Can scientists make a universe from nothing?

“Empty space is never really, truly empty,” says science writer Zeeya Merali.

by Amy Frykholm
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A composite photo illustration of the spiral galaxy Messier-106, located 22–25 million light-years from Earth (NASA, ESA, Hubble Heritage Team [STScI/AURA], R. Gendler [for Hubble Heritage Team], and G. Bacon [STScI])

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Let’s start with this mind-blowing idea that scientists are trying to create a universe in a lab. What did you learn about it?

They sound like supervillains, don’t they? They’re trying to create a universe in the laboratory.

When I was working at *New Scientist* as a reporter, I found this paper called something like, “The Universe Out of the Monopole in a Laboratory.” Oftentimes physicists will talk in terms of metaphors. For example, there’s this massive particle accelerator, the Large Hadron Collider in Switzerland, where they’re trying to re-create conditions that are similar to those in our early universe. So they’ll say things like, “We’re trying to make a Big Bang,” but they don’t literally mean it.

What was weird about this paper, I realized, was that they did mean it. They literally meant it. They wanted to take a hypothetical particle called a monopole, stick it into a particle accelerator, and fire other particles at it with a whole load of energy. It’s going to take more energy than we are currently capable of, but in theory, that would trigger the particle into inflating into a whole new universe.

It would create its own space and time, separate from ours but connected to ours. Looking at it from the outside, we would just see this tiny particle, which would show up like a tiny black hole spraying off other little particles, and that’s all we would know about it. Within it, it would be expanding to astronomical scales, big enough to house galaxies and stars and planets and life forms. It would be connected to our universe very briefly by a little wormhole, before that wormhole broke and we lost contact with this little baby universe entirely.

This is something that could happen in a particle accelerator like the Large Hadron Collider maybe one day in the future. This paper was like blueprints for how to do that. It blew my mind. First of all, I thought these people must be crazy. Papers are not all equally credible. Some scientists write more serious papers than others. Some are more speculative, and some are just bad. So I sat there thinking, “Is this actually a good paper? Is this just a load of nonsense?” And then I looked through the paper and the references and I suddenly understood that, actually, this is a well-established program with a long history behind it. So I decided to look into it further.

There’s a lot of conversation about how the universe might emerge from “nothing.” What is “nothing”?

It’s a bit of a loaded term. I had heard this said a lot: physicists have shown that the universe can be created from nothing. I met up with Alex Vilenkin, one of the people who actually came up with this. His calculation was based on the laws of quantum theory, which tell you that empty space is never really, truly empty. So even if you create a vacuum in the lab, there’s always some uncertainty about what’s happening. For a fleeting second, you can have pairs of particles, like an electron and a positron, popping up in the vacuum. They exist for less than a nanosecond, have a little look around, and then smash back into each other and disappear. In a sense, a vacuum itself is full of these little undulations, these tiny little frothing particles that disappear and reappear and disappear and reappear. That’s established. Physicists are comfortable with that.

Vilenkin asked, How far can you take that? Let’s say you start with a tiny little nugget of a universe. How might it inflate into a bigger universe? Then he said, let me think about this backward and make that tiny little nugget smaller and smaller. And he ended up making it so small that it disappeared. But because it was a quantum universe with quantum rules that he was thinking about, even when it disappeared completely—there was no nugget of a universe anymore, there was no space, there was no time—there was a probability that the universe could just pop out of “nothing” and then start to grow. That’s what people usually refer to when they say that physics has shown that you can have a universe created from nothing.

But what does “nothing” mean here? I understand you’ve got no space, no time, no matter. But Vilenkin is saying that the quantum laws of physics still apply. There are these abstract laws, this handbook of how matter and time and space should behave should they ever pop into existence. Vilenkin said yes, that’s right: these rules are still there. He said that he put “nothing” in quotes when he wrote his paper because it’s not really nothing.

I don’t know if that’s convincing to you or not. To me, it’s weird to think about why there would be one certain rule book that exists for the potential of applying to something that may pop into existence one day. Vilenkin had an answer, which maybe was just as equally perplexing. He said, well, when you think about it, it’s weird that these physical laws would apply to nothing, but at the same time, it’s kind of weird that these physical laws apply to anything, even when there’s something in the universe. Why do they do that? Nobody knows.

One scientist that you interviewed identifies a field of consciousness in the inner life that he says is something like photons and electromagnetic fields, and he doesn't just mean this metaphorically. What do you make of that?

Theoretical physicist Abhay Ashtekar is famous for having worked on an idea for how space-time itself is generated. So we talked about how the universe can come from nothing. He wanted to get an answer to how to actually go from nothing and then stitch together the space and time that we have around us.

Before I interviewed him, somebody told me I should ask him about his experience meditating, because he has a very serious dedication to meditation. That's not hugely common among physicists—or perhaps it would be better to say, it's not hugely common for physicists to feel comfortable talking about that.

Let me tell you a bit about the physics first, because you'd asked about how the physics connects to his inner life. Quantum fields are very well understood. We talk about, for instance, light being made up of photons or little particles, and we talk about an electromagnetic field that these photons come out of. You've got some soup on the stove and you turn up the heat and suddenly it gets so vigorous and you can see a kind of roiling surface. And those bubbling excitations would end up acting like little particles of light.

So you've got this kind of field and then you've got these bubbling things coming out of it. It's very similar to what we were talking about with the vacuum and things bubbling out of the vacuum. It's very natural for physicists to think about fields, or nothing that pervades everything and things popping out of it.

Then you have Ashtekar's more speculative ideas in physics. Let's say you have nothing. Again, this is one of these sneaky things where physicists will say "nothing," but then they'll say, "but there are certain rules that apply." And for Ashtekar, there's this sense of geometry that applies. Because you have a sense of geometry, you can have loops of geometry that can suddenly pop out of this empty field of nothing. These loops that jump out of nothing can somehow link together to create space-time, like they're these building blocks of space and time.

So we've already gone from something that's very well established in physics to something that's very speculative, which is how space and time could be created. It's an interesting idea that's been around for many decades now, and quite a few

physicists like it and are investigating it.

And then we get into something which is even more speculative than that: I started to ask Ashtekar about his meditative experiences. Being a physicist, he thought about what was happening in very physical terms. He was taking ideas from Eastern philosophy, in which there is a universal entity that we are all part of, in which the individual is part of a greater whole. As he was picturing it, you have a field like the electromagnetic field that pervades the whole universe, but now this is a field of consciousness, of one shared consciousness, and each of our consciousnesses is an excitation out of that field.

It's funny because for physicists it's easier to think in terms of the physics and talk about consciousness by analogy, whereas I think everybody else is probably like, "Why are you telling me about the electromagnetic field?" I think it's something that anybody who has tried meditating or mindfulness or something like that has probably experienced, which is that if you can quieten your mind, you can sink back into what he described as this "consciousness field." For some Eastern philosophies, it's this sense of actually sinking back into the shared consciousness that we all are part of.

I thought that was an absolutely beautiful analogy. And so I said to Ashtekar, This is a lovely way of thinking about it, but you don't literally mean that there is a field of consciousness. And he was like, No, I absolutely do. He's a serious physicist. And he was saying, Well, I think that we could one day discover this consciousness field.

Ashtekar hasn't worked out the mathematics of it yet, but Einstein posited space-time pervading the universe more than a hundred years ago, and it took a hundred years for experiments to detect ripples in that fabric of space-time. So just because it takes a very long time for people to work out how to actually find the physical proof of this, it doesn't mean that there's nothing there.

Ashtekar meant all of that very literally. Meditating certainly has a real, physical effect, so it's not so outlandish that he should think about it in very serious scientific terms and in terms of something that he's used to handling mathematically. I've never heard anybody else try to do that. Again, because people who are looking into these questions, cosmologists and physicists, are so used to thinking on these scales, it doesn't seem weird to them to say, "Well, if I can think of an electromagnetic field that is pervading all of space, why can't I think of a

consciousness field doing the same thing?”