REPORTS OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

Published bimonthly by the National Center for Science Education

REPORTS.NCSE.COM
ISSN 2159-9270

REVIEW

A Universe from Nothing: Why There Is Something Rather than Nothing

by Lawrence M Krauss
New York: Free Press, 2012. 224 pages

reviewed by Gordon Kane

Many of us grew up asking questions such as what are we made of? why is there a universe? (or why is there something rather than nothing?) and so on. Galileo recognized that he would not make progress on such "big questions", so he started at the beginning by asking some simple questions about motion. He defined velocity, and compared Aristotle's theory with experimental data. From those beginnings, science answered more questions, each result building on and extending what was known. Every new result fit appropriately with all that came before.

Eventually science developed tools to probe increasingly more basic questions. In the 1830s, Auguste Comte stated and emphasized that we could not know what our sun was made of, or what any of the stars was made of, because we could not go to them and take data. Soon after that, spectroscopy was recognized and developed. Atoms have energy levels. They can sit in their ground state, or in excited states, which they reach if energy is supplied by heating or bumping them around. They return to the ground state by emitting photons. Each chemical element emits photons of characteristic energies. Once an element is studied in the laboratory and its characteristic photon energies are learned, it is not hard to find out if that element is in the sun or a distant star. Comte was simply wrong.

Today we are lucky to live in an era where many of the perennial "big questions" are now topics of scientific research. There are of course many still saying that humans cannot learn the answers to such questions—that we cannot go there. But a combination of innovative technologies developed by remarkable experimenters and innovative thinking constrained by data has brought us to the exciting stage where testable answers may be emerging. While a number of issues remain, they are active research areas.

The ideas are new and exciting. In a universe obeying the rules of quantum theory, potential universes pop into existence. They have nine or ten tiny space dimensions (the difference between nine and ten is technical and can be ignored here). In some universes, three dimensions "inflate", yielding worlds potentially like ours. Space and time can emerge too. Several chains of logic based on string theory and inflationary cosmology imply that there are many universes potentially like ours and many potentially different from ours, a "multiverse". Theorists are studying the kinds of worlds that could exist, and astronomers and cosmologists are beginning to propose ways to test their theories.

Lawrence Krauss, in *A Universe from Nothing: Why There Is Something Rather than Nothing*, has written an accessible book about these topics. The book has an afterword by Richard Dawkins. Krauss has been a prolific and effective author and speaker on many topics in science and its implications. He is a leading spokesman for evolution and against creationism. He has come more lately to a reluctant tentative acceptance of string theory and multiverse ideas, having mainly spoken against them, describing them as bad science, in the past. His treatment of these areas, in the last 30% of the book, is consequently somewhat less positive than is warranted by recent progress and improved understanding. Overall, though, his treatment is basically fair and critically impartial. The reader can learn about the developments and issues, and in general should assume that the situation in theoretical physics is at least as promising as Krauss suggests.

Krauss emphasizes a major point: that the idea of a multiverse is now scientifically testable. Mathematically formulated theories in physics are coherent structures. Loosely speaking, if they have passed a number of experimental tests in certain domains, then further predictions in the same domains cannot fail without invalidating the theory. Thus predictions of such things as additional universes, if based on an empirically successful and mathematically coherent theory, are likely to be true.

In this regard he gives too little credit to the opportunities to learn about how the six or seven extra small dimensions of string theory are curled up. Different hypotheses about the relationship of our three large space dimensions to the small additional ones make predictions about Higgs boson physics and supersymmetry that are being tested at the CERN Large Hadron Collider as well as predictions about dark matter that are being tested at the Fermi Satellite and soon (perhaps about the time of publication of this review) at the Alpha Magnetic Spectrometer detector that has been taking data on the International Space Station for about a year.

Krauss enjoys exploring the implications of these frontier ideas of science. As we have learned more about the universe and its origins and properties, we have found no evidence for or hints of meaning or purpose. Anthropic or "just-so" arguments have been seen not to be meaningful. Krauss emphasizes that for him, as for many of us, such an outcome, along with increased human understanding, is a happy one. He mentions and elaborates on the wise insights of the physicist Steven Weinberg, and alludes (p 183) to Weinberg's comment that cannot be repeated often enough, "One of the great achievements of science has been, if not to make it impossible for intelligent people to be religious, then at least to make it possible for them not to be religious. We should not retreat from this accomplishment" (2001:242).

References

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