Hypertime

To exist outside of the temporal fourth dimension

Ella Alderson Follow
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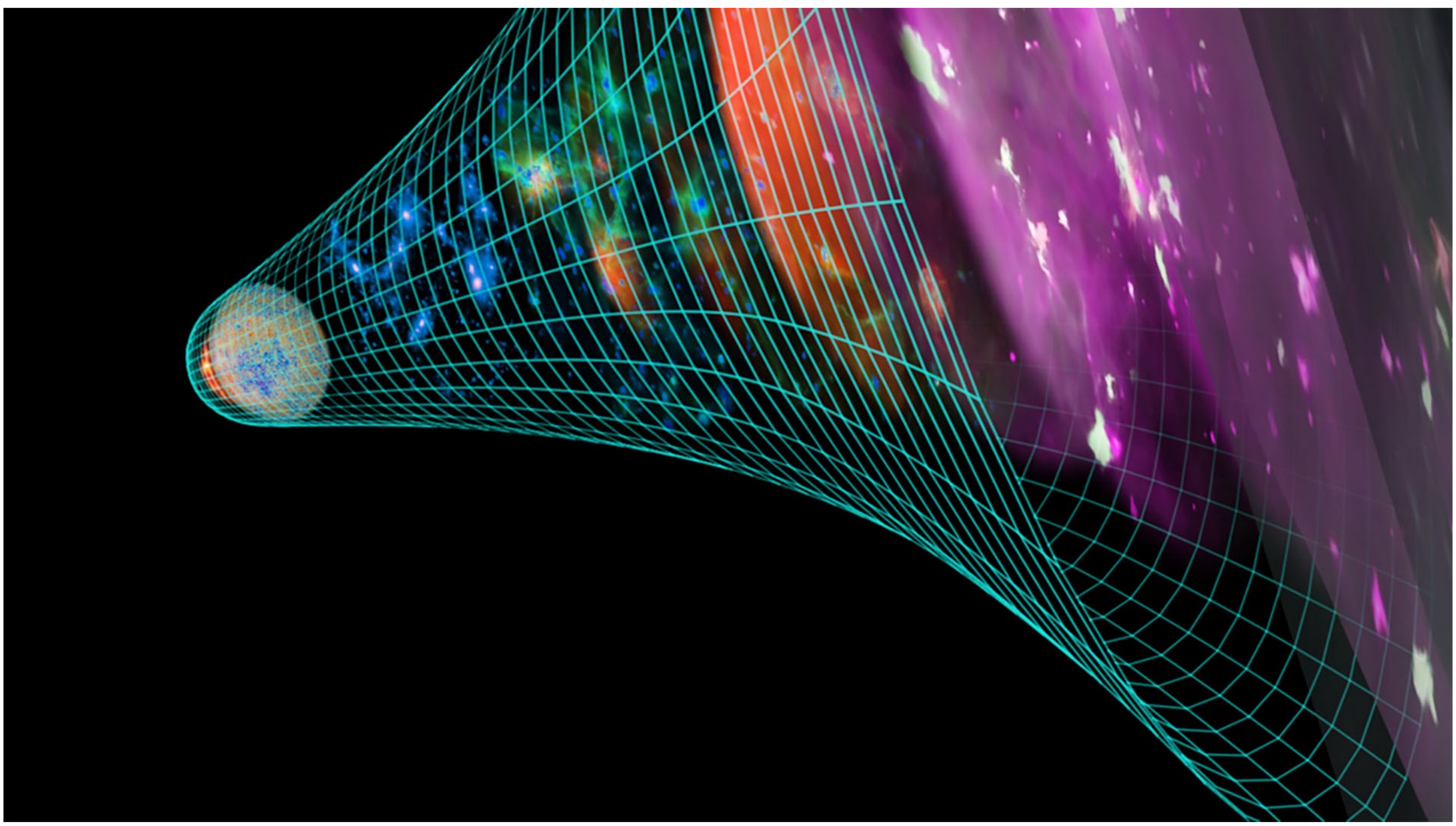


A simulation shows the concept of Stephen Hawking's "no-boundary" cosmos. Here the universe has no beginning.

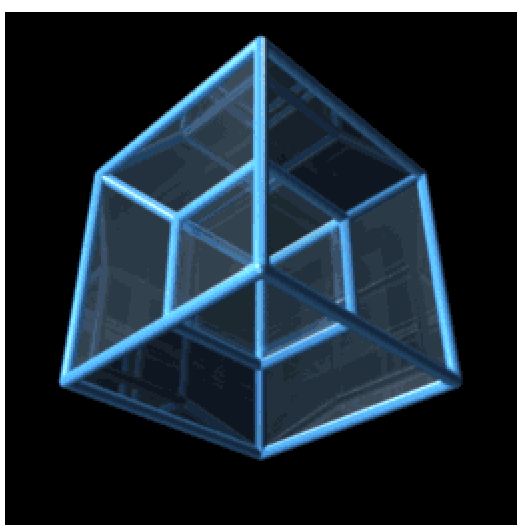
There are many ways in which we've found freedom over the years. Nowhere is that more apparent than in our exploration of the Earth. We began rooted to and struggling to find a way out of the wild umber landscape of Africa. Our earliest engineers built great salt-licked ships to traverse the seas, make familiar the strange fruits of the paradise islands. For better or for worse we have managed to build homes in the most uncanny places — on the rich, sooted sides of volcanoes and beyond the frosted mountain regions where only the thickest furs and soles keep the cold at bay. This exploration continues into the future with mounting hopes that one day we may even diverge from the Earth, moving on to coil through the garden of the cosmos.

And yet despite all this freedom we've made for ourselves, we continue bound to one thing — a thing more indiscriminate even than death.

Time.

We may visit new planets or wash ourselves in the light of another star, living longer and communicating better as we improve our technology. But we continue with the same inescapable perception of time: that one moment unfolds after the next whether or not we will it to. A great many, if not *every*, tragedy of a person's life comes from our inability to turn back the clock. We may hold onto memories, cherish or avoid them, but they can never be made real after their moment has passed.

And yet in our search for a unifying theory of physics we come across the idea that it could be possible to go back in time, or exist outside of the clock in what's called *hypertime*, or that time may not have existed at all if we look back far enough in our universe's history.

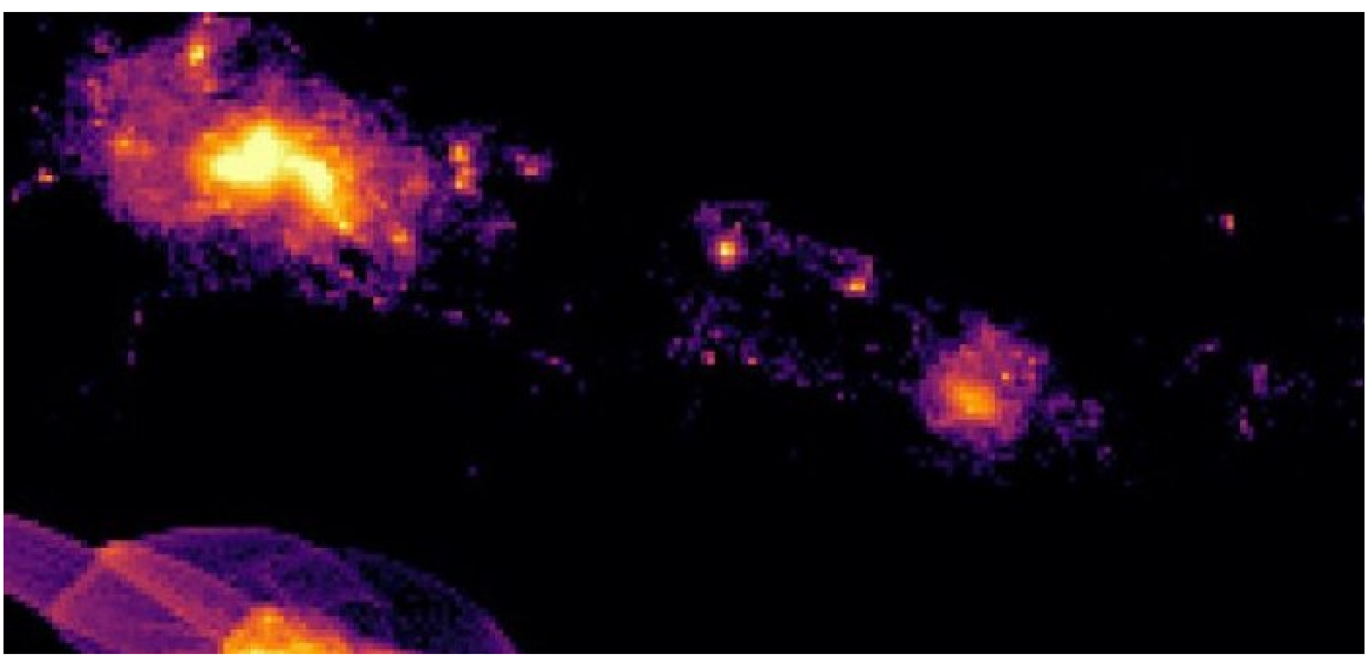


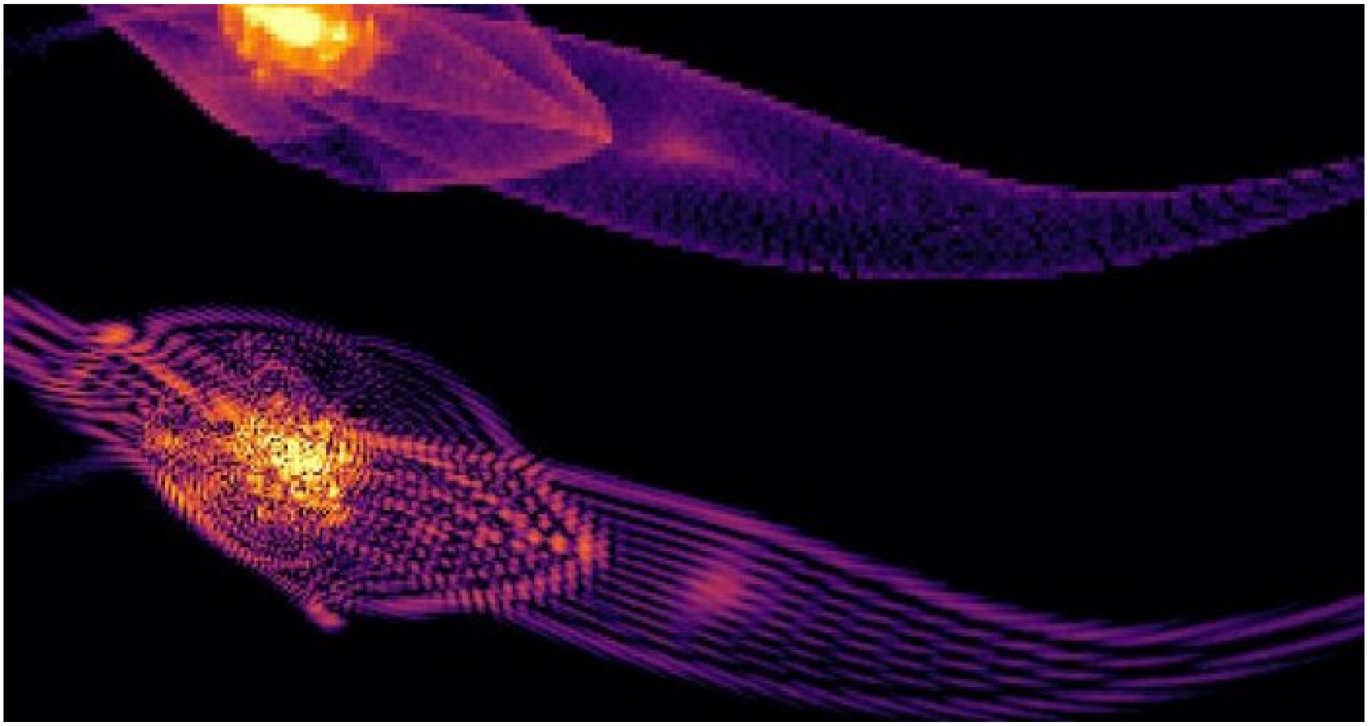
This computer graphic shows how we might imagine a 4D hypercube. Image by Jason Hise.

Popular theories that attempt to reconcile the two great pillars of physics — quantum mechanics and general relativity — suggest the idea of multiple dimensions. M-theory, for example, says that there are likely six more dimensions than the everyday four to which we're accustomed. We are currently thought to exist as beings of four dimensions: three of space, and one of time. In most interpretations of string theory's extra dimensions they are all considered to be spatial realms that evolve the way a square might evolve, first from a point in one dimension to a flat figure in two dimensions, to a cube in three dimensions and so on. We can even entertain the idea of a hypercube as we add yet another spatial dimension.

But it is just as possible that these extra dimensions could be of time, not just of space.

If we imagine our singular dimension of time to be a line extending outward in one direction, adding a second dimension would convert this line into a plane. Within this plane it would be possible to loop back to one's original starting point, encouraging time travel in this new area of hypertime. Now it becomes clear why most scientists avoid extra temporal dimensions: they give rise to problems in unitarity and causality, bringing into question time-travel paradoxes and our own psychological experience of how time flows. Where in one dimension we might experience the hours as having passed very quickly and we've arrived late to an event, in another dimension the hours may have passed slowly and we're now early to the same event as before. The paradoxes occur when time travel allows us to make choices in our past which cannot be reconciled with the future we've already experienced.

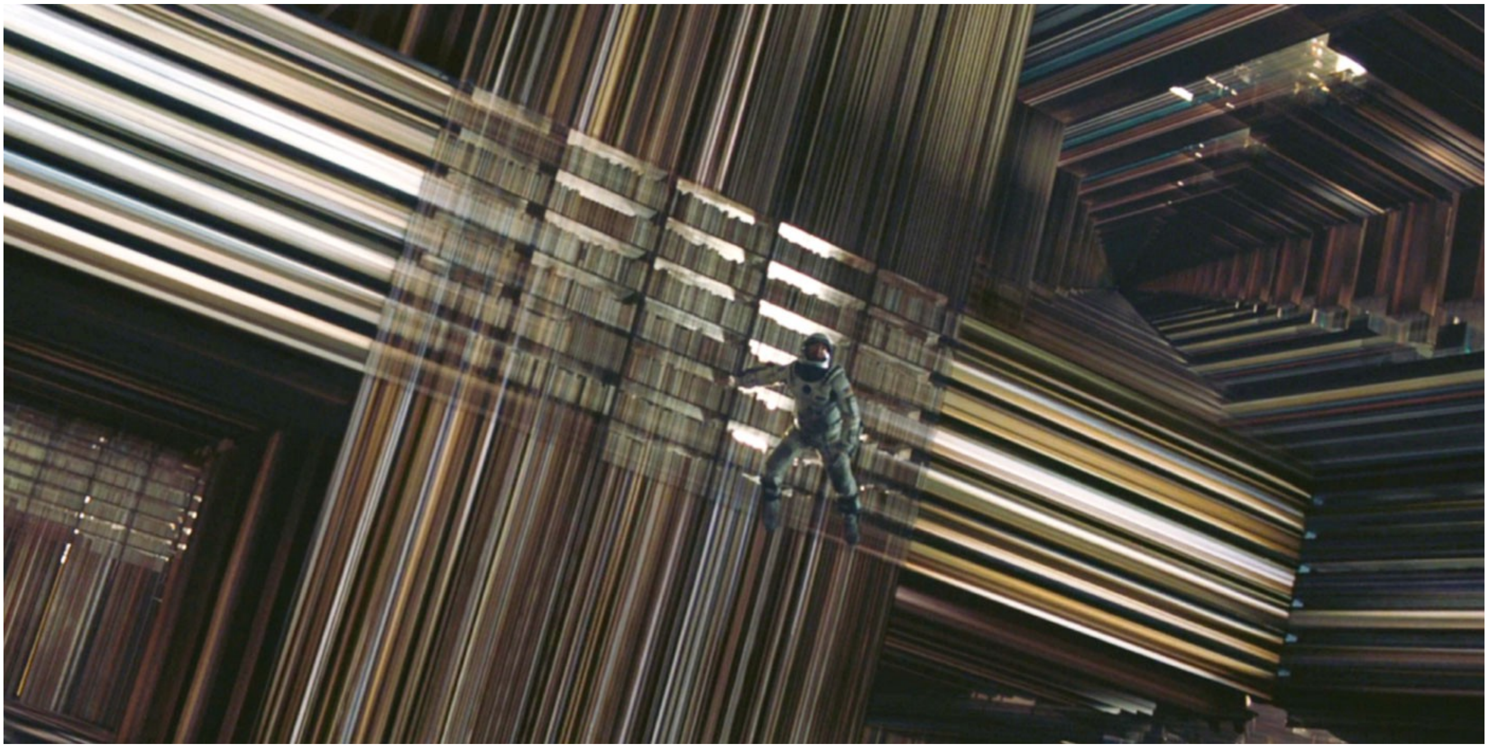




A second temporal dimension could also help explain the absence of axions — particles conjured up to help solve the strong CP problem within our standard model of particle physics. Like neutrinos, these particles would be very light and difficult to detect. Their elusiveness makes them the possible constituents of dark matter, though tests have yet to show evidence that fundamental axions exist. With an added temporal dimension the CP problem can be solved without the need of an axion. The above shows different distributions of dark matter resulting in varied galaxy formations. Image by P. Mocz et al.

Despite these complications, theoretical physicists studying M-theory in the 1990's noticed that when an additional dimension of space and an additional dimension of time were factored into the math, it reproduced an accurate mathematical description of our world and its fundamental particles and forces. Going further and adding these dimensions to M-theory would give us a space with a total of 13 dimensions — 11 of space and 2 of time. If this approach helps create a more complete understanding of M-theory, which up until now has held an ambiguous form, it means a second temporal dimension could be the key to unifying general relativity and quantum mechanics.

So in this two-time world it would be possible to slip back through the supple, gurgling waters of time and come to an earlier point, to perhaps meet yourself when you were younger and avoid so much of the tragedy that comes with being human. A newfound form of freedom. And what if one couldn't only move within time but exist *outside* of it altogether? Like looking into a garden and seeing there the seed and growth of every moment. Author Clifford Pickover calls this an "eternitygram", an artifact where every moment in time is frozen. Instants become like movie frames that collect to form the overall reel. It is a three-dimensional figure in hypertime. No event is actually occurring nor is anything actually moving, it is only our perception which makes it appear that way.



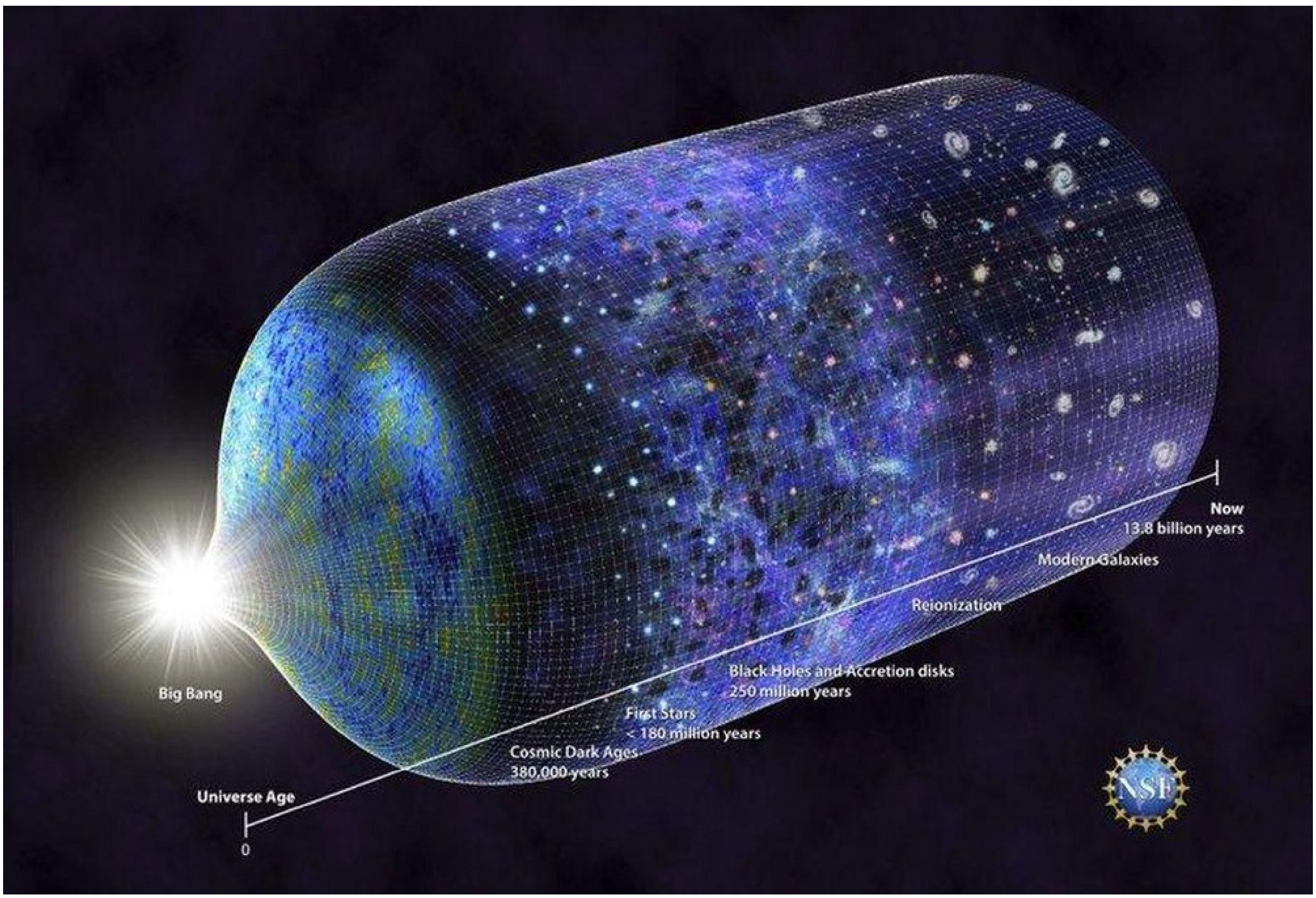
The tesseract in “Interstellar” is akin to the idea of an eternitygram. All moments — past, present, and future — exist in a three-dimensional form. It was difficult to pinpoint an exact moment within the tesseract because all of time lay before us like a landscape in which we’d have to find a single blade of grass or a single flake of snow. From “Interstellar”, dir. Christopher Nolan.

1983 brought a brilliant and controversial new proposal. Not for going forward and backward in time, not for adding dimensions to it, not for existing outside of it. It was that if we go back far enough, time never existed at all.

The proposal came from Stephen Hawking and fellow physicist J.B. Hartle. This “no-boundary” scenario attempts to answer one of the most compelling questions in all of science. What happened at the very beginning? Not the explosive moment of the Big Bang, but the moment even before that. If we try to go back that far, time morphs into something altogether different. It becomes another dimension of space so that at the beginning of the universe there were four spatial dimensions, and none of time. This idea is like the idea of life itself: there was none, and then it was here by some process we still don’t fully understand. Time and our perception of it seem to flow forward because of the increase in the world’s entropy (a kind of measure of disorder) but toward the beginning of the universe everything was condensed so small and correlations were so unreliable that time stopped existing. There was only space.

And so that is, at the boundary of something as spectacular as the entire universe, there is no boundary. There is no real beginning.

The universe followed from a smooth curve of zero size. No edge, like the hardy globe of the world that has no start and no end. This shape of the cosmos emerged from a wave function (a probabilistic quantum description) that takes into account many different histories. Real time becomes imaginary time, giving way to a curved four-dimensional space.



At first, the no-boundary proposal was thought to be unable to describe our world. It would result in a vastly empty universe with just a short period of inflation. But scientists have found ways to bring together inflation and the no-boundary theory, adding in the condition that we are a part of the universe and thus resulting in new universes that are large and have long if not eternal phases of inflation. This can give us big, blustering, growing breadths of cosmos like the very one we experience around us today. In the inflationary model above, the universe evolved from an initial singularity. Image by the National Science Foundation.

This idea is one that remains controversial and difficult to imagine to this day. There are many scientists that oppose the idea of no boundaries, noting that it's ambiguous and impossible under refined technicalities in the math. The Hawking-Hartle theory also calls for imaginary numbers, though these kinds of values are replete throughout quantum mechanics and are found in places like the Heisenberg relation equation and the Schrodinger equation.

So time plunders onward; on an individual level this can be a way to help let go of our past. There are as many terrible moments drowned in the sea of time as there are beautiful ones. To the cosmos it ushers the galaxies onward into an era devoid of life, where one day there will be no stars, no planets, no us. We are inseparable from the tick-tock of entropy. Perhaps this is a future we must come to accept, with time.

Physics Science Space Universe Mathematics