

# After death, Hawking cuts 'multiverse' theory down to size

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In his last contribution to cosmology, Hawking proposes dramatically scaling down the multiverse concept, a theory that has long divided theoretical physicists

With a science [paper published](#) after his death, Stephen Hawking has revived debate on a deeply divisive question for cosmologists: Is our

Universe just one of many in an infinite, ever-expanding "multiverse"?

According to one school of thought, the cosmos started expanding exponentially after the Big Bang.

In most parts, this expansion or "inflation" continues eternally, except for a few pockets where it stops.

These pockets are where universes like ours are formed—multitudes of them that are often likened to "bubbles" in an ever-expanding ocean dubbed the [multiverse](#).

Many scientists don't like the idea, including Hawking, who said in an interview last year: "I have never been a fan of the multiverse."

If we do live in an ever-inflating multiverse, it would mean the laws of physics and chemistry can differ from one [universe](#) to another, a concept that scientists struggle to accept.

In his last contribution to cosmology, Hawking—with co-author Thomas Hertog from the KU Leuven university in Belgium—does not dismiss the multiverse concept, but proposes dramatically scaling it down.

"We are not down to a single, unique universe," the University of Cambridge quoted Hawking as saying of the paper submitted before his death on March 14 and published this week in the Journal of High Energy Physics.

However, "our findings imply a significant reduction of the multiverse, to a much smaller range of possible universes."



While the multiverse theory has its defenders, others consider it a "fringe idea" that complicates our understanding of the universe

The new hypothesis relies on a branch of theoretical physics known as string theory, and concludes that the cosmos is "clearly finite", Hertog told AFP, though still composed of numerous universes.

### **'Fringe idea'**

"It is a debate that touches on the very foundations of cosmology," Hertog said.

"The underlying question is whether we can achieve a deeper understanding of where the laws of nature come from, and whether they are unique."

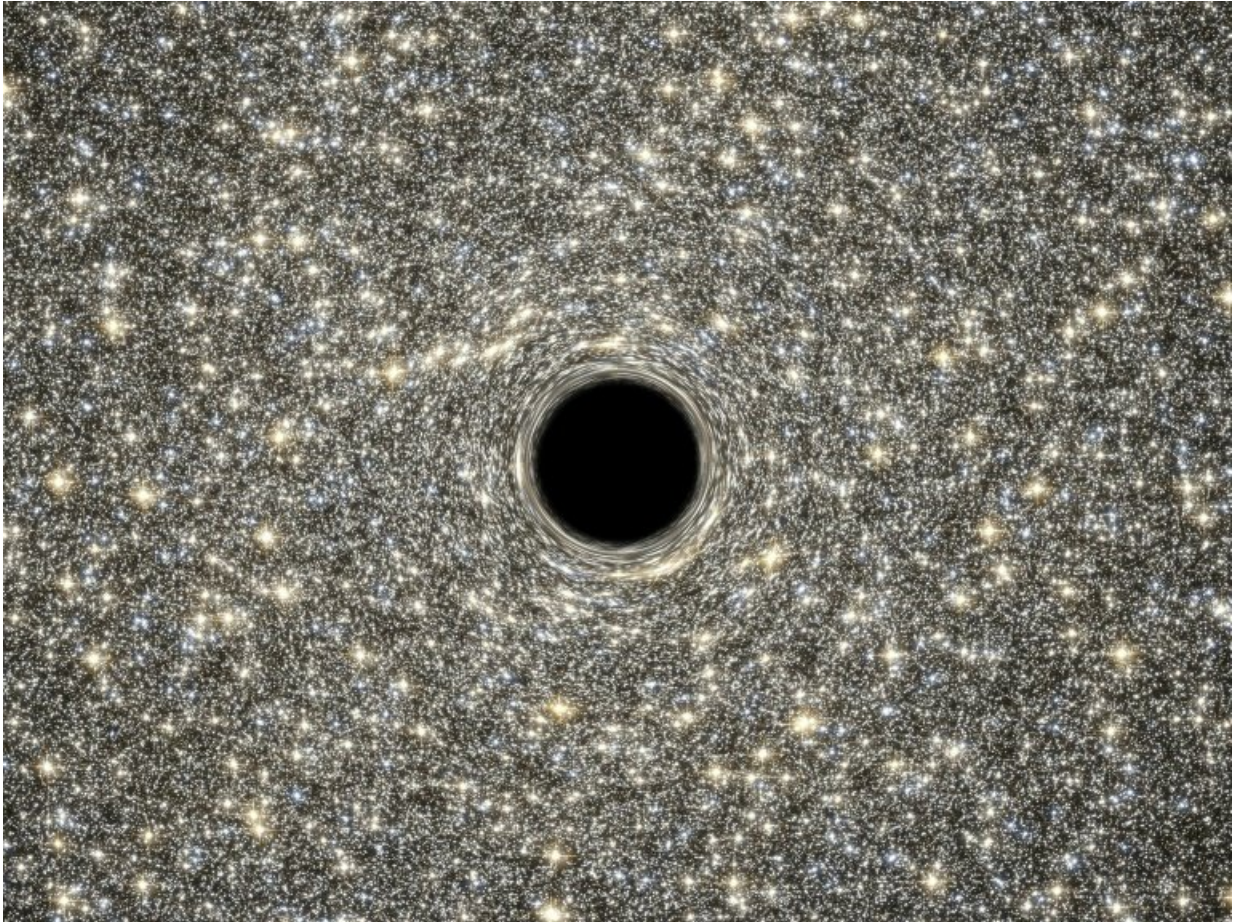
Not everyone likes the new theory.

"The idea that we live in a 'multiverse' is a fringe idea in a small part of a subfield of the physics community," said theoretical physicist Sabine Hossenfelder of the Frankfurt Institute for Advanced Studies.

"Nobody who does serious science works with the multiverse because it's utterly useless," she told AFP.

The main problem, Hossenfelder explains, is that any multiverse theory is "underdetermined" and "doesn't contain enough information to make calculations".

For detractors, a multiverse theory complicates our understanding of our own Universe.



Thomas Hertog, who co-authored work on the multiverse concept with Hawking, says the measurement of gravitational waves can help determine whether the theory is scientifically sound

But it has its defenders too.

For astrophysicist Aurelien Barrau of Laboratory of Subatomic Physics and Cosmology in Paris, "the concept makes sense."

"It is remarkable that today numerous types of universe can be envisaged. Several theories, reliable for some and speculative for others, lead to the prediction of a multiverse," he said.

For Hertog, the new theory is a step in the right direction.

It "makes the cosmology based on our new theory a lot more predictive, a lot... stronger as a scientific theory and therefore ultimately, we hope, testable", he explains on the UK Leuven website.

## 'Assumptions'

Hossenfelder disagrees. She described the new theory as just another "variant" of eternal inflation, "with some additional assumptions on top of it."

Thomas Hertog, who co-authored work on the multiverse concept with Hawking, says the measurement of gravitational waves can help determine whether the [theory](#) is scientifically sound. Hertog hopes to use gravitational waves, ripples in the fabric of spacetime caused by black hole collisions, supernova explosions, or the formation of the early Universe, to test the new hypothesis he created with Hawking.

The British cosmologist died at the age of 76 after a lifelong battle against [motor neurone disease](#), which paralysed him and left him unable to speak.

Hawking, who once said his life goal was "a complete understanding of the universe", famously overturned a core tenet of physics by predicting that black holes—believed until then to devour everything in their vicinity, including light—leak radiation.

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