1 A Shotgun Wedding
The Marriage of Science and Christianity

"*Seeing is believing!*" We hear all the time. In our normal view of things what could be more obvious? There seems to be no question that the objects that enter our field of vision are really *there*. That's why we tell our children to watch out for traffic when they cross the street and why we duck when someone throws a snowball our way. Visual confirmation is crucial for a wide range of day-to-day activities: In business we keep our eyes, literally, on the bottom line. As proof that something is true, we want to "see it in black and white." When we buy a home or a car, although we may be attracted by a sales pitch, we would never write the check without having carefully looked over the merchandise.

Proof that things are real extends to the other senses as well. We believe in things that we can touch, especially when we burn a finger while cooking or bang our head on a low-hanging branch. What could be more real than the smell of fresh-cut grass, the voice of a loved one on the telephone, or the taste of our favorite dessert? We have no doubt that these things exist, so generally speaking *sensing* is believing.

A Sixth Sense

Beyond our five senses we also perceive things "in our heads," with our mind's eye. We rely constantly on fleeting mental images that appear to us like some personal, internalized video monitor. Furthermore, the impressions we experience go well beyond the visual. We imagine that we see, touch, hear, smell, taste, and think—even in our dreams. Here we

don't actually perceive objects with our sense organs, but we do possess a mental perception that gives us that impression. These internally perceived objects have a strong sense of reality. When dreaming, we are convinced that these mental phenomena are real. Rarely if ever do we stop in the middle of a nightmare and say, "I don't believe this is really happening—I must be dreaming."

In the daytime we use this theater of the mind, this interior space, to organize our lives: to imagine how to get from downtown to the airport, or to figure out how much change we should receive from the cashier. The whole inner, or subjective part of our lives is played out in this arena. Hopes and dreams start and sometimes end there: "Does he love me? Does she not?" Since it makes us aware of this inner world of thoughts, feelings, mental images, dreams, and so forth, *mental perception* qualifies as our sixth sense.

Upon reflection it is clear that mental perception is a bit different from the other senses. The interior objects it perceives have no concrete, physical reality. The seeming reality of a dream vanishes when we awaken, and our daydreams don't have the immediacy of a burned finger or the coins handed to us at the checkout counter. But mental perception and imagination play a vital role in a second way we know things: by reasoning, or inference.

We wouldn't get very far if we relied exclusively on our senses to know things, would we? Lounging in a hammock, half asleep, you hear a high-pitched squeal and then a crash. It must have been an auto accident. You didn't see it, but you know the signs and can put two and two together. Our imagination provides a mental drawing board where we can make calculated guesses about the reality of things, reason things out. The objects we manipulate—images, thoughts, emotions, and so on—are illuminated by our faculty of mental perception. By thinking, remembering, and inferring, we use such symbols drawn from experience to enhance our knowledge and, hopefully, to make our lives better.

Science is a good example of this process. First a problem is presented —something mysterious or not clearly understood. Next a theory regarding the problem is devised in the scientist's mind, based upon earlier theories and experiments and the free flow of the scientific imagination. In the beginning this may be no more than an informed

guess. Later the theory may be altered to fit new data gathered experimentally with instruments such as the microscope or telescope, which extend the power of our senses. That, for example, is how the planet Neptune was discovered. Prior to its visual confirmation with a telescope, its presence was theorized on the basis of deviations detected in the movements of a neighboring planet. Shortly afterward, using the theory as a guide, Neptune's existence as a planet in our solar system was confirmed visually.

This brings us to a third way we know things—knowledge based on authority. No human has yet seen Neptune with the naked eye, and very few of us have seen it with a telescope. Yet we accept the authority of scientists who tell us Neptune is there. When shown a photo of Neptune, few of us are likely to say, "I don't believe Neptune is real. These astronomers may be showing us a doctored picture of a Ping-Pong ball." In the same way, we believe that a man named Napoleon Bonaparte once ruled most of Europe and that viruses can cause a cold. We've never met Napoleon, and few of us have studied microorganisms in a laboratory, but we accept the word of astronomers, historians, doctors, and many other authorities because we believe they have special expertise that we lack. According to conventional wisdom, they are reliable.

We could sum up the three main ways we know things with the following scenario: Glancing at the street outside my window, I see a pedestrian fall to the ground in agony after being sideswiped by a car. I call 9-1-1 and tell the operator what I saw. The pedestrian experienced the pain of the accident directly with his *senses,* mainly the sense of touch. With my eyes I witnessed the expression of pain on the face of the pedestrian and saw him fall to the ground gripping his leg. I may have also heard the pedestrian scream. However, the fact that the pedestrian was actually injured by the car, that he was in pain, was only an *inference* on my part. He might have been faking it as a prank, or he and the driver may have been in collusion to defraud the insurance company. The emergency operator believes me on *authority,* assuming I am an honest citizen with my senses intact. A few pertinent questions will convince the operator that I am a credible witness and not a prank caller.

The acquisition of knowledge can also be viewed in terms of the degree

to which objects are hidden from us and our capacity to understand them. For the man experiencing the accident, the object in question—his pain—was obvious, it wasn't hidden from him in the slightest. For me, the witness, his pain was slightly hidden in that I had to infer it from experience, for instance from knowing my own facial expressions when I suffer an injury or what I might feel like if I fell from a bicycle. The pedestrian's pain was very hidden for the 9-1-1 operator. He had neither direct experience of it nor enough evidence to make an inference. He had to take my word for it.

Hidden Truths

This last category—very hidden knowledge—covers many of the most mysterious and important aspects of life, answers to big questions such as the origins of the universe, the existence of a creator and of fate, life after death, and so forth. We all believe (or disbelieve) in things that are hard to prove on the basis of the senses or reasoning. Such beliefs may come from our family or community—we have learned to believe what they believe. Surrounded by others who share our beliefs, we take these same people as authorities. Beliefs may also come from the truth and wisdom we perceive in teachings of some prophet or religious leader. At some point in our lives the words of Muhammad, the Virgin Mary, Jesus, Lao-Tzu, Mahatma Gandhi, Buddha, or some other spiritual authority may strike a chord within us, inspiring us, connecting with our own thoughts, experiences, and views about life. "Ah-ha!" we say. "This person knows the truth."

We may accept that person as the ultimate authority on reality, perhaps because we believe him or her to be "divinely inspired," to be indivisible from the "one true God," or to be endowed with "perfect wisdom." A Christian may believe in the existence of heaven because Jesus said it exists. A Hindu or Buddhist may believe in reincarnation because authorities such as the Hindu saints or the Buddha said it is true. One could speculate that prophets and saints are able to penetrate these mysteries directly with the senses or by some form of reasoning. But such spiritual truths are hidden from most of us. With rare exceptions only the most holy or gifted are said to perceive them.

As far as the general public is concerned, much scientific knowledge also falls into this class of hidden information. As we saw in the case of the injured pedestrian, the degree to which knowledge is hidden depends upon the perceiver. Prior to the seventeenth century, Neptune's existence was a very hidden truth to all but Galileo, who in 1612, using a telescope, saw a vague something in the night sky that we now know to be Neptune. In 1843, when the British astronomer John Couch Adams deduced Neptune's existence from mathematical calculations of the orbit of neighboring Uranus, the truth of Neptune's existence became somewhat less hidden—it became a scientific theory, believed by some astronomers to be true by inference. After 1846, the year Neptune was correctly identified with a telescope, its existence as a planet within our solar system became an accepted scientific fact for all but the extreme skeptic.

Accepting the existence of Neptune was comparatively easy. Many of the most important and fundamental goals of scientific understanding are as hidden from us even today as proof of the existence of heaven or reincarnation. Recall the story of Isaac Newton and the apple. Prior to Newton's theory of gravitation, when an apple separated from its branch and moved toward the earth, it was said that the apple "fell." Anyone could tell directly with the senses that the apple was heavier than a feather or a dust mote and would therefore fall rather than be blown by the wind. Apples, stones, and cannonballs had weight, so they fell. Few people bothered to ask what weight was. Newton did, and his conclusion was that weight resulted from a force of attraction. The apple didn't fall, it was attracted to the earth. But why?

According to Newton, the mass of any given object emanates an invisible force called gravity, creating a gravitational field that attracts other objects to it. Newton formulated his gravitational theory mathematically. Gravitational fields cannot be comprehended directly with the senses, but rather only through inference. Once Newton's theory became a scientific law, having been confirmed by experiments and approved by the scientific community, the general public accepted it on authority. For those unable to confirm it through experiments or by understanding its mathematics, gravity was a very hidden truth accepted on faith in the scientific community, on authority.

This question of how we know what we know and believe what we believe becomes downright puzzling when we turn to a more recent theory of gravitation. In the early twentieth century Albert Einstein theorized that gravity is a feature of the curvature of space-time. The apple isn't attracted to the earth, but rather follows a path of least resistance built into the shape of space itself. Massive objects like the earth happen to create a particular space-time curvature that leads objects such as "falling" apples "downward." For physicists the gravity of curved space is a hidden object of knowledge understood through inference. Some members of the general public familiar with the theory of curved space may accept that explanation on the authority of Einstein, the most famous genius of the twentieth century. He had an excellent track record, they reason, so his theory, however strange it might seem, should be believed, for it has been corroborated by many other scientists as well. Some of us may hold to the classic Newtonian view, which has had several centuries to become widely known. But when we slip in the shower, Newton and Einstein are nowhere to be seen. We *fall.* Likewise when we watch Olympic weight-lifters grimacing and straining on barbells, or when we ourselves try to lift a heavy object, we all, even physicists, sense the *heaviness* of these objects rather than a gravitational field. Such is the force of habit.

So for falling apples, which is it—Newton, Einstein, or the habitual beliefs we call conventional wisdom or common sense? If scientific theories didn't lead to new capabilities and inventions, such as landing human beings on the moon, theories of gravity might sound like fairy tales or mere speculation. No one has yet seen gravity, so it remains, like heaven and reincarnation, a hidden object of knowledge. Just as with heaven and reincarnation, there is also the possibility that gravity, as such, is either unknowable to us or does not exist at all.

Science Says to Religion, "May I Have This Dance?"

For Western civilization back around the time of the Renaissance, hidden knowledge was obtained from many sources. Astrologers claimed to know the future from the stars. Tradition dictated the best time to plant

crops. However, the main place to look for hidden knowledge about the big metaphysical questions was the Bible. The nature and origins of the universe and human beings' part in it were all explained in this collection of stories written or handed down from Hebrew prophets, Jesus, and apostles who claimed inspiration from God. For the average Christian, God's word was the ultimate authority. So powerful and widespread was this belief that those who questioned it could be brought before the Inquisition, where excommunication, imprisonment, torture, or execution awaited.

Nonetheless, from the fifteenth through the mid-seventeenth centuries fresh ideas from the Arab world and from the rediscovery of Greek learning gradually transformed all aspects of European culture, including religion. Philosophy and the arts flew off in new, more secular directions. Education, too, gradually became secularized as universities replaced monasteries as the centers of learning. Commerce succeeded feudalism, new continents were discovered, city-states and nations gained power, while the theocracies and monarchies of the Middle Ages lost influence. Even ideas that challenged the Bible were cautiously advanced. The most important child of this European rebirth was science.

Usually we think of science as an orderly process of investigation through which theories must be proven experimentally. Inspiration plays a part, but as Thomas Edison said, genius is 99 percent perspiration—the hard work of devising new instruments, running experiments, and doing the math. This modern notion of science is summed up in the scientific method, which can be defined as "principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses."[1]

Ideally, once a theory has been proposed and convincing evidence gathered, the originating scientist or scientific team publishes its findings in a scientific journal. This initiates the process of peer review, where other scientists carefully examine the original work, debate it, and try to reproduce its results. Once this gamut of tests has been successfully run, the new theory is accepted, though only tentatively since new

theories appear frequently to challenge the old. The ideal for the process of scientific investigation was given by the physicist Richard Feynman: "Experimenters search most diligently, and with the greatest effort, in exactly those places where it seems most likely that we can prove our theories wrong. In other words we are trying to prove ourselves wrong as quickly as possible, because only in that way can we find progress."[2]

However, the science of the Renaissance did not emerge from the womb full-grown, with a guidebook to the scientific method in hand. Today, science is generally viewed as the antithesis of religion—facts proven experimentally as opposed to beliefs accepted on authority. Yet the development in the Renaissance of such a science, one completely divorced from religion, is inconceivable. In actual fact, science was the product of a highly religious society. The pioneers of science—men such as Copernicus, Descartes, Galileo, and Newton—were Christian believers. Many of the fundamental ideas of science are found in the writings of Saint Thomas Aquinas (1225–74), who assimilated the ancient Greek philosophy of Aristotle into Christian thought. Therefore, it was inevitable that science would develop initially along Christian lines. Then as science evolved and its theories and experiments produced proven, practical results, a dialogue, often political in nature, took place between scientists and ecclesiastical authorities—a cautious dance of give and take. Much was at stake.

Through the course of this exchange, the church was gradually forced to modify its opposition to science, so much so that by the twentieth century science had for many people replaced religion as the final authority on reality. Even so, scientific thinking never completely divested itself of ideas derived from Christian theology. They were too deeply embedded. As a consequence, the prevailing *popular* view of science in the West is based on the discoveries achieved by the scientific method, but infused with a hidden Christian view of nature. That view evolved from a set of metaphysical assumptions that underlie science and are believed by many scientists today—they're collectively called *scientific materialism.*

The philosophy of scientific materialism, which emerged clearly only in the nineteenth century, is an interpretation of science. It is based on five principles: Stated succinctly, the first and foremost is *objectivism,* which states that the only reality of importance exists "out there" beyond

our minds—the objects we perceive as the physical universe. Next is *metaphysical realism,* the belief that the objective universe can be known by the subjective human mind. Objectivism and metaphysical realism were further refined by the *closure* principle, which denies the possibility that anything other than material influences can affect any aspect of the natural world. Fourth, the principle of *universalism* declares that these rules are universal—they are the same in every corner of the universe be it the center of a cell or the center of a star. Finally, *physical reductionism* reduces all of nature to physical entities and interactions. Combining these five principles, this materialistic view of reality was the unintended offspring of the marriage of Christianity and science.

In the Beginning

With its Christian background it is hardly surprising that science was strongly influenced by the Bible, which opens in Genesis with the words: "In the beginning God created the heavens and the earth." On succeeding days God elaborated the physical universe, then populated it with the animals, and not until the sixth day, the last day he worked on his Creation, did he make humankind. And God made humans "in his own image." Later, when Adam ate from the tree of knowledge, that image was tarnished: the fall of humans from God's grace. This is the official starting place for the beliefs of Judaism and Christianity, and science too can be traced to this source.

Given these fundamental beliefs about the nature and origins of the universe, it was perfectly natural for the founders of science to see their main task as using the mind of humans (made in the image of God) to fathom the real, objective world created "out there" in the heavens by him. More specifically, since God also "governed" the universe, scientists sought to understand his "laws" of nature. This set the foundation for *objectivism*, which declares that there is an independent, objective reality outside of our minds, beyond our thoughts, and that this is what science aims to understand. The goal is to fathom the material stuff called the universe. Whether that is to be found in the chemistry of cells, the forces of subatomic particles, or in distant galaxies, all of these phenomena are "out there" beyond our inner, subjective thoughts and feelings,

just as the heavens were to Renaissance astronomers. Objectivism is the main principle of scientific materialism.

That seems perfectly natural, doesn't it? Whether the field is physics, chemistry, or biology, research is performed on material objects such as atoms, chemical compounds, or cells in order to understand how the universe ticks. Our image of scientists in their white coats, hovering over their instruments, making their calculations, includes the notion that they are seeking diligently to solve the riddles of physical existence. However, this view, this pattern of thought called objectivism, is really no more "natural" than reading tea leaves to tell the future. It has its roots in the Bible and seems obvious only because it is such an ingrained belief. If instead the universe were believed to be a fully integrated whole, as it was in ancient China, then reading tea leaves (or more likely reading patterns of sticks or coins, as was done in the *I Ching* system of divination), would itself seem perfectly natural. Just from observing the world's many cultures and beliefs we know that the naturalness of things depends largely on one's beliefs, reinforced by tradition—the force of habit.

But what if the tea leaves say, "Don't believe the tea leaves"? What are the consequences of seeking the objective truth of "God's domain" if the experimental results obtained differ from the beliefs held by religious authorities—"God's representatives"? As it turned out, seeking an understanding closer to God's led early scientists to conclusions that contradicted the cherished (and officially recognized) views of popes and cardinals. Those beliefs held sway, and prelates could use extreme measures to protect them. The conclusions of scientific experiments designed to understand the mind of God could be interpreted as heresy.

Since the original goal of science was to understand the universe "out there," astronomy, heavily influenced by biblical cosmology, became the first science of importance. Early astronomers studied the heavens and began to investigate the motions of the stars and planets, hoping in that way to understand God's Creation. Astronomers set out to achieve God's perspective on the universe by using an "impersonal" technology—something independent of the sinful human body—the telescope.

Prior to the Renaissance, the earth-centered model of Ptolemy, which was in perfect accord with the Bible, dominated astronomy. The basic

idea was that all the planets moved in circular orbits around the earth. A complicated and ingenious explanation using epicycles (circles within circles) accounted more or less for observed planetary orbits. (Viewed from the earth, which we know to be just another planet circling the sun and not the center of the solar system, the observed motion of other planets is complex and squiggly—not simple circular motion.) However, as time passed, trying to decipher planetary motions with Ptolemy's model became a frustrating affair. When new observations deviated from the theory, new, ever more complicated epicycles had to be devised. It just wasn't working.

Seeking a more accurate method, Copernicus, in the early sixteenth century, introduced the heliocentric system: it was the sun, not the earth, that remained at rest as the universe moved about it. This model accounted more simply for the motion of the planets, their order in the solar system, and their distances from the sun. In essence it also introduced a "God's-eye view" of the universe to science, though it might better be called a "sun's-eye view." If you were on the sun, Copernicus reasoned, this is the relative motion you would see: the sun, like God, is at absolute rest, while we on earth spin around it in circles. God, after all, did not view the universe from earth but from the heavens themselves, from a more objective standpoint. Suddenly, human beings' self-centered notion of their own importance—a subjective influence—would be replaced by God-like objectivity. The Copernican view therefore amplified the ideal of objectivism. Not only was the scientist to study exclusively the objects of the universe, but subjective distortions due to human beings' imperfections and limitations were to be eliminated.

There was a problem, however. The heliocentric theory could be interpreted as placing earth—home to sin, war, and pestilence—in the heavens. This was in conflict with a literal interpretation of the Bible. Copernicus, whose theory wasn't published until he died in 1543, wasn't around to get into trouble with the church over his potentially heretical theory. Certainly, as a church official (with a doctorate in canon law), he was aware of the theory's conflicts with theology. This was one reason he delayed its publication for thirty-six years. Galileo, on the other hand, who built the first astronomical telescope and vigorously advocated the heliocentric model, got into very hot water with the authorities.

In 1616 the church declared Copernicus's theory heresy. Subsequently Galileo, as its most avid and articulate proponent, was brought before the Inquisition in Rome and forced to renounce his belief in the Copernican model. He publicly accepted an explanation put forth by a church official, Cardinal Bellarmine, that the heliocentric model merely made astronomical calculations easier but did not represent reality. The Copernican model was officially reduced to the status of a useful gadget for calculating planetary geometry, that's all. This was a severe personal blow for Galileo. It was several years before he had the courage to reenter public debates on astronomical matters. Galileo's story illustrates the power of the Catholic Church at that time to modify scientific conclusions, at least publicly. Galileo's most important writings on astronomy were kept on the Index of Prohibited Books until 1835 (as were those of Copernicus and of Kepler, who improved the heliocentric model). Full acceptance of objectivism would have to wait.

By the Numbers

Galileo was the greatest scientific genius of his time. He believed, as did Plato and Augustine before him, that God ordered the universe through numbers, that mathematics was the divine language. He put it this way:

> Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it.[3]

Again, since humans were made in the image of God, scientists, by deciphering the universe in God's own language, mathematics, might also reveal God's way of thinking the universe into existence. This belief in a mathematical foundation of the universe became a cornerstone of science. It is an essential component of *metaphysical realism,* another of the principles of scientific materialism, which states that the universe is

ordered by ideas (such as mathematics) that lie beyond or transcend the senses. According to this view, these ideas are implicit in the very nature of reality, what the universe really boils down to. We know that different species perceive similar objects differently, and there are variations in how different people perceive the same things, such as colors and sounds. But what are these objects like really—objectively, independent of the perspective of any of God's creatures?

As with the workings of gravity, the transcendent reality of phenomena must be either inferred through a process of reasoning or accepted on authority. A scientific theory is a transcendental idea that aims to account for reality as it exists independently of our human experience and concepts. Again, the origin of this way of thinking can be found in scripture, the "grand book" that shaped the minds of Europeans prior to and during the Renaissance. So, just as God transcends the universe, his divine language (and later, scientific theories heavily dependent on mathematics) allows the scientific mind to transcend the senses and reach true understanding of reality. Often, according to this perspective, reality can be reduced to a mathematical formula.

Metaphysical realism seems just as natural as objectivism. We've all had a taste of geometry and its laws. Using pencil and paper or calculating in our heads, we can figure out the square footage for tiles we wish to lay on a bathroom floor. We don't have to rely on our senses and measure tile by tile. We can also calculate how many miles to the gallon we got on our last automobile trip, or the rate of growth of our business. Here the knowledge we attain about things is completely abstract. No one has ever seen or touched a "mile per gallon" nor a "one percent yearly increase in profits." Yet they are a perfectly natural part of our everyday reality.

Let's Be Practical

Of course science in the Renaissance was not propelled merely by the curiosity of talented intellects. Expanding commercial interests demanded improved technology in the field of navigation, and governments needed better military engineering to protect commerce and advance the interests of their domains. As science provided this technology, it gradually

gained enough credibility to prevent the church from censuring it each time a new theory or discovery contradicted religious doctrine. Rather, a delicate balance replaced the previous religious dominance over scientific ideas. Once the prestige of science had grown, theologians themselves began to rely on it. For example, science could be used to determine what was and was not a miracle: if some phenomenon could not be accounted for by a scientific law, it could be declared miraculous. Over time, as scientific knowledge expanded and God's role diminished, he would be called on merely to fill in the gaps in scientific knowledge—gaps that grew smaller and smaller as science advanced.

At this point, in order to provide technology as well as to effect a more perfect understanding of the heavens, specific knowledge of the laws of motion was required. The artillery captain needed to calculate the proper angle for his cannon in order to destroy enemy positions. Presuming that the motions of cannonballs and planets followed the same laws, the discovery of those regularities was a major interest for such leading scientists as Descartes, Leibniz, and Newton. One important step in that direction was to determine whether nonphysical factors played any part in the motion of objects. René Descartes (1596–1650) was the first to theorize the *closure principle* when he stated that there existed nothing in nature that could not be explained by "purely corporeal causes." That idea, another principle of scientific materialism, closed off nature from all but physical influences. Frightened soldiers couldn't cause cannonballs to fall elsewhere by wishing or praying. Nor could demons start fires or cause objects to levitate. Only matter could move matter. However, Descartes was careful to make two exceptions: biblical miracles and the human soul, which he believed could affect the body. But the influence of the church had already weakened considerably. Leibniz, born only four years after the death of Galileo (1642), boldly theorized that mind and spirit had no effect whatsoever on nature.

Sending God into Retirement

Isaac Newton believed the physical universe was composed entirely of inert matter created and put into motion by God, who imposed his laws upon it. Deeply religious, he argued that Leibniz's view, a universe com-

pletely self-contained and isolated from spiritual influences, would lead to materialism and atheism. But it was Newton himself who laid the ground for a completely mechanical model of the universe, one that God may have set in motion but that no longer required him to keep running. Scientists who succeeded Newton added to this mechanical model the belief in *universalism,* the principle that natural laws were the same everywhere and at all times, and *physical reductionism,* the idea that nature could be reduced to physical entities and their functions, each totally isolated from the rest, having no connections save the patterns imposed by the laws of nature (whose author was God). Everything could now be reduced to matter and its laws and properties.

In his *Principia* (1687), a treatise considered to be the foundation of classical physics, Newton set down his three famous laws of motion. They deal with the movement of objects in terms of inertia (the tendency for objects to remain either at rest or in motion until acted upon by an outside force), changes in velocity, and the effects of contact between two bodies (yielding equal and opposite reactions). The laws of motion led to Newton's theory of universal gravitation, and that put science on a roll for over two centuries. A whole series of scientific laws based on Newton's discoveries became known as classical physics. With these in hand one could build useful devices such as airplanes and guided missiles, or improve one's golf game.

Today, whether we have studied them or not, the laws of classical physics seem intuitive. Their best-known simplification is the analogy to billiard balls: ball A hits ball B at angle *x* and velocity *y,* causing ball B to move in direction *d* at velocity *z*—all very mechanical. In spite of the fact that physics has now gone far beyond this simplistic model, this style of cause-and-effect thinking still permeates the modern mind as a component of common sense. Even atoms are generally pictured as little balls in various arrangements resembling planetary systems. Whether it be atoms, the structure and functioning of machinery, the dynamics of weather systems, or the logic boards of computers, in the public's imagination "reality" is mechanical in nature. To understand reality, dissect it into its various parts and study how the parts interact in terms of cause and effect: billiard ball A hits ball B . . . —and the truth is revealed.

As one might expect, the many laws of classical physics, built upon the

foundation laid by Newton and his contemporaries, mesh nicely with the five principles of scientific materialism. Even though Newton and his early followers had never heard of "scientific materialism," they were guided by some of its tenets. They sought an objective view of an objective universe. They discovered laws, defined mathematically, that appeared to describe the essence of the material universe (metaphysical realism). Although Newton was in some degree a believer in the miracles of Christianity, later scientists gradually abandoned these beliefs, embracing the closure principle theorized by Descartes. The laws of classical science were assumed to be universal, and the universe could be reduced to physical entities and their interactions (universalism and physical reductionism).

The Wall Flower

But as science and religion twirled and curtsied in their dance for supremacy, someone else in attendance was not invited to dance. What about the human mind, the originator of scientific theories, the primary scientific instrument? Although created in the image of God, it wasn't part of the objective, physical universe. Why was an entity so prominent as the mind treated from the beginning like a wall flower, something that's obviously involved, yet excluded from the domain of scientific inquiry?

Here's why: the mind may have been capable of aspiring to understand God's kingdom, but many of its thoughts and emotions were impious. This was, after all, the mind of humans *after the fall of Adam.* The nature of human beings' mind or soul was that of original sin. And especially since Renaissance Europe had just emerged from two centuries of witch-hunting, the dark inner sanctum of the mind was highly suspect. It was this subjective aspect of human beings, especially their imagination, that harbored the evils inspired by the Devil. Such views are confirmed in the writings of popular Renaissance philosophers. Francis Bacon, an important philosopher of science, claimed that science was sanctioned by scripture as the means through which humans could reclaim their dominance over nature, lost through the fall of Adam. So as long as the mind was "scientific," facing outward, exploring

the objective universe created by God, all was in harmony with Christian beliefs. But the inner, slithery, subjective realm of the mind was neither part of nature nor to be trusted or ultimately believed in. As far as science was concerned, the mind got no respect. As we shall see later on, this is in stark contrast to views developed in Asia, where the mind has often been the principal topic of interest.

The European tendency to mistrust the subjective, imaginary, mental realm only increased with the Protestant Reformation at the beginning of the sixteenth century. The new religious reformers condemned the priestly magic of the Catholic Church—the sacraments and saintly miracles—and warned of the dangers of diabolical influences on the mind. Moreover the Protestant ethic, aimed at humans improving their lot in the world through hard work, mistrusted magic, not only because it was an inner phenomenon but also because it was a kind of easy way, a shortcut to achieving one's ends. If a magic spell could bring one wealth, why work? It is not surprising, then, that three centuries would have to pass before an experimental science of the mind, psychology, would emerge in the West.

This sword of mistrust cut both ways. The gradual decline in the belief in magic was accompanied by a questioning of God's role as a miracle-worker. It was a painful dilemma: If God could intervene at will by magically producing miracles, a universe of consistent natural laws based on the closure principle, universalism, and physical reductionism was illogical. On the other hand, if this mechanical model of the universe didn't need God, it was heresy.

Even so, science was soon to squeeze everything nonmaterial out of the universe —spirits and demons, the human mind, and God himself. Before long, the astronomer Pierre Laplace (1749–1827), when asked about God's role in the world of nature would say, "I have no need for that hypothesis."

The Triumph of Materialism

By the beginning of the nineteenth century, with the road now relatively clear of philosophical and religious obstructions, classical physics provided the basis for a string of important discoveries that inspired

scientists to believe they could account for the entire universe using sophisticated mathematics.

In the physical sciences Joule, Mayer, and Helmholtz devised the principle of the conservation of energy. This evolved into the first of the three laws of thermodynamics, revealing the relationships between heat and energy and giving them mathematical formulations. The work of Augustin Jean-Fresnel led to the wave theory of light. Lord Kelvin and James Clerk Maxwell gave magnetism and electricity precise mathematical formulations. It was theorized that magnetism, light, and electricity propagated by means of electromagnetic waves. Radio waves were detected. Dmitry Mendeleyev devised the periodic table of elements based on the assumption of subatomic structures underlying chemical qualities. And the earth's geological past was probed in the rock studies of Charles Lyell.

Classical principles regarding the physical properties of matter and the mechanisms of their interactions, derived from Newton's seminal work, were also applied to the life sciences. In 1838 cell theory was formulated, revealing a basic structure of life at the microscopic level. This opened the way to the study of cell structure, where chemical principles were seen to govern the activities of cells and therefore all living matter. Taking this reductionist view a step farther, Jacques Loeb claimed that the instincts of lower animals are mere physiochemical reactions. At the macroscopic level Charles Darwin (1809–92) proposed a purely mechanical explanation, natural selection, for the evolution of animal and plant species. Here nature, operating by random mutations, mindlessly selects for survival those traits that adapt a species most successfully to unpredictably changing physical and biological environments. Mendel's theory of inheritance introduced the gene to science, which paved the way for the twentieth-century integration of natural selection and genetics.

These and many other scientific discoveries of the nineteenth century led to practical knowledge and inventions that rapidly transformed human life. Understanding the role of bacteria in disease ushered in dramatic advances in medicine. Pasteurization and the canning of foods soon followed. Chemistry opened the way for the internal combustion engine to power automobiles and eventually airplanes. Plastics, artificial

fibers, and chemical fertilizers were developed. Steam trains and steam-powered, metal-hulled ships came on line, helped along by advances in metallurgy. Military technology expanded with the invention of the bullet cartridge, the revolver, the repeating rifle, the machine gun, and a wide range of new explosives. The exploration of electricity resulted in artificial lighting, the telegraph and telephone, electric generators and transformers, hydroelectric power, the battery, modern factories, and the recording of sound and motion pictures. It was as if some new god wearing a white coat had declared, "Let there be light!" and then thrown the switch.

The Divorce

It was inevitable that the rise of science would have dramatic political and religious consequences. At this juncture, the mid-nineteenth century, a number of scientists emerged from their laboratories to crusade for political and religious changes that they felt were demanded by scientific knowledge. They became public speakers, writers, popular educators—salespeople for the science descended from Newton.

One of the most popular spokesmen for scientific materialism in the nineteenth century was the German physician and philosopher Ludwig Büchner. His book *Force and Matter* (1855) reduced the mind and consciousness to physical brain states produced by active matter. Büchner rejected religion, God, Creation, and free will, and in a later work denied there was any difference between mind and matter at all. In the same vein the Dutch physiologist and philosopher Jacob Moleschott expounded a theory that thoughts and emotions had a physiological basis. He became famous for the statement "No phosphorus, no thought."

The program of scientific materialism scored its greatest triumphs in England, largely due to the X Club. This informal group of nine men included the distinguished biologist T. H. Huxley, the philosopher Herbert Spencer, the physicist John Tyndale, and the botanist Joseph Dalton Hooker, all preeminent in their fields. Huxley in particular was a man of enormous talent and energy and a strong popularizer and defender of Darwin and the theory of evolution. In his scientific research he sought to explain physiochemical laws as the basis of living processes. In public

he was a brilliant and pugnacious speaker who promoted science in public education and worked for the creation of a scientific elite. He trained schoolmasters in science, authored introductory science textbooks, held important posts in government, and was one of the founders of the journal *Nature*. Huxley claimed that science could achieve "domination over the whole realm of the intellect," and even spoke of the creation of a "church scientific."[4]

The philosophical bases for the group were provided by Herbert Spencer, another high-profile figure in Victorian England, who reduced social philosophy to scientific concepts. It was Spencer who coined the phrase "the survival of the fittest," associated since that time with Darwin's theory of evolution. These scientists-turned-promoters believed in a natural order to the universe determined by cause and effect, one that might prove unknowable, but one that was to be investigated by science, not religion. For the development of the intellect they thought that a scientific education was superior to the previous classical training (of classical literature, Latin, Greek, rhetoric, history, and moral philosophy). Members of the X Club held prominent positions enabling them to lobby successfully for official support of science and the teaching of science in all levels of education. Most importantly it was they who interpreted science to the public—a public that was becoming increasingly industrialized and secularized.

What did that interpretation boil down to? The five principles examined previously: objectivism, metaphysical realism, the closure principle, universalism, and physical reductionism. Yet the package sold to an unwitting public was labeled simply "science." Because scientific materialism had developed gradually and naturally from the interplay of theology and science, it is unlikely that these salespeople were even aware of the principles that guided their beliefs. By the nineteenth century these beliefs had become the scientific "gospel." Though unspoken, they were taken for granted as patently obvious. And although the roots of many of these beliefs could be traced to the Bible, their original cause had been forgotten, replaced, banished. God was now at most a ghost passively observing the machine that he had supposedly engineered with his "intelligent design." The object of scientific enquiry, originally the heavens created by God, had been replaced by "objective reality." God's

sacred language, mathematics, had become a subset of the scientific method. The resulting universe could be likened to an immense clockwork, operating automatically—without morals or miracles—driven solely by the laws of nature. Humans and their thoughts and emotions were ruled by that machine. Scientists now saw themselves and the rest of humanity as organic robots.

The foundation of this mechanical philosophy was built with the stones and mortar of scientific materialism. Its tenets formed a grand metatheory, hidden behind the scenes, from which scientific laws were reasoned. These beliefs shaped the mentality from which science was interpreted. The images and explanations they conveyed to scientists and to the general public now seemed natural, intuitive, and rational. The mind's eye traveled the axes of Cartesian planes, plotted the proper angle for parallel parking, calculated the location, velocity, and spin of a tennis ball—whap! If *x* caused *y* and *y* caused *z, x* must be the cause of *z*! How could it be otherwise? The roots of modern-day secularism had been planted in the fertile soil of rapidly expanding scientific knowledge.

Scientific *What*?

Why is the distinction between science and this philosophy so little known today and what is its significance? *Scientific materialism* is an academic term for a science-based dogma, developed in Europe in the mid-nineteenth century primarily by German materialist philosophers (including Karl Marx) and their English counterparts—T. H. Huxley, the X Club, and others. These men certainly didn't all call themselves scientific materialists. Many of them were in fact eminent scientists. As we have seen, these science promoters firmly believed that religion was bankrupt as a useful guide to truth and that physical science held the answers to all important questions. So strong was their enthusiasm for an all-embracing scientific worldview that they often allowed their hopes, dreams, and beliefs to masquerade as facts.

They were especially impressed by Darwin's theory of natural selection. According to their own interpretation, natural selection meant that organisms best suited to win the competition for scarce resources survived, passing on their advantageous traits to succeeding generations—

Spencer's "survival of the fittest." This was a biological counterpart to the impersonal, clockwork universe of classical physics. For them, the no-nonsense, hard-nosed fact of this struggle for survival was the pattern behind every facet of life. Social philosophers influenced by scientific materialism created social Darwinism, the view that nations and individuals competed for economic supremacy in an arena where only the "favored races" or toughest individuals would succeed. There was no room here for any softness or idealism and, of course, such a philosophy gave at least tacit approval to war, imperialism, and racism. In like manner, Karl Marx reduced all aspects of culture to economics.

All of this was tied to "science." Marx called his philosophy "scientific socialism." By studying history "scientifically" Marx skimmed away utopian and romantic notions such as culture and consciousness, leaving the bare bones of economic struggle—capital versus labor. Similarly, by appropriating the name "Darwin" in its title, social Darwinism linked itself to the prestige of a leading scientist. It conveniently ignored the fact that Charles Darwin himself arrived at a softer version of evolutionary theory, one that factored in the changing natural environment and other elements and was thus not primarily concerned with a "competition" of the "fittest."

So nineteenth-century scientific materialists created a philosophy based on a set of beliefs that was not arrived at scientifically, or to put it differently, was supported by modes of inquiry that focused exclusively on material phenomena. They speculated beyond the scientific evidence into the realm of metaphysics, normally the sphere of religion and philosophy. Just as the public was unaware that there was more to this new philosophy than pure science, its promoters were themselves probably ignorant of the theological origins of the underlying tenets of scientific materialism—objectivism, metaphysical realism, the closure principle, universalism and physical reductionism. As we saw earlier, these elements had slipped into science surreptitiously beginning in the Renaissance.

According to these nineteenth-century crusaders, the message of science for human society was essentially this:

> Existence is purely physical—there is no other reality. The sources of this reality are the laws of nature, forces that are

> entirely impersonal, having no connection whatsoever with the mind of human beings, their beliefs, or values. These laws operate in isolation from any supernatural, spiritual influences, all of which are illusory. Life in the universe is an accident, the outcome of mechanical interactions among complex patterns of matter and energy. The life of an individual, one's personal history, hopes and dreams, loves and hates, feelings, desires—everything—are the outcome of physical forces acting upon and within one's body. Death means the utter destruction of the individual and his or her consciousness, and this too is the destiny of all life in the universe—eventually it will disappear without a trace. In short, human beings live encapsulated within a vast, alien world, a universe entirely indifferent to their longings, unaware of their triumphs, mute to their suffering. Only by facing this reality and accepting it fully can humans live rationally.

Most people today, asked if this sounds familiar and where does it come from, would answer, "This is what science tells us about life and the universe." This is the philosophy of modernity, where, stated succinctly by the existential philosopher Jean-Paul Sartre, "everything is born without reason, prolongs itself out of weakness, and dies by chance." We have been exposed to this philosophy throughout our lives—in the classroom, in the media, by our doctors, and through the decisions of government agencies ruling on health, the environment, and elsewhere. It has been pounded into us consistently for so long that we've come to accept it as common sense. This, we are told, is what "non-believers" accept as the truth.

According to its proponents, this view alone is an authentic picture of the universe. Anything that deviates from it is (ironically) "metaphysical," idle speculation, or sheer fantasy. Perhaps one of the reasons for the strong polarity existing today between religion and secularism is the widespread influence of this view. In this modern "scientific" world, we are given a narrow choice: accept either scientific materialism or religious faith (which, according to scientific materialists, means turning your back on reality). For the strongly religious, this "message of science"

is so radically opposed to their beliefs and traditions that it evokes anger, the entrenchment of religious fundamentalism, culture war, or jihad.

Wedded to classical science, scientific materialism shared in its enormous success, prestige, and influence, particularly in the nineteenth century. By the year 1900 most physicists believed that a complete understanding of the universe was only a few decades away. In the words of a supremely confident Lord Kelvin, "There is nothing new to be discovered in physics now . . ." All the great discoveries had already been made, leaving future generations of scientists with nothing more to do than to carry out calculations to the next decimal point of accuracy.

However, classical physics was about to take a fall. The heady optimism of the late nineteenth century had cost science a more open-minded, philosophical approach that had nurtured it in previous centuries (a facet we will examine later on). Overconfident and holding tightly to a dogmatic viewpoint, science was soon tripped up by a tiny detail—the atom.