized in doing metaphysics of this sort are almost certainly *false*. Our two best theories of physics, quantum theory and relativity theory, are incompatible. The evidence in favor of quantum theory suggests that relativity theory is false, and the evidence in favor of relativity theory suggests that quantum theory is false.

Here is an example of what I have in mind. Some of the evidence for quantum theory (from, for example, the two-slit experiment) suggests that a particle can be in a superposition of different positions. But in general relativity, where the curvature of spacetime is based on the distribution of matter, there is no way to have a superposition of spacetimes. Also, some of the evidence for general relativity involves experiments done with precise clocks; these experiments show that clocks in strong gravitational fields run slow compared to clocks in weak gravitational fields. But according to quantum theory, ideal clocks run at the same rate regardless of the strength of the gravitational field they are in.

There are attempts by physicists to come up with a new theory that will replace both quantum theory and relativity theory—yielding proto-theories like loop quantum gravity and string theory—but that project is very much an ongoing one, without clear results as of yet. As a result, when physics-based metaphysics is done, it's relying on false theories of physics; this is why physics-based metaphysics rests on shaky foundations.

I will elaborate on this below, in the course of looking at a couple of case studies of questionable physics-based metaphysics. But before I begin, let me emphasize what I am and am not trying to argue. I do not want to say that physics-based metaphysics should not be done. Instead, I just want to point out that there are some tensions in the approach that haven't been adequately recognized, let alone dealt with. By pointing out the tensions, and by providing preliminary suggestions for how they might be resolved, I am providing a sort of prolegomena to any future physics-based metaphysics.

II. PRESENTISM AND RELATIVITY

Below, I will take up philosophy of religion issues, when I talk about the kalam cosmological argument, and in doing so I will provide a critique of extant physics-based philosophy of religion. But it's not just in philosophy of religion that one finds problematic physics-based arguments—non-theistic metaphysics has such arguments as well. Because there are such close parallels between these two sorts of arguments, I'll lay the groundwork for the philosophy of religion discussion by starting with an example from non-theistic metaphysics.

The most well-known physics-based argument in metaphysics is perhaps Hilary Putnam's argument in "Time and Physical Geometry." Putnam starts with what he calls the "man on the street's" view of time: "All (and only) things that exist *now* are real." He gives an argument against this presentist thesis, appealing to physics: "I shall assume Special Relativity." By appealing to the relativity of simultaneity in special relativity, he reaches the following conclusion:

> the problem of the reality and the determinateness of future events is now solved. Moreover, it is solved by physics and not by philosophy. We have learned that we live in a four-dimensional and not a three-dimensional world. . . . Indeed, I do not believe that there are any longer any *philosophical* problems about Time . . .[1]

It is clear from Putnam's conclusion that he takes special relativity to be *true*; otherwise, he could only conclude: *assuming special relativity*, we live in a four-dimensional world.

Putnam isn't the only person to argue against presentism by appeal to special relativity; the argument is quite a popular one in the literature on time (and presentists have given a number of arguments modifying either presentism or special relativity to restore compatibility). For example, Ted

[1] Putnam (1967: 247).

Sider, in his book defending a perdurance theory of persistence, gives a number of arguments against presentism, but saves what he considers to be the best for last: "I turn finally to what is often (justifiably, I think) considered to be the fatal blow to presentism: that it is inconsistent with special relativity."[2]

The problem with this Putnam/Sider line of reasoning is that special relativity is a *false* theory, and prima facie it's not a good idea to derive metaphysical lessons for our world on the basis of a theory that doesn't correctly describe our world. The reason special relativity is false is that it makes predictions at variance with reality. For example, according to special relativity, a clock at the base of a building will run at the same rate as a clock at the top of the building (assuming that the building is in an inertial frame of reference), but in fact the clock at the base runs slower. This fact about clocks is one piece of evidence for general relativity—according to general relativity, a clock in a stronger gravitational field runs more slowly than a clock in a weaker gravitational field.

Now, the relativity of simultaneity that holds in special relativity also holds in general relativity, so perhaps Putnam and Sider simply should have given their argument utilizing general relativity. The argument wouldn't go through in quite the same way though, because the spacetime of special relativity has more symmetry than a generic spacetime of general relativity. Specifically, there are some spacetimes of general relativity where the spacetime has sufficient structure that one can use it to pick out a preferred simultaneity relation. Nevertheless, actually specifying that there is a preferred simultaneity relation is incompatible with general relativity (on the standard interpretation of general relativity, at least). Moreover, as Gödel famously pointed out,[3] there are some spacetimes of general relativity that don't even allow a preferred simultaneity relation to be picked out—one can't foliate the spacetime into spacelike hypersurfaces. So it seems that presentism doesn't fare any better on general relativity than special relativity. Still, it would be better if anti-presentists like Putnam and Sider actually went through the details of the general-relativity-based argument.

While this would be better, it still wouldn't be good enough to conclude that presentism is false. The reason is that general relativity is most likely false. General relativity and quantum theory are incompatible, and a key project in theoretical physics is to come up with a new theory that supplants both general relativity and quantum theory. The most popular version of such a theory is string theory, but we currently don't have a full grasp of

[2] Sider (2001: 42). [3] Gödel (1949: 557–62).

what string theory even says. According to physicist Lee Smolin, there are as many as 10^{500} distinct string theories, and "we understand very little about most of these string theories. And of the small number we do understand in any detail, every single one disagrees with the present experimental data . . ."[4] Further, according to string theory proponent Brian Greene: "Even today, more than three decades after its initial articulation, most string practitioners believe we still don't have a comprehensive answer to the rudimentary question, What is string theory?"[5] Thus, it is difficult to reach definitive metaphysical lessons about our world on the basis of string theory. I'm not saying that it couldn't be done, but I am saying that a successful physics-based argument against presentism would have to be much more sophisticated than has so far appeared in the literature.

III. THE LESSON OF SPECIAL RELATIVITY?

Here is one attempt at how such an argument might go. One could argue that, even though special relativity is false, we have learned an important lesson about the world via special relativity. Specifically, we have learned that simultaneity is relative, and hence we fully expect that any successful future theory that supplants special relativity will incorporate this result. Thus, just as presentism is incompatible with special relativity, so presentism will be incompatible with any successful future theory that supplants it, and hence presentism is false.

I want to point out some potential problems with this line of reasoning. First, there are some physicists who are working on developing theories that reject the idea that simultaneity is relative. One way of solving certain conceptual problems in the development of theories of quantum gravity is to postulate a preferred simultaneity relation. While this method is not popular, the fact that it is being pursued at least shows that one can't unequivocally assert that any theory of quantum gravity will incorporate the relativity of simultaneity.[6]

Second, there are some reasons from quantum mechanics to think that perhaps simultaneity will be shown to be non-relative. Quantum mechanics predicts,[7] and experiment confirms,[8] that there are correlations between spacelike-separated events (that is, events that are simultaneous in some inertial frame of reference) that can't be accounted for via a local

[4] Smolin (2006: xiv). [5] Greene (2004: 376).
[6] For more detail on this point, see Monton (2006).
[7] Bell (1964). [8] Aspect *et al.* (1982).

common-cause mechanism. Prima facie, this is incompatible with relativity. Perhaps one way of resolving the incompatibility is to give up the relativity of simultaneity.[9] While this proposal is not a popular one, it is certainly a live option, and that's enough to show that we cannot unequivocally conclude on the basis of relativity theory that simultaneity is relative.

Third, there are broader conceptual reasons to think that perhaps simultaneity will be shown to be non-relative. The history of physics contains many examples where a theory has been developed with a fundamental symmetry, but the symmetry does not hold in reality. For example, all these known or proposed symmetries are broken in nature: charge/parity symmetry, time reversal symmetry, chiral symmetry, electroweak symmetry, and supersymmetry. Perhaps Lorentz symmetry will turn out to be another symmetry of a theory that is broken in nature.[10] In fact, various experiments by reputable physicists are being done to search for violations of Lorentz invariance.[11] If Lorentz invariance is violated in the right way, then there is a preferred frame of reference, and hence simultaneity is non-relative.[12]

I want to make clear that none of the above reasons would be subscribed to by the majority of physicists. Most physicists would maintain that the relativity of simultaneity is a lesson from special relativity that will not be dropped in future physics. Could this be turned into an argument against presentism? One would presumably want to establish that the physicists have good reasons for thinking that the relativity of simultaneity will hold in future theories. One would then presumably conclude that there is good inductive reason to think that simultaneity actually is relative (and hence, presentism is false). Note that this argument, even if successful, is weaker than the arguments Putnam and Sider purport to give. Putnam says that the problem of the reality of future events is *solved by physics*—but I maintain that the most he could legitimately argue is that, based on the opinions of physicists regarding how physics is going to develop, we have good reason to think that future events are real. Sider's appeal to special relativity as a "fatal blow" to presentism is similarly overstated.

[9] For more discussion of this move, see for example Maudlin (1996: 295–8) and Tooley (1997: 358–62).

[10] See for example Pospelov and Romalis (2004: 40) for an endorsement of this line of thought.

[11] For one representative experiment, see Stanwix *et al.* (2006); for a list of over forty such experiments, see <http://www.physics.indiana.edu/~kostelec/faq.html>, archived at <http://www.webcitation.org/5YtluOslD>.

[12] See Kostelecky (2004: 3) for some discussion of the circumstances in which a violation of Lorentz invariance would imply a preferred frame of reference.

Now, perhaps I am being uncharitable here; perhaps one could come up with a knock-down argument against presentism based on how future physics is expected to develop. But no such argument has yet been given, and hence the physics-based arguments against presentism that do exist are misleading in their apparent conclusiveness.

IV. IS THE SMART MONEY ON SCIENCE?

Sider recognizes a potential problem with his special-relativity-based argument against presentism. He writes:

> Some presentists have said: so much the worse for special relativity, at least in its Minkowskian formulation. Perhaps future empirical research will bear this out, but in cases of science versus metaphysics, historically the smart money has been on science.[13]

There are multiple problems with this line of reasoning. First of all, as I've pointed out above, empirical research has already shown that special relativity is false. But more importantly, if one looks at historical examples of conflicts between science and metaphysics, it's not at all clear that one would want to endorse the view of (then-)current science. The history of science is littered with false theories, such that one could easily reach incorrect conclusions about the world if one based one's metaphysics on these false theories.

This is an important point, so it's worth looking at a couple of examples where science-based metaphysics has gone wrong in the past. First, consider the Aristotelians versus the atomists. Aristotle's theory was the dominant theory of science, and the atomists, having little empirical evidence for their view, were arguably endorsing a metaphysical view at variance with current accepted science. We now think that the atomists' view of the universe is closer to reality. Second, consider a nineteenth-century Cartesian arguing against Newton's theory of gravity, on the basis that there is no local mechanism for gravitational influence. In the nineteenth century, the action-at-a-distance view of the gravitational force was widely accepted by physicists; the Cartesian's complaint would be viewed as a metaphysical one. But in fact, we now believe that the action-at-a-distance view of gravity is misguided, and that gravitational influence does propagate locally (specifically, at the speed of light, according to general relativity). The smart money was

[13] Sider (2001: 42).

on the Cartesian's metaphysics, not on the nineteenth-century Newtonian science.

The examples above are real-life examples of cases where one would not want to base one's metaphysics on science; the argument against science-based metaphysics can also be made by appealing to hypothetical examples. Imagine a presentist/eternalist debate during the 1800s, when Newtonian physics is the dominant theory, and suppose that the discussants, being well-versed in considerations of possibility, are aware that it's possible for the structure of spacetime to be such that there's no privileged simultaneity relation. One can imagine the presentist appealing to Newtonian physics and arguing that, since science shows us that there actually is a privileged simultaneity relation, this provides evidence that the privileged simultaneity relation corresponds to something metaphysically fundamental. While this is by no means a knock-down argument in favor of presentism, it would perhaps have some force in a time period where Newtonian physics is the dominant theory of science. But by the lights of our current science, this pro-presentism argument is misguided.

Unfortunately, Sider doesn't give any examples or argument to back up his claim that, in cases of science versus metaphysics, historically the smart money has been on science. Perhaps Sider could give such an argument, and could show that my examples where the smart money appears to be on metaphysics are just anomalies. This is one reason that my paper just provides a prolegomenon—in future arguments of physics-based metaphysics, a Sider-style appeal to the success of science versus metaphysics would have to be backed up.

V. THE BIG BANG AND THE KALAM COSMOLOGICAL ARGUMENT

Now, let's turn to the second example of problematic physics-based metaphysics—an appeal to the Big Bang to support the kalam cosmological argument. The basic structure of the kalam cosmological argument is as follows:

Premise 1: The universe began to exist.
Premise 2: Everything that begins to exist has a cause of its existence.
Conclusion: Therefore the universe has a cause of its existence.

The argument goes on to establish that the cause of the universe's existence counts as God.

What I want to focus on is the first premise of the argument. There are two lines of defense that are standardly given, a philosophical defense and an empirical defense. The philosophical defense holds that actual infinites are impossible, and hence it is impossible for a series of events to have been going on forever. To discuss that defense is beyond the scope of this paper. The empirical defense that is standardly given is physics-based. For example, William Lane Craig supports Premise 1 with the claim: "scientific evidence…indicates that the universe is finite in duration."[14] Similarly, William Rowe asserts: "science tells us that the universe is finitely old."[15]

What Craig and Rowe have in mind is the Big Bang hypothesis, which arises out of general relativity. The Big Bang hypothesis holds that the universe, including space and time itself, came into existence a finite amount of time ago, and shortly after the universe came into existence it was in a state of large energy density, and the energy density in the various regions of the universe has been decreasing overall. General relativity has an infinite number of models of spacetime, and in some of the models there is a Big Bang, whereas in others there isn't. Based on the empirical data we have about our universe, the models of general relativity that best describe our universe are models where there is a Big Bang.

If the Big Bang hypothesis is true, then the first premise of the kalam cosmological argument is true. This leads to the question: should we believe the Big Bang hypothesis?

In support of the Big Bang hypothesis, Craig cites a paper by four astrophysicists, with J. Richard Gott as the lead author. Gott and his co-authors write:

> the universe began from a state of infinite density about one Hubble time ago [i.e., about 15 billion years ago]. Space and time were created in that event and so was all the matter in the universe. It is not meaningful to ask what happened before the Big Bang; it is like asking what is north of the North Pole.[16]

At first glance, this passage looks like it is supporting Craig's claim. But one has to be careful here. When physicists present a theory, they may be presenting it *as true*, or they may just be presenting it as a live option, putting it on the table for consideration. According to Bas van Fraassen's understanding of science,[17] at least, physicists can *accept* a theory, and treat the theory as if it is true for the purposes of doing their science, without actually *believing* the theory. In this vein, it's worth noting that Gott and his

[14] Craig (1979: 140).
[15] Rowe (2005: 113).
[16] Gott et al. (1976: 65).
[17] Van Fraassen (1980).

co-authors put an important caveat in their paper, a caveat that Craig doesn't quote. Gott and his co-authors write:

> That the universe began with a Big Bang is an inevitable conclusion *if* the known laws of physics are assumed to be correct and in some sense complete. It is conceivable, however, that there are laws of nature whose effects are negligible on the scale of the physics laboratory, or even on the scale of the solar system, but that might predominate in determining the behavior of the universe as a whole.[18]

So this leads to the question: should we assume that the known laws of physics are correct and complete?

The answer is: we should not. As I've mentioned, the two current fundamental theories of physics on the table, general relativity and quantum theory, are incompatible. The Big Bang hypothesis is true given the assumption that general relativity is true, but we don't know that the Big Bang hypothesis is true of the actual universe. The Big Bang hypothesis is based on a theory (general relativity) that can't accommodate evidence that supports quantum theory, and that gives us reason not to believe the Big Bang hypothesis.

In Craig's 1979 book, he doesn't seem aware of this potential problem regarding taking quantum effects into account, but by 1993 he shows more awareness of the potential problem. (In this sense, Craig is showing more sophistication than Putnam and Sider, because Putnam and Sider don't even acknowledge that developments in physics have cast doubt on the truth of the theories to which they're appealing.) Here is what Craig writes in 1993:

> During the 1980s, through the marriage of particle physics and cosmology, scientists have attempted to push back the frontiers of our knowledge of the early universe ever closer to the Big Bang. . . . Prior to 10^{-12} sec, however, the physics becomes speculative. . . . Prior to 10^{-35} sec the physics becomes extremely speculative and even unknown.[19]

I'll start with a couple of preliminary points to elucidate what Craig is talking about here, and then I'll make my main critical point.

Preliminary point #1: When Craig talks about "Prior to 10^{-12} sec," he's talking about the time period between the Big Bang and 10^{-12} seconds after the Big Bang.

Preliminary point #2: Physicists tend to talk about stages in the development of the early universe, not in terms of the time period after the Big Bang, but in terms of the approximate amount of energy that particles in

[18] Gott *et al.* (1976: 65). [19] Craig (1993: 67–9).

the universe have at that time. So, 10^{-12} seconds corresponds to energies of 100 GeV (that is, 100 billion electron volts), whereas 10^{-35} seconds corresponds to energies of 10^{14} GeV.

Now, my main point: If one were to watch the history of the universe going backwards in time, one would see the energies increasing. Let me make the same point that Craig made about the physics getting speculative, but put in terms of energy. As the energy increases to 100 GeV, the physics becomes speculative—we're not really sure what happens at that point. As the energy increases to 10^{14} GeV (assuming it does increase to that point), the physics becomes extremely speculative, even unknown. In other words, we just don't know what happens once the energies get that high.

The way Craig puts the point, it sounds like we know that there's a Big Bang, and we know what happens in the history of the universe once 10^{-12} seconds have passed, but we don't know what happens between the Big Bang and 10^{-12} seconds after the Big Bang. But in fact our lack of knowledge is much more fundamental. Because the physics doesn't tell us what happens once we trace the history of the universe backwards in time to these high energies, we don't even know whether there's a Big Bang at all.

So given that the physics is unknown, we ought to conclude that it's unknown whether there's a Big Bang, and hence (assuming that the philosophical defense of Premise 1 is flawed) we ought to conclude that it's unknown whether the universe began to exist. An appeal to physics is not successful in showing that Premise 1 of the kalam cosmological argument is true.

VI. OBJECTIONS

I'll now consider three objections to my line of reasoning in the previous section. (Similar objections could be given for my line of reasoning about presentism and special relativity, but I'll focus on the kalam cosmological argument.)

VI.1. Isn't This Scientific Anti-Realism?

Let's step back for a moment, and think about other ways one might reject the physics-based defense of the first premise of the kalam cosmological argument. If one were a strong scientific anti-realist, in such a way that one didn't think that science delivered any substantive truths about the world, then one would have clear grounds for rejecting the physics-based line of reasoning—the evidence from physics would give one no reason to believe the Big Bang hypothesis. Suppose one were a more moderate scientific anti-realist, along the lines for example of van Fraassen's (1980) constructive empiricism. One would believe that the aim of science is truth about the *observable* aspects of the world. Since the beginning of the universe is presumably not an observable event, the aim of science would not include finding out whether the universe had a beginning. Note though that it would be a mistake to argue that the beginning of the universe is not an observable event simply because we couldn't exist then, because in fact we can observe events that occur before times that we could exist. For example, we can now observe the cosmic microwave background radiation, which was emitted 300,000 years after the Big Bang (assuming the Big Bang hypothesis is true). The reason the beginning of the universe is not observable is both that we couldn't exist then (given the high amount of energy in each region of the universe), and that it's physically impossible for us to observe back that far—we can't see back any further than the cosmic microwave background radiation. So a moderate scientific anti-realist like van Fraassen would also hold that the physics-based defense of the first premise is unconvincing.

What I want to make clear is that my argument from the previous section does not rely on any sympathies I might have with scientific anti-realism. According to van Fraassen's characterization of scientific realism, at least, to be a scientific realist is to believe that the aim of science is to come up with true theories, about both the observable and unobservable aspects of the world. One can be a scientific realist and still be skeptical of whether our current physical theories are true. In fact, given the current state of play in physics, even scientific realists have good reason to doubt that general relativity is true, because it does not take into account quantum effects. Because of this, it's inappropriate to appeal to general relativity as providing the theoretical framework that allows us to establish that the universe began to exist a finite amount of time ago.

To put the point dramatically: my argument only works because physics is in crisis. If there were a worked-out consistent fundamental theory of physics, scientific realists could appeal to that theory to tell them whether the universe began to exist. But since there isn't, they can't.

VI.2. Our Theories are Approximately True

Perhaps van Fraassen's characterization of scientific realism is too weak. Consider for example James Ladyman and Don Ross's characterization:

we ought to believe that our best current scientific theories are approximately true, and that their central theoretical terms successfully refer to the unobservable entities they posit.[20]

These scientific realists could say: maybe general relativity in all its details is false, but nevertheless we should expect general relativity to be *approximately* true. The realists could thus say that we should believe what general relativity tells us about the Big Bang. The realists could maintain that general relativity gets the details of what happens between the Big Bang and 10^{-12} seconds after the Big Bang wrong, but the overall picture is approximately right—the universe did start a finite amount of time ago.

The notion of approximate truth is notoriously slippery—the question that always has to be asked is: in what respects, and to what degree, is the theory approximately true? Suppose that general relativity is right in suggesting that spacetime is curved, and that the curvature of spacetime is correlated with the distribution of matter in spacetime. This would be enough to make it reasonable to consider the theory to be approximately true. This could be the case even if general relativity makes incorrect predictions for what happens at large energy scales. As one traces the history of the universe backwards in time, toward larger and larger energy density, it could be that at sufficiently large energy density the universe undergoes a bounce, and energy density starts decreasing again. This scenario is compatible with the universe having been in existence forever—the cycle of the universe expanding and then contracting could have been going endlessly. If that were the case, general relativity could reasonably be considered to be approximately true, even though the Big Bang hypothesis is false.

This endless crunch/bounce model is not just pure philosophical speculation; at least some prominent physicists consider such a scenario to be a live option. Specifically, Paul Steinhardt and Neil Turok have proposed the *cyclic model*, where the expansion phase that the universe is in now will be followed by a contraction phase.[21] At the end of the contraction phase the universe will undergo a "bounce," and will begin expanding again. Steinhardt and Turok still use the terminology of the "Big Bang," but for them the Big Bang is just the event of the bounce, where the universe starts expanding again. The cyclic model is compatible with the universe having been in existence forever.

For those who are familiar with the discredited oscillatory models of the 1920s, it's worth making clear that the cyclic model is not one of those models, but is instead based on up-to-date physics. It is arguably compatible

[20] Ladyman and Ross (2007: 68).

[21] Steinhardt and Turok (2002).

with M-theory, and utilizes the branes (the multi-dimensional analogue to strings) that M-theory endorses. According to the cyclic model, there are ten dimensions of space, but six of those dimensions are compactified. We are living in one three-dimensional brane, and there is one other three-dimensional brane, which is at some distance from ours as measured in the fourth uncompactified spatial dimension. The branes oscillate back and forth relative to each other, and the Big Bang corresponds to the moment when these two branes get so close that they repel each other and bounce. There are many more details to the cyclic model, and it is detailed enough that it makes empirically verified quantitative predictions, but there's no need to go into those details here. I've said enough to show that there is a respected theory under consideration by physicists which does not entail that the universe came into existence with a Big Bang.

One could legitimately hold that, according to the cyclic model, general relativity is approximately true. Indeed, many aspects of general relativity carry over to the cyclic model. But if the cyclic model is true, and the universe has been in existence forever, general relativity is not approximately true with respect to general relativity's suggestion that the universe came into existence at the Big Bang. This shows that general relativity can be approximately true, even if the Big Bang hypothesis is false. Thus, one can't appeal to the approximate truth of general relativity to establish that the universe came into existence a finite amount of time ago.

VI.3. We Should Work With the Best Theories We Have

The third and final objection I want to consider goes as follows. I haven't seen it in print before, but I have heard it in discussion, so here is my best representation of the objection:

> Where else should we look for our guidance for our metaphysics, if not our best fundamental physical theory? Unless and until general relativity is replaced by a better theory, we should just assume that general relativity is true, for the purposes of doing metaphysics. It would be unreasonable to ask scientists and engineers to send rockets into space using a non-existent physical theory; the best they can do is to use the best fundamental physical theories we have. The same sort of reasoning holds for the metaphysician. Thus, in evaluating the first premise of the kalam cosmological argument, we should assume that the best theory we have regarding the beginning of the universe is true.

This is perhaps the line of thought that Mauro Dorato has in mind when he gives a physics-based argument against presentism. He rejects special-relativity-based arguments because special relativity is false, and instead gives a general-relativity-based argument. He recognizes that general relativity may well be false as well, but in a footnote he says "until a reasonably agreed upon quantum theory of gravity is available, we can assume that [general relativity] *is* a fundamental physical theory."[22] Dorato doesn't go on to say *why* this assumption is appropriate, but perhaps I've represented above what he has in mind.

I'll point out two problems with this line of reasoning. The first problem is that, in the absence of some sort of hedging, someone reasoning this way could end up having contradictory beliefs. General relativity is not our only fundamental physical theory—quantum theory is also standardly considered by physicists to be a fundamental physical theory. Thus, if we're going to assume, for the purposes of evaluating the kalam cosmological argument, that general relativity is true, we should also assume that quantum theory is true. But general relativity entails that the structure of spacetime is correlated with the distribution of matter, whereas quantum theory has a fixed spacetime. If one assumes that both general relativity and quantum theory are true, one will end up believing that the structure of spacetime both is and is not correlated with the distribution of matter, and hence have contradictory beliefs. It would be arbitrary to assume that general relativity is true and not quantum theory, because they are standardly considered to be equally fundamental theories. (Or at least, one would need a worked-out argument to explain why it's legitimate to assume that general relativity is true but not quantum theory, and that's an argument proponents of the kalam cosmological argument haven't given.) But if one assumes both are true, one ends up believing a contradiction.

Even setting this logical problem aside, there is another reason one wouldn't want to simply assume that general relativity is true for the purposes of doing metaphysics. The reason is that metaphysics isn't meant to be an elucidation of our best current scientific theories; metaphysics is meant to get at truth. In order to rely on our current best scientific theories in doing metaphysics, one would need to argue that these theories are true. As we've seen, given the state of current physics, it is unreasonable to simply assume that general relativity is true.

Moreover, if philosophers assume that general relativity is true, they won't be able to make sense of much of the work that's being done in contemporary theoretical physics. Why would physicists spend so much effort to develop string theory, if general relativity is true? Philosophers who took this approach would be viewed by physicists as naive.

[22] Dorato (2002: 255).

But perhaps my focus on truth is misguided—perhaps it is wrong to construe metaphysics as a search for truth. Perhaps metaphysics is simply out to elucidate the fundamental structure of the world, under the supposition that our best fundamental physical theories are true. This can be thought of as counterfactual metaphysics: what metaphysical claims would be true, were general relativity true? Assuming that there are no problems with the rest of the kalam cosmological argument, the argument can establish that it would be true that God exists, were general relativity true. This would be an interesting and important philosophical result, but we have to recognize what the limitations of the result are. It would be of the same importance as establishing that God would exist, were Cartesian physics true, or that God would exist, were Ptolemaic astronomy true. While these are philosophically interesting results, they don't get at reality—or at least, one would need an independent argument to show that they are getting at reality, even though the physical theory in question is false. Proponents of the kalam cosmological argument, historically at least, have tried to establish that God actually exists, not that God would exist if it were the case that some particular scientific theory is true.

VII. BRINGING IN PROBABILITIES

The kalam cosmological argument is presented as a deductive argument, and so far I have been treating it as such. If we aren't warranted in believing that all the premises are true, then we aren't warranted in believing that the argument is sound. But what happens if we treat it instead as an inductive argument—one that leads to an increase in the probability assigned to the hypothesis that God exists?

Imagine an agent who fully believes that the kalam cosmological argument is valid, and fully believes that the second premise is true, but doesn't know whether the first premise is true—this agent isn't sure whether the universe began to exist. Also, suppose that this agent starts out not knowing any physics. Now, suppose that the agent becomes an expert in physics—her beliefs about physics match the beliefs that top physicists have. Will this lead to an increase in the probability she assigns to the truth of the first premise, and hence, will this lead to an increase in the probability she assigns to the hypothesis that God exists?

My answer to these questions is: it depends. But seeing why that's the right answer will help us better to understand the inductive version of the kalam cosmological argument.

Let's first focus on the conclusion of the argument, the proposition that God exists. It could be that, before learning any physics, the agent already fully believes that God exists; she already assigns probability 1 to that proposition. As a result, learning the physics is not going to lead to an increase in the probability for that hypothesis.

Let's suppose then that, before learning any physics, the agent assigns a non-extremal probability, between 0 and 1, to the proposition that God exists—call that proposition G. For similar reasons, let's assume that the agent assigns a non-extremal probability to the hypothesis that the universe began to exist—call that proposition B. Note that the probability that the agent assigns to G, $P(G)$, is greater than or equal to the probability that the agent assigns to B, $P(B)$, since the agent fully believes that B, along with other propositions the agent fully believes, entails G.

Now, let E be the set of beliefs that expert physicists have. The key question we want to ask is: when the agent learns E, does this lead to an increase in the probability she assigns to G? In other words, is it the case that $P(G|E) > P(G)$?

The answer is: it depends on what agent we're discussing. I'll describe two sorts of agents, each of whom is rational and has intuitively reasonable probability assignments, but where for one agent $P(G|E) > P(G)$, whereas for the other agent $P(G|E) < P(G)$.

First, imagine an agent, Alice, who is an atheist—she initially assigns a low probability to G. Alice starts out not knowing any physics, and she thinks it highly improbable that the universe began to exist. As a result, she initially does not find the kalam cosmological argument at all plausible, even though she believes the second premise, and believes that the argument is valid. Moreover, suppose that the kalam cosmological argument provides the only reason she has to believe that the universe has a cause of its existence. But then, she learns physics, and learns that the hypothesis that the universe began to exist is a live option, an option taken seriously by expert physicists. This leads her to increase her probability assignment to the hypothesis that the universe began to exist, and hence to increase her probability assignment to the hypothesis that the universe has a cause of its existence. She believes that this cause would be God, and hence learning the physics E leads her to increase her probability assignment to G.

Now, imagine an agent, Bob, who is a believer—he initially assigns a high probability to G. Bob starts out not knowing any physics, and he thinks it highly probable that the universe began to exist. Moreover, the kalam cosmological argument provides the only reason that Bob believes in God. You can see how the story goes: when Bob learns physics, he learns that the hypothesis that the universe has been in existence forever is a live option, an option taken seriously by expert physicists. This leads him to decrease his probability for *B*, and hence to decrease his probability for *G*.

The lesson I draw is that the evidence from physics can, in conjunction with the kalam cosmological argument, lead to an increase in the probability that a rational and reasonable agent assigns to *G*; to this extent the inductive version of the kalam cosmological argument is effective. However, the same evidence and argument can lead to a decrease in the probability assigned to *G* for a different rational and reasonable agent; to this extent the argument is counterproductive (from a theistic perspective).

Is that all there is to say? Isn't there an objectively right answer as to whether the inductive kalam cosmological argument is successful? I have been implicitly utilizing a subjectivist interpretation of probability in this section, and while I think that is the right interpretation of probability to endorse, this is a controversial matter. Could a different interpretation of probability yield a more definitive answer as to whether the inductive kalam cosmological argument is successful?

I'm not going to try to answer these questions here—these are the sorts of questions one would have to address if one wanted to give a successful physics-based inductive version of the kalam cosmological argument. Perhaps there is an objectively right way to fill in the blank in the following statement: given the current state of physics, the probability that the universe began to exist is ___. But without seeing the argument, I am doubtful.

VIII. OTHER ARGUMENTS

The problems with physics-based metaphysics are not restricted to the special-relativity-based argument against presentism and the big-bang-based argument in support of the existence of God. In the interest of concision, I won't go into details regarding other problematic arguments; I'll just give a couple of examples so the reader sees what I have in mind.

I'll start with another non-theistic example of physics-based metaphysics, and then I'll give another example from philosophy of religion. Sometimes one encounters vague claims that physics has pretty much gotten things right, even though it has not yet found a potentially true most fundamental theory. For example, Frank Jackson writes:

> it is reasonable to suppose that physical science, despite its known inadequacies, has advanced sufficiently for us to be confident of the *kinds* of properties and relations that are needed to give a complete account of non-sentient reality. They will be

broadly of a kind with those that appear in current physical science, or at least they will be as far as the explanation of macroscopic phenomena go . . .[23]

Jackson doesn't say anything to defend these claims, and it's not at all obvious to me that these claims are true. Why is Jackson so confident that the theory that supplants general relativity and quantum theory won't have new kinds of properties and relations that are used in explaining some macroscopic phenomenon? I simply don't see any reason to think that. While that may be true, I'd want to see the argument, and as far as I know no such even semi-compelling argument has been given.

Here is another example from philosophy of religion of problematic physics-based metaphysics. Peter van Inwagen, in the context of discussing the problem of evil, writes:

there is at least good reason to think that a deterministic world that contains complex life—or any life at all—may not be possible. Life depends on chemistry, and chemistry depends on atoms, and atoms depend on quantum mechanics . . . and, according to the "Copenhagen interpretation," which is the interpretation of quantum mechanics most favored by working physicists, quantum mechanics is essentially indeterministic.[24]

There are at least three problems here. First, while it is part of the content of the Copenhagen interpretation that quantum mechanics is indeterministic, it's not part of the content of the Copenhagen interpretation that quantum mechanics is *essentially* indeterministic. That is, it's not part of the content of the Copenhagen interpretation that there are no deterministic interpretations of quantum mechanics that are empirically equivalent to the Copenhagen interpretation. Or at least, if that is a part of the content of the Copenhagen interpretation, then the Copenhagen interpretation is demonstrably false, since David Bohm's theory is a deterministic interpretation of quantum mechanics that is empirically equivalent to the Copenhagen interpretation.[25]

The second problem with what van Inwagen says is that he seems to be assuming quantum mechanics is true when he says "atoms depend on quantum mechanics." In fact quantum mechanics is false, since it makes predictions at variance with the evidence standardly taken to support general relativity. So either atoms exist in the actual world, in which case they don't depend on quantum mechanics, or atoms don't exist, in which case chemistry doesn't depend on atoms.

[23] Jackson (1998: 7).
[24] Van Inwagen (2006: 118).
[25] Bohm (1952).

The third problem with what van Inwagen says is that he's illegitimately assuming that complex life could only exist in a world with our sort of physics when he says that there's good reason to think that it's *impossible* for there to be a deterministic world with complex life. Even if our world is in fact indeterministic, it doesn't at all follow that it's only possible for complex life to exist in a world with our sort of physics. I conclude that van Inwagen has presented another example of problematic physics-based metaphysics.[26]

IX. LOOKING FORWARD

My criticism is of extant arguments of physics-based metaphysics. This leads to the question: how could metaphysicians of the future successfully appeal to physics? By way of closing, I'll summarize seven potential options they have for doing so:

1. One option is to simply wait for progress in physics to be made. If a prima facie successful theory of quantum gravity is developed, then physics will no longer be in the position of having two most fundamental conflicting theories. At this point, the debate over physics-based metaphysics will more closely parallel the debate over scientific realism generally.
2. Another option for metaphysicians to successfully appeal to physics is to make explicit that their arguments are based on opinions about how physics will go. There is some prima facie force to the idea that, if almost all physicists think that future theories of physics will make certain claims about the world, then it is reasonable for philosophers to conclude that those claims about the world are true. But the argument would need to be more developed, and so far, metaphysicians who appeal to physics have not developed that argument.
3. A third option is for metaphysicians to restrict the scope of metaphysics. They can say that metaphysics isn't about discerning fundamental truths about the world, but instead is about establishing conditional claims, of the form: if that physical theory were true, then the world would be such-and-such way. Even setting aside issues of physics-

[26] If I were to continue the list, I'd endorse Tim Maudlin's (2007: 62–3) critique of David Lewis (1986): Lewis inappropriately appeals to classical physics to support Humean supervenience. I'd also endorse Ladyman and Ross's (2007: 22–7) critique of metaphysicians who inappropriately assume that fundamental physics describes the world in terms of "microbanging"—little things coming into contact with each other.

based metaphysics, there is some evidence that metaphysicians reason this way. For example, consider David Lewis's line that set theory "offers an improvement in what Quine calls ideology, paid for in the coin of ontology."[27] One can read this as part of the project of different metaphysicians offering competing packages regarding the nature of the world, without providing any truth-conducive grounds to favor one over the other. Obviously this is a controversial reading of metaphysics (one that Lewis himself would probably not accept), but it is one in which simplistic physics-based arguments could find a home.

4. Another option for metaphysicians to successfully appeal to physics is to limit the scope of the conclusion they're drawing from physics. For example, in the relativity-based arguments against presentism, the metaphysicians could refrain from asserting that relativity theory is true, but could instead just assert that it's *possible*. They could then argue against those presentists who think that presentism is necessarily true. This is an interesting line of argument, but it's quite different from the arguments that, for example, Putnam and Sider give. Putnam and Sider, recall, are trying to show that presentism is false in the actual world, not that there's some possible world where presentism is false. Moreover, this new line of argument is itself controversial. Presentists could argue that special relativity is in fact impossible; or they could simply concede that eternalism is possibly true; or they could hold that presentism is true of any world with time, and that a world where special relativity is true is timeless.
5. A fifth option for metaphysicians to successfully appeal to physics is to give an argument analogous to one that Kurt Gödel gives.[28] Gödel argues for the ideality of time (and, implicitly, against presentism) with the following line of reasoning. He points out that there are some spacetime models of general relativity where there is no passage of time, and suggests that those who hold that there is passage of time in other spacetime models of general relativity are committed to holding that "whether or not an objective lapse of time exists (i.e. whether or not a time in the ordinary sense of the word exists), depends on the particular way in which matter and its motion are arranged in the world."[29] Gödel then says: "This is not a straightforward contradiction; nevertheless, a philosophical view leading to such consequences can hardly be considered as satisfactory."

   Whether Gödel's argument is sound or not is a subject of much controversy. All I want to point out here is that metaphysicians

[27] Lewis (1986: 4). [28] Gödel (1949). [29] Ibid. (562).

could potentially give an analogous argument to justify their particular argument of physics-based metaphysics. For example, for the relativity-based argument against presentism, the metaphysician could hold that there is a lot of evidence for *something like* special relativity, and could hold that whether presentism is true shouldn't depend on the details of whether special relativity is true, or whether a theory closely related to special relativity is true.

6. The sixth option for metaphysicians to give successful arguments of physics-based metaphysics is to appeal only to uncontroversial aspects of physics. This is arguably what Guillermo Gonzalez and Jay Richards have done in their pro-intelligent design argument.[30] In brief, their argument holds that there is a correlation between habitability and observability—the regions of the universe that are best suited for life are also the regions of the universe that are best suited to make scientific observations. They conclude that this provides evidence for the existence of a designer.

   Setting aside the question of whether their argument is successful, what is interesting to note is that they aren't appealing to controversial physics to give their argument. Instead of making the strong claim that some particular fundamental physical theory is true, they are simply appealing to more empirically oriented facts about where life could flourish in the universe, and what sorts of observations could be made in different regions of the universe. This wouldn't help with the kalam cosmological argument, but it does provide a different way to give a physics-based argument for the existence of God.

7. The final option I'll consider for how to do physics-based metaphysics is for metaphysicians to appeal to some form of structural realism. They can recognize that our extant fundamental theories of physics are false, and yet can hold that such theories surely get something about the structure of the world right. This move is forthrightly made by Ned Hall:

> I think that we in fact possess detailed knowledge of the structure and internal nature of molecules and atoms. At the same time, I have no confidence whatsoever that our best current physics is anywhere close to right about the fundamental nature of the physical world. I conclude that, somehow or other, our empirically well-grounded knowledge of molecular and atomic structure must be the sort of thing that can survive wholesale revisions in our conception of the fundamental natures of the constituents of molecules and atoms. For example, we can be perfectly and justifiably confident that meth-

[30] Gonzalez and Richards (2004).

> ane has a tetrahedral structure, even if our current best explanation of what it is for it to have that structure is fatally flawed. It's an interesting puzzle how exactly we can manage to be in such an epistemic situation.[31]

> It's not obvious to me that we are in such an epistemic situation, but if we are, I agree that it's an interesting puzzle regarding how we can manage to be in that situation. If we can discern aspects of the fundamental structure of the world from false physical theories, then some physics-based metaphysics can be done. From an epistemological standpoint, it would be nice to know how such discernment is possible. (Hall doesn't attempt to provide an answer, and I haven't seen anyone else successfully do so.)

So, to sum up: I am not saying that physics-based metaphysics can't be done. What I am saying is that metaphysicians who want to appeal to physics successfully are going to have to be more sophisticated than they have been in giving such arguments.

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[31] Hall (2007).

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