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# In God's Place

**With his discovery of gravity, Newton taught that understanding the cosmos is not confined to the divine.**

By Alan Lightman

**G**iovanni di Paolo's 15th-century painting "The Creation of the World and the Expulsion From Paradise," which hangs in the Metropolitan Museum of Art in New York, offers an unexpected synthesis of Western art, religion and thought.

The picture has a split-level appearance. On the right is the title scene: a grove of fruit trees, the Garden of Eden and the frail, ashamed figures of Adam and Eve being shoved out by an angel. The left half is dominated by concentric spheres. At the middle is the earth, center of the universe, encircled by the planets and sun. An outermost sphere contains the stars, all straight out of Aristotle's "On the Heavens." Above this cosmic hierarchy floats a divine God, who gravely reaches down with an index finger to spin His heavenly spheres.

This painting presents a doubled portrait of the fierce boundary between human and divine. Aristotle made all terrestrial phenomena out of earth, air, water and fire. For the moon, the sun and the stars, however, he decided he needed to introduce a completely new kind of substance: the *divine* ether. Adam and Eve were banished from Eden for crossing a more local boundary and eating from the tree of knowledge, God's knowledge. As it turns out, the forbidding separations of substance and place in Aristotle's cosmology seem to resonate with the forbidden knowledge, transgression and guilt in Judeo-Chris-

tian theology. In both cases, and on both sides of di Paolo's painting, the proper domain of human existence and understanding is severely restricted.

Indeed, for centuries Western culture was ingrained with the notion that some areas of knowledge are inaccessible, or forbidden, to human possession. In this view, humankind is entitled to comprehend only what God deigns to reveal. Zeus chained Prometheus to a rock for giving fire, the secret of the gods and the wellspring of advanced civilization, to mortal man. St. Thomas Aquinas (1225–74) distinguished between scientific knowledge, discoverable by the human mind, and divine knowledge, "higher than man's knowledge." Divine knowledge could "not be sought by man through his reason, nevertheless, once... revealed by God [it] must be accepted by faith." When Dante asks the divine Beatrice about the mysteries of the moon, she replies that "the opinion of mortals errs where the key of sense does not unlock." When Adam, in Milton's "Paradise Lost" (1667), questions the angel Raphael about celestial mechanics, Raphael offers some vague hints and then says that "the rest from Man or Angel the great Architect did wisely to conceal, and not divulge His secrets to be scann'd by them who ought rather admire."

The idea that there are limits to the rightful scope of human knowledge is, of course, partly a cultural belief. Surrounding it is an entire worldview, an un-

derstanding of how the cosmos is put together, spiritually and physically, and where we fit into the grand scheme. But the idea is also deeply psychological. It is an introspection, a state of mind that subtly imprisons individual thinkers as well as societies, and its effects and ramifications cannot possibly be weighed. No one can say how the history of civilization would have changed if God had never forbidden us to taste from that tree. However, a number of developments over the 16th and 17th centuries did succeed in introducing a new belief: that the entirety of the universe, at least its physical parts, was knowable and discoverable by human beings. This new belief, a belief in the unfettered entitlement to knowledge, was the most important intellectual development along the lengthy time line of the past millennium.

Perhaps the most glorious culmination of the new thinking was Isaac Newton's "Principia" (1687). This monumental treatise established fundamental ideas like inertia and force, articulated general laws of motion of bodies under general forces and proposed a specific law for the force of gravity. Newton's book was unprecedented in the history of science and played a pivotal role in the birth of modern science. But what was most important about Newton's work was not his particular law of gravity, great as it is, but the universality and unbounded application of that law. The same gravity that caused an apple to fall from a tree also caused the

moon to orbit the earth, and these trajectories, and an infinity of others, could be mathematically calculated from equations that the English physicist and mathematician had discovered on his own. The heavenly bodies were, after all, physical things, like rocks—or inkwells tossed in frustration against a stone fireplace. The “Principia” dealt a mortal blow to Aristotle’s strong division between earthly and cosmic phenomena.

Beneath Newton’s idea of the universality of gravity, in turn, lay the implicit assumption that the physical universe was knowable by man. This was a new idea in the evolution of human self-awareness, a psychological turning point, a liberation, an empowerment. Without this idea we might never have had Newton. Nor would we have had the intellectual and scientific breakthroughs that followed: Lavoisier’s discovery of oxygen and the beginnings of modern chemistry, Mendel’s seminal work on genetics, Dalton’s concept of the atom, Darwin and Wallace’s theory of evolution and natural selection, Maxwell’s formulation of the laws of electricity and magnetism, Einstein’s relativity, Hubble’s discovery of the expanding universe, Watson and Crick’s unraveling of DNA and countless other scientific discoveries.

Even Newton’s contemporaries realized that the great physicist had achieved something far deeper than his individual laws. Roger Cotes, in his introduction to the second edition of the “Principia,” wrote that Newton had reached “discoveries of which the mind of man was thought incapable before.... The gates are now set open.” Submersed in a scientific and technological culture as we are today—a culture that has been so totally shaped by telephones and microchips, daily reports on the genes of disease or the recession rate of galaxies—it is hard for us to conceive any limitations in knowledge. All things are our province. The universe is our oyster. We are mostly oblivious to the intellectual history that led us to this point. And we take for granted the active part being played by our own psyches.

What produced the new psychology found in Newton’s “Principia”? Certainly, changes in religious thought

played a role. Martin Luther’s proclamations of 1517, which sparked the Protestant Reformation, helped diminish the authority of the church. Despite Luther’s vicious anti-Semitism, his argument that every person should be able to read and interpret the Bible for herself, without lock-stepping with the priesthood, encouraged a certain freedom of mind. This religious freedom spread. For example, the subject matter of art turned from almost exclusively religious themes to landscapes, still lifes, interiors and other broad explorations of the secular and natural worlds. Compare Masaccio or Michelangelo with Rembrandt or Vermeer.

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There were scientific discoveries as well. On Nov. 11, 1572, soon after sunset, the Danish astronomer Tycho Brahe sighted an intensely bright object in the constellation Cassiopeia that he realized had not been there before. Brahe was the first person to prove that such novae lay beyond the orbit of the moon, within the celestial realm. Brahe had discovered an exploding star, and his discovery exploded the centuries-old belief that the stars were eternal and constant. The divine perfection of the heavens was further questioned when the Italian physicist Galileo turned his new telescope to the moon in 1610 and found the surface “to be not smooth, even, and perfectly spherical, as the great crowd of philosophers have believed about this and other heavenly bodies, but, on the

contrary, to be uneven, rough and crowded with depressions and bulges.”

Also of enormous influence, in the decades just preceding Newton, were the scientific and philosophical ideas of René Descartes. Most of the great thinkers throughout history have debated the kind of knowledge that is knowable by the human mind, but philosophers before Descartes assumed that at least some certain knowledge already existed. Descartes, for the first time, began a philosophical system by doubting everything, even his own existence. After convincing himself of his own reality (“I think, therefore I am”), he entered a long meditation that eventually established the existence of God.

Descartes helped us to question. He also prefigured Newton’s idea of universality of physical law by proposing a universal mechanism himself, namely his “vortices,” which swirled here and there through space, like whirlpools in an ocean, directing the motions of planets and other heavenly bodies. Although Descartes’s vortices lacked quantitative description and proved finally unworkable, they had the psychological import of explaining and unifying a vast range of terrestrial and cosmic phenomena under one rational system.

One way of looking at these developments is that they altered and clarified the distinction between what one could call a physical universe and a spiritual universe. Little by little, the sacred geography of Aristotle was replaced by a more amorphous and subtle map of the world. In this map, there exists a material universe, which includes all matter and energy: electrons and atoms, light and heat, brains and stars and galaxies. This vast cosmos is subject to the inquiries of science and to rational mathematical laws that we can discover with our minds.

Coexisting with this physical universe is a spiritual one, not quantifiable, not located in space, not made of atoms and molecules but, to believers, pervasive nonetheless. Each universe poses an infinity of important questions. It is the physical universe, not the spiritual, that is the domain of science. Science has everything to say about the physical universe and nothing to say about its

spiritual counterpart. Science can push back the equations of modern cosmology to less than a nanosecond after the “big bang,” but science cannot answer the question of why the universe came into being in the first place or whether it has any purpose. Science can, in principle, explain all human behavior in terms of biochemical processes in the brain, but science can never determine what is ethical behavior.

These new perceptions did not happen quickly, neatly or with finality. Like all deep psychological seeds, the idea that some areas of knowledge are off-limits to human beings is not easily excised from our consciousness. The scientist in Mary Shelley’s “Frankenstein” (1818), a novel significantly subtitled “The Modern Prometheus,” laments,

“Learn from me...how dangerous is the acquirement of knowledge, and how much happier that man is who believes his native town to be the world, than he who aspires to become greater than his nature will allow.” Some of the horror at the first test of the atom bomb in New Mexico was surely that we had unleashed forces greater than our nature. Soon after the Second World War, J. Robert Oppenheimer, the head of the Manhattan Project, told an audience that “we thought of the legend of Prometheus, of that deep sense of guilt in man’s new powers.” The troubled public reaction to Dolly, the first adult mammal to be cloned, shows that our fear remains. The sheep’s human manipulators were described by The New York Times as having “suddenly pried open one of

the most forbidden—and tantalizing—doors of modern life.”

Most likely, each new door opened will continue to disturb us and play upon our guilt. We are advanced and we are primitive at the same time. We are Newton’s flight of mind and we are Prometheus chained to a rock, we are Watson and Crick and we are Adam and Eve. All of it, all of the centuries of liberation and imprisonment, creation and dread, live together in one house. And each new door opened will disturb us. Yet we will keep opening the doors; we cannot be stopped.

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trust in God, placing himself like the Psalmist before God to confess: "Against you have I sinned" 175 . vatican.va.Â Just as the ancient tent of meeting in the wilderness was God's place of dwelling with men, a sanctuary where they could approach him, so during the thousand years God's tent will again be with mankind in a much closer, more lasting and beneficial way, as he deals with them representatively through his great High Priest, Jesus Christ, and the 144 "In God's Country" is a song by Irish rock band U2. It is the seventh track from their fifth studio album The Joshua Tree and was released as the album's fourth single in November 1987 in North America only. "The desert was immensely inspirational to us as a mental image for this record. Most people would take the desert on face value and think it's some kind of barren place, which of course is true. But, in the right frame of mind it's also a very positive image, because you can actually do something