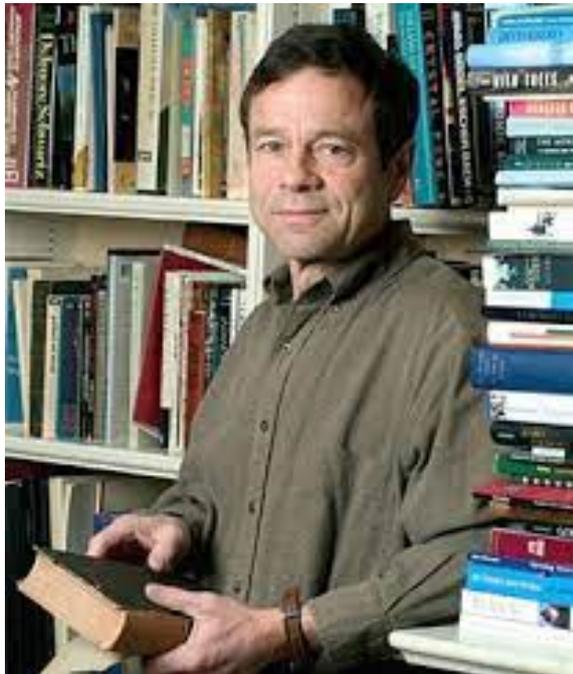


Opinion Page: Where Science and Miracles Meet, Alan Lightman, MIT



Alan Paige Lightman is an American physicist, writer, and social entrepreneur. He has served on the faculties of Harvard University and Massachusetts Institute of Technology (MIT) and is currently a Professor of the Practice of the Humanities at the Massachusetts Institute of Technology (MIT). He was one of the first people at MIT to have a joint faculty position in both the sciences and the humanities. In his thinking and writing, Lightman is known for exploring the intersection of the sciences and the humanities, especially the dialogue between science, philosophy, religion, and spirituality.

He is the author of the international best-seller *Einstein's Dreams* which has been translated into more than 30 languages and adapted into dozens of independent theatrical and musical productions worldwide, most recently (2019) at the off Broadway Prospect Theatre in New York. It is one of the most widely used "common books" on college campuses. Lightman's novel *The Diagnosis* was a finalist for the National Book Award. He is also the founder of [Harpswell](#), a non-profit organisation

whose mission is to advance a new generation of women leaders in Southeast Asia.

On the morning of October 13, 1917, a year from the end of World War I, a crowd of tens of thousands gathered in the town of Fátima, Portugal. They came to witness a miracle. Three shepherd children had prophesied that the Virgin Mary would miraculously appear on that day and give the world a sign. In the previous several months, the three children—Lúcia Abobora, and Francisco and Jacinto Marto—had claimed to have seen apparitions, visions much discussed by the Portuguese press. On this day, the gathered pilgrims apparently got what they came for, a spectacle since referred to as "the Miracle of the Sun." One journalist at the scene, Avelino de Almeida, an editor at *O Século*, reported in his paper:

One can see the immense crowd turn toward the sun ...and we hear the nearest spectators crying, "Miracle, miracle! Marvel, marvel!" Before the astonished eyes of the people ...the sun has trembled, and the sun has made some brusque movements, unprecedented and outside of all cosmic laws—the sun has "danced" ...The greatest number avow that they have seen the trembling and dancing of the sun. Others, however, declare that they have seen the smiling face of the Virgin herself; swear that the sun turned around on itself like a wheel of fireworks, that it fell almost to the point of burning the earth with its rays.

I've had miracles on my mind for a number of reasons. To start with, a few friends recently told me about personal experiences that they thought were miracles. I also came upon some survey data. According to the [Pew Research Center](#), as many as 79 percent of Americans believe in miracles – events that lie outside natural law and any explanation by science. Not just the parting of the Red

Sea or the resurrection of Jesus or the splitting of the moon by Muhammad, but “supernatural” phenomena in the world of today: such things as ghosts, voices from the dead, instructions from God, accurate prophecies, sudden recoveries from grave illnesses, telekinesis, reincarnation. Hundreds of people write to the evangelical Mario Murillo Ministries website with reports of miracles.

A woman recently described there how her brother’s stroke and paralysis in March 2019 had been cured overnight by prayer. “I have NO doubt it was a miracle,” she said. The violinist and musician Bonnie Rideout wrote to me about her first miraculous experience:

An unexplainable light appeared before me in the alfalfa field. It was a ball of light about six feet off the ground, motionless and accompanied by a warm gentle breeze. I had a feeling of warmth and peace. Even at the age of six and never having been told of guardian angels, I knew it was something of such ilk. It was the first experience I had that made me conscious of a mystical entity that has intentions and is aware of me always.

These are just two accounts from the roughly 200 million miracle believers in the United States today. Many miracles are associated with God, but not all are. [According to Pew](#), 65 percent of Americans believe in miracles not necessarily connected to God.

In contrast to this widespread belief in miracles, the great majority of scientists firmly and unequivocally reject anything “supernatural.” Given some ostensibly miraculous event, almost all scientists will insist on a logical, rational, “natural” explanation. (Scientists dismiss the Fatima Miracle of the Sun as the result of local atmospheric effects, spurious images on the retina brought about

by staring at the sun, and self-delusion.) If no logical or rational explanation immediately presents itself, most scientists will conclude that a scientific explanation will eventually be forthcoming, rather than abandon their commitment to a totally lawful universe.

This prevailing view was articulated to me recently by the Nobel Prize–winning biologist David Baltimore:

If I could not find any way out of believing that a miracle had occurred, would I then believe it to be a miracle? I think the answer is that I would still not believe it to be a miracle, only some outcome that I can’t understand.

When believers and nonbelievers discuss or witness a seemingly miraculous event, they find little common ground, as if one is speaking French and the other Swahili. Such radically different attitudes represent radically different views of the world, which are largely impervious to argument or appearance and have some resonance with our deeply polarised society today. And yet, surprisingly, some recent proposals in physics reveal that believers and nonbelievers may have more in common than they think.

The miraculous has meaning and definition only by comparison with the non-miraculous. That is, for an event to be declared “supernatural,” we must first have some concept of the “natural,” the ordinary course of events. Early human beings had no such concept – except perhaps for individual deaths and the repeated rising and setting of the sun. Phenomena simply happened. Nature was strange, sometimes beautiful, largely unpredictable, and often frightening. Some concept of the “supernatural” must have been understood in the powers attributed to the gods and spirits of early

civilisations. These mythic beings could perform feats beyond those possible for mortal flesh and blood. According to ancient Chinese belief, the god of archery, Yi, had such prowess with the bow and arrow that he shot down nine of the 10 suns that crossed the sky. And there was clearly an established concept of the miraculous in the feats of Jesus.

The development of the so-called laws of nature in science, which began with the ancient Greeks, gave a sharper definition of the natural versus the supernatural. Around 250 B.C., Archimedes proposed his “law of floating bodies,” which stated how much liquid would be displaced by a partially submerged object: a weight equal to the weight of the object, regardless of its size or shape. Isaac Newton was a landmark figure in the emerging concept of a lawful and miracle-free universe. His 1687 law of gravity – stating that the gravitational force between two objects is proportional to the product of their masses and inversely proportional to the square of their distance apart – was not only one of the first mathematical expressions of a fundamental force underlying the motions of bodies. It was also the first proposal that a rule for the behaviour of material bodies on Earth should apply in the heavens as well – that is, the first real understanding of the universality of a law of nature.

Then, in the 19th century, physicists proposed and confirmed detailed laws for the behaviour of electricity and magnetism. By 1900, the absolute inviolability of the laws of nature was well established as part of the central doctrine of science. In the thousands of natural phenomena that scientists have observed—from the orbits of planets to the firings of neurones to the radiation of atoms—they have always found rational, logical, and usually testable explanations, cementing their belief in the lawfulness and predictability of nature.

What is the origin of these strong commitments for and against miracles?

Part of the appeal of miracles was stated by the Scottish philosopher David Hume in his 1748 essay “[Of Miracles](#)”: “The passion of *surprise* and *wonder* arising from miracles, being an agreeable emotion, gives a sensible tendency towards the belief of those events from which it is derived.” In their book [Wonders and the Order of Nature](#), the historians of science Lorraine Daston and Katharine Park document humankind’s enchantment with wonders and oddities. Things that don’t fit. Surprises and peculiarities. Miracles. Marco Polo enthuses over finding completely black lions in the Indian Kingdom of Quilon. Other travellers excitedly record gourds with little lamblike animals inside, beasts with the faces of humans and the tails of scorpions, unicorns, and people who vomit worms.

Ross Peterson, a psychiatrist practicing in the Boston area, told me: “We want miracles as a solution to helplessness. We want miracles for meaning at a deeper level. Miracles lift us out of a humdrum life.” Peterson says that all of us fall on a spectrum, with hysterical emotion at one end and emotionless rigidity at the other. I would suggest that those of us who believe in miracles are more able to surrender ourselves fully to our emotional experiences and the nonmaterial world they might represent, without attempting to analyse or reduce such experiences. Those of us who become scientists, through our understanding of scientific achievements and especially the logical construction of the laws of nature, are satisfied by a fully lawful explanation of the world and see no reason to invoke anything supernatural.

That is not to say that scientists are emotionally rigid on Peterson’s spectrum. But they have com-

partmentalised those emotions. Scientists have such abiding faith in a lawful cosmos that any personal experience or recounted “story” that seems to violate the laws of nature is recast as “to be understood with a lawful explanation” rather than accepted as fundamentally unlawful or miraculous.

I remember when I first came to the “lawful explanation” viewpoint myself. At the age of twelve or thirteen, I built my own laboratory and stocked it with test tubes, petri dishes, Bunsen burners, beautiful curved glassware, resistors, capacitors, and coils of electrical wire. Among other projects, I began making pendulums by tying a fishing weight to the end of a string. I’d read in *Popular Science* or some similar magazine that the time for a pendulum to make a complete swing was proportional to the square root of the length of the string. With the help of a stopwatch and a ruler, I verified this wonderful law. Logic and pattern. Cause and effect. As far as I could tell, everything was subject to analysis and quantitative testing. I saw no reason to believe in supernatural events or in any other unprovable hypotheses.

To Hume’s and Peterson’s arguments, I would add one more suggestion as to why many of us believe in miracles. We desire escape from the limited capacities of our material bodies. We yearn for some kind of permanence, something eternal, something beyond our impending personal death. A world in which miracles occur might contain such a possibility. In this regard, it is not surprising that [a survey by Pew’s](#) 2014 Religious Landscape Study found that 72 percent of Americans believe in heaven, defined as a place where “people who have led good lives are eternally rewarded.”

Recent discoveries in science underscore the extreme commitments of believers and nonbelievers

to their respective views of the world. In the 1960s, scientists first noticed what has become known as the “fine-tuning problem”: The numerical value of many of the fundamental constants of nature, such as the speed of light or the strength of the forces in the nuclei of atoms, must lie within a narrow range for life to arise in our universe – not merely life similar to life on Earth, but any kind of life. For instance, if the strength of the nuclear force had been just a little greater, all of the hydrogen in the early universe would have fused to form helium. With no hydrogen remaining, there would be no water. Biologists believe that water, with its special chemical properties, is needed for life. By contrast, if the nuclear force had been just a little weaker, the bigger atoms needed for life, such as carbon and oxygen, could not hold together.

One of the most striking of these finely tuned constants is the amount of so-called dark energy in the cosmos. Dark energy, first discovered in 1998, fills up all of outer space and acts in the opposite way of normal gravity. It causes the galaxies to move away from one another with increasing speed. The density of dark energy has been measured to be about 100-millionth of an erg per cubic centimetre. (Don’t worry if you aren’t familiar with these arcane units. The important point is that it is a specific number.) If the amount of dark energy in our universe were a little larger than it actually is, gaseous matter could never have pulled together to form stars. A little smaller, and the universe would have re-collapsed and ended before stars had time to form. Physicists have strong evidence that all of the bigger atoms needed for life were created at the centres of stars. Without stars, no big atoms and no life.

So [how to explain](#) this observed fine-tuning? Why should our universe care about life? There are two explanations, one offered by believers and one by

nonbelievers. Believers give the argument of Intelligent Design: that the universe was designed by God, who wanted the universe to have life. Alvin Plantinga, a professor emeritus of philosophy at the University of Notre Dame, wrote, “It still seems striking that these constants should have just the values they do have ... It is still much less improbable that they should have those values if there is a God who wanted a life-friendly universe.”

The majority of scientists are not comfortable with this argument – not because it invokes God, but because it invokes a cause not subject to rational analysis. An explanation that many scientists accept is what is called “the multiverse.” If there are lots of universes with different properties – some with 17 dimensions or some with 12 dimensions, some with values of dark energy much larger or much smaller than in our universe, some with nuclear forces much stronger or weaker, and so on – then some of those universes would, by chance, have the right properties to make stars and life. Most would not. By definition, we live in one of the universes that permits life. According to this explanation, our universe is just an accident, a random throw of the dice.

An analogous line of reasoning is the explanation of why our planet is the right distance away from the sun to have liquid water. If we were a bit closer, all of the water would evaporate in the high heat, and if we were a bit farther away, it would freeze in the cold. The scientific answer to that seemingly extraordinary fact is simply that there are lots of planets besides Earth. Some are the right distance from their central stars to have liquid water, but most are not.

The inconvenient truth about both of these explanations of the fine-tuning problem – intelligent

design, on the one hand, and the existence of a multiverse, on the other – is that neither can be proved. Both must be taken as a matter of faith by their respective supporters. Believers cannot prove the existence of God, much less what God’s intentions were in creating the universe. It is likely that scientists will never be able to prove that other universes exist. The different universes in the hypothesised multiverse can never communicate with one another for the infinite future. And if they were connected in some way in the infinite past, confirming that connection would present the same problems as understanding how our universe came into being before the Big Bang. Even with a theory, testing that theory would be next to impossible. It is a testament to the powerful commitment of scientists to their belief in a totally lawful and miracle-free cosmos that they are willing to invoke a slew of probably unverifiable other universes to uphold their belief.

In 1934, the great philosopher of science Karl Popper introduced the concept of *falsifiability* in determining the boundaries of science. A scientific theory or idea can never be proved true, because we cannot be certain that tomorrow a new phenomenon won’t contradict the theory. However, a scientific theory can certainly be proved wrong, or falsified, by the observation of a single phenomenon at odds with it. Popper argued that if a proposition or belief or theory could not be tested, and thus potentially proved wrong, it did not lie within the realm of what we call science. Philosophy or religion or mythology, perhaps, but not science.

Which brings us back to the proposal of the multiverse. Is it science or not? Are the many physicists who endorse the multiverse idea thinking as scientists? There is indeed a chain of scientific argument supporting the proposal. The Nobel Prize–

winning physicist Steven Weinberg used the multiverse idea to predict the approximate value of dark energy before the value was discovered. And the Stanford University physicist Andrei Linde's theory of "eternal chaotic inflation" actually predicts the creation of multiple universes with different properties. But the multiverse idea remains untested and probably untestable.

March 22, 2021

A similar predicament at the forefront of physics has occurred with "string theory," in which it is conjectured that the smallest subatomic entities of matter and energy are not point-like particles but one-dimensional "strings" of energy. Moreover, according to the requirements of the theory, these strings vibrate in a space of 10 or 11 dimensions – all but three (height, width, and length) curled up into ultra-tiny loops that we cannot see. There are strong theoretical ideas and a lot of beautiful mathematics in favour of string theory. But, as with the multiverse idea, testing it may never be possible.

So, we have reached a paradox: The commitment to a totally scientific view of the world has led to theories that may be unscientific, according to Popper's definition of science. In a sense, the miracle believers and the miracle nonbelievers have found a bit of common ground. This is not to say that the transcendent experience of miraculous phenomena has somehow fused with the 0's and 1's of modern science, or that the world-views of believers and nonbelievers have merged. But both believers and nonbelievers have sworn allegiance to concepts that cannot be proved. Those passionate beliefs must originate from somewhere deep inside our minds, a secret room that all of us share, vital and primitive, like the ancient rituals of our ancestors.

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