

## **The Origin of the Universe**

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According to the Boshongo people of central Africa, in the beginning, there was only darkness, water, and the great god Bumba. One day Bumba, in pain from a stomach ache, vomited up the sun. The sun dried up some of the water, leaving land. Still in pain, Bumba vomited up the moon, the stars, and then some animals. The leopard, the crocodile, the turtle, and finally, man.

This creation myth, like many others, tries to answer the questions we all ask. Why are we here? Where did we come from? The answer generally given was that humans were of comparatively recent origin, because it must have been obvious, even at early times, that the human race was improving in knowledge and technology. So it can't have been around that long, or it would have progressed even more. For example, according to Bishop Usher, the Book of Genesis placed the creation of the world at 9 in the morning on October the 27th, 4,004 BC. On the other hand, the physical surroundings, like mountains and rivers, change very little in a human lifetime. They were therefore thought to be a constant background, and either to have existed forever as an empty landscape, or to have been created at the same time as the humans. Not everyone, however, was happy with the idea that the universe had a beginning.

For example, Aristotle, the most famous of the Greek philosophers, believed the universe had existed forever. Something eternal is more perfect than something created. He suggested the reason we see progress was that floods, or other natural disasters, had repeatedly set civilization back to the beginning. The motivation for believing in an eternal universe was the desire to avoid invoking divine intervention to create the universe and set it going. Conversely, those who believed the universe had a beginning, used it as an argument for the existence of God as the first cause, or prime mover, of the universe.

If one believed that the universe had a beginning, the obvious question was what happened before the beginning? What was God doing before He made the world? Was He preparing Hell for people who asked such questions? The problem of whether or not the universe had a beginning was a great concern to the German philosopher, Immanuel Kant. He felt there were logical contradictions, or antimonies, either way. If the universe had a beginning, why did it wait an infinite time before it began? He called that the thesis. On the other hand, if the universe had existed for ever, why did it take an infinite time to reach the present stage? He called that the antithesis. Both the thesis and the antithesis depended on Kant's assumption, along with almost everyone else, that time was Absolute. That is to say, it went from the infinite past to the infinite future, independently of any universe that might or might not exist in this background. This is still the picture in the mind of many scientists today.

However in 1915, Einstein introduced his revolutionary General Theory of Relativity. In this, space and time were no longer Absolute, no longer a fixed background to events. Instead,

they were dynamical quantities that were shaped by the matter and energy in the universe. They were defined only within the universe, so it made no sense to talk of a time before the universe began. It would be like asking for a point south of the South Pole. It is not defined. If the universe was essentially unchanging in time, as was generally assumed before the 1920s, there would be no reason that time should not be defined arbitrarily far back. Any so-called beginning of the universe would be artificial, in the sense that one could extend the history back to earlier times. Thus it might be that the universe was created last year, but with all the memories and physical evidence, to look like it was much older. This raises deep philosophical questions about the meaning of existence. I shall deal with these by adopting what is called, the positivist approach. In this, the idea is that we interpret the input from our senses in terms of a model we make of the world. One can not ask whether the model represents reality, only whether it works. A model is a good model if first it interprets a wide range of observations, in terms of a simple and elegant model. And second, if the model makes definite predictions that can be tested and possibly falsified by observation.

In terms of the positivist approach, one can compare two models of the universe. One in which the universe was created last year and one in which the universe existed much longer. The Model in which the universe existed for longer than a year can explain things like identical twins that have a common cause more than a year ago. On the other hand, the model in which the universe was created last year cannot explain such events. So the first model is better. One can not ask whether the universe really existed before a year ago or just appeared to. In the positivist approach, they are the same. In an unchanging universe, there would be no natural starting point. The situation changed radically however, when Edwin Hubble began to make observations with the hundred inch telescope on Mount Wilson, in the 1920s.

Hubble found that stars are not uniformly distributed throughout space, but are gathered together in vast collections called galaxies. By measuring the light from galaxies, Hubble could determine their velocities. He was expecting that as many galaxies would be moving towards us as were moving away. This is what one would have in a universe that was unchanging with time. But to his surprise, Hubble found that nearly all the galaxies were moving away from us. Moreover, the further galaxies were from us, the faster they were moving away. The universe was not unchanging with time as everyone had thought previously. It was expanding. The distance between distant galaxies was increasing with time.

The expansion of the universe was one of the most important intellectual discoveries of the 20th century, or of any century. It transformed the debate about whether the universe had a beginning. If galaxies are moving apart now, they must have been closer together in the past. If their speed had been constant, they would all have been on top of one another about 15 billion years ago. Was this the beginning of the universe? Many scientists were still unhappy with the universe having a beginning because it seemed to imply that physics broke down. One would have to invoke an outside agency, which for convenience, one can call God, to determine how the universe began. They therefore advanced theories in which the universe was expanding at the present time, but didn't have a beginning.

<http://www.hawking.org.uk/the-origin-of-the-universe.html>

## No End in Sight: Debating the Existence of Infinity

Despite being in existence for more than 2,000 years, the concept of infinity has endured as an enigmatic, and oftentimes challenging, idea for mathematicians, physicists and philosophers. Does infinity really exist, or is it just part of the fabric of our imaginations?

A panel of scientists and mathematicians gathered to discuss some of the profound questions and controversies surrounding the concept of infinity here Friday (May 31), as part of the World Science Festival, an annual celebration and exploration of science.

Part of the difficulty in trying to solve some of the abstract questions related to infinity is that these problems fall beyond the more established mathematical theories, said William Hugh Woodin, a mathematician at the University of California, Berkeley. [Watch: World Science Festival Highlights]

"It's kind of like mathematics lives on a stable island — we've built them a solid foundation," Woodin said. "Then, there's the wild land out there. That's infinity."

### Where it all began

A philosopher named Zeno of Elea, who lived from 490 B.C. to 430 B.C, is credited with introducing the idea of infinity.

The concept was studied by ancient philosophers, including Aristotle, who questioned whether infinities could exist in a seemingly finite physical world, said Philip Clayton, dean of the Claremont School of Theology at Claremont Lincoln University in Claremont, Calif. Theologians, including Thomas Aquinas, used the infinite to explain the relationship between humans, God and the natural world.

In the 1870s, a German mathematician named Georg Cantor pioneered work in a field that became known as set theory. According to set theory, integers, which are numbers without a fraction or decimal component (such as 1, 5, -4), make up an infinite set that is countable. On the other hand, real numbers, which include integers, fractions and so-called irrational numbers, such as the square root of 2, are part of an infinite set that is uncountable.

This led Cantor to wonder about different types of infinity.

"If there are now two kinds of infinity — the countable kind and this continuous kind, which is bigger — are there other infinities? Is there some infinity that's sandwiched in between them?" said Steven Strogatz, a mathematician at Cornell University in Ithaca, N.Y.

Cantor believed that no infinities exist between the sets of integers and real numbers, but he was never able to prove it. His statement, however, became known as the continuum hypothesis, and mathematicians who tackled the problem in Cantor's footsteps were labeled set theorists.

### **Exploring beyond**

Woodin is a set theorist, and has spent his life trying to solve the continuum hypothesis. To date, mathematicians have not been able to prove or disprove Cantor's postulation. Part of the problem is that the idea that there are more than two types of infinity is so abstract, Woodin said.

"There's no satellite you can build to go out and measure the continuum hypothesis," he explained. "There's nothing in our world around us that will help us determine whether or not the continuum hypothesis is true or false, as far as we know." [5 Seriously Mind-Boggling Math Facts]

Trickier still is the fact that some mathematicians have dismissed the relevance of this type of mathematical work.

"These people in set theory strike us, even in math, as sort of strange," Strogatz joked. But, he said he understands the importance of the work being done by set theorists, because if the continuum hypothesis is proven false, it could uproot basic mathematical principles in the same way that contradicting number theory would wipe out the bases for math and physics.

"We know that they're doing really deep, important work, and in principle, it's foundational work," Strogatz explained. "They're shaking the foundations that we're all working on, up on the second and third floors. If they mess something up, it could tip us all over."

### **The future of mathematics**

Still, despite all of the uncertainties, the work done by set theorists could have positive ripple effects that serve to strengthen the foundations of mathematics, Woodin said.

"By investigating infinity, and to the extent that we can be successful, I think we make the case for the consistency of arithmetic," he explained. "That's a bit of a fanatical statement, but if infinity doesn't lead to a contradiction, certainly the finite doesn't lead to a contradiction. So, maybe by exploring the outer reaches to see if there is a contradiction, you gain some security."

The paradoxes that characterize the concept of infinity are perhaps best explained with the number pi, Strogatz said. Pi, one of the most recognizable mathematical constants, represents the ratio of a circle's circumference to its diameter. Among its myriad applications, pi can be used to find the area of a circle.

"Pi is typical of real numbers ... in that it has this infinite amount of unpredictable information in it, and at the same time, is so totally predictable," Strogatz said. "There's nothing more orderly than a circle, which pi embodies — it's the very symbol of order and perfection. So this coexistence of perfect predictability and order, with this tantalizing mystery of infinite enigma built into the same object, is part of the pleasure of our subject and, I suppose, of infinity itself."

<http://www.livescience.com/37077-infinity-existence-debate.html>

