

Philosophy of the Multiverse

On what side of the borderline between science and philosophy are multiverses?

by GOVERT SCHILLING

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Readers'
Choice

Conference Idea: On what side of the borderline between science and philosophy are multiverses?

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We once thought the Earth was the center of the universe, but it turned out to be just one of many planets orbiting the sun.

Then we thought the sun was unique, but it was discovered to be one inconspicuous star amongst a multitude.

For a while, we also believed our Milky Way was all there is, but now we know of hundreds of billions of individual galaxies.

So wouldn't it be strange if there were just one universe?



SEAN CARROLL
California Institute of
Technology

"In history, our view of the world has always been growing," says theoretical cosmologist Sean Carroll of the California Institute of Technology in Pasadena. "It should not surprise us if that's happening again."

Welcome to the mind-boggling world of "parallel universes," in which our own cosmos is just one grain of sand on a

"Multiverse" beach. Today, theoretical physicists are seriously contemplating the idea that more than one universe exists, despite the fact that there's currently not a single shred of observational evidence for multiple universes.

But, says Carroll, "I've never been afraid of the idea."

Inevitable Conclusion?

In fact, many cosmologists believe we can't do without other universes. Inflation theory – the most popular and successful description of the first fraction of a second of the universe – almost demands the existence of other, similar universes.

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- Sean Carroll

"In inflation, in order to end up with just one universe, you have to contrive things," says theoretical physicist Anthony Aguirre of the University of California at Santa Cruz. A less contrived solution may be multiple universes.

As a bonus, the Multiverse concept solves the mystery of the apparent "fine-tuning" of the universe we live in. The constants of nature, the intrinsic strength of the fundamental forces, the value of the energy density of the vacuum (which turns out to be improbably small), and even the number of space-time dimensions of our universe, all appear, in our universe, to be finely tuned to enable complexity and life to form. If there's only one universe, this seems odd, to say the least: as if just one random lottery ticket is being sold, and it happens to be the jackpot number.

But, explains Carroll, we can make sense of the universe forced upon us by

imagining there is a multitude of universes. If all possible universes are realized somewhere in the Multiverse, our special case would naturally be among them. All lottery tickets are sold, so the jackpot number – the universe that permits life to form – *must* be out there. And of course we can't help finding ourselves living in this particular universe – the one that allows our form of life to exist.



ANTHONY AGUIRRE
UC Santa Cruz

To theoretical physicist Alexander Vilenkin, who heads the Institute of Cosmology at Tufts University, the "winning lottery" aspect is a very compelling reason to believe in the existence of parallel universes, if not strong evidence in favor of the idea. And according to astrophysicist Aurélien Barrau of the Laboratory of Subatomic Physics and Cosmology in Grenoble, France, the existence of many parallel universes may be the only remaining hypothesis "if one does not want to use God or rely on an unbelievable luck that led to extremely special [...] conditions."

Or Philosophical Exercise?

But can universe-imagining still be regarded as science? Or is this talk about parallel universes just a grand philosophical exercise?



ALEXANDER VILENKIN
Tufts University

Writing in the December 2007 issue of *CERN Courier*, Barrau notes that the idea of the Multiverse indeed “seems to lie outside of science because it cannot be observed. How, following the prescription of Karl Popper, can a theory be falsifiable if we cannot observe its predictions?” But Barrau goes on to say that Popper may not be the final word in the philosophy of science. “If scientists need to change the borders of their own field of research, it would be hard to justify a philosophical prescription preventing them from doing so.”

Actually, according to Aguirre, things may not look so bleak. First of all, he says, there may be room in the idea for some falsification. Parallel universes are a natural outcome of eternal inflation – a popular version of inflation theory. But eternal inflation also predicts an infinite, “open” universe. “If we would detect that the curvature of the universe is actually positive, the idea of eternal inflation is ruled out,” says Aguirre. Moreover, he is currently studying the possible observable effects of a “collision” of our universe with another. “We have long lived with the idea that parallel universes can never be observed, so this is very exciting.”

For Vilenkin, direct observational evidence of the existence of other universes isn’t even that important. “If we

have a cosmological theory, like the theory of inflation, that has been tested in our observable range,” he says, “we should give some credence to what it tells us about the universe beyond the horizon.” Barrau agrees. “It has never been necessary to check all of the predictions of a theory to consider it as legitimate science,” he writes in his *CERN Courier* article. “General relativity, for example, has been extensively tested in the visible world and this allows us to use it within black holes even though it is not possible to go there to check.”

Which, of course, is not to say that the idea of parallel universes is beyond doubt. As Barrau notes, “This could be either one of the most important revolutions in the history of [cosmology] or merely a misleading statement that reflects our lack of understanding of the most fundamental laws of physics.”

Aguirre goes even further. “It feels OK with me,” he says. “After doing cosmology for a number of years, I’ve become quite accustomed to the universe being a simple, little physical system. You can’t help wondering if that’s really all there is – it starts to feel a little cramped.”

Multiple Me’s

Parallel universes challenge the imagination. But even without parallel universes, some consequences of cosmology can be hard to swallow – like the idea that another version of you is out there, somewhere, reading an article just like this one.

Imagine that we live in an infinite universe. Then there is an infinite number of regions beyond our horizon that are comparable in size to our observable region. Since each “observable universe” has a finite size, and can only be filled with particles in so many different ways, it is inevitable that there must be many (in fact, infinite) copies of our own local universe out there -- including an infinite amount of duplicates of yourself.

“It’s a very disturbing thought experiment,” says theoretical physicist Anthony Aguirre of the University of California at Santa Cruz. “What does it mean to exist over time? What is it to be “me”? I struggle with it.”



THE COPERNICAN UNIVERSE put the Sun, not the Earth, at the center of the universe. What is the center of a Multiverse?