

AFTERWORD

by Richard Dawkins

Nothing expands the mind like the expanding universe. The music of the spheres is a nursery rhyme, a jingle to set against the majestic chords of the *Symphonie Galactica*. Changing the metaphor and the dimension, the dusts of centuries, the mists of what we presume to call “ancient” history, are soon blown off by the steady, eroding winds of geological ages. Even the age of the universe, accurate—so Lawrence Krauss assures us—to the fourth significant figure at 13.72 billion years, is dwarfed by the trillennia that are to come.

But Krauss’s vision of the cosmology of the remote future is paradoxical and frightening. Scientific progress is likely to go into reverse. We naturally think that, if there are cosmologists in the year 2 trillion AD, their vision of the universe will be expanded over ours. Not so—and this is one of the many shattering conclusions I take away on closing this book. Give or take a few billion years, ours is a very propitious time to be a cosmologist. Two trillion years hence, the universe will have expanded so far that all galaxies but the cosmologist’s own (whichever one it happens to be) will have receded behind an Einsteinian horizon so absolute, so inviolable, that they are not only invisible but beyond all possibility of leaving a trace, however indirect. They might as well never have existed. Every trace of the Big Bang will most likely have gone, forever and beyond recovery. The cosmologists of the future will be cut off from their past, and from their situation, in a way that we are not.

We know we are situated in the midst of 100 billion galaxies, and we know about the Big Bang because the evidence is all around us: the redshifted radiation from distant galaxies tells us of

the Hubble expansion and we extrapolate it backward. We are privileged to see the evidence because we look out on an infant universe, basking in that dawn age when light can still travel from galaxy to galaxy. As Krauss and a colleague wittily put it, "We live at a very special time . . . the only time when we can observationally verify that we live at a very special time!" The cosmologists of the third trillennium will be forced back to the stunted vision of our early twentieth century, locked as we were in a single galaxy which, for all that we knew or could imagine, was synonymous with the universe.

Finally, and inevitably, the flat universe will further flatten into a nothingness that mirrors its beginning. Not only will there be no cosmologists to look out on the universe, there will be nothing for them to see even if they could. Nothing at all. Not even atoms. Nothing.

If you think that's bleak and cheerless, too bad. Reality doesn't owe us comfort. When Margaret Fuller remarked, with what I imagine to have been a sigh of satisfaction, "I accept the universe," Thomas Carlyle's reply was withering: "Gad, she'd better!" Personally, I think the eternal quietus of an infinitely flat nothingness has a grandeur that is, to say the least, worth facing off with courage.

But if something can flatten into nothing, can nothing spring into action and give birth to something? Or why, to quote a theological chestnut, is there something rather than nothing? Here we come to perhaps the most remarkable lesson that we are left with on closing Lawrence Krauss's book. Not only does physics tell us how something could have come from nothing, it goes further, by Krauss's account, and shows us that nothingness is unstable: something was almost bound to spring into existence from it. If I understand Krauss aright, it happens all the time: The principle sounds like a sort of physicist's version of two wrongs making a right. Particles and antiparticles wink in and out of existence like subatomic fireflies, annihilating each other, and then re-creating themselves by the reverse process, out of nothingness.

The spontaneous genesis of something out of nothing happened in a big way at the beginning of space and time, in the singularity

known as the Big Bang followed by the inflationary period, when the universe, and everything in it, took a fraction of a second to grow through twenty-eight orders of magnitude (that's a 1 with twenty-eight zeroes after it—think about it).

What a bizarre, ridiculous notion! Really, these scientists! They're as bad as medieval Schoolmen counting angels on pinheads or debating the "mystery" of the transubstantiation.

No, not so, not so with a vengeance and in spades. There is much that science still doesn't know (and it is working on it with rolled-up sleeves). But some of what we do know, we know not just approximately (the universe is not mere thousands but billions of years old): we know it with confidence and with stupefying accuracy. I've already mentioned that the age of the universe is measured to four significant figures. That's impressive enough, but it is nothing compared to the accuracy of some of the predictions with which Lawrence Krauss and his colleagues can amaze us. Krauss's hero Richard Feynman pointed out that some of the predictions of quantum theory—again based on assumptions that seem more bizarre than anything dreamed up by even the most obscurantist of theologians—have been verified with such accuracy that they are equivalent to predicting the distance between New York and Los Angeles to within one hairsbreadth.

Theologians may speculate about angels on pinheads or whatever is the current equivalent. Physicists might seem to have their own angels and their own pinheads: quanta and quarks, "charm," "strangeness," and "spin." But physicists can count their angels and can get it right to the nearest angel in a total of 10 billion: not an angel more, not an angel less. Science may be weird and incomprehensible—more weird and less comprehensible than any theology—but science works. It gets results. It can fly you to Saturn, slingshotting you around Venus and Jupiter on the way. We may not understand quantum theory (heaven knows, I don't), but a theory that predicts the real world to ten decimal places cannot in any straightforward sense be wrong. Theology not only lacks decimal places: it lacks even the smallest hint of a connection with the real world. As Thomas Jefferson said, when founding his University of Virginia, "A

professorship of Theology should have no place in our institution.”

If you ask religious believers why they believe, you may find a few “sophisticated” theologians who will talk about God as the “Ground of all Isness,” or as “a metaphor for interpersonal fellowship” or some such evasion. But the majority of believers leap, more honestly and vulnerably, to a version of the argument from design or the argument from first cause. Philosophers of the caliber of David Hume didn’t need to rise from their armchairs to demonstrate the fatal weakness of all such arguments: they beg the question of the Creator’s origin. But it took Charles Darwin, out in the real world on HMS *Beagle*, to discover the brilliantly simple—and non-question-begging—alternative to design. In the field of biology, that is. Biology was always the favorite hunting ground for natural theologians until Darwin—not deliberately, for he was the kindest and gentlest of men—chased them off. They fled to the rarefied pastures of physics and the origins of the universe, only to find Lawrence Krauss and his predecessors waiting for them.

Do the laws and constants of physics look like a finely tuned put-up job, designed to bring us into existence? Do you think some agent must have caused everything to start? Read Victor Stenger if you can’t see what’s wrong with arguments like that. Read Steven Weinberg, Peter Atkins, Martin Rees, Stephen Hawking. And now we can read Lawrence Krauss for what looks to me like the knockout blow. Even the last remaining trump card of the theologian, “Why is there something rather than nothing?” shrivels up before your eyes as you read these pages. If *On the Origin of Species* was biology’s deadliest blow to supernaturalism, we may come to see *A Universe from Nothing* as the equivalent from cosmology. The title means exactly what it says. And what it says is devastating.