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ESSAY

The Universe, Expanding Beyond All Understanding

By [DENNIS OVERBYE](#)

When [Albert Einstein](#) was starting out on his cosmological quest 100 years ago, the universe was apparently a pretty simple and static place. Common wisdom had it that all creation consisted of an island of stars and nebulae known as the Milky Way surrounded by infinite darkness.

We like to think we're smarter than that now. We know space is sprinkled from now to forever with galaxies rushing away from one another under the impetus of the Big Bang.

Bask in your knowledge while you can. Our successors, whoever and wherever they are, may have no way of finding out about the Big Bang and the expanding universe, according to one of the more depressing scientific papers I have ever read.

If things keep going the way they are, Lawrence Krauss of Case Western Reserve University and Robert J. Scherrer of [Vanderbilt University](#) calculate, in 100 billion years the only galaxies left visible in the sky will be the half-dozen or so bound together gravitationally into what is known as the Local Group, which is not expanding and in fact will probably merge into one starry ball.

Unable to see any galaxies flying away, those astronomers will not know the universe is expanding and will think instead that they are back in the static island universe of Einstein. As the authors, who are physicists, write in a paper to be published in *The Journal of Relativity and Gravitation*, "observers in our 'island universe' will be fundamentally incapable of determining the true nature of the universe."

It is hard to count all the ways in which this is sad. Forget the implied mortality of our species and everything it has or has not accomplished. If you are of a certain science fiction age, like me, you might have grown up with a vague notion of the evolution of the universe as a form of growing self-awareness: the universe coming to know itself, getting smarter and smarter, culminating in some grand understanding, commanding the power to engineer galaxies and redesign local spacetime.

Instead, we have the prospect of a million separate Sisyphean efforts with one species after another pushing the rock up the hill only to have it roll back down and be forgotten.

Worse, it makes you wonder just how smug we should feel about our own knowledge.

"There may be fundamentally important things that determine the universe that we can't see," Dr. Krauss said in an interview. "You can have right physics, but the evidence at hand could lead to the wrong conclusion. The same thing could be happening today."

The proximate culprit here is dark energy, which has been responsible for much of the bad news in physics over

the last 10 years. This is the mysterious force, discovered in 1998, that is accelerating the cosmic expansion that is causing the galaxies to rush away faster and faster. The leading candidate to explain that acceleration is a repulsion embedded in space itself, known as the cosmological constant. Einstein postulated the existence of such a force back in 1917 to explain why the universe didn't collapse into a black hole, and then dropped it when Edwin Hubble discovered that distant galaxies were flying away — the universe was expanding.

If this is Einstein's constant at work — and some astronomers despair of ever being able to say definitively whether it is or is not — the future is clear and dark. In their paper, Dr. Krauss and Dr. Scherrer extrapolated forward in time what has become a sort of standard model of the universe, 14 billion years old, and composed of a trace of ordinary matter, a lot of dark matter and Einstein's cosmological constant.

As this universe expands and there is more space, there is more force pushing the galaxies outward faster and faster. As they approach the speed of light, the galaxies will approach a sort of horizon and simply vanish from view, as if they were falling into a black hole, their light shifted to infinitely long wavelengths and dimmed by their great speed. The most distant galaxies disappear first as the horizon slowly shrinks around us like a noose.

A similar cloak of invisibility will befall the afterglow of the Big Bang, an already faint bath of cosmic microwaves, whose wavelengths will be shifted so that they are buried by radio noise in our own galaxy. Another vital clue, the abundance of deuterium, a heavy form of hydrogen manufactured in the Big Bang, in deep space, will become unobservable because to be seen it needs to be backlit from distant quasars, and those quasars, of course, will have disappeared.

Eventually, in the far far future, this runaway dark energy will suck all the energy and life out of the universe. A few years ago, Edward Witten, a prominent theorist at the Institute for Advanced Study, called a universe that is accelerating forever “not very appealing.” Dr. Krauss has called it simply “the worst possible universe.”

But our future cosmologists will be spared this vision, according to the calculations. Instead they will puzzle about why the visible universe seems to consist of six galaxies, Dr. Krauss said. “What is the significance of six? Hundreds of papers will be written on that,” he said.

Those cosmologists may worry instead that their galaxy cloud will collapse into a black hole one day and, like Einstein, propose a cosmic repulsion to prevent it. But they will have no way of knowing if they were right.

Although by then the universe will be mostly dark energy, Dr. Krauss said, it will be undetectable unless astronomers want to follow the course of the occasional star that gets thrown out of the galaxy and is caught up in the dark cosmic current. But it would have to be followed for 10 billion years, he said — an experiment the [National Science Foundation](#) would be unlikely to finance.

“This is even weirder,” Dr. Krauss said. “Five billion years ago dark energy was unobservable; 100 billion years from now it will become invisible again.”

It turns out that you don't actually need dark energy to be this pessimistic about the future, as Dr. Krauss and Dr. Scherrer point out. In 1987, George Ellis, a mathematician and astronomer at the University of Cape Town, in South Africa, and Tony Rothman, currently lecturing at Princeton, wrote a paper showing how even ordinary expansion would gradually carry most galaxies too far away to be seen, setting the stage for cosmic ignorance.

Dark energy speeds up the picture, Dr. Ellis said in an e-mail message, adding that he was glad to see the new paper, which adds many astrophysical details. "It's an interesting gloss on the far future," he said.

James Peebles, a Princeton cosmologist, said there were more pressing worries. We might be headed toward a universe that is "asymptotically empty," he said, "But I have the uneasy feeling that the U.S.A. is headed into asymptotic futility well before that."

You might object that the inhabitants of the far future will be far more advanced than we are. Maybe they will be able to detect dark energy — or the extra dimensions of string theory, for that matter — in the laboratory. Maybe they will even be us, in some form or other, if the human race manages to get out of the solar system before the Sun blows up in five billion years. But if relativity is right, they won't be able to build telescopes that can see past the edge of the universe.

It's not too late to start thinking about sending out the robot probes that could drift down through alien skies eons from now with, if not us or our [DNA](#), at least a few nuggets of wisdom — that the world is made of atoms and that it started with a bang.

The lesson in the meantime is that we don't know what we don't know, and we never will — a lesson that extends beyond astronomy.

Einstein once said, "The Lord God is subtle but malicious he is not."

I wondered in light of this new report whether it might be time to revise that quotation. Max Tegmark, a cosmologist at the [Massachusetts Institute of Technology](#), told me the problem was not malice but human arrogance — a necessary but unfortunate condition for scientific progress.

"We have a tendency to put ourselves at the center of the universe," he said. "We assume all we see is all there is."

But, as Dr. Tegmark noted, Big Bang theorists already suppose that basic aspects of the universe are out of sight.

The reason we believe we live in a smooth, orderly universe instead of the chaotic one that is more likely, they say, is that the chaos has been hidden. According to the dominant theory of the Big Bang, known as inflation, an extremely violent version of dark energy blew it up a fraction of a second after time began, stretching and smoothing space and pushing all the wildness and chaos and even perhaps other universes out of the sky, where they will never be seen.

"Inflation tells us we live in a messy universe," Dr. Tegmark said. Luckily we never have to confront it.

Ignorance is us, or is it bliss?

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