

Infinite Universe or Intelligent Design?

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ABSTRACT: To reach the conclusion that the universe is infinite, physicists (a) make some observations; (b) fit those observations to some mathematical model; (c) find that the neatest model that accommodates the data extrapolates to an infinite universe; (d) conclude that the universe is infinite. In my presentation I will examine the logic by which physicists reach this conclusion. Specifically, I will show that there is no way to empirically justify the move from (b) to (c). An infinite universe should therefore properly be viewed as a metaphysical hypothesis consistent with certain physical theories but hardly mandated by them. By contrast, I will argue that the hypothesis of intelligent design—that a designing intelligence has left clear marks of intelligence in the biophysical universe—is not a metaphysical hypothesis at all but a fully scientific one. In particular, I will argue that whereas an infinite universe does not (and indeed cannot) admit empirical evidence, intelligent design can. Finally, I will indicate why an infinite universe, though sometimes introduced to get around the problem of design, in fact cannot get around it.

I want in my few minutes here to examine the grounds for claiming that the universe is infinite as well as what, if any, significance an infinite universe has for intelligent design. I'm going to present two arguments. First, I'm going to show that an infinite universe is not an empirical but a metaphysical proposition. Second, I'm going to show that an infinite universe cannot circumvent the challenge of intelligent design.

To reach the conclusion that the universe is infinite, physicists do the following: First, they make some observations. Second, they fit those observations to some mathematical model. Third, they find that the neatest model that accommodates the data extrapolates to an infinite universe. Fourth, they conclude that the universe is infinite. Quantum many worlds, cosmological natural selection of black holes, and inflationary cosmology all follow this logic. Although there is a certain cogency to this logic, I'm going to show that there is no way empirically to justify the move from step two to step three. In other words, I'm going to show that the extrapolation of a mathematical model to an infinite universe cannot be empirically justified.

The problem with an infinite universe for science is that human investigators are incapable of getting an empirical handle on its infinity. Indeed, our sensory apparatus is capable of delivering only so many experiences. Consider that a digital video disk (DVD) contains no more than about 10 gigabytes of data (that is, 10^{10} bytes of information), but it can reasonably capture two hours of a human being's visual and auditory experience. It's probably safe to say that a human being's entire sensory experience for one hour (taste, touch, and smell in addition to sight and sound) can be captured with as high a degree of accuracy and resolution as the human organism is able to distinguish by one petabyte (that is, 10^{15} bytes). We can think of one petabyte as the equivalent of running

100,000 DVDs simultaneously. Surely that's enough to cover the range of our sensory experiences for a single hour.

Now the average human life span is less than 100 years. With 24 hours in a day and 365 days in a year, that means humans have less than a million hours in which to live their lives. It follows that the entire sensory experience of a human being can be captured in one zettabyte (that is, 10^{21} bytes). Any scientific theory that is the product of a single human scientist will therefore have to be made on the basis of no more than one zettabyte of information. Any scientific theory that is the product of a community of N human scientists will therefore have to be made on the basis of N zettabytes of information.

Now the only obligation of an empirically adequate scientific theory is to be faithful to these few zettabytes of information. Thus, for a scientific theory to posit an infinite universe necessarily exceeds anything that's empirically warranted. Call it physics untethered to observation or call it metaphysics, it doesn't matter. The infinite is beyond empirical observation, which means that any appeal to the infinite in our scientific theories signifies not that our finite experience has given us a window on the infinite but rather that we are using infinity as a construct to approximate our finite experience (as Peter Huber at MIT used to say, "We use the infinite to approximate the finite").

It's important to understand that the phenomenological argument I've just given (namely, that it is impossible for human experience to empirically confirm an infinite universe) in no way undercuts the big numbers that come up daily in physical sciences research. I argued that one zettabyte (that is, 10^{21} bytes) can represent the entire sensory experience of a human being (given our present physical make-up). At most there have been ten billion human beings. So the total data set we have to explain cannot be bigger

than ten wekabytes (that is, 10^{31} bytes). Now, according to our current extremely well confirmed physical theories, the atmosphere of the earth contains no less than 10^{44} molecules. Similarly, our current theory of electromagnetism is extremely well confirmed down to distances of about 10^{-16} centimeters. Thus, it is meaningful to talk about the electric and magnetic fields that exist in a box of size 10^{-16} centimeters on a side. At least 10^{56} such boxes partition this room. Thus our tried and true theory of electromagnetism posits more than 10^{56} physically meaningful spatial units just in this room.

Am I therefore saying that physicists cannot assert that the earth's atmosphere is made up of that many molecules or that they cannot assert that this room consists of so many boxes because no group of people have the ability to go out and empirically confirm the separate existence of each of these entities. Not at all. What's behind my criticism of an infinite universe is a well known result from mathematical logic which states that for any consistent theory (i.e., collection of sentences that does not entail a contradiction), there are infinitely many models of mathematical reality that can accommodate it.

Thus, by looking to 10 wekabytes as the maximal number of sensory experiences of humans taken collectively, I'm not saying that numbers in this range are the only numbers that humans may reasonably assign to features of reality. Rather, I'm saying that ten wekabytes represents the maximal dataset on which our scientific theorizing can be based. Given the finiteness of this dataset, there will be finite as well as infinite models of reality that accommodate it, and thus there can be no empirical grounds for preferring one over another. To be sure, there might be other grounds, for instance, aesthetic. But an infinite universe is not an empirical proposition. Nor for that matter is a finite universe.

The only way around these strong finiteness limitations on human experience is for humans to transcend their biology. Christian theology, for instance, holds such a promise by resurrecting our physical bodies and thereby transforming them into spiritual bodies of infinite potentiality. Philosophical materialism, by contrast, doesn't have that option. Confined to understanding all of reality in terms of material mechanisms, the best the materialist can do is merge humans with machines and thereby increase human sensory and processing capacities. The most radical of these proposals is that we upload ourselves onto a superdupercomputer, preferably a quantum computer, and thus dispense with our biology entirely. (This is Ray Kurzweil's grandiose vision in *The Age of Spiritual Machines*.)

There are two problems with this proposal. First, there's no evidence that consciousness and its comprehension of sensory experience has anything to do with complexity or computation. To be sure, on the assumption of materialism, consciousness must reduce to complexity and computation. But consciousness remains a mystery for materialism. Biological survival and reproduction could make do quite nicely without it. It's easy to imagine a world of robot creatures doing all the right things without consciousness.

The other problem is that machines, even the fastest and biggest superduper quantum parallel processors, are still finite. I just argued that humanity's collective sensory experiences could be captured in ten wekabytes of information. But even if the entire known universe were a computer, it could never perform more than 10^{120} elementary calculations (as Seth Lloyd showed convincingly last year in *Physical Review Letters*). To be sure, what one means by an elementary computation differs between a

conventional and a quantum computer, but there is no escaping the finiteness of computation whatever form it takes. At no point in such a computer's existence will anything but a strictly limited number of items of information be stored in memory and a finite number of processing steps be executed.

Thus we see that an infinite universe cannot even in principle be an empirical proposition. But perhaps an infinite universe's explanatory virtue offsets its failure to be an empirical proposition? So what if an infinite universe cannot be grounded in an empirically based physics. It can certainly be posited as a metaphysical hypothesis. Indeed, as a metaphysical hypothesis it increasingly is doing a lot of work, not least undermining, at least for certain thinkers, intelligent design in nature.

An infinite universe is supposed to undercut intelligent design because it underwrites unlimited probabilistic resources. Probabilistic resources, for our purposes, can be thought of as the number of opportunities for an event to happen. The greater the probabilistic resources, the greater the probability that an otherwise unlikely event will happen by chance. For instance, if every elementary particle in the known universe were a monkey randomly typing letters at a typewriter at the rate of the Planck time, it would still be highly unlikely that any of these monkeys would ever type the first three lines of Hamlet's soliloquy, even with billions and billions of years to do so. But with an infinite universe housing an infinite number of such monkeys, it's a sure thing that they will randomly type not only Hamlet's soliloquy but the entire works of Shakespeare, and not just once but infinitely often. It therefore appears that unlimited probabilistic resources allow us to explain absolutely everything by reference to chance.

Or perhaps not. Consider the following possibility: Was Arthur Rubinstein a great pianist or was it just that whenever he sat at the piano, he happened by chance to put his fingers on the right keys to produce beautiful music? It could happen by chance, and there is some corner of an infinite universe where everything is exactly as it is on planet earth except that the counterpart to Arthur Rubinstein cannot read or even appreciate music and happens to be incredibly lucky whenever he sits at the piano. Examples like this can be multiplied. There are corners of an infinite universe where counterparts to me cannot do arithmetic and yet sit down at a computer and write probabilistic tracts about intelligent design. There are even extremely remote pockets of an infinite universe where my Chicago Cubs win the world series. Perhaps Shakespeare was a genius. Perhaps Shakespeare was an imbecile who just by chance happened to string together a long sequence of apt phrases. An infinite universe, in virtue of its unlimited probabilistic resources, ensures not only that we will never know but also that we have no rational basis for preferring one to the other.

Not so fast. Given unlimited probabilistic resources, there does appear to be one way to rebut such anti-inductive skepticism, and that is to admit that while unlimited probabilistic resources allow bizarre possibilities like this, these possibilities are nonetheless highly improbable in the little patch of reality that we inhabit. Unlimited probabilistic resources make bizarre possibilities unavoidable on a grand scale. The problem is how to mitigate the craziness entailed by them, and the only way to do this, once such bizarre possibilities are conceded, is to render them improbable on a local scale. Thus, in the case of Arthur Rubinstein, there are portions of an infinite universe where someone named Arthur Rubinstein is a world famous pianist and does not know

the first thing about music. But it is vastly more probable that in portions of the universe where someone named Arthur Rubinstein is a world famous pianist, that person is a consummate musician. What's more, induction tells us that ours is such a portion.

But can induction really tell us that? How do we know that we are not in one of those bizarre portions of an infinite universe where things happen by chance that we ordinarily attribute to design? Consider further the case of Arthur Rubinstein. Imagine it is January 1971 and you are at Orchestra Hall in Chicago listening to Rubinstein. As you listen to him perform Liszt's Hungarian Rhapsody No. 2 in C sharp minor, you think to yourself, "I know the man I'm listening to right now is a wonderful musician. But there's an outside possibility that he doesn't know the first thing about music and is just banging away at the piano haphazardly. The fact that Liszt's Hungarian Rhapsody is cascading from his fingers would thus merely be a happy accident."

The idea that Rubinstein is just banging away at a keyboard and getting lucky seems to you absurd. But if you take seriously the existence of an infinite universe, then you need to take seriously some counterpart to you pondering these same thoughts, only this time listening to the performance of someone named Arthur Rubinstein who is a complete musical ignoramus. How, then, do you know that you are not that counterpart?"

To answer this question, let us ask a prior question: What leads you to think that the man called Rubinstein performing in Orchestra Hall is a consummate musician?

Reputation, formal attire, and famous concert hall are certainly giveaways, but they are neither necessary nor sufficient. Even so, a necessary condition for recognizing Rubinstein's musical skill (and therefore the design in his performance) is that he was playing a complicated arrangement of musical notes and that this arrangement was also

specified (in this instance, the concert program specified that he was to play Liszt's Hungarian Rhapsody No. 2 in C sharp minor).

In other words, you recognized that Rubinstein's performance exhibited *specified complexity*. Moreover, its degree of complexity enabled you to assess just how improbable it was that someone named Rubinstein was playing the Hungarian Rhapsody with apparent proficiency but did not have a clue about music. Granted, you may have lacked the probabilistic and information-theoretic apparatus to describe the performance in these terms, but the implicit recognition of specified complexity was there nonetheless, and without that recognition there would have been no way to attribute Rubinstein's playing to design rather than chance.

In the theory of intelligent design, specified complexity is a reliable empirical marker for design. It is how we preclude the interplay of chance and necessity and properly detect the agency of an intelligence. Granting this use of specified complexity (and we certainly use it this way for human artifacts), on what basis could we attribute natural phenomena that exhibit specified complexity to material mechanisms, which by definition operate purely through the interplay of chance and necessity? Note that we are not just talking about an analogy here (as in classical design arguments that depend on finding similarities between artifacts and biological systems, say). Rather, we are talking about an *isomorphism*—the specified complexity in artifacts is identical with the specified complexity in natural systems (be they cosmological or biological).

It follows that the challenge of an infinite universe to intelligent design fails. It fails because there is no principled way to discriminate between using the unlimited probabilistic resources from an infinite universe to preclude design and using specified

complexity to infer design. You can have one or the other, but you cannot have both. And the fact is, we already use specified complexity to infer design. Moreover, unlike an infinite universe, which is inherently beyond the reach of empirical inquiry, specified complexity is an empirically determinable feature of objects, events, and structures. Bottom line: Regardless whether the universe is finite or infinite, it is possible for empirical evidence to confirm intelligent design in nature. Postscript: The million dollar question is the extent to which specified complexity actually is present in nature. For an overview of how to approach this question, I refer you to my book *No Free Lunch*, subtitled *Why Specified Complexity Cannot Be Purchased without Intelligence*.

Acknowledgment. I want to thank Stephen Barr for concerns he raised about my phenomenological argument, according to which scientists can have no empirical justification for concluding that the universe is infinite. I've preserved some of Steve's remarks from personal correspondence exactly. I've also, to my mind, addressed his concerns completely.