UNIVERSE, ORIGIN OF THE, AND UNBELIEF. Since religions usually claim that our universe was supernaturally created, denying that the universe has divine origins has been an important part of unbelief. The universe, unbelievers think, does not depend on any personal being outside of the natural order.

Philosophical discussions about the origin of the universe center on the classical *cosmological argument* for the existence of a God, expressing the intuition that everything contingent requires a cause, and that therefore the universe as a whole must be caused by something beyond the natural causes operating within the universe. As with most philosophical arguments, varieties of the cosmological argument are never absolutely conclusive. It is not strictly necessary that the universe have any cause, divine or otherwise. Nevertheless, to many philosophers a divine cause for the natural universe has seemed more plausible than the option left to unbelievers, which is to provide no explanation at all.

Recently, however, the debate over the origins of the universe has shifted away from traditional philosophical territory. With the maturing of physical science, the universe as a whole has become subject to investigation within physics. Indeed, modern physics has changed the very concepts involved in discussing origins, such as causality, or a universe. So currently, though the philosophical tradition continues to influence the debate, the question of how the universe came about is primarily addressed by physical cosmology.

Early ideas about the origins of the universe took shape long before modern science. In antiquity, the alternative to stories of divine creation was to present the world as eternal, perhaps self-existing. The Greek philosophical tradition particularly encouraged belief in an eternal universe. Aristotle, for example, argued that some sort of God was necessary as a First Cause, but he also presented arguments that the world was eternal.

As Greek philosophy developed further, the notion of an eternal universe became more closely tied to philosophical ideas about divinity. The God of the philosophers had to be perfect: beyond time, beyond human passions, beyond anything subject to change. This meant that any direct involvement with the changeable realm of material objects would be an imperfection. Especially within Platonic philosophy, the highest divinity did not get its hands dirty with acts of creation. Instead, God "emanated," out of necessity, slightly less perfect intermediate beings such as Reason or Wisdom. These intermediates then did the actual work of shaping the material world. The universe depended on God—it derived its very reality from the God which was ultimately the only truly Real being—but it was also eternal. And with a universe eternally emanating from the divine layers of reality, there was less change even intermediaries had to be responsible for.

The Hellenistic period following Alexander's conquests, and the Roman Empire which followed, brought Greek speculative philosophy together with Near Eastern religious beliefs about creation. The version of Christianity that became the state religion of the Roman Empire tried to integrate philosophy and revealed beliefs in its theology, and later on medieval Islam faced a similar challenge. Reason and revelation agreed on many things such as the existence of a supreme being, but there were also points of friction. Pagan philosophy favored an eternal universe, but the guardians of revelation were reluctant to allow other eternal entities alongside their creator-God. The God of monotheism was much more personal, much more free to act, compared to the God of the philosophers who could seem too much in the grip of impersonal necessities. So monotheists developed a doctrine of creation *ex nihilo*. Creation from nothing went further than Near Eastern myths about divine forces shaping primeval chaos; not even raw material could be eternal like God.

Well into the middle ages, discussions of origins were framed by the contrast between the pagan option of an eternal (though dependent on God) universe and the monotheistic doctrine of creation out of nothing. Conceptually, the notion of creation from nothing was a potent source of headaches, but on the other hand, pagan concepts of eternity could also seem to harbor contradictions. Without the modern apparatus of transfinite mathematics to keep them straight, philosophers had plenty of opportunity to tie themselves into knots when thinking about infinities. Still, since an eternal universe was a pagan idea, it was attractive to the heterodox. Educated dissenters from officially-sanctioned religion could embrace an eternal universe as an intellectually respectable alternative. Both in Christendom and the lands of Islam, belief in the eternity of the universe became a marker of infidelity.

The scientific revolution radically changed the accepted picture of the universe. The heavens no longer revolved around the earth; in fact, the heavens no longer embodied divine perfection in contrast with the sublunar realms of change and decay. Copernican astronomy and Newtonian physics presented a world where the same laws of physics applied everywhere, all the time. They joined the heavens and the Earth, and removed some of the old philosophical motivations to think the universe might be eternal. However, in the Newtonian clockwork universe, it was also hard to see how there could be a beginning in time. To reveal the presence of God, early modern science emphasized the classical *design argument*. Newtonian physics could not, it seemed, explain functional complexity. If the planets had stable orbits rather than undergoing haphazard motion, this must have been because a divine hand adjusted their orbits just so. Moreover, the complex structures of living things were clearly designed by an awesome intelligence. At the start of modern science, it remained easy to think that the history of the universe was as told in Genesis.

Eventually, however, Newtonian physics made it easier to conceive of a universe infinite in space and time. Problems such as the stability of orbits were solved within physics. Geologists found that our planet was much older than a few thousands of years. And finally, biological evolution showed that that complexity did not have to be due to intelligent design. At the end of the 19th century, it had become clear that the literal Genesis story was wrong.

Still, there remained one prominent physical argument that the universe was a divine creation in the distant past. This came from the second law of thermodynamics, which suggested that the universe would always change to become more disordered over time. The fate of the universe was a “heat death” in which everything became a featureless soup in a state of maximum entropy, able to sustain no life or any order of any interest. The religious implications of such a view were ambiguous; the notion of a heat death could just as easily feed into an atheism of a cosmic-pessimist style. But believers looked toward the origins of the universe. If the clockwork universe was winding down, there had to be a beginning where an outside force wound everything up. The initial order could not be provided by physics, and there had to be a beginning in time. Once again, the design and cosmological arguments reinforced one another.

Modern physical cosmology began in the first half of the 20th century, and once again changed the debate over the origin of the universe. The most important theoretical development for cosmology was Einstein’s general theory of relativity. Now physicists could treat space and time as a single geometric entity shaped by the distribution of matter/energy throughout the universe. Gravity was due to energy bending spacetime.

As it turned out, general relativity made it hard to construct static models of the universe, where the largest-scale structure of the universe looked more or less the same all the time. Einstein realized that his equations could include a “cosmological constant” term which led to a peculiar long-range attractive force alongside ordinary gravity. A stable universe required a non-zero cosmological constant. Soon, however, the issue was settled by observational evidence: astronomers discovered that our universe was expanding. And an expanding universe could be described without a cosmological constant.

Other new observations would also advance cosmology. Indeed, in the 20th century, cosmology began to enjoy the mutual interaction between theory and observation that characterizes any successful science. Ideas about the origins of the universe could now be subjected to reality tests, becoming more than philosophical speculation. Aside from the expansion of the universe, other observations such as the cosmic microwave background radiation also supported the claim that our universe had started out, billions of years ago, from a much hotter and denser initial state. The *big bang* theory came to dominate cosmology in the second half of the 20th century. In an expanding universe like ours, general relativity demanded that a singularity should exist back in time—not only was the universe once extremely hot and dense, it was infinitely so at the big bang. The big bang was, in fact, when the universe began.

It took no great leap of the religious imagination to equate the big bang, as the beginning of time, with a moment of creation. And so unbelievers, who have typically identified with the philosophical tradition of an eternal universe, have often been drawn to alternatives to big bang cosmology. The problem was, the alternatives were full of arbitrary assumptions, they failed to match the predictive success of the big bang, and they did not make sense of multiple independent lines of evidence as did the big bang.

One early rival to the big bang was the steady state universe, in which the universe was eternal and looked the same at all times. This required the continual creation of new matter as the universe expanded. Fred Hoyle and collaborators continue working on a “quasi-steady state cosmology” even today, but this has become a marginal effort which is considered a failure by the vast majority of cosmologists. Another alternative that preserved an eternal universe was the notion that the universe oscillated. The expansion of each phase of the universe would be followed by a contraction to a “big crunch,” followed by a new big bang and another cycle of the universe. This too has numerous difficulties, from failure to fit observations to arbitrary theoretical assumptions needed to make the universe rebound after the big crunch and to overcome the problems due to increasing entropy throughout the cycles. “Plasma cosmology” is the most recent attempt to construct a serious physical alternative to the big bang, though it also suffers from numerous defects and thus has not found acceptance in mainstream cosmology.

The standard model of the big bang had, besides the beginning, another feature attractive to religious apologists who were willing to let go of a literally interpreted Genesis. The natural outcome of the big bang was a universe that almost immediately collapsed on itself. Our universe has been around for about 14 billion years. It also looks very similar in all directions, even when areas of the universe farther than 14 billion light years apart are observed. But since no physical signal can travel faster than light, such areas could not have interacted with each other to become so similar. Our universe fit the standard big bang model, but nothing like our universe came about unless the parameters that went into the model were adjusted with uncanny precision. This suggested that not only was the big bang a moment of creation, but that the creator was a designer who fine-tuned the physics just so the universe could support intelligent life.

So early physical cosmology had ambiguous consequences for unbelief. On one hand, cosmology became an ordinary branch of physics, addressed in the typically naturalistic fashion that dominates modern physics. This development could only demystify the origins of the universe, supporting the view that we live in a natural world that can be understood without gods and demons. On the other hand, in the context of the longstanding philosophical dispute about the eternity of the universe, physical cosmology came down on the side of a universe with a beginning.

Even now, thinkers who argue that science supports theism typically make cosmology a centerpiece of their case. The “kalam cosmological argument” has become popular; it asserts that the universe has a beginning, that everything that begins has a cause, and that the only cause that can act to create a universe is outside of nature—the free choice of a personal agent. Proponents of such updated cosmological arguments usually also bring up cosmic fine-tuning, saying it proves the universe is a result of intelligent design.

Cosmology today, however, is not so full as signs of God. Much of the current debate over cosmic origins and divine creation barely updates the traditional philosophical dispute; it continues to rely on commonsense understandings of time and causality which have been superceded by modern physics.

In relativity, time is tied to physical events such as the periodic ticking of a clock; time is not external to the physical universe. In general relativity, spacetime as a whole is curved by matter/energy; there is nothing especially odd if the geometry of spacetime turns out to be curved and finite rather than extending to infinity. It becomes easy to think of spacetime as self-contained, regardless of its overall shape. The standard big bang is not the beginning of the universe *in* some point of time external to the universe. Physically, time cannot be extended back before the big bang. In fact, in the standard picture, time before the big bang is a meaningless concept, just like it makes no sense to talk about a location north of the North Pole. A year before the big bang is like a place with a latitude of 500. So thinking of a cause preceding the big bang becomes difficult.

The standard big bang could still allow an echo of a conventionally conceived cause of the universe, however. This is because the big bang is a singularity—a boundary of spacetime and hence a very special point. Attaching a God to the singularity can therefore seem attractive. Nevertheless, this is an arbitrary metaphysical exercise unless divine creation also succeeds in explaining some nontrivial features of the resulting universe. Hence a design argument, such as that for cosmic fine-tuning, has to all the real work.

Even then, there is a fundamental problem. General relativity, and hence the standard big bang, is not a quantum theory. Therefore it cannot be entirely correct. It should break down particularly where very high energies and very small distances are concerned—precisely the conditions immediately after the big bang. No adequate account of the origins of the universe will be possible without a quantum theory of gravity.

If general relativity warps commonsensical notions of time and causality, quantum mechanics forces an even more radical rethinking. Even in Newtonian mechanics, the laws of physics do not distinguish between forward and backward directions of time; the "arrow of time," or the direction in which entropy increases, emerges in many-particle systems. Quantum mechanics retains this time-reversibility and introduces true randomness in the behavior of particles. The quantum universe is not a place of definite causes and effects, with clockwork motion preceding in deterministic fashion. Instead, it is a sea of random, uncaused events, where even a particle popping into being or vanishing in a vacuum is not a miracle but just the routine way of things. Everyday causes and effects emerge in the macroscopic world, from a substrate of random interactions. In other words, the intuitions about causality and time which go into the classical cosmological argument and the traditional debate about the origins of the universe are not applicable to a quantum universe.

Unfortunately, physicists have not yet been able to combine gravity and quantum mechanics to obtain a full-blown theory of quantum gravity. Still, physicists have *some* idea about what an eventual theory of quantum theory of gravity should imply, and have been applying approximate quantum approaches to cosmology for some time. A common feature of quantum cosmologies is getting rid of the singularity as it stands in the standard big bang. This removes the last hint, weak though that was, that the physical universe might depend on something external to itself.

For example, the boundary-free cosmology of Hartle and Hawking, though somewhat outdated now, illustrates how the universe can be finite in time and yet entirely self-contained. Their model smears out the singularity, removing the boundary of spacetime that existed in the standard big bang. No point in the universe can be identified to attach a non-physical cause.

Another approach is inflationary cosmology. Originally, inflation was developed to account for some of the puzzles raised by the standard big bang, such as certain kinds of apparent fine tuning and the fact that the universe looked the same even for areas separated by more than 14 billion light years. Cosmology that includes quantum theories of elementary particles allows for a brief episode of "inflation" after the big bang, where a small bubble of spacetime expanded much faster than the speed of light. Inflation solved the problems it was supposed to address, and was also developed further. Notably, the notion of inflating universes into being naturally brings up the notion of multiple universe-bubbles, perhaps inflating into existence randomly somewhat like virtual particles in a quantum vacuum. Naturally, without a full theory of quantum gravity, none of these ideas can be worked out in a completely consistent fashion. Still, today, scenarios like chaotic eternal inflation, or infinite sets of universes linked together by what appear as singularities in general relativity (such as black holes), are commonly discussed in physical cosmology. Multiple universes have even been an impetus to think of populations of reproducing universes, and to speculate on whether a Darwinian-style mechanism ensures that large universes that create lots of black of holes, like ours, might be the most common variety.

A leading current approach to quantum gravity centers on the idea that the fundamental particles of physics are not extensionless points but strings or "m-branes." An immediate consequence of such theories is that there is a length scale beyond which objects cannot be compressed—the singularity disappears. String theory-inspired cosmological scenarios typically have an eternal universe, in that time can be extended back before the big bang. Still, the physics involved is alien to commonsense conceptions of time, so that thinking of such cosmological scenarios in terms of an eternal universe vs. a universe with a beginning is misleading. Neither of the traditional options are really in play any more.

Physical cosmology today is a rapidly changing field, with few settled conclusions. Large theoretical questions remain, from uniting gravity with quantum mechanics to figuring out problems with the cosmological constant. And improving observations continually produce surprises, such as the recent discovery that the expansion of the universe is accelerating. With better space-based telescopes to come, and further refinements to physical theories, cosmology will continue to change. So today's models of the origin of the universe are all highly uncertain. Nevertheless, some conclusions can be drawn.

Most importantly, physical cosmology has no need for the supernatural. The universe seems self-contained regardless of whether time can be extended back indefinitely. Any intervention by a supernatural creator would be a strange imposition on the structure of physics. The universe need not be eternal to be uncreated; the traditional debate is simply not relevant anymore. It is not a problem if there is no ultimate explanation for the universe, so that the universe appears uncaused. Modern physics heavily relies on randomness, finding that much in the universe appears to be fundamentally without cause, and that there is no good prospect to find a cause for such events. Physical science has been enormously successful in explaining the world in terms of combinations of chance and necessity—in terms of blind, purposeless, starkly physical processes. Cosmology has progressed in the same direction.

Attempts to provide a theistic explanation for the universe continue. At present, however, it is notable how bringing in God as an ultimate cause does not actually explain anything. Cosmology does not lack for unknowns and surprising discoveries, so any genuine explanation for the universe should be able to predict some new things. But current theistic ideas, including fine-tuning arguments, do not lead physicists to expect anything new; they produce only the dead silence of divine inscrutability. The classical cosmological argument has become irrelevant, and the design argument has become relegated to the fringes of science such as the "intelligent design" movement.

Bibliography

Craig, William Lane, and Quentin Smith. *Theism, Atheism and Big Bang Cosmology*. Oxford: Clarendon, 1993.

Edis, Taner. *The Ghost in the Universe: God in Light of Modern Science*. Amherst: Prometheus, 2002.

Grant, Edward. *Science and Religion, 400 BC–AD 1550 From Aristotle to Copernicus*. Westport: Greenwood, 2004.

Guth, Alan H. *The Inflationary Universe: The Quest for a New Theory of Cosmic Origins*. Reading: Addison-Wesley, 1997.

Hawking, Stephen W. *The Universe in a Nutshell*. New York: Bantam, 2001.

Price, Huw. *Time's Arrow and Archimedes' Point: New Directions for the Physics of Time*. New York: Oxford University Press, 1996.

Smolin, Lee. *The Life of the Cosmos*. New York: Oxford University Press, 1997.

Smolin, Lee. *Three Roads to Quantum Gravity*. New York: Basic, 2001.

Stenger, Victor J. *Has Science Found God? The Latest Results in the Search for Purpose in the Universe*. Amherst: Prometheus, 2003.

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