THE LONE GALILEO

Iconic Deep Structure and the Scientific Enterprise

Science isn't an alternative to folk taxonomy; science is a folk taxonomy.

Myrdene Anderson[1]

To scientists, myths are false theories, a primitive stage in the development of scientific truth, but to anthropologists they are stories of past events that explain the nature of the world and justify community standards of collective action. All institutions have origin myths and culture heroes, and the enterprise of modern science is chartered by the tale of The Lone Galileo.[2] Like most legendary figures, Galileo is most famous for things he did not do. He probably never dropped an orange and a cannonball from the Tower of Pisa to show they fall at the same speed, for he understood the effects of air resistance and knew that they would not. He was not the first to use scientific instruments, for astronomical devices had been used for thousands of years. He was not the first to grind optical lenses, for eyeglasses had been available in Europe since the 13th century. He was not the first to apply mathematics to descriptions of nature—all the astrologers of the ancient world did that. He did not even invent the telescope, which was developed by anonymous contemporaries somewhere in the Low Countries. Rather, Galileo realized that the relation between theory and observation in physics is analogous to the logical deduction of theorems in pure mathematics. That is, theoretical propositions in physics correspond to axioms in mathematics, whereas observations correspond to theorems, so that the truth of a physical theory can be assessed by making the observations implied by the axioms. This is a very subtle idea—far too subtle to make someone a popular hero, so Galileo is remembered best for something that he did not do: the use of the telescope to prove that the earth goes around the sun.

A classic account of the origin myth of science is given in J. Bronowski's television series, *The Ascent of Man*, which presents Galileo as an unequivocally heroic figure: Galileo "was forty-five when he heard the news of the Flemish invention [the telescope], and it electrified him. He thought it out for himself in one night, and ... before he came to the Campanile in Venice, he stepped the magnification up to eight or ten, and then he had a real telescope."[3] As Galileo himself tells it in a letter dated 29 August 1609: "It is 6 days since I was called by the doge, to which I had to show it together with the entire Senate, to the infinite amazement of all; and there have been numerous gentlemen and senators, who, though old, have more than once scaled the stairs of the highest campaniles in Venice to observe at sea sails and vessels so far away that, coming under full sail to port, 2 hours or more were required before they could be seen without my spy glass."[4] In the classic accounts of the Galilean accomplishment, the invention of the telescope is a prelude to the birth of science. For example, in the words of Bronowski: "Galileo is the creator of the modern scientific method," and he did "for the first time what we think of as practical science: build the apparatus, do the experiment, publish the results."[5]

This portion of Galileo's life can be summarized as follows:

The Lone Galileo, Verse One:
A lone male genius
Builds a tubular apparatus,
In which lenses transform celestial light.
He publicly displays the apparatus
From the top of the Campanile,
Amazes political and business leaders,
And discovers aspects of nature hitherto unknown, namely:
    Four moons of Jupiter,
    The phases of Venus,
    Sunspots,
    Countless new stars in the Milky Way,
    And mountains and craters on the moon.

The imagery of this myth exploits such culturally loaded terms as sun and moon, Venus and Jupiter, Venice and the Campanile; and even today, heavenly bodies have profound connotative meanings that extend far beyond their astronomical roles, conjuring up semantic associations to astrology, Greek mythology, romantic literature, and the history of science, to name only the most obvious. Also, there is the linear plot

encoded in the verbs that resonates to Nebuchadnezzar's Dream: *builds* → *displays* → *discovers*. In addition, there is the imagery of the Campanile itself, the dominant architectural structure of Venice, and the symbol of a prosperous and sophisticated commercial society. The Lone Galileo draws on the power of its associated symbols to present a mythically potent vision of a technocratic world.

The Lone Male Apparatus

Like *Star Wars*, the charter myth of science encodes the imagery of the Y-forked organ. The very act of looking through a telescope merges both phallic and cephalic shapes into a composite image, such that, to a naive observer, the phallic-shaped object appears to emerge from one of the astronomer's eyes. Moreover, the phallic properties of telescopes are emphasized in the popular media by conflating the astronomer's inflexible tube with the telescoping variety favored by pirates, which can be shortened or extended at will. The phallic imagery of telescopes is also enhanced by the locations where telescopes are erected. When we first meet Galileo, he has mounted his tube on the top of a tower to look at ships at sea, and astronomical telescopes are still built in close proximity to the sky. In fact, the epochs in the history of astronomy are commonly demarcated by the size of the tools constructed on mountain tops: the 60-inch reflector on Mount Wilson (1908), the 100-inch reflector, also on Mount Wilson (1918), and the 200-inch reflector on Mount Palomar (1949). Nor has the advent of radio astronomy dampened enthusiasm for large optical instruments. A huge telescope of new design has been constructed on the top of Mauna Kea in Hawaii, and the 94-inch Hubble Space Telescope was launched by the space shuttle. Thus, the tubular shape of the optical telescope is essential to its role in the iconic deep structure of industrial mythology, whereas the newfangled radio telescopes, concave hemispheres better known as "dishes," are not symbolically equivalent at all.

Science, like other mythical systems, elaborates on the imagery of natural symbols, giving them its own particular interpretation, and for this reason the telescope is no ordinary phallus but a phallus with eyes. Physics recognizes the equivalence of lenses with eyes, calling the science optics, but the iconic deep structure takes this perception a step further, seeing lenses as extensions of the human body and not just as implementations of mathematical equations. The eye of the telescope is documented by the slang of astronomers. On Mount Palomar, the

Hale Telescope, a battleship-gray cylinder seven stories tall and housed in a dome the size of the Pantheon in Rome, is called the Big Eye by astronomers. A few hundred yards to the south, hidden in trees and underbrush, is a much smaller dome, housing an eighteen-inch Schmidt telescope, known as the Little Eye.[6] Also, it is not an accident that the astronomical eyes do not form an anatomical pair, side by side on the anterior end of the body, but are conceptualized as at lower and higher elevations, for the two eyes of the Galilean body are hierarchically ranked.

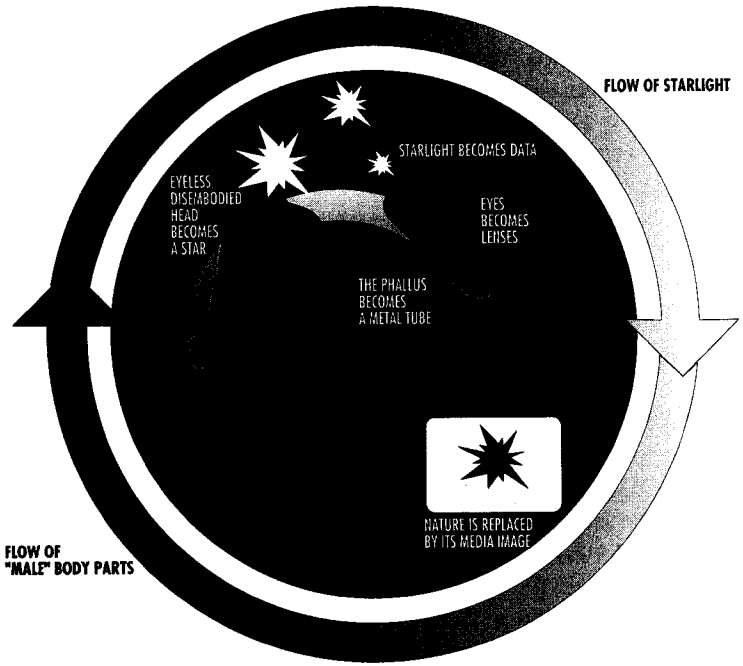
The prominent role of phallic imagery in dream and myth led Freud to the idea of the libido, which is a form of psychic energy based on the channeling of sexual motivation, but this psychoanalytic interpretation confounds the phallus as an organ of sex with the phallus as the symbol of male power. The ancient Greeks, for example, erected large stone phalluses, often surmounted by a male head, in front of their houses. These statues, called herms, did not symbolize sexuality per se but maleness in its social aspect, namely patrilineal continuity and domestic authority. In the same way, phallic imagery in science does not mean that scientific activity is necessarily motivated by sexual energy. Rather, the predominance of the phallus in scientific imagery has much in common with that of the ancient Greeks, namely, the use of a male body part to symbolize specifically male contributions to the social and natural order.

In science as in *Star Wars*, the status of maleness is achieved through a succession of cuts that separate the so-called male body parts from their prescientific antecedents, as well as by the development of prostheses to fill the holes created by the repression operations. Thus, as shown in Figure 4.1, Galileo's head has been transformed into a star and his phallus replaced by a cylinder with eyes. Significantly, in science, the eyes themselves are considered "male" organs, for in contemporary neuroanatomy, the eye is defined as part of the brain not the body, and it is interpreted as a central nervous system structure that penetrates to the surface of the body through holes in the skull called *eye sockets*. This choice of word is not fortuitous, for the double-headed organ, when turned on the stars, forms a circuit between heaven and earth, such that starlight passes down the tube, into the eye, and finally into the brain, where it is transformed—not into human experience—but into a new, objectified category of knowledge called *data*. Moreover, the myth tells us that these "male" body parts are unilateral, for only one eye is used when looking through a telescope and only one hand is used in writing and drawing—and we know which hand too, for in

English *write* is pronounced *right*. In confirmation of this mythic diagnosis, neuroanatomy tells us that the right hand is controlled by the left cerebral hemisphere, which is also the language hemisphere in the vast majority of humans, the so-called "dominant" hemisphere.[7] Thus, the symbolic system of science defines a pathway that runs from celestial bodies into the eye, through the left hemisphere of the brain, and back out to the right hand. The symbolism of the eye, however, is a little trickier, for neuroanatomy also tells us that in the human brain the optic nerve splits at the optic chiasma, such that the medial portion of the retina projects to the same side of the brain, whereas the lateral portion projects to the opposite side of the brain. For example, in the case of the right eye, the lateral portion, namely the part closest to the right side of the body, projects to the left hemisphere of the cerebrum whereas the medial portion, namely the part closest to the midline of the body, projects to the right hemisphere. Thus, in the body, as in the telescope, there are no left and right eyes, only higher and lower ones: the highest eye is the one that conveys starlight to the dominant hemisphere.

Thus, if we take a purely anthropological approach to Galileo's achievement, giving imagery and body language an equal place with theory and experiment, then the result is quite at variance with the official interpretation of the scientific method. As shown in Figure 4.1, an essential aspect of science is what I call the *Galilean circuit*, the channeling of celestial light through the eyes of a man-made phallus to create an enhanced image of nature accessible to a wider public. Although these enhanced images are now known as scientific discoveries, the primary function of science is not to describe natural events but rather to construct an image of them by means of lenses and celestial light. Natural events that cannot be transformed by photography and instrumentation are simply excluded from scientific consideration on the grounds that the phenomena are "too complex" or the terminology "too vague and imprecise." In fact, the image of the apparatus is far more important than the images of nature, which are only secondary and derivative. As the charter myth of science emphasizes, Galileo first used his telescope to look at ships at sea and only later applied it to astronomy, so it is the *apparatus* itself, not the facts of nature it reveals, that first amazes the merchants of Venice and makes Galileo into a star.

Thus, as shown in Figure 4.1, the Galilean circuit is the replacement of the scientist's own flesh and blood by a man-made phallic apparatus, such that data flow replaces blood flow. Because the Galilean circuit is in effect a kind of disembodiment, it is not surprising that contemporary



4.1 In the Galilean circuit, so-called male body parts are replaced by artificial organs, which channel starlight to earth.

astronomy takes this process to its logical conclusion and replaces the human eye with a photographic plate. On Mount Palomar, as Preston tells us, the light that passes down the telescope is normally used to expose a circular piece of film. That is, really scientific astronomers observe *pictures* of stars under artificial light, while presenting to the public at large huge, phallic apparatuses erected on mountain tops. If this process results in "discoveries," that is, in new, transformed images of natural events that capture the public imagination, then both the hero and his instrument are themselves subsequently transformed into celestial objects.

In the scientific world view, there is a profound separation between the "natural" and "symbolic" worlds, such that stars exist "out there" in nature whereas the names of stars are taken to be arbitrary cultural constructions, but empirically both the images of stars and their scientific names are symbolically mediated entities that are part of the same cultural complex; and the names of stars are as much a part of

the scientific process as the stars themselves. This explains why scientists literally fight for the right to name a new image of nature. Significantly, in the modern, canonical sky chart, the person of Galileo is represented as the Galilean satellites of Jupiter, and his instrument has been transformed into the constellation Telescopium. The lenses of the instrument, Galileo's eyes, have been celestialized as well. The word *telescope,* Greek for "seeing at a distance," was first conferred on the new invention at a banquet held for Galileo in 1611 by one of the world's first scientific societies, the Accademia dei Lincei in Rome, "the society of lynxes." *Lynx,* which means "shining eyes," is also a constellation, recognized by its pair of bright stars, in the northern hemisphere between Auriga and Ursa Major. Not surprisingly, Lynx (7 to 9 right ascension, 30 to 60 celestial latitude, north) and Telescopium (19 right ascension, 45 to 60 celestial latitude, south) are at almost exactly opposite points on the celestial sphere, just as they are at opposite ends of the Galilean circuit.

In the story of Galileo and his telescope, which is set in Renaissance times, nature is viewed through a single eye from a fixed position, and this stance is also the defining characteristic of Renaissance art. As Robert D. Romanyshyn shows in *Technology as Symptom and Dream*, the invention of perspective drawing in 15th-century Italy makes it possible to convert a three-dimensional scene into a two-dimensional representation in a mathematically exact way. In one of the first descriptions of this technique by Leon Battista Alberti, published more than a hundred years before Galileo's telescope, the artist tells us to imagine the drawing surface as a window through which the scene to be painted is being viewed. The artist assumes that the viewer is standing on the horizontal plane and staring straight ahead through the "window," such that his line of sight converges on a "vanishing point" on a distant horizon line. Under these conditions, the horizon line in the painting is at the same level as the viewer's eye, and all the objects in the picture are arranged so that they will appear "in perspective" when viewed from this position. As art historians have pointed out, there is no picture known before 1425 A.D. that intentionally shows this construction of the relationship between viewer and subject matter. Romanyshyn rightly concludes that the Renaissance view of the world, as manifested in its art, is essential in the development of the technocratic body image: "Esconced behind the window the self becomes an observing *subject,* a *spectator,* as against a world which becomes a *spectacle,* an *object* of vision."[8] Moreover, he concludes, "the condition of the window also

initiates an *eclipse of the body*,"[9] for the world is primarily something to be seen in two dimensions, not touched, smelled, or experienced. When nature is viewed from behind a window, it becomes equivalent to light. Thus, the technique of perspective art, which was developed simultaneously with the heliocentric theory, contains, as Romanyshyn points out, the three major ingredients of the modern technocratic world view: "There is the window as the boundary of separation between the viewer and the world; there is the self, portrayed in the figure of the artist, on this side of the window looking out on the world; and there is the world, out there, on the other side of the window, which has become primarily an object of vision."[10]

Moreover, in Alberti's original description of perspective drawing, the window is not open but literally draped with a veil, which divides the world into horizontal and vertical rows like a chessboard. As Alberti himself tells us: "A veil loosely woven of fine thread, dyed whatever color you please, divided up by thicker threads into as many parallel square sections as you like, and stretched on a frame. I set this up between the eye and the object to be represented, so that the visual pyramid [that is, rays converging on the vanishing point] passes through the loose weave of the veil."[11] Thus, as Romanyshyn points out, the veil that obscures the truths of nature is imposed by the Renaissance observer himself, who uses it to divide the unity of the original scene into arbitrary geometrical shapes, then strips it off in the name of science.

It is no accident, as Romanyshyn notes, that the same year, 1543, that the human body was ejected from the center of the universe by the theory of Copernicus it first appears as a corpse on the dissecting table of Vesalius[12]—for the very same acts of repression that transform the intellect into starlight also require that the abandoned body be incorporated into the system in objectified form. Thus, science, like industrial technology, is a one-two punch, in which the "head" of the body is projected onto the heavens, while the polluted, post-cranial remains fall back to earth, where they become grist for a whole new cycle of transformation by celestial light.

The disembodied observer viewing nature through a window is common to both science and Renaissance art, but, unlike the images of art, those produced by science are considered to be true descriptions of nature and not mere acts of imagination. Where Leonardo's painting *Lady with a Stoat* is firmly in the realm of "culture," Galileo's watercolor renderings of the phases of Venus are just as certainly descriptions of "nature." How can the same methodology lead to two such radically

different interpretations? The answer is that science and art cannot be distinguished by their methodologies or by the images they produce but only by their *structural relationships to the human body on the one hand and to religion on the other.*

π in the Sky

The structural opposition between science and religion is encoded in the story of Galileo's censure by the Church for advocating the heliocentric theory of Copernicus, which is portrayed in popularizations as contrasting the unprovable tenets of theology with the empirical methods of science. For example, under the entry "Galileo" in *Webster's New World Dictionary*, we find that he improved the telescope, demonstrated the truth of the Copernican theory, and was condemned for heresy by the Inquisition. Or as Bronowski tells us: "By turning his telescope on the moon, on Jupiter, and on the sunspots, he [Galileo] put an end to the classical belief that the heavens are perfect and unchanging, and only the earth is subject to the laws of change."[13] James Burke in the television series *The Day the Universe Changed* is even less circumspect: "The telescope radically altered man's view of his position in the universe. No longer was he the centre of things, the uniquely chosen manifestation of God. The telescope freed man to look at himself and the world around him."[14] Moreover, Burke presents Copernicus as a modern scientist whose "principal aim was to explain the apparent anomalies in the motions of the planets with a simpler version of events than was currently held, closer in concept to the original plan adopted by Aristotle."[15] Thus, in canonical versions of the myth of The Lone Galileo, a physical act of observation proves the truth of the Copernican theory and repudiates a speculative theology; but, unfortunately, as modern scholarship has demonstrated, Copernicus was not a scientist, and the telescope was irrelevant to proving his theory.

Copernicus's book on the heliocentric theory is commonly taken as the founding date of science (1543 A.D.), but historical scholarship shows that its author, far from being the exemplar of the scientific method that he is commonly imagined to be, was a philosophical idealist whose vision of the world would be unrecognizable to a modern astronomer. Copernicus had been much influenced by Platonism, particularly by a collection of works in the Neoplatonic tradition that had recently been translated from Greek into Latin. The authors were Greek philosophers writing at the time of the Roman Empire, but they

attributed their works to Hermes Trismegistus, who was equated with the Egyptian god Thoth. Unaware of this literary convention, Renaissance intellectuals thought Hermes was an ancient Egyptian philosopher from whom Plato derived the essential features of Platonic philosophy.[16] A hundred years after Copernicus's death, in the 17th century, linguistic scholarship would reveal that "Hermes's" works had been written in late Roman times and were completely derivative of Plato; but by then the damage, so to speak, had already been done. Copernicus thought he was in touch with the ancient roots of European philosophy. Reflecting on the Hermetic doctrine, he reasoned that as God is the source of light and life, then the sun, not the earth, is more logically the center of the universe. Applying this idea to astronomy, he showed that the motions of the heavenly bodies are consistent with the heliocentric conception. This heliocentric idea, far from originating with Copernicus, was, as he himself admits, well known to astronomers in the ancient world. Thus, Copernicus more properly marks a chapter in Platonic philosophy than in the history of modern science, and he is only regarded as a scientific ancestor because Galileo proclaimed himself a descendant. Moreover, this whole process had been set in motion by the naive acceptance of a literary convention as historical fact.

Indeed, the heliocentric theory, at that time, made no better predictions than the astronomy it sought to replace; and epicycles were still needed to explain certain movements of the heavenly bodies, just as with the system of Ptolemy. Moreover, there was no physical evidence for the motion of the earth at all.[17] Thus, in the 17th century, the Copernican theory was hardly a clear-cut case of fact versus superstition, and not even the astronomers could agree. Kepler was predisposed to the geometrical simplicity of the heliocentric system, but Tycho Brahe, whose meticulous sky charts helped confirm Kepler's laws of planetary motion, was an outspoken critic of Copernicus, and he offered a compromise of his own, in which the sun and moon went around the earth while the other planets went around the sun. Nor was the Catholic Church opposed to astronomy. In 1582, it reformed the calendar, using the services of the most eminent astronomers of the day, and it did not even oppose the teaching of the heliocentric system provided that it was taught as a mathematical device and not as a physical description of the heavens.

But in the popular mythology of science, the heliocentric theory of Copernicus is conflated with Galileo's use of the telescope, such that the invention of the latter proved the truth of the former. Although Galileo makes passing mention of Copernicus in *Sidereus Nuncius*, his translator

Van Helden points out that the radical aspect of Galileo's book is the role given to mathematics and instrumentation in the evaluation of astronomical theories. In Galileo's view, mathematics expresses a true description of physical reality, and instrumentation creates new sources of data that are simply unavailable to the naked eye.[18] Van Helden sums up this argument as follows: "Methodologically speaking, this was a very bold claim, for not only was there no optical theory that could demonstrate that the instrument [the telescope] did not deceive the senses, it was not even accepted in principle that optical theory could have much to do with reality."[19] In other words, Galileo was defining a new concept of truth, one based on an apparatus that he happened to control, that in effect repudiated the concept of truth, namely tradition and the scriptures, on which Christian dogma was based. It was not Galileo's astronomy but his philosophy that brought him into conflict with the church—and this constitutes the second phase of the myth.

The Lone Galileo, Verse Two:
Scientific discovery invalidates Church doctrine
And establishes the truth of a heretical theory;
But it leads to the trial of the hero
Who repudiates his heretical ideas,
Is banished from the public arena,
Loses his eyesight,
And writes his greatest work.

Galileo wrote his major defense of the Copernican theory in 1632, more than twenty years after his initial discoveries with the telescope; and shortly thereafter, the Church department charged with investigating heresy ordered Galileo to appear in a court of law, showed him the instruments of torture, and forced him to sign a document that repudiated the Copernican theory. The trial of Galileo is always faithfully recorded in popularizations of science, but the authors typically ignore the political aspects of the story, focusing instead on the fine points of difference between the mathematical models of Ptolemy, Copernicus, and Tycho Brahe. If they examine the institutional environment of Galileo's actions at all, they usually retrofit it with modern ideas of freedom of speech and technocratic notions of scientific autonomy; but as Redondi argues in *Galileo Heretic*, the Copernican theory, far from being the substance of the case, may have only been the legal vehicle that the Church used to silence Galileo. The proceedings were held in secret, and scanty documentation survives, so the exact nature of the

Church's grievances can never be known; but there is circumstantial evidence that the newly awakened concern in 1633 over Galileo's beliefs had more to do with the doctrine of the Eucharist than with astronomy, for the atomic theory advocated by Galileo, by repudiating the Aristotelian distinction between substance and accident as real principles of matter, vitiated the reconciliation of the doctrine of the Eucharist with natural reason.

The Mass is a ritual reenactment of the Last Supper of Jesus with his disciples, and essential to the ceremony is the sacrament of the Eucharist, in which the priest, by repeating the words that Christ used at his Last Supper, "This is my body...This is my blood," changes ordinary bread and wine into the actual body and blood of Christ. The mystical transformation of bread and wine is known in Christian theology as the doctrine of transubstantiation. In Renaissance times, the Church intellectualized this doctrine in terms of Aristotle's theory of matter, in which the bread and wine retained the appearance ("accidental" properties) of foodstuffs but were changed on the level of substance into the body and blood of Christ.[20] As shown in Figure 4.2, this physical transformation is paralleled by a spiritual transformation of the participants in the ritual. Just as the bread and wine are transformed into the body and blood of Christ while retaining their normal material attributes, so the bodies of the participants, while retaining material form, are themselves incorporated into a mystical body that embraces the entire Christian community.

Figure 4.2 also shows what happens when materialist reductionism is incorporated into this ritual context. By asserting as he did, that substances such as bread and wine have the physical attributes they do because of underlying differences in their atomic structure, Galileo in effect eliminates any possible disparity between the physical form of a substance and its observable properties. Thus, the atomic theory operates as the logical inversion of the Catholic Mass, reducing the body and blood of Christ to the material substances of bread and wine and precipitating the mystical body of the Christian community into a collection of individual physical bodies with no spiritual connections among them at all. Moreover, the agent of this transformation, the scientist, has the same role in the ritual of materialist reduction as the priest has in the ritual of the Mass, mediating between symbolic powers of transformation on the one hand and the community of the faithful on the other.

In short, the Church's instincts in regard to Galileo were sound, for by rejecting the Aristotelian distinction between substance and accident,

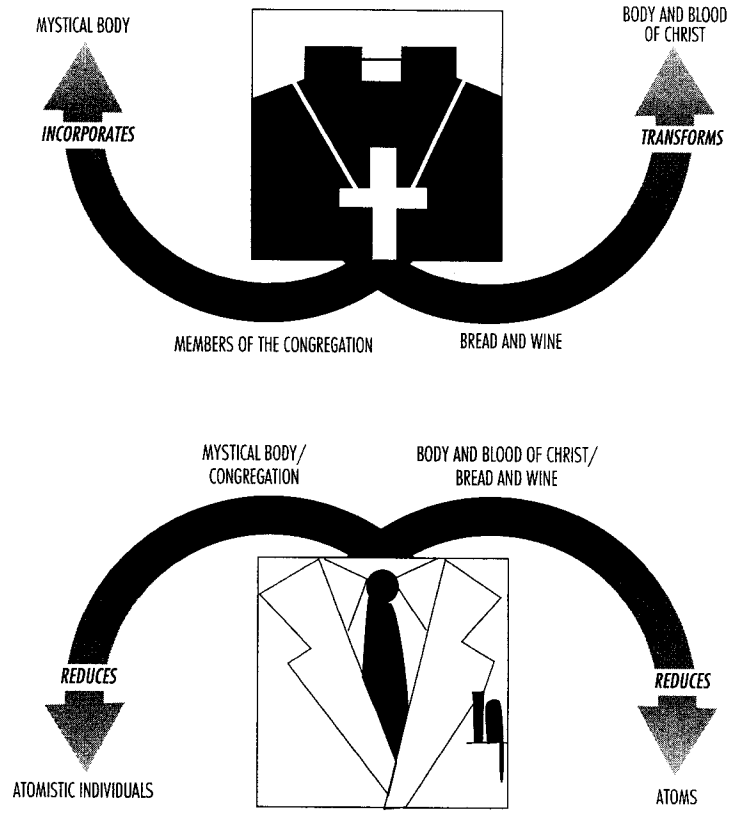


Figure 4.2 Scientific and Judeo-Christian rituals are in structural opposition.

the new physics threatened the very heart of the Catholic system of myth and ritual, the Mass; and it played into the hands of Protestant critics of the Church, who rejected both the doctrine of transubstantiation and the need for priests as mediating agents between God and the congregation. In Redondi's view, rather than fuel the fires of heresy by calling attention to these issues publicly, the Church tried to discredit Galileo by declaring him a heretic—not for the newly vulnerable doctrine of the Eucharist but on a legal technicality that linked him to Copernicus, the very Copernicus who was already condemned by no less a Protestant than Martin Luther himself.

As a condition of his punishment, Galileo publicly recanted his Copernican beliefs, and the Holy Office sentenced him to life imprisonment,

which was subsequently commuted to house arrest by the pope. Although prohibited from advocating Copernicanism, Galileo was free to pursue more terrestrial research; and during the last years of his life, while under confinement, he wrote his greatest work, *Discourse on Two New Sciences*, which laid the foundation for modern physics. But paradoxically, in the surface structure of the myth, it is the Church that is the clear winner of the conflict, for it is Galileo who recants, is banished, and goes blind. He even had considerable trouble publishing *Discourse on Two New Sciences*, as no printer in a Catholic country would touch it. In short, Galileo dies, as he himself expresses it, "incurably blind, so that this heaven, this earth, this universe ... are now shrivelled up for me into such a narrow compass as is filled by my own bodily sensations."[21]

Thus, in the story, Galileo dies ignorant of the final verdict of history, which has to be provided by the commentator, in a meta-myth, who tells us that Galileo's last work is indeed immortal, dividing forever the intellectual worlds of Catholic and Protestant Europe, of theology and science. As the story of Galileo is remembered by people who are not otherwise interested in the history of science, who may even be unaware of Tycho Brahe's critique of Copernicanism, of Galileo's own crackpot theory of comets, or Cardinal Bellarmine's essentially 20th-century view of the role of mathematics in physical description, it must be because they remember the story of Galileo as myth and not as history. But if this be so, then why do they remember a myth in which it is the Church who emerges the winner? Although one can argue that the Church does not *really* win, because Galileo becomes a hero whereas the Church becomes increasingly irrelevant to the intellectual development of industrial society, the myth does not actually say this. This conclusion may be implicit in our modern reading of the historical events, but it is not itself a statement about the life of Galileo, who died, not only blind, but without four centuries of hindsight. Thus, in the classic version of the tale, Galileo dies under rather unfortunate circumstances, like a Hamlet or an Oedipus. His pathetic demise is only redeemed by the fact that he is ultimately vindicated by history, like a scientific Joan of Arc, who was burned at the stake as a heretic, only to have the judicial verdict reversed long after her death and the bones of her inquisitor exhumed and dishonored. Since history has in any case been edited, why does not science make the life of Galileo more consistent with its premises?

As the story of Galileo is always told in the context of Nebuchadnezzar's Dream, in which the Copernican theory is vindicated by history, his censure by the Church has the effect of making religion look

ridiculous by implicitly contrasting outmoded superstitions to modern scientific truth. The myth is structured in such a way that a modern mind draws this conclusion even though there is nothing in the overt description of events that explicitly makes reference to it. Although the trial subsequently proved to be a strategic political blunder, for it provided historical material for a persuasive anticlerical mythology, modern scholarship has shown that there is nothing inherently ridiculous in the Church's views on the Copernican theory. The Church did not deny the truth of Galileo's observations; to the contrary, the Jesuit astronomers at the Collegio Romano were among the first to verify his findings. The Church was not hostile to astronomy; it had hired astronomers to reform the calendar. The Church did not believe in the literal interpretation of the Bible; that is a Protestant contribution. The Church was not resistant to change; it was engaged in an extensive program of reform. Moreover, in the years before the trial, the Church *did* allow discussion of the Copernican model among astronomers, provided that it was taught as a mathematical construction and not as a physical fact. (Nor is the Copernican theory taught as fact today: few 20th-century astronomers would claim that the sun is the center of the universe and immobile.) Moreover, the strongest evidence for the heliocentric theory was its mathematical simplicity, which owed more to Kepler's laws of planetary motion and Newton's laws of gravitation than to Galileo's observations through the telescope. However, when people in a technocratic society are presented with the skillfully edited facts of the Galilean myth, they draw the conclusion that the Church is ridiculous when compared with science.

The second function of the myth is to show that Galileo is immortal in spite of his ignominious death. This also is accomplished by embedding the story of Galileo's trial within Nebuchadnezzar's Dream, so that his improvement of the telescope marks the beginning of a long period of astronomical progress culminating in the landing on the moon. This interpretation of history not only firmly establishes religion as a more primitive stage of human thought, but it also allows the spirit of Galileo to be carried forward after his death in a secular rendering of immortality.

The two verses of The Lone Galileo, namely Verse One, in which Galileo makes a number of discoveries about the nature of the universe, and Verse Two, in which we learn of his personal fate, roughly correspond to the difference between what theologians call the cosmogonic and eschatological functions of religion. *Cosmogony* answers the question "How did we get here?" whereas *eschatology* answers the question

"Where are we going?" The cosmogonical and eschatological functions, far from being incidental to science, are the essence of the system, for it is these that motivate scientific practitioners to devote their lives to the enterprise and establish scientists as the spiritual leaders of our time. In fact, the cosmogonic and eschatological functions dominate the endless popularizations of science that are broadcast on American television. In Bronowski's *The Ascent of Man*, for example, the immortality of scientists is unequivocally expressed: "Physics in the twentieth century is an immortal work. The human imagination working communally has produced no monuments to equal it, not the pyramids, not the *Iliad,* not the ballads, not the cathedrals."[22]

The immortality of scientists is not just a vulgar affectation of mass-media popularizations but, as the charter myth itself suggests, is an essential aspect of mainstream science as well. In the dedication to *Sidereus Nuncius* Galileo names the four moons of Jupiter the "Medicean stars" after his patron Cosimo II de' Medici; and he explicitly points out that whereas all forms of earthly immortality inevitably wane, he can offer his patron a fame that will endure until "the splendor of the stars themselves is extinguished."[23] He assures the prince: "for scarcely have the immortal graces of your soul begun to shine forth on earth than bright stars offer themselves in the heavens, which like tongues, will speak of and celebrate your most excellent virtues for all time."[24] Operationally defining an immortal as someone whose framed portrait is hung in an institution after he is dead, then science is still as addicted to stars as Hollywood. Indeed, the walls of the theoretical astrophysics division at Caltech are decorated with photographs of Niels Bohr, J. Robert Oppenheimer, and Albert Einstein;[25] and in scientific textbooks, there are always pictures of famous scientists interspersed with the equations to show the student the clear and unambiguous relationship between the mastery of scientific content on one level and the proof of star quality on the other. Although in the folk theory of science, stars are considered one thing, their names another, to the anthropologist the celestialization of the scientist's body is an essential component of the Galilean circuit, for it connects the dry, disembodied products of scientific research with such normal human motivations as the desire to transcend death. Indeed, to achieve immortal status, the scientist need only emulate the life and works of the culture hero himself—for are not the Medicean stars now known as the Galilean satellites?[26]

The Two Faces of Science

Because eschatology is as important to science as it is to theology, the two institutions are necessarily in competition for the same niche, and this explains why the trial of Galileo gets so much air time in contemporary America, a culture not otherwise known for its historical depth. The Lone Galileo is 20th-century myth not 17th-century history, and tells us that religion is a *prerequisite* to *contemporary* science, whose charter is to demonstrate physical facts (Verse One), then use them to repudiate a theological position (Verse Two). Therefore, to faithfully follow in the path of Galileo is to challenge Church doctrine by demonstrations of physical facts that seem to contradict theological propositions. Far from trying to abolish religion, science seeks to preempt it, assuming the mantle of theology for itself.

Some religions are more congenial to this scientific agenda than others. In mainstream Protestant sects, the ones that founded the Ivy League universities, science and theology are considered to be oars on the same boat, with science responsible for matter, theology for the spirit. Progressive theologians, taking science at its word, as an open-minded inquiry into the laws of nature, and fancying themselves as the second oar, like to see scientists as closet Christians.[27] Much is made, for example, of the lecture entitled *Religion und Naturwissenschaft* ("Religion and Natural Science") delivered in 1937 by the physicist and "dedicated churchman" Max Planck,[28] which affirms the importance of theology in the modern world by telling us that Kepler, Newton, and Leibnitz were very interested in religion. Even the vague, pantheistic rambling of Einstein is somehow construed as endorsing the Judeo-Christian concept of God. But nature theology fails to see that this open-mindedness is a one-way street, for scientists have no reservations whatsoever in appropriating theology's turf whenever they have the power to do so. Also, it confounds the beliefs of individual scientists with the role of the institution. Even if hitherto undiscovered documents prove conclusively that Einstein was a practicing Presbyterian, it will simply underscore the fact that personal religious practices are not definitive of the scientific agenda—Galileo went to church too. Not only is there a profound intellectual objection to the whole idea that science and theology have a natural division of labor between body and soul, matter and spirit, but this doctrine ignores the covert agenda of the scientific program and the unconscious elements of its iconic deep structure. The analysis of science's own charter mythology indicates that the two

disciplines are in structural opposition and essentially unreconcilable within the context of industrial society.[29]

Once again, there is an anomaly in the myth of Galileo, an anomaly rarely pointed out, and never by the popularizers: the fact that the founding hero of science is not very heroic. Where John Wayne would have faced down his accusers with manful, monosyllabic contempt, and Rambo blown off the doors of the papal palace, Galileo signs the document retracting his vision of the truth. Even from the vantage point of history, Galileo's predecessors were made of sterner stuff: Bruno preferred to burn at the stake rather than repudiate his Neoplatonic theology, and Sir Thomas More tipped the executioner with a gold coin before resting his head on the block. But Galileo probably avoided a similar fate by signing a document that said he repented of his heresy and repudiated Copernicanism, agreeing that he "must altogether abandon the false opinion that the sun is the centre of the world and immovable, and that the earth is not the centre of the world, and moves."[30]

Did Galileo *really* repudiate his Copernican ideas? The implication of the popularizations is that he did not, for otherwise he would have suffered in vain, without even the cold solace of scientific immortality. Yet consider the implications of his actions, if not for Galileo, then for his intellectual descendants. If the founding hero of the scientific enterprise can sign a document that in effect repudiates all that he believes in, what does this tell us about the scientific concept of truth and the relationship of science to authority? It says that scientific heroes should lie about their beliefs if their activities ever bring them into conflict with governments and theologians, even if it means presenting a public posture that is in conflict with scientific truth. This mythology also shows why scientists are so useful to the state, for even when they are privately skeptical about religion and politics, they can be publicly counted on to do whatever is necessary when the chips are down, such as Oppenheimer, who literally buried his pinko past to heed his country's call. The charter myth of science says to its practitioners: "Don't be heroes"—and not surprisingly, not one of them is.[31]

There are two major public events in the life of The Lone Galileo, namely his demonstration of the telescope and his public capitulation to the inquisitors, and this suggests that the institution of science has a double standard of truth: a firm commitment to truthfully expressing empirical knowledge supplemented by a willingness to deceive organized religion as to the nature of its real agenda and beliefs. Moreover, Verse Two of the charter myth begins with a challenge to the Church, suggesting

that this course of action is equal in value to the practice of science in a strict sense of the term. Also, the Copernican theory, far from being neutral, had already been censured by the Church, for it was suspected, probably justly so, of being a heretical system of theology disguised as astronomical propositions. In other words, the tale of the Lone Galileo is not only a blueprint for a complete religion, with both cosmogonic (how we got here) and eschatological (where we are going) functions, but it encodes a practical program for challenging theological propositions while denying that this is really one's intention at all.

In scientific biographies, this phenomenon is typically expressed as a conversion to science after a crisis of faith. For example, in *The Making of the Atomic Bomb*, Rhodes tells how the young Einstein while attending school took a foray into Judaism, only to conclude that many stories in the Bible could not be true. As Einstein expressed it, "'Suspicion against every kind of authority grew out of this experience, a skeptical attitude towards the convictions which were alive in any specific social environment.'"[32] This quotation is interesting, not only because Rhodes takes it at face value, but because Einstein is held up to us, more than anyone else, as the modern scientific ideal: the pacifist genius of vaguely leftist leanings dedicated to enlarging the intellectual horizons of all mankind. But the problem is that Einstein's pacifism and self-proclaimed skepticism towards all forms of authority did not extend to burying Szilard's proposal for an atomic bomb under the pile of papers on his desk. Instead, he used his own considerable moral and intellectual authority to launch the largest weapons development project in all of recorded history—the Galilean hero par excellence.[33]

The theological referents of scientific activity are never mentioned in the "technical" scientific literature, only orally and in the popularization; and if pressed on any of the underlying religious and philosophical issues, scientists, like the censured Galileo, disclaim any theological intent. Nonetheless, almost all popular works on science, as well as memoirs by scientists themselves, convey an implicit theological agenda in which manifestly metaphysical propositions, such as free will or the perfectibility of human nature, are evaluated in the light of scientific theories of nature—and found to be wanting. For example, a 1989 cover story in *California* magazine on the Caltech astrophysicist Kip Thorne describes how he mathematically models billiard balls traveling backwards in time by means of "wormholes" in the fabric of space-time.[34] On the surface, this is pure science, because it is overtly concerned with billiard balls, relativity, and physical laws, but further along in the article

we come to an atheological conclusion: Thorne asserts that his research into billiard balls reveals contradictions in the concept of free will.[35] What sort of mind investigates billiard balls in order to understand free will? The pervasiveness of science in a culture is measured by the extent to which theological and philosophical questions are confounded with the mathematics of gravity—and nobody notices.

The bifurcation of scientific thought into a seemingly neutral theory expressed in textbooks and a vociferous theological position expressed in so-called popularizations has been part of the scientific enterprise for centuries. The discovery of atomic energy, for example, exemplifies this strategy perfectly. In 1901 Ernest Rutherford and Frederick Soddy discovered that an atom of thorium changes into an atom of argon by the emission of radioactivity, and they carefully examined other radioactive elements in turn, establishing their breakdown products and measuring their half-life. Soddy's scientific description of the transmutation of elements, for which he won the Nobel Prize, has all the dispassionate precision of pure science, but in his popular works he attacked the Judeo-Christian doctrine of original sin. In his widely read *The Interpretation of Radium*, published in 1908, he wrote that "A race which could transmute matter would have little need to earn its bread by the sweat of its brow.... Such a race could transform a desert continent, thaw the frozen poles, and make the whole world one smiling Garden of Eden."[36] Moreover, Spencer Weart, himself a physicist, in *Nuclear Fear: A History of Images*, shows that the articulation of all of the major policy issues pertaining to the use of atomic energy—underground shelters, limitless energy, universal holocaust, and universal peace—*preceded* both the scientific discoveries of atomic physics and the development of atomic technology, indicating that the mythical concerns, far from being post hoc rationalizations, are in fact the driving force behind the scientific and technological activities. In the same vein, historians of science have shown that Isaac Newton was a closet alchemist who believed himself to be the divinely chosen representative of the ancient Hermetic wisdom, and he even rewrote the Latinized form of his name, Isaacus Neuutonus, as the anagram *Jeova sanctus unus*—Jehovah the holy one.[37] But none of the alchemical and occult sources of his thought are referenced in his published works, which present his conclusions in terms of a sanitized mechanical philosophy.

Yet the academically orthodox position is that of Stephen Toulmin, a respected philosopher of science, who draws a hard-and-fast distinction between the truth of scientific theory and the distortions

imposed by the myth-making process. He tells us that the 20th century considers itself myth-free because "the material from which we construct our myths is taken from the sciences themselves,"[38] so that modern myths are mechanomorphic, not anthropomorphic. He also points out that this fact shows the impossibility of the Enlightenment's dream of a scientifically grounded system of economy and government, for to the extent to which a scientific term is used metaphorically to justify the wider concerns of society, it loses the relationship to a well-defined class of physical phenomena on which its scientific precision is based. Yet Toulmin's argument still assumes that scientific activity is itself essentially myth-free, a generator of truths, so that *myth* is something that happens to scientific knowledge in the course of its journey from the ivory tower to the factory floor.[39] Philosophers and historians of science are themselves professional academics, with a vested interest in the concept of the expert who commands the machinery of truth, so they take at face value the major premises of science itself: first, that its first priority is truth; second, that it produces objective descriptions of nature; third, that physical theory is the engine of the enterprise; and fourth, that mythic conceptions have been rigorously excluded from the fundamental operations of the scientific process. In effect, it is science itself that defines the proper subject matter of academic inquiries into science, declaring the attic and the basement off bounds to inquisitive sleuths.

The Atheological Agenda

Yet the interpretation of science as a covert, atheological agenda can explain major conceptual changes in the history of Western thought without recourse to science's own ideology of theoretical progress. Ever since the work of Thomas Kuhn on *The Structure of Scientific Revolutions*, scholars have been aware that science advances through what this scholar calls paradigm shifts—the replacement of one scientific world view by another. The new paradigm provides an alternative interpretation of previously established scientific facts, introduces new concepts and research techniques, and, most importantly, defines the problems that still need to be solved. The paradigmatic paradigm is Einstein's theory of relativity which replaced the three-dimensional space of classical mechanics, itself conceptualized as a kind of empty box in which material bodies interacted through forces at a distance, with a radically new vision of physical reality in which matter bends

the fabric of four-dimensional space–time to create gravitational effects undreamt of by Newton. But as Kuhn points out, before a paradigm can become accepted, "the new candidate must seem to resolve some outstanding and generally recognized problem that can be met in no other way. Second, the new paradigm must promise to preserve a relatively large part of the concrete problem-solving ability that has accrued to science through its predecessors."[40] But significantly, as Kuhn expresses it, "paradigm debates are not really about relative problem-solving ability, though for good reasons they are usually couched in those terms. Instead, the issue is which paradigm should in the future guide research on problems many of which neither competitor can yet claim to resolve completely."[41]

Although there is no denying that new scientific paradigms typically address and resolve many of the problems raised by prior scientific research, Kuhn's analysis implies that the source of scientific revolutions is to be found within the intellectual framework of science itself. Thus, his interpretation, for all of its surface iconoclasm, reaffirms science's own folk model that the theory is where the action is. Moreover, it is not Kuhn's theory which determines what is and what is not a scientific revolution—it is science itself that dictates these judgements. So Kuhn's re-analysis of scientific development may jettison the dogma of mindless empiricism, but it also preserves the arrow of progress from Newton to Einstein, which explains, no doubt, why Kuhn is a tenured professor at Einstein's very own institute, the Center for Advanced Studies at Princeton. In short, Kuhn's theory of scientific change not only assumes science's own ideology of forward motion, but it elevates these folk interpretations to a theory of history in a strict sense of the term.

The advent of Einstein's theory of relativity is more satisfactorily explained by the hypothesis of a covert atheological agenda of institutional science than by anomalies in classical mechanics. Admittedly, there were intellectual problems with the previous paradigm, as there are in any system of thought, but problems do not create their own answers. Rather, the new paradigm is first evaluated for its atheological potential, and only after it passes this test is it systematically applied to scientific problems. In the atheological interpretation, Einstein's intense antipathy to organized religion, documented by his own statements quoted above, is the real inspiration of his physical theory, not the Michelson-Morley experiment. Moreover, it was Newton's theology, not his mathematics, that was becoming increasingly embarrassing to physics, for Newton had devoted a good deal

of his professional life to mathematical explications of the book of Revelation; and his celestial mechanics presumed the actions of a Creator who imparted to the planets their initial motions. Although in Newton's cosmic drama God had been demoted from producer to set director, arranging the scenery against which subsequent physical actions take place, in Einstein's relativistic universe the planets are locked into their relative positions by purely physical forces, a curvature of space–time appropriate to their masses. Thus, the divine presence can be banished to the first few nanoseconds of the universe, making it possible for science to provide a complete and seamless cosmogony stretching from the act of creation to the lunar landing. It is the hegemonic potential of Einstein's ideas that made them so instantly attractive to 20th-century physicists.

Every generation of professional scholarship digs into the scientific mother lode to extract its own shiny nugget to characterize the uniqueness of science—empirical, experimental, progressive, falsifiable, to name only the most famous finds; and these examinations of the scientific process by academic outsiders have shown the inadequacy of the scientists' own explanations of what it is they do. Kuhn's historical research shows, for example, that science does not progress by the patient accumulation of facts and the judicious weighing of negative evidence. Instead, theories organize the perception of facts as well as their acquisition, so that observations that do not fit the theory are largely ignored until a new theory comes along that can better accommodate them. Moreover, individual scientists typically do not abandon the theory of their youth in favor of a radically different way of looking at the world, changing from Newtonians to Relativists, or from Catastrophists to Darwinians. As in other institutions, the old guard eventually dies off, abandoning the field to the young. Thus, historical and philosophical studies of the scientific method show that science, whatever it is, is certainly *not* a dispassionate observer staring wide-eyed at nature, building instruments, and writing down facts. Also, a "scientific fact" is not something that one can establish simply through direct observation, for the facts, like theories, are a collective effort. When Galileo looked at the planet Saturn, he did not see the concentric rings we now take as self-evident but described it as a sphere with a bump on each side, just as when Herschel first saw the planet Uranus with an improved telescope of his own construction, he interpreted it as a comet.[42] Yet, in spite of their contribution to our understanding of the scientific process, the historical and philosophical disciplines have also

reinforced the scientific world view by assuming, with science itself, that theory is where the action is.

In Kuhn's analysis of the history of science, for example, when one paradigm stumbles, another paradigm picks up the pieces and carries on; but the recruitment of scientists to the new theory cannot itself be explained by the rules of scientific evidence. The validation of a new theory requires that a number of scientific researchers abandon the established framework to make observations and undertake experiments in conformity with the new guidelines, a process that requires commitment of time and resources in advance of the evidence needed to justify such a change. For this reason, the philosopher Paul Feyerabend, in *Farewell to Reason*, has likened the paradigm shift to a conversion process within science itself.

The classic case is that of Charles Darwin, whose theory of evolution by natural selection, as presented in 1859, did not resolve any pressing scientific issues, and had almost no scientific evidence to support it.[43] In fact, it was contradicted by a wide range of well-established scientific facts across a broad range of disciplines. By Darwin's day, vertebrate paleontology had developed into a significant science that had excavated the fossils of hundreds of extinct animal species, from mammoths to dinosaurs, and it showed that the history of life on earth is punctuated by mass extinctions in which one type of fauna dies off, to be replaced sometime later by another, a process that Cuvier called catastrophism. But Darwin's theory assumes gradual, incremental changes in species, analogous to the selection of characteristics by animal breeders, and it was flatly contradicted by the fossil record so laboriously built up by paleontology. Darwin argued that the gaps in the fossil record would eventually be filled in, so that species could be seen to merge one into another over time, but this optimism has not been borne out. (In fact, the essential features of Cuvier's catastrophic evolution, minus the doctrine of special creation, have been scientifically rehabilitated in the last decade under the new name of punctuated equilibrium.) Also, Darwin's theory assumes that the natural state of a species is genetic diversity, so that some individuals can be better adapted to their environment than others. Indeed, to Darwin, the very concept of a "species" is intrinsically statistical. As a breeder of show pigeons, Darwin had a good practical understanding of genetic selection, but there was nothing in the biology of his day to support the idea that species are intrinsically variable in nature. To the contrary, academic biology thought of species as ideal forms, like Platonic

archetypes, a concept in which statistical variability is assumed to be irrelevant or even pathological. Moreover, a science of genetic diversity supportive of Darwin's conclusions would not become generally available to the scientific community until several decades after the theory of natural selection had become commonly accepted among educated people. Also, there were significant arguments against Darwin's theory made by more established sciences. As the gradual accumulation of adaptive characteristics required an extremely long time scale in which to work, the eminent physicist Lord Kelvin argued on the basis of physics that there was simply not enough energy in the sun to sustain the earth for the time scale required by the theory of natural selection. Thus, Darwin's theory, when first presented, lacked any evidence for innate variability; it was contradicted by the fossil evidence of the history of life; it assumed a statistical concept of the species quite foreign to the working biology of the day; it did not resolve any specifically scientific issues raised by previous biological research; and it appeared to be in conflict with physics. The best that one could say was that it was consistent with Lyell's uniformitarian geology, that it explained the similarity of embryos among widely divergent species, and that it resolved anomalies in the geographic distribution of plants and animals. Although these topics no more animated the average man of Darwin's day than they do now, the book was an instant best-seller; and the theory of natural selection became canonical science by the end of the 19th century—well in advance of the observations and mechanisms that are now invoked as evidence for it.

Significantly, Darwin's theory cannot even be called a paradigm by Kuhn's definition because it did not resolve the contradictions of previous biological theories, and it ignored the fossil record entirely. But it did effectively demolish the argument that Darwin *claimed* he set out to refute, namely, Archdeacon Paley's idea that the existence of God can be proved by the evidence of design in nature. Paley, an Anglican clergyman, had written a number of books on biological subjects that he used as evidence for an intelligent creator. His thesis is often expressed by the story of the lost watch: if you found a watch on the beach, the intricate design of the artifact with its multiplicity of parts working together would enable you to infer the existence of a watchmaker, even if there was no other evidence that watchmakers existed. To the theologian Paley, this was a forceful natural argument for the existence of God (what sort of God is another matter), and it is this thesis which Darwin debunked in his scientific writings, showing that the complexity

of organisms developed gradually through the selective retention of adaptive characteristics, what he called the principle of natural selection, and that the design in organic nature so obvious to Paley was in fact largely illusory. In Darwin's case, where significant scientific evidence for his position was all but non-existent, this not-so-covert atheological agenda was the primary criterion for scientific acceptance of the theory, and it explains the enthusiastic reception by all factions of the industrialist intelligentsia: by Marx and Engels who saw it as proving their materialist theory of human nature, by Fabian socialists who saw it as the agency for the perfectibility of man, and by laissez-faire capitalists who thought it showed that unrestricted competition leads inevitably to progress. But Darwin's greatest service, still too little appreciated, is to theology itself—for he was as good as his word and banished the banal abstraction of Paley's divine watchmaker from God's green earth forever.

As with the presentation of established scientific theories to a general audience, the elimination of prescientific ideas that conflict with the underlying atheological agenda is done in the pages of the popularization. In fact, a prescientific idea judged to be atheologically anathema is personalized in popular scientific writing as a character found nowhere else but in this genre—the character of "the crank." In this literature, there are antievolutionist cranks, antivivisectionist cranks, antinuclear cranks, indeed as many classes of crank as there are critics of science's institutional position as arbiter of truth and heir to theology. It is for this reason that the most severe criticism is reserved for people who claim to be scientists but who refuse to accept the underlying atheological program, such as the universally condemned arch-crank Immanuel Velikovsky. The problem with Velikovsky is not with the intrinsic craziness of his ideas, for there are numerous notions in contemporary, mainstream science of such crystalline lunacy as to make Velikovsky's baroque excrescences seem drab in comparison: pollution-free sources of energy, providential asteroids exterminating dinosaurs, time-travelling through wormholes—to list only ideas on the cutting edge. Rather, the problem of Velikovsky is that he uses scientific data and methods to try to prove the essential truth of mythical conceptions of reality as preserved in religion and folklore—a research program totally at cross-purposes with everything that science stands for. No wonder he is called a *crank*—a device that converts one form of motion into another.

Thus, it follows that popularizers are the gatekeepers of the scientific enterprise, for it is in the popularization, not in the technical treatise, that mythical concepts are introduced, evaluated, and adopted. Although in academic circles *popularization* is a dirty word, suggesting the debasement of pure ideas by the values of the marketplace, the more important the scientist (as measured on purely scientific criteria, such as the number of journal citations and the dollar volume of research grants), the more likely the scientist is to write popularizations in a strict sense of the term, namely books and articles addressed to the general public: Watson's *The Double Helix*, Pauling's *Vitamin C and the Common Cold*, and so on.[44] This too has a mythical charter, for Galileo's career begins, not with a new and better theory, as academic historians and philosophers of science would lead one to expect, but with an unequivocal *popularization*, namely, the demonstration of the power of the telescope to the rich merchants of Venice. Until catapulted to fame by his exploits on the Campanile, Galileo was a respected university professor, popular with the students, but he had far less claim to immortality than many of his contemporaries. Only after his successful foray into the marketplace does the mythic Galileo begin to do scientific work in a strict sense of the term, such as observing heavenly bodies, publishing the results, and raising doubts about a predecessor's theory. In short, Galileo becomes a famous scientist *before* he does any memorable science.

The dramatic conflict between science and religion in the tale of The Lone Galileo indicates that science to this day has a theological agenda—*theological* in a strict sense of the term, namely, the study of God, particularly the relation between God, mankind, and the universe. The primary agenda of science is to promulgate its own materialist inversions of theological propositions (atheologies) at the expense of overt religion—and this is not surprising, given that Nebuchadnezzar's Dream is itself an inversion of a biblical myth. In other words, science is a negative to theology's positive, and by compiling a simple list, it is easy to show that each scientific theory inverts a thesis in Judeo-Christian theology while carefully skirting any real consideration of the underlying philosophical and existential issues:

Thesis	Antithesis
The world was created by God.	The world was created by the Big Bang.
Human beings have a spiritual as well as a material nature.	The world is made out of matter.
God is immanent in His creation.	The world is a machine.
God is a person.	Scientific laws are statistical.
People are responsible for their actions.	Human behavior is determined by genes and environment.
God loves his creatures.	Altruism is just genetic self-interest.

The latent agenda of the scientific enterprise is to *replace theological propositions by materialist propositions while denying that this is the intention at all.*

Thus, it is hardly surprising that each philosopher of science comes away with a different interpretation of the essence of the scientific method, for the distinctiveness of science is not in its method at all but in the underlying imagery of the transformation of nature by starlight and in the ideology of objectivity with which it disguises its atheological agenda. For all of the talk about evidence and empiricism, the facts and theories of science are like the pieces on a chessboard: place holders in a higher strategy. Although chess tokens are demonstrably *physical* entities, each with a certain weight, shape, and size that can be objectively described and measured, their material properties are irrelevant to the game, which can be played equally well on a computer screen or with a different set of conventional tokens entirely. In the same way, we accept the intellectual revolutions of our time—the shift from Newtonian to relativistic mechanics, from uniformitarianism to plate tectonics—with such equanimity because we already know in our heart of hearts that scientific content is irrelevant to our faith in the technocratic ideology. The geological record, the diversity of species, the topography of the sea floor, the development of galaxies, the neurons of the human brain—all of these natural phenomena are grist for science's mill, but none of them will have any more effect on our conception of the world than the shape of the tokens has on the outcome of a chess game. Just as in Nebuchadnezzar's Dream, in which constantly

evolving tools and techniques affirm the eternal truth of the underlying mythology, so the frantic forward motion of scientific research disguises profound stability in the underlying cultural assumptions. Science does not so much "progress" as recycle its charter myths in new, more dramatic forms, so we never have to address the fact that the underlying mythology—Nebuchadnezzar's Dream and The Lone Galileo—has scarcely changed in four hundred years.