

Christianity and Cosmology

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Abstract

Christianity arose in Judea 2,000 years ago when the cosmos was envisaged as a flat Earth floating on water. It made sense at the time for the Jews and Christians to view God as a great king sitting at the apex of a series of heavens above the vault of the sky watching everything that happens and making sure events proceed according his divine plan.

The view of the cosmos that science holds today could not be more dissimilar. Our telescopes have revealed a hundred billion galaxies, each with a hundred billion stars, within the visible universe. Furthermore, recent observations suggest that there may be 5 quadrillion planets capable of supporting biological life of some form. Perhaps trillions of sentient life forms live on these planets.

If Christian teachings are to apply throughout all of Creation, then you would expect that all these sentient life forms would be in the need of redeeming. This would seem to suggest that Jesus must be continually dying on the cross, every nanosecond or so on some planet, in order to save from eternal damnation every form of life that evolved sufficient intelligence to eat from the Tree of Knowledge and merit that punishment.

The Mesopotamian Cosmos

The Christian faith emerged 2,000 years ago out of the older faith of a tiny tribe of desert dwellers in Canaan called the Hebrews. The civilizations of Mesopotamia and Canaan all had similar concepts of the cosmos and humanity's place in it (Babinski, 2010).

The Hebrews divided the universe into Heaven, Earth, Sea, and the Underworld, as shown in figure 1. Earth is a more-or-less flat disk floating on water with the vault of heaven resting on foundations at the edge of the sea. Beneath Earth were the waters of the abyss. God sits at the apex of a series of heavens above the vault of the sky.



Figure 1. The ancient Mesopotamian model of the cosmos as adopted by the Hebrews. Image © Michael Paukner reproduced by permission.

Of course Christians today, even those who insist that the Bible is infallible, know that there is more to the universe than what is depicted in figure 1. Furthermore, God is now generally imagined to be either everywhere in space and time or outside both (depending on the theologian), rather than at one special place. Nevertheless, it must be kept in mind that the Christianity was built on the superstitions of very simple people for whom the model in figure 1 represented the best knowledge available at the time—based on their own observations of the land, sea, and sky. It was easy for them to conceive of God as a great king watching everything that happens and making sure events proceed according to his divine plan.

Atoms and the Void

The view of the cosmos that we hold today could not be more dissimilar to that of the ancient Hebrews. But it is almost as old, at least conceptually. In the modern view, the universe is composed of elementary material particles moving around in an otherwise empty void. Moreover, there are good reasons to conjecture that our universe is just one of a multitude of universes termed the *multiverse* that is limitless in time and space—infinite and eternal. However, this remains unproven and I will limit the discussion in this essay to the universe that is visible to us with our eyes, telescopes, and other instruments--and what can be solidly inferred from that data.

The notion that everything is just “atoms and the void” was proposed in the fifth century BCE by Leucippus and Democritus, two presocratic Greek thinkers living in Ionia at the time and place where science and Western philosophy had their beginnings.

The most influential philosophers of ancient Greece, in particular Plato and Aristotle, rejected material atomism. It conflicted too much with their ingrained beliefs in the world of gods and myths that had been passed down through the ages.

However, the Athenian philosopher Epicurus, who lived a generation after Aristotle, built a materialistic philosophy of life based on atomism. Epicureanism was mischaracterized as debauched by those who maintained ancient superstitions and saw atomism as the threat it really was to any kind of supernaturalism (Epicurus and Strodach 2012). In fact, it was a philosophy of moderation that would be highly beneficial to individuals and society if adopted today.

Although he wrote volumes, most were lost and we would know little of Epicurus and ancient atomism today were it not for the lucky survival of a copy of a magnificent poem titled *De rerum natura* (“The Nature of Things”) written in Latin hexameter at the time of Julius Caesar by the Roman poet Titus Lucretius Carus (Stallings and Jenkyns 2007).

Ancient Cosmology

Besides the atomists, several other ancient Greek and Roman thinkers developed highly sophisticated, scientific cosmologies. Despite the common belief that people thought Earth was flat until 1492, when Columbus sailed the ocean blue, it was long known among scholars that Earth is spherical. Aristotle said the form of the universe had to be a sphere, because it is the most perfect solid.

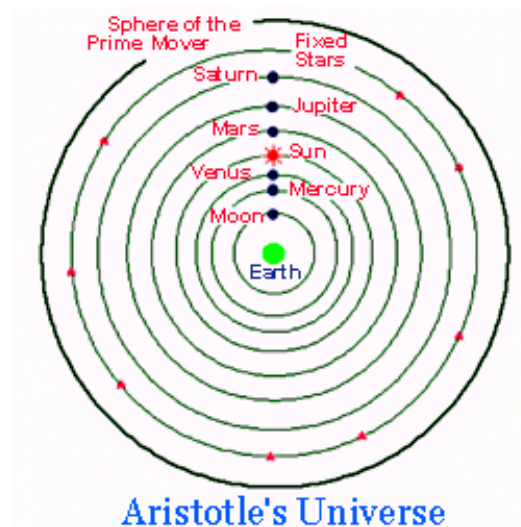


Figure 2. Aristotle's cosmology.

Aristotle's cosmology is illustrated in figure 2 (NASA 2013). He made a major advance in proposing that the planets and stars were actual physical bodies (they were previously viewed as gods), although still perfect spheres.

Note the sphere of the "Prime Mover" in the figure. Aristotle's physics required that all motion have a cause and the ultimate cause, the Prime Mover, was the "First Cause Uncaused."

Ancient cosmology achieved its highest level of mathematical sophistication in the second century CE with the geocentric model developed by Claudius Ptolemy of Alexandria, shown in simplified form in figure 3 (NASA 2013). While resembling the cosmos of Aristotle in figure 2, Ptolemy's model was completely quantitative. Knowing how to use Ptolemy's model, you could predict the positions of planets with remarkable accuracy.



Figure 3. The Ptolemaic model of the solar system. The planets move in circles on the surfaces of concentric spheres that revolve in circles around a point not precisely at the center of Earth.

While most ancient cosmologies remained Earth-centered, Aristarchus of Samos anticipated Copernicus by 1,700 years and placed the sun at the center.

The Dark Ages

Unfortunately, the Ptolemaic system and scientific cosmology in general were largely forgotten in Europe after the Catholic Church gained control of the Roman Empire in the fourth-century and ushered in the thousand-year decline known as the Dark Ages. At that point Christian cosmology returned to childish images taken from the Bible.

Early Church leaders flatly rejected the Greek conception of the world. Tertullian asked, “What indeed has Athens to do with Jerusalem?” The influential bishop Lacantius, advisor to Emperor Constantine, dismissed the sphericity of Earth as a heretical belief, as well as the ridiculous notion that people on the other side “have footprints above their heads” and that “rain and snow and hail fall upwards” (Kragh 2007, p. 34).

Not only was Earth non-spherical according to early Church fathers, so too was heaven. Rather, according to their interpretation of Scriptures, it was like a tent or tabernacle. Furthermore, some argued that Earth could not be the center of the universe but must rest at the bottom because of its heaviness. Obviously, heaven is the center of the universe. But the celestial bodies still revolved around Earth.

The works of Epicurus and Lucretius were also suppressed during the Dark Ages. A manuscript of *De rerum natura* survived to be re-discovered in a monastery in Germany in 1417. After a copy was taken to Florence where more copies were made, it became a sensation that played an important role in the

nascent Renaissance and the scientific revolution that was soon to follow (Greenblatt 2011).

While Europe was dark, Islam had gone through its remarkable Golden Age and preserved much of Greek and Roman science as well as developing a great deal of its own (al-Khalili 2011). But Arabic scholars, also confined by their religion, still promoted a human-centered cosmos. They preserved Ptolemy's work giving the name by which it is still known: *Almagest*, "The Majestic."

Gradually ancient scholarship seeped back into Europe. Christian theology adopted Aristotle as the authority on most subjects, especially his idea of the Prime Mover, which was interpreted by Christian theologians, notably Thomas Aquinas, to be the creator God. In fact, Aristotle's Prime Mover was not the Creator but a spiritual something that is the source of all celestial motion and, as we saw, located at the outermost part of the universe (Kragh 2007, pp. 21-23). Aristotle's cosmos had no beginning and will have no end, a teaching Christianity would ignore.

In any case, the first great European universities built by the Catholic Church became so deeply entrenched in what is called *Aristotelian Scholasticism* that the scientific revolution, which repudiated much of Aristotle's science—especially his physics—occurred outside these institutions.

The Scientific Age Begins

Finally, in the sixteenth century, Europe awoke to the dawn of the Renaissance. With the rediscovery by Nicolaus Copernicus of the notion of Aristarchus that Earth is just another planet rotating about the sun, the scientific age had begun.

Copernicus's masterwork *De revolutionibus orbium coelestium* (On the Revolutions of the Celestial Spheres) was published shortly before his death in 1543. At the time, the Church did not deem Copernicus heretical and he had dedicated his book to Pope Paul III. First, the work was highly technical so only the most mathematically sophisticated reader could follow it. Second, it did not ask to be taken as literal reality.

In a curious turn in history, an early disciple of Martin Luther, Andreas Osiander, a theologian and amateur mathematician who had helped proofread the printing of *Revolutionibus* in Munich, added an unsigned preface. There he states that the Copernican model should only be taken as a tool for astronomical calculations with no philosophical or theological implications. Osiander wrote:

You may be troubled by the ideas in this book, fearing that all of liberal arts are about to be thrown into confusion. But don't worry. An astronomer should make careful observations, and then frame hypotheses so that planetary positions can be established for any time. This our author has done well. But such hypotheses need not be true nor even probable. Perhaps a philosopher will seek truth, but an astronomer will just take what is simplest, and neither will

find anything certain unless it has been divinely revealed to him. So if you expect to find truth here, beware, lest you leave a greater fool than when you entered.

The story of the resistance of the Catholic Church to the notion that Earth and humans were not at the center of the universe is well known. Less familiar, perhaps, is that the new Protestant reformers, notably Martin Luther, were also strongly opposed. Luther is reported to have remarked when hearing about the new sun-centered universe, "So it goes now. Whoever wants to be clever must agree with nothing that others esteem. He must do something of his own [Luther himself included?]. This is what that fellow does who wishes to turn the whole of astronomy upside down. Even in those things that are thrown into disorder, I believe the Holy Scriptures, for Joshua commanded the Sun to stand still and not the Earth (Sobel 2011, p. 178)."

Copernicus's supporters had a hard time reconciling the Copernican model with the Bible, particularly the Joshua story (Joshua 10:12-13), as well as with Psalms 93:1, 96:10, 104:5, and Chronicles 1, 16:30 which declare that the foundation of Earth remain forever unmoved.

While the Church did not immediately reject the Copernican picture as a computational model, forces were coming into play at the time that would eventually lead to its condemnation in theological circles. The Reformation produced a deep split with the Roman Church on the location of the source of authority in Christendom. Although the Church revered the Bible, it did not regard it as the final authority on theological matters. That authority rested ultimately

with the Pope, based on the claim of an unbroken line of succession from Peter who, the Church claimed, was given rule over all earthly matters directly from Christ. The Reformation had to find a replacement for papal authority and the only alternative was the Bible, which meant that it was to be taken literally as the word of God.

Even today, we find Bible inerrancy to be a basic dogma in many Protestant sects, which leads them to reject those scientific results such as evolution and the age of Earth that conflict with what is revealed in this sacred document. On the other hand, the Catholic Church has little problem with these conflicts. Popes have declared most scientific discoveries acceptable, as long as they do not deny divine creation and the immaterial and immortal nature of the soul. In fact, as we will see, some Popes have seen science as confirming Catholic teachings.

Luther and other reformers who preached that the Bible was literal truth objected to the Copernican picture since it disagreed with Scriptures. However, it should be noted that Luther died in 1546, just three years after the publication of *Revolutionibus* when the model was far from being established on scientific grounds. Nevertheless, under the pressure of the Reformation, over the next century the Roman Catholic Church found it necessary to take more conservative stands on many issues and that included backing off from Copernicanism.

Another thorn in the Church's side at the time was the Italian Dominican friar Giordano Bruno, whom they could only shut up by burning him at the stake in 1600. Bruno committed many heresies to earn his toasting, but his cosmology is

particularly relevant to our story. Bruno proposed that the sun was just another star in a universe containing an infinite number of worlds and having no center. Furthermore, these worlds were populated by other intelligent beings.

Galileo and the Telescope

The story of Galileo is familiar but still widely misunderstood. Unlike Osiander, Galileo was not satisfied to simply assent that the heliocentric model was merely a useful tool for predicting celestial events. He insisted it was a fact of nature. The refracting telescope had been invented in 1608 by the Dutch eyeglass maker Hans Lipperhey (or Lippershey). The earliest versions had a magnification of only a few times and Galileo was able to improve that to a factor of thirty and turned his superior instrument on the heavens in 1609.

The initial publication of his observations appeared in 1610 in *Sidereus nuncius*, known popularly today as *Starry Messenger*, where he shows sketches of craters on the moon (Galileo 1989). He later reported seeing spots on the sun. These observations provided the direct empirical falsification of the common belief, as taught by Aristotle, that the heavenly bodies are perfect spheres.

He viewed ten times as many stars than are visible to the naked eye and fuzzy nebulae that he interpreted, along with the Milky Way, as collections of stars too far away to resolve.

In 1610 Galileo also made the important discovery that, similar to the moon, Venus exhibited phases that result from the partial illumination it gets from the

sun as it circles around inside Earth's orbit. This observation cannot be explained in the Ptolemaic system.

But perhaps the most important set of observations by Galileo was the four moons of Jupiter. From January 7, 1610, through March 1 he sketched the positions of four bodies near Jupiter, except when clouds obscured his view. Some sixty-four such sketches can be found in *Sidereus nuncius*, extending from page 65 to page 83 in the cited edition.

These observations left no doubt that these bodies were moons revolving around Jupiter. This meant they were not revolving around Earth, implying that Earth is perhaps not the center of the universe after all.

In 1616, the Church ordered Galileo not to claim that the sun was the center of the universe and that Earth moves, which violated several biblical references mentioned earlier where it is stated that Earth cannot be moved. There were only so many biblical contradictions that the Church was willing to live with.

Nevertheless, Galileo continued his telescopic observations and in 1632 published *Dialogues on the Two Chief World Systems* in which he forcefully presented his conclusions. In *Dialogues*, the character Simplicio, who represents the Aristotelian position, makes arguments that the Pope himself had previously expressed. Pope Urban VIII, who earlier was a friend and supporter of Galileo, was, to say the least, not pleased. Galileo was tried by the Inquisition for disobedience, forced to recant on his knees, and sentenced to permanent but quite comfortable house arrest.

Although technically forbidden from writing any more about physics and astronomy, Galileo continued work in physics and laid the foundation for Newtonian mechanics that appeared a generation later. Isaac Newton was born in 1642, the year Galileo died.

The Clockwork Universe

Newton's laws of motion and gravity provided the final confirmation of the validity of the sun-centered model of the solar system. Kepler had introduced the idea that the orbits of the planets are not circles but ellipses and introduced his laws of planetary motion. Newton was able to derive them mathematically. When he showed his proof to astronomer Edmund Halley, Halley convinced Newton to publish (at Halley's expense) what is inarguably the greatest scientific work in history, *Philosophiae naturalis principia mathematica*. Now referred to simply as *Principia*, it presented the three laws of motion and the law of universal gravitation, from which Kepler's laws of planetary motion were then derived. Today this is a simple exercise in freshman physics.

Using Newton's laws, Halley calculated that a comet seen in 1682 was the same as one that had been recorded by astronomers as far back as 240 BCE, circling the sun in a highly elliptical orbit every 75-76 years. Halley predicted it would return in 1758. The success of Halley's prediction, after his and Newton's deaths, may have been the single most important event in history that established the power of the new science in the minds of scholars and laypeople alike.

René Descartes had earlier proposed that God created the universe as a clockwork of perfect motion that required no further intervention, a philosophy that later became known as *deism*. During the period in the eighteenth century called the *Enlightenment*, the *clockwork universe* would become associated with Newtonian particle physics and form the basis of deism. Since God is perfect, so must be his laws and thus the deist God has no need to step in to make changes. Deism clearly contradicts Christian belief, although this did not seem to get Descartes into trouble when he initially made his proposal. He certainly did not reject Christianity and, indeed, withdrew a manuscript on cosmology when he heard of the trouble Galileo had gotten himself into.

While the clockwork universe was perhaps the primary motivating factor for deism, Newton did not profess deistic views himself and remained a Christian who saw the need for God to step in from time-to-time to keep the universe running properly.

Still, Newton was an unconventional Christian who rejected the Trinity (while holding the chair of mathematics of Trinity college, Cambridge, now held by atheist Stephen Hawking). But he still was very much a believer not only in the Christian God but also in the occult. He spent more time and wrote more on alchemy and biblical interpretation than he did on physics. And God entered his physics in important ways. Unlike Galileo, who did not mix his religion and science but still claimed belief, Newton turned to God to provide explanations for what he could not explain himself. He may have been the first to use what we now call the “God-of-the-gaps” argument, also known as the “argument from

ignorance.” When you don’t understand how something can have come about naturally, you conclude it must have been supernatural.

Newton’s gravitational theory admitted only attractive forces, which implied that the stars, which everybody at the time assumed to be fixed, should collapse upon one another as a result of their mutual attraction. Newton conjectured that God had placed them in just the right positions where their attractions balanced.

Newton also invoked God to provide for the stability of planetary motion. He was fully aware that his derivation of Kepler’s laws assumed each planet moved independently of the others while, in fact, the planets also exert gravitational pulls on one another. Newton reasoned that the orbits of planets would not maintain their regularity by blind chance. Thus, he concluded, God had to intervene from time to time to keep things in order.

Newton’s archrival Gottfried Wilhelm Leibniz scoffed at this (Clarke 1956, p.11).

Sir Isaac Newton and his followers have also a very odd opinion concerning the work of God. According to their doctrine, God Almighty wants to wind up his watch from time to time: otherwise it would cease to move. He had not, it seems, sufficient foresight to make it a perpetual motion.

Newton and Leibniz quarreled over the priority of the invention of calculus, which both developed independently. We still use Leibniz’s superior notation today.

We have seen that a conflict has long persisted over the location of what is termed “the center of the universe.” For the most part, we humans have found it easy to position ourselves at the center. All living species are self-centered, if not always the individual organism but what Richard Dawkins termed their “selfish genes.” Species would not have survived if they weren’t selfish at some level.

There is also a good empirical reason for us to think we are the center of the cosmos. When we look at the sky everything seems to revolve around us. The planets sometimes turn around and go back the other way, but they soon turn back again and resume circling Earth.

Of course, we know today that the sun is not the center of the universe either, as it was thought to be when Copernicus’s picture of the cosmos was one of seven planets surrounded by a rotating shell of stars fixed to the shell called the “firmament.” As telescopes improved, they discovered that our sun is just another star and no point in space can be identified as the center of all things.

A century after Newton, the French mathematicians, astronomers, and physicists Pierre-Simon Laplace and Joseph-Louis Lagrange independently proved that the solar system was highly stable despite the gravitational effects of planets on one another. The French mathematicians Siméon Poisson and Henri Poincaré later confirmed this to greater precision. This removed one of the objections Newton had to the clockwork universe. God is not needed to step in to keep the solar system in order.

Laplace was able to account for all of Ptolemy's observations within a minute of arc, including the motions of Jupiter and Saturn that were inconsistent with previous calculations. Thus, Laplace showed that Newton's laws were, in themselves, sufficient to explain the movement of the planets throughout previous history (Laskar 2012). This led him to propose a radical notion that Newton had rejected: *nothing besides physics is needed to understand the physical universe*.

One often hears a story of Laplace's encounter with the emperor Napoleon in or about 1802. Here's one version, but it is still disputed and the whole story is probably apocryphal:

Laplace had an audience with Napoleon and presented him a copy of his book *Mécanique céleste* ("Celestial Mechanics"). Someone had told Napoleon that the book contained no mention of God. Napoleon, received it with the remark, "M. Laplace, they tell me you have written this large book on the system of the universe, and have never even mentioned its Creator." Laplace, answered, "Je n'avais pas besoin de cette hypothèse-là." ("I had no need of that hypothesis"). Napoleon, greatly amused, told this reply to Lagrange, who exclaimed, "Ah! c'est une belle hypothèse; ça explique beaucoup de choses" ("Ah, that's a beautiful hypothesis; it explains many things").

Laplace never wrote anything denying the existence of God and he may have been a deist. As discussed previously, deism—as opposed to theism—supposes a creator who set the universe in motion and then left it alone to carry out the instructions coded into the natural laws by that god. The

quotation above, if true, may simply say that Laplace did not need to hypothesize anything beyond the laws of mechanics and gravity to describe the motions of the heavenly bodies.

In his 1796 book *Exposition du système du monde*, Laplace quotes Newton as saying, "The wondrous disposition of the Sun, the planets and the comets, can only be the work of an all-powerful and intelligent Being." Laplace expresses the deist position when he comments that Newton "would be even more confirmed, if he had known what we have shown, namely that the conditions of the arrangement of the planets and their satellites are precisely those which ensure its stability" (Laplace 1796).

Laplace agreed with Leibniz's criticism of Newton: "This is to have very narrow ideas about the wisdom and the power of God . . . that God has made his machine so badly that unless he affects it by some extraordinary means, the watch will very soon cease to go." We will see this mistake being made today by those who say that the universe is so imperfect that it had to be fine-tuned by God so that life could evolve. Laplace and Leibniz would counter, "God is smarter than that." I would put it another way: The universe is smarter than that.

Deism and the Enlightenment

Deism became prominent during the period called the Enlightenment in the eighteenth century when science and reason began to hold sway over theology and revelation. Deists, following the opinions of Leibniz and Laplace I have already quoted, regarded it as illogical that a perfect god

needed to step in at any time after the creation to fix things that may have gone awry.

Many prominent people of the time were either avowed deists or regarded as deists based on their published views. In Europe these included Adam Smith, Frederick the Great, James Watt, and Voltaire. In America, Benjamin Franklin, Thomas Paine, and at least the first four presidents—George Washington, John Adams, Thomas Jefferson, and James Madison—were deists.

However, the Enlightenment and its deterministic version of deism did not survive into the nineteenth century for a lot of reasons that had little to do with science. The impersonal deist god did not provide the comfort of religion sought by the average person. Christian revivalism, which appealed to rich and poor alike with emotion in place of reason, spread throughout Europe and America. At the same time, the intellectual world of art and literature reacted against scientific rationalization and replaced it with an emphasis on intuition and emotion that was termed Romanticism.

It should be mentioned that Enlightenment deism based on the Newtonian clockwork universe is pretty much ruled out by the uncertainty principle of quantum mechanics. However, this still leaves open a new kind of deist god, one who “plays dice.” He creates the universe and its laws, and then randomizes the initial conditions so that what happens is independent of any previous event. This is consistent with the fact that,

according to modern cosmology, at the very beginning the entropy of the universe was maximal for a region of its size. This does not violate the second law of thermodynamics since the maximum entropy of the universe increases as the universe expands.

The Universality of Physics

The nineteenth century saw many advances in astronomy as both technology and mathematical theories continued to improve. In particular, the universality of physics became firmly established. Newton had made the first great leap in that direction with his universal law of gravity. Previously, it had been assumed that one set of laws applied on Earth and another set in the heavens. Newton proposed that the force that causes an apple to fall from a tree to the ground was the same force that caused the moon to fall around Earth.

The universality of physics was corroborated in the nineteenth century with the observation that the spectral lines in the light from stars were the same as those observed from hot gases in laboratories on Earth.

When it was discovered that many of the observed stellar spectra maintained the same pattern but were Doppler-shifted in wavelength, it became possible to measure the velocities at which stars were moving toward or away from Earth. Most were shifted toward the red, indicating those stars were receding from us.

In the early twentieth century, Edwin Hubble and others established that the universe was much vaster than previously assumed and that the Milky Way,

within which we reside, is just one of countless “island universes” called *galaxies* that contain hundreds of billions of stars. Furthermore, Hubble showed that the larger the redshift of the stars in a galaxy, the further that galaxy is from us. By 1920 galaxies as far away as a million light-years had been observed. But they still were just a drop in the bucket.

The Expanding Cosmos

The twentieth century also saw the application of Einstein’s special and general theories of relativity to cosmology. Although Einstein himself resisted the notion, it was soon established that general relativity predicted that the universe is expanding, in agreement with the observation of galactic redshifts.

The first scientist of the time who seemed to grasp the developing connection between mathematical cosmology and the remarkable telescopic observations that were coming in at the same time was a Belgian Jesuit priest and physicist, Georges Lemaître. In 1927, Lemaître published an article in French titled, “Un Univers homogène de masse constante et de rayon croissant rendant compte de la vitesse radiale des nébuleuses extragalactiques” (“A homogeneous Universe of constant mass and growing radius accounting for the radial velocity of extragalactic nebulae”) (Lemaître, 1927). There he showed that Einstein’s general relativity leads to an expanding universe that accounts for galactic redshifts. In the paper Lemaître says explicitly, “The receding galaxies are a cosmical effect of the expansion of the universe.”

Lemaître's paper lay unrecognized for several years. However, it began to receive attention 1931 when it was translated into English (Lemaître, 1931). Einstein finally came around and by 1933 so had the astronomical community.

The Big Bang

During a conference in London in 1931 on the relation between physics and spirituality, Lemaître proposed that the universe expanded from an initial glob of nuclear matter in an explosion that the British astronomer Fred Hoyle would, in 1948, derisively term the "big bang."

Much has been made of the fact that Lemaître was a Jesuit priest and his notion that the universe began a finite time ago with a giant explosion was informed by his religious beliefs. Perhaps it was. But he always insisted that the primeval atomic nucleus was purely a scientific hypothesis not yet confirmed by the data. Indeed, Lemaître's scenario sounds more like the Chinese creation myth of a "cosmic egg" than what is described in Genesis.

Nevertheless, against his expressed wishes, Lemaître's big bang has been used by theologians and believing scientists to claim scientific evidence for a divine creation. On November 22, 1951, Pope Pius XII spoke before the Pontifical Academy of Sciences where he announced that modern science and the Church are converging on the same fundamental truths (Pope Pius XII, 1951).

Introducing a theme that would be expanded upon by religious apologists in succeeding decades, the pope said: “According to the measure of its progress, and contrary to affirmations advanced in the past, true science discovers God in an ever-increasing degree—as though God were waiting behind every door opened by science.”

With respect to the cosmos, the pope said, “Everything seems to indicate that the material universe had in finite times a mighty beginning, provided as it was with an indescribably vast abundance of energy reserves, in virtue of which, at first rapidly and then with increasing slowness, it evolved into its present state.”

The pope concluded:

[Modern science] has followed the course and the direction of cosmic developments, and, just as it was able to get a glimpse of the term toward which these developments were inexorably leading, so also it has pointed to their beginning in time some five billion years ago. [This was a reasonable estimate at the time].

Thus, with that concreteness which is characteristic of physical proofs, it has confirmed the contingency of the universe and also the well-founded deduction as to the epoch when the cosmos came forth in the hand of the Creator.

And, in the lines that have been quoted frequently in the decades since:

Hence creation took place in time. Therefore, there is a Creator.

Therefore, God exists.

Interestingly, in no place in his speech does the pope refer to specific Catholic doctrines or to the Bible. While he talks of “cosmic developments” that point to the “beginning of time some five billion years ago,” he does not mention that Genesis implies a much more recent creation—on the order of 10,000 years. He also does not mention the doctrine of the immutability of species unmistakably present in Genesis.

Of course, that’s the advantage of being pope. It is he who determines the official doctrines of the Catholic Church, not the Bible. Poor Protestants. They do not have available to them the same continuous line of authority going back to Christ and must rely on an obviously flawed book of myths thousands of years old.

Even so, in 1951 there still was no convincing evidence for the big bang, so it wasn’t proof of anything. As historian Helge Kragh points out, “At the time the pope gave his presentation of cosmology, the field was not characterized by harmonious agreement, but on the contrary, by a fierce controversy.” The pope’s message was actually quite misleading, leaving the impression among laypersons that “the biblical Genesis had literally been proved by big-bang cosmology.” Lemaître knew this was not the case and managed to get the pope to slightly moderate his views in later speeches (Kragh 2007, pp. 150-51).

The Inflationary Universe

With the discovery of the cosmic microwave background in 1964, and the many other advances in both observational and theoretical cosmology that have

continued into the twenty-first century, we can now describe the evolution of the universe in remarkably quantitative detail. During its first tiny fraction of a second, the universe underwent an exponential expansion called *inflation* during which the universe increased in size by many orders of magnitude. The inflationary model has just recently received a huge boost by the observation of primordial gravitational waves (Ade 2014).

We can now plausibly explain the production of the first elementary particles and how they combined to give the lightest chemical elements as the universe cooled. Thanks to Hoyle and collaborators, we also understand how the heavier elements are formed in the death throes of stars.

We can also now describe how the first stars and galaxies formed as gravity brought atomic matter together in clumps, aided by a still unidentified but clearly present component in the universe termed *dark matter*. All of these theoretical accounts are based on the data from every type of telescope in space and on Earth, as well as the exquisite knowledge of elementary particles we now have from almost a century of experimentation with particle accelerators.

I don't have the space to provide the details of all these recent scientific developments and will stick to the theological implications of our current picture of the cosmos. Most Christian apologists are content with inflationary big-bang cosmology and continue to argue, as did Pius XII, that it conforms to the modern Christian view of a created cosmos. However, as I have already noted, the big bang bears little resemblance to the cosmology presented in the Scriptures.

The best that theologians can make out of big-bang cosmology is that our universe has a beginning and so a divine creation is not ruled out—but not proved. A number of scenarios for a purely natural origin of the universe can be found in the published literature (Vilenkin 1982, Linde 1982, Atkatz and Pagels 1982, Stenger 2006). These scenarios have been worked out with mathematical rigor and are consistent with our best knowledge of physics and cosmology, showing that a divine creation is not required by either the data or theory.

Christianity and the New Cosmos

Let's now ask how the Christian faith fits in with our current scientific understanding of the cosmos, which far exceeds that of just a few decades ago. The universe visible from Earth contains on the order of 100 billion galaxies, each galaxy containing on the order of a hundred billion stars. It is known to be 13.8 billion years old with an uncertainty of less than 100 million years. The most distant object we can in principle see is now 46 billion light-years away, taking into account the expansion of the universe during the time the photons carrying its image travelled to our telescopes. This marks a horizon beyond which we cannot see because light has not had the time to reach us in the age of the universe.

Well-established inflationary cosmology implies that on the other side of our horizon lies a region perhaps hundreds of orders of magnitude larger than our visible universe that arose from the same primordial seed.

And that's just our personal universe. Besides that, there may be an eternal multiverse containing an unlimited number of other universes. However, for the purposes of this discussion I will ignore the possibility of other universes, which is still debatable, and just stick with the one that indisputably exists—our own.

So, let us consider two possibilities that are so far consistent with our best knowledge:

1. Intelligent life exists on only a single planet, Earth.
2. Life is rare, and intelligent life even rarer. But the universe is so vast that there still are countless numbers of intelligent beings in our universe.

1. We Are Alone

Christians are told that they are the special creation of a lone divinity that created everything that is. While making sure every photon and electron in the universe behaves properly without us noticing, their God is also listening to their every thought and helping them to do the right thing—as he defines it.

This involves God controlling momentous events such as telling a president of the United States to go to war, as George W. Bush said God did (MacAskill 2005), or redirecting a tennis ball off a Christian lady's racquet so it wins her the point as she shouts, "Thank you Jesus!"

Of course, a God of limitless power could do all that. By why would he have waited until just 150,000 years ago to create humans? And why would he have confined us to a tiny speck of dust in a vast ocean of space, with no chance, at

least with our present physical makeup, of ever travelling much beyond the environs of Earth? If he desired the worship of humans so badly, then you would think he should have made it available to him for all times and from all places.

Apologists make an illogical argument that they think is the clincher for the existence of God. They claim that life in the universe depends very sensitively on the value of a large number of physical parameters. According to this view, since the specific values of the parameters needed for life cannot possibly have resulted from chance (they can't prove that), they must have been "fine-tuned" by God in order to produce us.

Surely any God worthy of the name would not have been so incompetent as to build a vast, out-of-tune universe and then have to delicately twiddle all these knobs so that a single planet is capable of producing human beings. It would have made a lot more sense for him to have enabled us to live anywhere in the universe, even outer space. But the fact is--he did not.

2. We Are Not Alone

New estimates based on the brightness variations of thousands of stars measured by the Kepler Space Telescope suggest that within our horizon there may be as many as 5×10^{21} planets capable of sustaining biological life of some form (Petigura, Howard, and March 2011, Shostak 2013). We have seen that beyond our horizon exists a far vaster region of space. It is estimated that this region that contains a *minimum* of twenty-three orders of magnitude as many

galaxies as those inside our horizon but is likely to be much bigger (Guth 1997). This gives at least 10^{44} possible habitable planets in our universe.

This is not pure speculation. It is based on observations and the theory of cosmic inflation that is now empirically well established. So even if the probability of intelligent life for an otherwise habitable planet is miniscule, say one part in a trillion-trillion (10^{-24}), that would leave 10^{20} planets with some form of intelligent life.

So, let us consider the scenario of a Christian God presiding over a universe containing a multitude of intelligent life forms, all created in his image (being unlimited, he has an unlimited number of images) living on other planets. Of course, the Christian could simply say that this adds to the magnificence of her God. But the God of Christianity does not hold a patent on magnificence. The gods of all the major religions are equally magnificent. Christianity is more than the worship of an infinite being. It is the worship of a highly personal God who so loved the world that he sent his only begotten son there to die an excruciating death on the cross to atone for the sin of the first human beings eating from the Tree of Knowledge.

In *The Age of Reason*, Thomas Paine wrote, "Are we to suppose that every world in the boundless creation had an Eve, an apple, a serpent, and a redeemer?" Of course, Paine was unaware how vast this "boundless creation" really is. Jesus must be continually dying on the cross, every nanosecond or so

on some planet in our universe, in order to save from eternal damnation every form of life that evolved sufficient intelligence to eat from the Tree of Knowledge.

In the 1930s, astronomer Edward Milne suggested how multiple crucifixions across the universe could be avoided by Jesus dying just once, here on Earth, and the information of his act of atonement then transmitted by radio to other civilizations. However, it would take well over 46 billion years for a signal sent from Earth to reach every planet currently within our horizon and even longer to reach those beyond. So most intelligent beings would have to wait an awful long time to learn of the Atonement.

While I know of no official policy on this question provided by the Catholic Church or any Protestant denomination, the Vatican is not unaware of the problem. Speaking unofficially, in 2008 the director of the Vatican Observatory, Fr. José Gabriel Funes, told *L'Osservatore Romano*, the Vatican newspaper, that there may be other intelligent beings created by God (Catholic News Agency 2008). However, he suggested, "They could have remained in full friendship with the creator." He likened humans to "lost sheep" for which "God became man in Jesus to save us." The other intelligent beings did not necessarily need redemption. (The fact that none have communicated with us yet could indicate that they avoided eating from the Tree of Knowledge and, as a result, never developed radio). According to Funes, "Jesus became man once and for all. The Incarnation is a single and unique event."

Writing for *Christian Answers*, evangelical Mark Van Bebber is even more unequivocal (Van Bebber 2014).

The Bible does not teach that intelligent life exists elsewhere in our universe. Although our all-powerful God could have created such life had He desired, it seems rather obvious from Scripture that He did not. The timetable for this present universe is measured by God's dealings with us. It appears that God has created the human race, on the planet called Earth, as the sole beneficiary of His fellowship. This fellowship is of such a unique design that we are told that God's only true extra-terrestrial creations—angels—are eager to observe it in action. It is our privilege to be the center of attention in our vast and wonder-filled universe.

It is a deeply entrenched Christian tradition that humanity is a special creation of God, existing on a higher metaphysical plane than all other living creatures. So, if Funes and Van Bebber are accurately reflecting Christian thinking, humans are the favorite of God—although a strange kind of favorite that needs redeeming while the countless other intelligent life forms do not. We should be the least sinful—not the most. We should be the least in need of redeeming—not the only one.

My guess, based on what one hears from pulpits across America, is that Protestants would take the same view. Of course, fundamentalists still believe literally in the cosmology of the Bible and think scientists are a bunch of frauds, so they have no self-contradiction here. Science is just wrong. There is just one universe created 6,000 years ago (and no evolution or climate change, which are also just “hoaxes”).

Moderate Protestants, on the other hand, have yet one more conflict between science and religion among the many that they must reconcile in order to accept both the findings of science and still hold on to some semblance of Christian faith.

The Judaic-Christian-Islamic God is a mighty God when viewed from the perspective of the desert tribes in the Middle-East that conceived him. But that God is not mighty enough from the perspective of modern science.

Religion claims to teach us humility. But it really trades in a false pride, telling people they are the children of God, that they are the center of the universe and the reason for its existence—that they'll live forever if they just follow instructions. But it's an unearned pride. So, when science shows that we for a brief time occupy but a tiny mote in space and time, the religious recoil from this lesson in humility.

Still, the very fact that in the short period of a few thousand years humans have been able learn so much about the universe by just looking up in the sky and at the world around them, and reasoning over what they saw, testifies that we are unique among the millions of species on this planet. A dispassionate alien observer of life on Earth can only conclude that it is meaningless, brutal, and short—with one possible exception.

We cannot yet compare ourselves with whatever intelligent life forms might be out there. But we are special, at least on Earth and the solar system. Even though magical thinking and hubris may still destroy us, we can hope that that our unique abilities will lead us to a better future.

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