

RELIGION AND SCIENCE: A BEAUTIFUL FRIENDSHIP?

Robert W. Fuller

Live your life as if there are no miracles and everything is a miracle.
– *Albert Einstein*

Awe is an intuition of the dignity of all things, a realization that things not only are what they are but also stand, however remotely, for something supreme.
– *Abraham Heschel*

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Personal web site: <http://www.robertworksfuller.com>

Dignity Movement web site: <http://www.breakingranks.net>

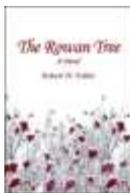
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For readers who want to explore dignity as a foundation for interpersonal and international relations, Robert W. Fuller's novel *The Rowan Tree* is now available as an [ebook](#), a [paperback](#), and an [audiobook](#).



As Arthurian myth sowed seeds of democracy, The Rowan Tree foretells an international culture of dignity. Anchored by two interlocking love stories, this unflinching novel of ideas brims with passionate quests, revelatory failures, and inextinguishable hope.

The Rowan Tree is an inspirational tour de force that reaches from the rebellious American '60s into humanity's global future. Soul-searching treks around the world intersect with campus revolution, basketball, math, ballet, and a destined rise to the White House. Love runs ahead of politics and lights the way for nations to follow.

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*To my mother, Willmine Works Fuller, who made me go to Sunday School, and
my father, Calvin Souther Fuller, who modeled the scientific method, and
to my mentor, John Archibald Wheeler, who accorded dignity to all.*

Religion and Science: A Beautiful Friendship?

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Preface: Reason to Hope

[The 21st] century will be defined by a debate that will run through the remainder of its decades: religion versus science. Religion will lose.

– *John McLaughlin*, TV talk show host (1)

Former priest John McLaughlin is hardly alone in his pessimism about religion's future. A spate of bestsellers—*The God Delusion*; *The End of Faith*; and *God Is Not Great: How Religion Poisons Everything* (2)—argues that religion, as we've known it, no longer serves the needs of people with a modern education and a global awareness.

Books like these have spelled out religion's shortcomings and I see no point in piling on. Rather, I will make the case that, in the long view, both religion and science come off as godsend (forgive the pun). And that, looking ahead, both are indispensable to letting go of old predatory practices and creating a fair, just, and peaceful world. If religion can see its way clear to making a mid-course correction and science can get off its high horse, John McLaughlin's prediction could be proven spectacularly wrong.

Many of the voices now being raised against religion are over-confident and patronizing, rather like those of trial lawyers who feel the jury is in their pocket. Perhaps that's because they are increasingly preaching to a public alarmed by clerical abuses and fundamentalist zealotry. Contemporary religious leaders, painfully aware of the relationship between public participation and institutional viability, know that religion is in a fight for its life.

I realize that this terrain is full of landmines. In the hope of defusing a few, let me acknowledge at the outset that the word religion means different things to different people. To some, it's knowledge and wisdom; to others, superstition and dogma. To some, it's worship; to others, wonder. To some, religion is salvation; to others, it's seeking. To some, religion is of divine origin; to others, it's manmade.

In this book, I'll use "religion" to refer loosely to the metaphysical, moral, and transformational precepts of the founders, prophets, saints, and sages of the major religions. The focus here is neither the theological doctrines associated with particular faiths nor the liturgical practices characteristic of various sects. Rather, the goal is to present a unifying perspective on the *findings* of religious and scientific inquiry.

Then, since the divergence between science and religion no longer serves either, I'll address the obstacles that have kept them from developing a "beautiful friendship" and describe the pay-off we may expect once they're both on the same side.

Science gives us reason to think we can vanquish famine, disease, and poverty. Religion heralds "peace on Earth, goodwill toward men." Neither of these venerable institutions can deliver on its promise without help from the other, but together there is reason to hope that they can.

The book concludes with a model of morality that emerges, unexpectedly, as a peace dividend. As partners, science and religion can make the golden rule largely self-enforcing, and hasten our arrival into a world wherein everyone's dignity is secure.

I know this sounds utopian, but wait and see. Developments in both science and religion have made a partnership possible. Ending centuries of fruitless squabbling and initiating a beautiful friendship is no longer an impossible dream.

I begin with what hooked me on these issues in the first place: the incompatible notions of truth advocated by my two schools: Sunday School and Public School.

Chapter 1: My Two Schools

My parents were not church-goers, but they thought their children should be exposed to the religious perspective. So, until we graduated from eighth grade, they made my brothers and me attend a Presbyterian Sunday School.

When I asked my Sunday School teacher how Jesus could turn a few fish and a little bread into enough food to feed a crowd, she explained it as a miracle. She gave the same answer about walking on water, raising Lazarus, and coming back from the dead. When I pressed her on the biblical account of creation—"He did all that in six days?"—she reread Genesis to the class.

My other school, a public school in Chatham, New Jersey, was located in the shadow of Bell Laboratories, where my father worked. Bell Labs was then one of the top scientific research labs in the world.

In third grade we studied the solar system. Our textbook had a diagram of Copernicus's heliocentric model showing the planets revolving around the sun in circles. A table gave the distance of each planet from the sun in miles and its period of revolution in days: 365 for the earth, 225 for Venus, just 88 for Mercury, and so on, all the way out to Pluto. Printed alongside each planet's orbit was its average speed in miles per hour as it circled the sun.

It was just then that we were studying circles in arithmetic. The lesson for the week was that the circumference of a circle $C = 2\pi R$, where R is the circle's radius and π is a universal constant approximately equal to 3.14. A closeted nerd in the days before we had our own identity group, I decided to verify the speed shown for the orbiting earth using this formula. The computation was simple enough—just form the product $2\pi R$ and divide by the time—one year—that it took the Earth to complete one revolution.

But something was wrong. My result did not agree with the Earth's speed in the book. It was not even close. So I tried the same calculation for Venus and Mercury. No agreement with those either. I did the other six planets. Not one of my calculations agreed with the numbers in the book. Frustrated, I asked my father for help. He checked my figures, examined the textbook, and announced the unthinkable: *the book was wrong*. I had thought books couldn't be wrong. We all had.

The next day I showed the error to my teacher, Mrs. Bahoosian. It made her nervous. She drew me aside and spoke in a hushed voice. I think she worried that if word got out it might cast doubt on the entire

educational enterprise among my peers. But she mollified me by promising to write the publishing company.

Months later she reported that the publisher was going to change the numbers in the next edition. She never told the class. I remember checking a year later and sure enough the mistakes had been corrected.

Catching that mistake broke the spell of the printed word, and a new notion of truth took hold of me: the truth is not necessarily what some authority says it is, but rather what can be proven.

But, if so, where did that leave the truths taught in my Sunday School? Some of what was taught there contradicted our science lessons. It seemed my two schools stood for two incompatible worlds: science and religion.

People hadn't always had to face this dilemma. For millennia, science and religion were not regarded as distinct. Religion offered explanations of life and the cosmos, and for a long time there was scant evidence to contradict them.

However, bit by bit, evidence contradicting the religious explanations was gathered and, by the seventeenth century, battle lines were forming. A more evidence-based way of pursuing truth was taking shape within the religious consensus, and sometimes the findings of those who insisted on seeing for themselves threatened the doctrine espoused by church leaders.

Science cited facts, made predictions, and tolerated dissent. In contrast, religion invoked scripture, urged faith, and required conformity. Science said, "Doubt me." Religion said, "Trust me."

As a child, I couldn't make peace between my Sunday school and my grade school, so I took the easy way out. I dismissed religion as unfounded and resolved to ignore it. With hardly a backward glance, I set my sights on a career in math and physics where I was encouraged to question authority.

But I did not go away empty-handed. I took with me a pair of questions that, in time, would shape my life's work.

Peace on Earth, Goodwill toward Men

It is not instruction but provocation that I can receive from another.
– *Ralph Waldo Emerson*

In Sunday School, I had noticed, everyone had noticed, that the commandments, precepts, and rules taught there were often disregarded, not only by the scoundrels and criminals we read about in the news, but by some of the very people whose job it was to teach us these morals.

Upon detecting hypocrisy in the messenger, my impulse had been to throw out the message. But I couldn't quite shake the golden rule. Its symmetry gave expression to an intuition that ran deep: that I shouldn't expect to be well-treated by those whom I treated poorly; that I should afford others the dignity I sought for myself.

My take-away questions from Sunday School were:

1. Why are moral precepts—even those that everyone accepts—widely ignored?
2. Why has "peace on Earth, goodwill toward Men" not been realized?

I wondered about this gap between the ideal and the reality as World War II raged, as the Holocaust was revealed, and as Japan surrendered to American atom bombs. It seemed to me then, as it does now, that

religion's most serious short-coming was not that it harbored "deniers" of well-established science models, but that it had not found a way to realize its own aspirational goals.

For example, the golden rule was suspended when it came to so-called "Negroes" (they were not allowed to own homes in my town), the mentally handicapped (a boy with Down Syndrome hung around my school's perimeter, but was barred from school property), homosexuals (a boy we thought "queer" was humiliated), and poor, overweight, unstylish, or "dumb" kids were often subjected to ridicule.

At college, when I argued that life might someday be created in a test tube, I was mocked as a "heathen" and dismissed as a "mechanist." When I responded with insults of my own, the result was a shouting match.

Later, I wondered if "getting even" gave me a pass when it came to obeying the golden rule. After all, *they* had hurled the first insult. But, then hadn't I upped the ante? The logician in me noticed that the golden rule, like the best rules in physics, allows for no exceptions. It didn't say anything about who went first. Did that mean that retaliating in kind—an eye for an eye, a tooth for a tooth—was wrong?

Finding an answer to this question took decades, and I'll return to it after addressing an even more fundamental, methodological question, a question that no discussion of religion and science can ignore.

[Are There Really Two Kinds of Knowledge?](#)

In the mid-1960s, stirred by the passions of the civil rights movement, I left physics to play a part in the reform of higher education then sweeping the country. Overnight, my life took an activist turn toward issues of equity and justice. Though exposure to the golden rule had predisposed me to sympathize with those demanding equal rights, I did not trace my political ideals to religion.

I'd spent most of my time since Sunday School in pursuit of scientific truth, where evidence rules. During that time, my skepticism toward the faith-based claims of religion had grown stronger. But in my political work, I couldn't help but notice that the reformers I worked with often invoked religious teachings to good effect in support of the goals we shared.

By the mid-seventies, the transformational energy of the sixties was spent and, seeing no chance for further reforms, at age thirty-seven, I left academia. The bitter academic politics of that period had left me bruised and burnt out. In search of a less contentious way to bring change, I wondered if the world's holy books contained anything that might have helped me be a better leader. In particular, Eastern religions, like Buddhism and Vedanta, were drawing attention from Western seekers, and the word was that they offered a more tranquil, enlightened path to personal and social change.

Before I could take in anything positive from religion, Eastern or Western, I had to deal with the negative. Yes, some churches had provided a home for leaders of the civil rights movement, but it seemed to me that if institutional religion practiced what it preached, it could have done a lot more to oppose racism and done it sooner. What more obvious violation of the golden rule could there be than segregation?

My old questions about religion's ineffectiveness were joined by new ones concerning its exceptionalism. What if religion defended its teachings in the same way science does—by marshaling evidence, making predictions, and testing them against outcomes? What if religion applied its teachings to its own practices? What if seemingly utopian prophecies like "peace on Earth, goodwill toward men" (3) were regarded not as naïve pieties but rather as testable *predictions* of a state of social equilibrium toward which humankind was groping?

It seemed to me that, with a few changes, religion could stand up to the criticisms of non-believers, regain the respect of its critics, and be the transformational force its founders and prophets had envisioned. In this re-visioning, the parts of religion that are counterfactual or unproven could either be

dropped—as science jettisons theories that don't withstand scrutiny—or retained as speculation, metaphor, or personal preference. After all, anyone is free to believe anything, and most of us, including scientists, discreetly exercise that right in one area or another.

Fast forward thirty years. The twenty-first century has brought an avalanche of evidence, and official admissions, of religion's moral lapses. Extreme ideologues and fanatical true believers continue to tarnish the religious brand. When religion aligns itself with discredited science, its losing streak is unbroken, and in countries where educational levels are on the rise, religion is in decline. This wouldn't matter if religion had succeeded in imparting its most important teachings, but the golden rule is still widely flouted, and "peace on Earth, goodwill toward men" remains a distant dream.

Sometimes, when you can't get from A to B, it's for lack of a steppingstone. In that spirit, it seemed possible to me that for religion to realize its vision of peace on Earth, it may first need to make peace with science. The goal of this book is to show that religion and science can indeed co-occupy that steppingstone of peace, and from it, deliver on their complementary promises.

Although grievances leap to mind when we consider making peace with an old foe, ultimate success depends on identifying not where each side is wrong, but where each is right. Nowhere was this more evident than in ending the Cold War. One of the unacknowledged solvents of Soviet-American enmity was mutual acknowledgement by thousands of citizen diplomats of what each party to the conflict had got right. For example, that it was the Red Army that played the lead role in defeating the Germans in World War II; and that the USSR provided universal healthcare and access to affordable higher education to its citizens. Seeing some good in others doesn't mean blinding ourselves to what's wrong, and harping on the latter is no way to make peace with a foe.

Current attacks on religion are ignoring the fact that it got some very big things right. However, religion must take responsibility for much of the criticism directed its way because its spokesmen have repeatedly failed to distinguish between its great discoveries and its mistakes. Not only have some religious leaders ignored compelling evidence, but they, like the leaders of secular institutions, have all too often failed to live up to the standards of behavior they espouse. Nothing undermines authority like hypocrisy.

Paradoxically, science makes even more mistakes than religion; but it saves itself by being quicker to recognize and correct them. Niels Bohr, the father of atomic physics, ascribed his breakthroughs to "making my mistakes faster than others."

The difference between science and religion is not that one has "babies" in its bath water and the other doesn't. The difference is that science drains its dirty bath water faster, leaving its gleaming babies for all to admire. As the American scientific statesman, James B. Conant, said:

The stumbling way in which even the ablest scientists in every generation have had to fight through thickets of erroneous observations, misleading generalizations, inadequate formulations, and unconscious prejudice is rarely appreciated by those who obtain their scientific knowledge from textbooks.

In what follows, I'll try to give both religion and science their due without soft-peddling their differences. Signing onto a new deal will require adjustments from both of these venerable antagonists.

The principal tool needed to end the historical enmity between science and religion, though nothing new, goes by a name that may be unfamiliar. It's called model building—"modeling," for short.

In ordinary language, models are representations of an object, a phenomenon, or a person or group that describe or prescribe the behavior of what's represented. Some models take the form of stories, rules, or codes that show us how to behave. Hence the phrase "*model* behavior." Other models take the form of

explanations or theories that tell us how nature behaves, for example, Bohr's atomic *model*. These days one does not start a company without first creating a business *model*.

A model is a representation of an object, phenomenon, or person that resembles the real thing. By studying the model we can learn about what it mirrors.

When we ask if there are two distinct kinds of knowledge—scientific truths and religious truths—we're really asking if the same methodology can unlock the secrets in both realms. The tool of modeling, coupled with demystification of the discovery process, provides a conceptual framework broad and deep enough to hold both science and religion.

I begin with a look at some models from science, then examine some models from religion. Once we have identified what's of lasting value—that is, some of the time-tested teachings—in both traditions, the next step is to spell out their complementary roles in addressing the life-threatening challenges facing humankind.

Chapter 2: Science

We Make Models

Man is a creature who makes pictures of himself, and then comes to resemble the picture.
– *Iris Murdock*, as quoted by Simon Leys (4)

The title of Mark Twain's *What Is Man?* poses a question that humans have pondered for millennia. Our species modestly calls itself *Homo sapiens*—Man, the wise. We've also been dubbed Man, the builder; the tool maker; the game player; and the talker. Twain himself argued that man is a machine, *Homo machinus*.

While all these characterizations capture some aspect of humanness, none does so uniquely. On the contrary, it seems that every time someone makes a case that a particular trait sets humans apart, experts in animal life say, 'No, animals do that too.' Animals show intelligence and build nests, dams, and webs. They make tools, play games, and make war. They communicate and display emotion.

But no species other than ours holds the fate of the Earth in its hands. The question, then, is what is it about humans that has brought us such power?

There's one faculty that humans have developed more than other animals. It's our capacity to build ever more accurate and comprehensive models that explain the world and nature and thereby give us a measure of control over it. In this context, you can think of models as explanations and stories—explanations of how the world works; stories about how we ourselves behave.

I'm not saying that other animals don't employ models. Once again, the distinction doesn't appear to be absolute. We may never know when our hominid ancestors began inventing stories and telling fortunes, making maps and myths, keeping accounts and ledgers, depicting animals, explaining disasters, and speculating about death.

What's clear, though, is that these first steps to simulate aspects of the world and our place in it were taken at a time when there was no distinction between religion and science. Though we didn't think of it as modeling, building models was what we were doing. The crowning accomplishment of proto-religion and proto-science, which were then one, was the emergence of a model featuring us as individuals in the cosmos.

It's beside the point that these early models are now dismissed as "creation myths." What's important about them is not their validity but their existence. When humans began trying to explain the world, they embarked on a path that in time would give them a power advantage not only over other animals, but also over other human groups that handicapped themselves by clinging to inferior explanations.

Explanations, theories, maps, laws—models—are the path to power. Most of them are no good, but the few good ones rule. When models compete, better ones confer advantages on those who adopt them, and, over time, these first adopters gain an advantage over people saddled with models that harness and organize less power.

A Primer on Models

The sciences... make models. By a model is meant a ... construct which, with the addition of certain verbal interpretations, describes observed phenomena. The justification of such a construct is solely and precisely that it is expected to work.
– *John von Neumann*, creator of game theory and computer logic

Scientists use the terms "model," "theory," "explanation," and "law" almost interchangeably. The popular idea that a theory is more tentative than a model, or even a law, is quite wrong. These terms do not indicate relative degrees of certainty, but rather have their origins in history. For example, Newton's classical dynamics are referred to as "*laws* of motion" whereas the relativistic dynamics that Einstein discovered go by the name of the "*theory* of relativity." One might think the word law would indicate greater certainty, but in this case it's just the opposite. As of this writing, Einstein's "theory" has no known exceptions, and Newton's "laws" break down in the subatomic realm and for ordinary objects moving at high speeds.

Similarly, Darwin's "theory of evolution" is not so-named to suggest flaws in it. The theory of evolution has been thoroughly tested and to date has not been found wanting. Another very accurate, comprehensive scientific theory describes the elementary particles and their interactions. It goes by the unassuming name of "the standard model."

Building better models is humankind's defining activity. For better or worse, it's made us who we are. The aforesaid "standard model" describes three of Nature's four forces, and, by enabling us to predict their effects, allows us to tap sources of energy otherwise unavailable. The flip side of taming Nature's power is that we may use it in ways that damage the planet and harm each other.

We learn modeling early, starting with Legos, dolls, and model trains. The fables we grow up with can be understood as models that show us how to behave. People fancy themselves as characters in video games, sometimes deploying an avatar, and can try out different behaviors vicariously without risking their own lives.

Scientists Francis Crick and James Watson modeled the double-stranded helical structure of the DNA molecule with Tinker Toys. There is a model of the San Francisco Bay—complete with miniature piers poking into the water, a scaled-down Golden Gate Bridge, and "tidal currents" propelled by pumps—that fills a warehouse in Sausalito, California. By studying it, scientists can anticipate the effects of proposed real-world alterations of the Bay.

Weather bureaus, using computers and mathematical models, provide weather forecasts. As everyone knows, the predictions are not always right, but they're getting more accurate as the models are improved.

Experimenting with model planes in wind tunnels enabled the Wright brothers to build the aircraft they flew at Kitty Hawk. Even more significant than the plane they built was their pioneering use of modeling in engineering. Models enabled them to anticipate problems through trial and error without paying the

price of crashing a piloted plane. Today, flight can be simulated on computers by representing both the airplane and the atmosphere in a mathematical model.

Grand unifying models are the holy grail of every branch of science. In biology, Darwin's theory of evolution by natural selection is such a model. In chemistry, it's Mendeleev's periodic table of the elements. In geology, the theory of plate tectonics accounts for the earth's principal geological features. Physicists are searching for a "theory of everything" (often abbreviated TOE) that, as Leon Lederman, a Nobel laureate in physics (5), picturesquely puts it, would "explain the entire universe in a single, simple formula that you can wear on your T-shirt." One of these models is called string theory (6). Like all theories and models, string theory will ultimately live or die depending on whether its implications agree with observations.

Though much of science consists of building models, the use of models is hardly limited to science. Indeed, normative, prescriptive social models predate by millennia the descriptive and predictive nature models mentioned above. Beginning in the distant past, cultural codes of conduct—for example, the Ten Commandments—were used to regulate family and tribal relationships. Other examples of socio-political models include the theologies of religious institutions, organizational charts of universities, by-laws of corporations, and national constitutions.

Entrepreneurs and the venture capitalists who invest in their companies are guided by hypothetical plans—that is, models—that delineate scenarios based on various economic assumptions to chart a path to profitability. The governance models of nation-states range from the divine right of kings to fascism, communism, constitutional monarchies, and many sub-species of democracy. Sometimes users of social models actually lose sight of the difference between their models and reality. As Alan Greenspan, former Chairman of the Federal Reserve Bank, warns: "A surprising problem is that a number of economists are not able to distinguish between the models we construct and the real world" (7).

When we see parents, heroes, public figures, and fictional characters as "role models," we're using behavioral models to shape our own character.

In summation, models are descriptive or prescriptive representations of the world and ourselves. Their functions include providing us with an identity, shaping our behavior, maintaining social order, and guiding our use of power. Modeling has made humans what we are and our success as a species depends on learning to use them wisely.

Teen Epiphany: No Place to Stand

Know you what it is to be a child? ... it is to believe in belief....
– *Francis Thompson*, 19th c. British poet

We don't forget our first ah-ha experience any more than we forget our first kiss. The difference is we have some idea of what to expect from a kiss, but we don't know what to make of an enlightening incident. The experience lingers in memory as something special, but since we can't account for it, we're apt to keep it to ourselves.

Only in my thirties did I realize that an experience I'd had in my teens was the analogue of that first kiss. About six years after discovering that our third grade science book contained mistakes, it struck me that *anything* could be wrong. There were no infallible truths, no ultimate explanations.

In high school we were learning that science theories and models were not to be regarded as absolute truths, but rather taken to be useful descriptions that might someday be replaced with better ones. I accepted this way of holding scientific truth—it didn't seem to undercut its usefulness. But I still wanted

to believe there were absolute, moral truths, not mere assumptions, but unimpeachable, eternal verities. My mother certainly acted as if there were.

But one day, alone in my bedroom, I had the premonition that what was true of science applied to beliefs of every sort. I realized that, as in science, political, moral, or personal convictions could be questioned and might need amending or qualifying in certain circumstances. The feeling reminded me of consulting a dictionary and realizing that there are no final definitions, only cross references. I remember exactly where I was standing, and how it felt, when I discovered there was no place to stand, nothing to hold on to. I felt sobered, yet at the same time, strangely liberated. After all, if there were no absolutes, then there might be an escape from what often seemed to me to be a confining social conformity.

With this revelation, my hopes for definitive, immutable solutions to life's problems dimmed. I shared my experience of unbelief with no one at the time, knowing that I couldn't explain myself and fearing others' mockery. I decided that to function in society I would have to pretend to go along with the prevailing consensus—at least until I could come up with something better. For decades afterwards, without understanding why, I was drawn to people and ideas that expanded my premonition of a worldview grounded not on immutable beliefs, but rather on a process of continually improving our best working assumptions.

Science Models Evolve

It's the essence of models that they're works in progress. While nothing could be more obvious—after all, models are all just figments of our fallible imaginations—the idea that models can change, and should be expected to yield their place of privilege to better ones, has been surprisingly hard to impart.

Until relatively recently we seem to have preferred to stick to what we know—or think we know—no matter the consequences. Rather than judge for ourselves, we've been ready to defer to existing authority and subscribe to received "wisdom." Perhaps this is because of a premium put on not "upsetting the apple cart" during a period in human history when an upright apple cart was of more importance to group cohesiveness and survival than the fact that the cart was full of rotten apples.

Ironically, our principal heroes, saints and geniuses alike, have typically spilled a lot of apples. Very often they are people who have championed a truth that contradicts the official line.

A turning point in the history of human understanding came in the seventeenth century when one such figure, the English physician William Harvey, discovered that the blood circulates through the body. His plea—"I appeal to your own eyes as my witness and judge"—was revolutionary at a time when physicians looked not to their own experience but rather accepted on faith the Greek view that blood was made in the liver and consumed as fuel by the body. The idea that dogma be subordinated to the actual experience of the individual seemed audacious at the time.

Another milestone was the shift from the geocentric or Ptolemaic model (named after the first-century Egyptian astronomer Ptolemy) to the heliocentric model or Copernican model (after the sixteenth-century Polish astronomer Copernicus, who is regarded by many as the father of modern science).

Until five centuries ago, it was an article of faith that the sun, the stars, and the planets revolved around the earth, which lay motionless at the center of the universe. When the Italian scientist Galileo embraced the Copernican model, which held that the earth and other planets revolve around the sun, he was contradicting the teaching of the Church. This was considered sacrilegious and, under threat of torture, he was forced to recant. He spent the rest of his life under house arrest, making further astronomical discoveries and writing books for posterity. In 1992, Pope John Paul II acknowledged that the Roman Catholic Church had erred in condemning Galileo for asserting that the Earth revolves around the Sun.

The Galileo affair was really an argument about whether models should be allowed to change without the Church's consent. Those in positions of authority often deem acceptance of their beliefs, and with that the acceptance of their role as arbiters of beliefs, to be more important than the potential benefits of moving on to a better model (8).

Typically, new models do not render old ones useless, they simply circumscribe their domains of validity, unveiling and accounting for altogether new phenomena that lie beyond the scope of the old models. Thus, relativity and quantum theory do not render Newton's laws of motion obsolete. NASA has no need for the refinements of quantum or relativistic mechanics in calculating the flight paths of space vehicles. The accuracy afforded by Newton's laws suffices for its purposes.

Some think that truths that aren't absolute and immutable disqualify themselves as truths. But just because models change doesn't mean that anything goes. At any given time, what "goes" is precisely the most accurate model we've got. One simply has to be alert to the fact that our current model may be superseded by an even better one tomorrow (9). It's precisely this built-in skepticism that gives science its power.

Most scientists are excited when they find a persistent discrepancy between their latest model and empirical data. They know that such deviations signal the existence of hitherto unknown realms in which new phenomena may be discovered. The presumption that nature models are infallible has been replaced with the humbling expectation that their common destiny is to be replaced by more comprehensive and accurate ones (10).

Toward the end of the nineteenth century, many physicists believed they'd learned all there was to know about the workings of the universe. The consensus was that between Newton's dynamics and Maxwell's electromagnetism we had everything covered. Prominent scientists solemnly announced the end of physics.

There is nothing new to be discovered in physics now. All that remains is more and more precise measurement.
– *Lord Kelvin* (1900)

Then a few tiny discrepancies between theory and experiment were noted and as scientists explored them, they came upon the previously hidden realm of atomic and relativistic physics, and with it technologies that have put their stamp on the twentieth century.

Albert Einstein believed that the final resting place of every theory is as a special case of a broader one. Indeed, he spent the last decades of his life searching for a unified theory that would have transcended the discoveries he made as a young man. The quest for such a grand unifying theory goes on.

Chapter 3: Religion

The most incomprehensible thing about the universe is that it is comprehensible.
– *Albert Einstein*

God

With the idea of god, early humans were imagining someone or something who knows, who understands, who can explain things well enough to build them. Now then, if God knows, then maybe, just maybe, we can learn to do what He does. That is, we too can build models of how things work and use them for our purposes.

The idea of modeling emerges naturally from the idea of god because with the positing of a god we've made understanding itself something we can plausibly aspire to: we need only imitate our father figure. There has probably never been an idea so consequential as that of the world's comprehensibility. Even today's scientists marvel at the fact that, if we try hard enough, the universe seems intelligible. Not a few scientists share Nobel-laureate E. P. Wigner's perplexity regarding the *unreasonable* effectiveness of mathematics in the natural sciences (11).

Comprehensibility does not necessarily mean that things accord with *common* sense. Quantum theory famously defies common sense, even to its creators. Richard Feynman is often quoted as saying, "If you think you understand quantum mechanics, you don't understand quantum mechanics." But a theory doesn't need to jibe with common sense to be useful. It suffices that it account for what we observe.

Our faith in the comprehensibility of the world around us mirrors our ancestors' faith in godlike beings to whom things were intelligible. Yes, it was perhaps a bit presumptuous of us to imagine ourselves stealing our gods' thunder, but *Homo sapiens* has never lacked for hubris.

Genesis says that after creating the universe, God created Man in his own image. The proverb "Like father, like son" then accounts for our emulating our creator, and growing up to be model builders like our father figure.

Just One God

In contrast to polytheism, where a plethora of gods may be at odds, monotheism carries with it the expectation that a single god, endowed with omniscience and omnipotence, is of one mind. To this day even non-believers, confounded by tough scientific problems, are apt to echo the biblical, "God works in mysterious ways" (12). But, miracle of miracles, not so mysterious as to prevent us from understanding the workings of the cosmos, or, as Stephen Hawking famously put it to "know the mind of God."

Monotheism is the theological counterpart of the scientist's belief in the ultimate reconcilability of apparently contradictory observations into one consistent framework. We cannot expect to know God's mind until, at the very least, we have eliminated inconsistencies in our observations and contradictions in our partial visions.

This means that the imprimatur of authority (e.g., the King or the Church or any number of pedigreed experts) is not enough to make a proposition true. Authorities who make pronouncements that overlook or suppress inconsistencies in the evidence do not, for long, retain their authority.

Monotheism is therefore not only a powerful constraint on the models we build, it is also a first step toward opening the quest for truth to outsiders and amateurs, who may see things differently than the establishment. Buried within the model of monotheism lies the democratic ideal of no favored status.

To the contemporary scientist this means that models must be free of both internal and external contradictions, and they must not depend on the vantage point of the observer. These are stringent conditions. Meeting them guides physicists as they seek to unify less comprehensive theories in a grand "theory of everything," or TOE. (A TOE is an especially powerful kind of model, and I'll say more about them later.)

There's another implication of monotheism that has often been overlooked in battles between religion and science. An omniscient, unique god, worthy of the designation, would insist that the truth is singular, and that it's His truth. In consequence, there cannot be two distinct, true, but contradictory bodies of knowledge. So, the idea of monotheism should stand as a refutation of claims that religious truths need not be consistent with the truths of science. Of course, some of our beliefs—be they from science or religion—will later be revealed as false. But that doesn't weaken monotheism's demand for consistency; it

just prolongs the search for a model until we find one that meets the stringent condition of taking into account of *all* the evidence (13).

It is said that it takes ten years to get good at anything. Well, it's taken humans more like ten thousand years to get good at building models. For most of human history, our models lacked explanatory power. Models of that kind are often dismissed as myths. It's more fruitful to think of myths as early models, stepping stones to better ones. We now understand some things far better than our ancestors and other things not much better at all. But the overall trend is that we keep coming up with better explanations and, as more and more of us turn our attention to model building, our models are improving faster and our ability to usurp Nature's power is growing. To what purpose?

We'll discuss a variety of responses to this question in the sequel. Religion famously heeds us to "separate the wheat from the chaff," and we'd be remiss if we did not apply this proverb to beliefs of every kind, including those of religion itself.

[An Eye for an Eye](#)

"An eye for an eye" comes down to us from King Hammurabi (18th century, BCE) who had it carved in stone at a time when there was no distinction between religion and science. It can be usefully understood not just as a formula for punishment, but rather as a simple descriptive model of how humans behave. When we're injured or abused, our immediate impulse is to do unto the perpetrator what's been done to us. We call it biblical justice. Often, victims of predation are not satisfied with merely getting even, but rather are inclined to "better the instruction," as Shylock points out in *The Merchant of Venice*. Escalation follows. Not to stand up to the perpetrator of a predatory act is to signal weakness and invite a follow-up that may bring death or enslavement.

It may be hard to tell who started a feud because the initial act of predation lies buried in a disputed past and escalation has since blurred the picture. A pattern of reciprocal indignities is what we see today in any number of ongoing conflicts around the world. At some point, it becomes more important to find a way to interrupt the cycle of revenge than to assign blame.

Attempts to stop cycles of predation by "turning the other cheek" can be suicidal unless they're part of a broad-based strategy of civil disobedience, and even then can result in great harm to protestors. Religious teachings, decoupled from political pressure, have seldom been enough to prevent predation or to arrest the cycles of vengeance that tend to ensue.

On the other hand, turning the other cheek, in the form of forgiveness—as institutionalized, for example, in "Truth and Reconciliation" commissions—is the only thing that can permanently end a cycle of revenge.

[The Golden Rule](#)

The golden rule embodies a symmetry reminiscent of those that turn up everywhere in physics models. A variant of the golden rule can be found in virtually every religion, ethical code, or moral philosophy (14).

Do not do to others what would cause pain if done to you.
– Hinduism

Treat not others in ways that you yourself would find hurtful.
– Buddhism

What you do not want done to yourself, do not do to others.
– Confucianism

What is hateful to you, do not do to your neighbor.
– Judaism

Do unto others as you would have them do unto you.
– Christianity

Not one of you truly believes until you wish for others what you wish for yourself.
– Islam

We should behave to our friends, as we would wish our friends to behave to us.
– Aristotle

Act only on that maxim through which you can at the same time will that it should become a universal law
– Immanuel Kant's Categorical Imperative

Neminem laedere (15)
– Legal codification of the golden rule, which translates as "general rule of care," or "hurt no one."

As in physics, a deviation from symmetry signals the existence of a force that breaks it. Among humans, asymmetries take the form of inequitable or preferential treatment of persons or groups and, as in the physical world, these deviations from the equal-handedness implicit in the golden rule reveal the existence of coercion. For example, slavery requires force or the threat of force.

If the most famous formula in physics is $E = mc^2$, then the golden rule, as a formula for reciprocal dignity, is perhaps its religious counterpart, a jewel in the crown of religious insight.

Dignity for All

If the idea of god, as signifying comprehensibility, were not enough to warrant a tip of the hat to religion, the god idea also contains the seeds of the egalitarian notion of universal dignity.

Notwithstanding the fact that religion has often impugned the dignity of adherents to other faiths, it has usually defended the dignity of its own followers. Theistic religions go further and proclaim the existence of a personal, caring god, a father figure who loves all who share the faith, according them equal dignity regardless of status, rank, or role.

The universal equality of dignity is among religion's most revolutionary ideas. It's not a description of life as we know it, but rather a prescription for life as it could be. Once formulated, the ideal of "dignity for all" exerts a pull that's felt in every human interaction. In the concluding chapter, I'll make the case that, despite appearances to the contrary, human behavior is slowly coming into alignment with that prophetic, aspirational, religious model (16).

The need for dignity runs so deep that when our fellow man seems determined to deny it to us, even non-believers may suspend their disbelief. Arthur Hugh Clough gives this insight a comical twist:

And almost every one when age,
Disease, or sorrows strike him,
Inclines to think there is a God,
Or something very like Him (17).

In the epigraph at the beginning of this book, Rabbi Abraham Heschel draws attention to dignity in an even larger sense. As we try to fathom our place in the cosmos, most of us, at one time or another, experience a sense of awe. Heschel interprets awe as an "intuition of the dignity of all things, a realization that things not only are what they are but also stand, however remotely, for something supreme."

The intuition of the dignity of all things is tantamount to recognizing that everything has an integral place in the whole, everything belongs and has an indispensable role. There is a perfection to things, not necessarily as they are at the moment, but rather at the next level up—as an inseparable part of the *process* of becoming. Everything is integral to the process, including our judgments and opinions, positive or negative, about what's happening. Heschel's observation recognizes this property of the universe and identifies awe as an appropriate response to the world's intricate integrity.

Again, it's now widely acknowledged that religion's record at upholding dignity is spotty. Religious leaders of every faith have at times sanctioned indignity toward others, persecuting them as infidels, heathens, and heretics.

Science makes as many mistakes as religion, probably more, but it rectifies them relatively quickly. As a result there are few who doubt its value. In contrast, the proposition that "The world would be better off without religion" has many takers (18).

Religious models such as monotheism, the golden rule, and universal dignity are pillars of human civilization. Like science models, their strength is due to the truth they embody, and not dependent upon the zeal of "true believers." A prerequisite to realizing religion's vision of "peace on Earth, goodwill toward men" is a new relationship to the idea of belief itself.

Chapter 4: Belief

The public...demands certainties... But there are no certainties.
– *H. L. Mencken*

True Believers

When we hear the word fundamentalist, images of fanatical proselytizers, religious extremists, and suicide bombers leap to mind. But I shall use the word more broadly to refer to any true believers and even to that part of ourselves that might be closed-minded about one thing or another. By generalizing in this way, we include those who reflexively dismiss anything contrary to their own views, whether religious, scientific, artistic, or ideological. Such closed-mindedness is the antithesis of the modeling perspective.

Though the popular stereotype is that all fundamentalists are intolerant zealots, there are people who call themselves fundamentalists who hold that their beliefs are for themselves only, and who make no effort to convert anyone else. It may be that the fixity of their beliefs handicaps them—by keeping them ignorant of advances in scientific, political, or religious thought—but they're hardly alone in that regard.

Fundamentalism of the imperious sort comes in a variety of disguises: moral righteousness, technological arrogance, intellectual condescension, and artistic snobbery, to name a few. Such domineering forms of fundamentalism tend to be magisterial, overbearing, strident, elitist, and supercilious.

In a world without absolutes, fundamentalists' claims to represent higher authority would not be given special credence. In such a setting, inerrancy is out, fallibility is in. Questioning the current consensus is not only permitted, it's encouraged. The one thing that tolerance does not extend to is aggressive

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