# THE HERASAGA

## BOOK ONE: HERA, OR EMPATHY

## BOOK TWO: THE PRIESTHOOD OF SCIENCE

## BOOK THREE: HERA THE BUDDHA

## NOTE TO THE READER:

This PDF file contains Chapter 3, "Modern Science and its Space-Time," in the book entitled *Hera The Buddha*; the entire volume is available as an E-book on Amazon, as follows:

https://www.amazon.ca/Hera-Buddha-Utopian-Fiction-Herasaga-ebook/dp/B074KP7Q1R/ref=sr_1_1?s=books&ie=UTF8&qid=1501945489&sr=1-1&keywords=hera+the+buddha

PRODUCT DETAILS:
AUTHOR: WILLIAM LEISS (www.leiss.ca)
LENGTH: PAGES XIX, 225
LANGUAGE: ENGLISH
ISBN 978-0-9738283-2-0



PLEASE USE THE FOLLOWING CITATION WHEN QUOTING FROM THIS MATERIAL:

William Leiss, "Modern Science and its Space-Time," Chapter 3 in *Hera The Buddha: A Work of Utopian Fiction* (Book 3 of *The Herasaga*), Kindle Digital Publishing, 2017.

*Figure 1 Yucca brevifolia in bloom, Joshua Tree National Park, California (Photo: W. Leiss)*

# HERA THE BUDDHA

A WORK OF UTOPIAN FICTION

WILLIAM LEISS

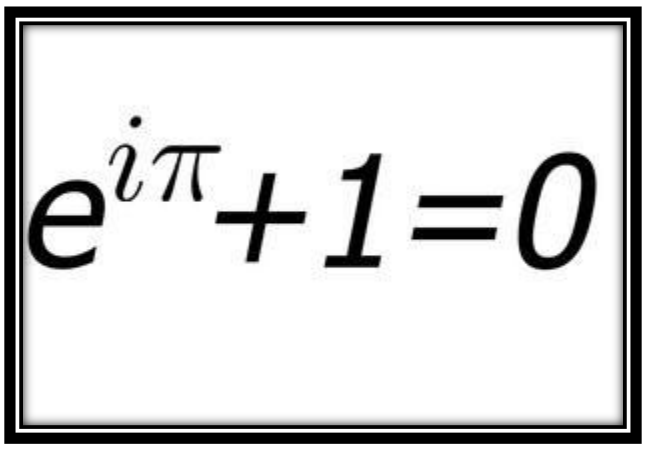


*Figure 2 Euler's Identity*

A CANGRANDE BOOK

A CANGRANDE BOOK
Ontario, Canada
william.leiss@gmail.com // www.leiss.ca

*This is a work of fiction. Names, characters, places, and incidents are products of the author's imagination or are used fictitiously. Any resemblance to actual persons, living or dead, is entirely coincidental.*

Library and Archives Canada Cataloguing in Publication
Leiss, William, 1939-
Hera the Buddha: A Work of Utopian Fiction/
William Leiss.
(The Herasaga ; bk. 3)
"A Cangrande Book".
ISBN 978-0-9738283-2-0

I. Title II. Series: Leiss, William, 1939- Herasaga ; bk. 3.

COVER ARTWORK: ALEX COLVILLE (CANADIAN 1920-2013),
*MOON AND COW* (1963), OIL AND SYNTHETIC RESIN ON HARDBOARD
PRIVATE COLLECTION, USA

COVER DESIGN BY HYDESMITH COMMUNICATIONS, WINNIPEG

*for HEIDEMARIE and THE DAUGHTER*

# EPIGRAPHS

What happens when machines become more intelligent than humans? One view is that this event will be followed by an explosion to ever-greater levels of intelligence, as each generation of machines creates more intelligent machines in turn. This intelligence explosion is now often known as the "singularity." …. If there is a singularity, it will be one of the most important events in the history of the planet. An intelligence explosion has enormous potential benefits: a cure for all known diseases, an end to poverty, extraordinary scientific advances, and much more. It also has enormous potential dangers: an end to the human race, an arms race of warring machines, the power to destroy the planet.

David Chalmers (2010)

As if somehow intelligence was the thing that mattered and not the quality of human experience. I think if we replaced ourselves with machines that as far as we know would have no conscious existence, no matter how many amazing things they invented, I think that would be the biggest possible tragedy. There are people who believe that if the machines are more intelligent than we are, then they should just have the planet and we should go away. Then there are people who say, 'Well, we'll upload ourselves into the machines, so we'll still have consciousness but we'll be machines.' Which I would find, well, completely implausible.

Stuart Russell (2017)

We are the first species capable of self-annihilation. Elon Musk (2017)

If you want a picture of A.I. gone wrong, don't imagine marching humanoid robots with glowing red eyes. Imagine tiny invisible synthetic bacteria made of diamond, with tiny onboard computers, hiding inside your bloodstream and everyone else's. And then, simultaneously, they release one microgram of botulinum toxin. Everyone just falls over dead. Only it won't actually happen like that. It's impossible for me to predict exactly how we'd lose, because the A.I. will be smarter than I am. When you're building something smarter than you, you have to get it right on the first try.

Eliezer Yudkowsky (2017)

[W]e need not worry about the forecast that, in the near future, a "really smart" digital computer/machine will supplant human nature or intelligence. In all likelihood, this day will never come because, in a more-than-convenient

arrangement, our most intimate neural riddles seem to have been properly copyright-protected by the very evolutionary history that generated our brains, as well as the very complex emergent properties that make it tick. As such, neither evolution nor neurobiological complexity can be effectively simulated by digital computers and their limited logic.

Miguel Nicolelis (2014)

# List of Figures

# Table of Contents

# Chapter 3: Modern Science and its Spacetime

> A Frenchman named Chamfort, who should have known better, once said that chance was a nickname for Providence. It is one of those convenient, question-begging aphorisms coined to discredit the unpleasant truth that chance plays an important, if not predominant, part in human affairs. Yet it was not entirely inexcusable. Inevitably, chance does occasionally operate with a sort of fumbling coherence readily mistakeable for the workings of a self-conscious Providence.
>
> Eric Ambler, *A Coffin for Dimitrios* (1937)

**THIS IS A STORY BASED** on the discoveries of modern science, particularly in twentieth-century physics, and the question to be posed at its ending is: How could anyone living in the modern age possibly find solace in such a tale when lying on one's deathbed?

In this tale, “reality” consists of three elements, although as we shall see, the largest portion of the reality of the universe as described by science is, at least for now, mysterious! Only a mere 4% or 5% of reality (a.k.a. the known universe), the portion that is known as mass-energy, making up what is currently detectable by us on earth and in the universe beyond, is well-described in scientific terminology. The rest is only inferred – that is, hypothesized indirectly – from our observations of the behavior of matter in the visible universe. Even the apparent reality of the matter all around us is misleading, for when modern physics writes “m” in its equations, the reference is to mass, not matter. For example, in the equation $W=mg$, the weight of an object on earth is said to be equivalent to its mass times gravity. In terms of any physical object, what we see with our naked eyes and think of in common-sense terms can be called matter, but the physical reality of that object is more accurately expressed as mass, which is invisible to us. All matter has mass, but so do many forms of energy.

Matter and energy are convertible: The “solid” matter we now know as being composed of atoms was once formed out of energy (around 400,000 years after the Big Bang), and in the great super-hot furnaces inside stars such as our sun, some matter is being turned back into radiant energy before our very eyes, although a basic postulate holds that the sum total of matter/energy always remains the same. In every dimension of the visible universe there are well-grounded quantitative estimations of magnitude, including the origins of the universe itself and both the larger and the smaller aspects of its constituents: time, space, and the quanta (“packets”) of matter/energy itself.

As to space: The diameter of the universe is at least 93 billion light-years across and the universe is still expanding. By the way, it makes no sense to ask what the universe is expanding “into,” since the universe is by definition everything that exists in the space that is observable. Light travels at a speed of 300,000 kilometers per second, therefore one light-year measures 10 trillion kilometers in distance. Thus, the diameter of the universe is about one septillion [trillion trillion] kilometers, or 1 followed by 24 zeros. The 5% of visible mass-energy that exists in space is organized into 100 billion

galaxies, like our own Milky Way, containing many trillions of stars, totaling somewhere between a sextillion [$10^{21}$] and a septillion in number.

As to time: The age of the universe is 13.82 billion years – actually, 13.799±0.021 billion ($10^9$) years – a length of time which we can at least crudely represent to ourselves: If one human generation had succeeded another during each period of 25 years since the beginning of time, then 600 million generations of humankind would have come and gone. But at the "other end" of time, namely its briefest dimensions, events apparently happen in units of duration so small as to be literally unimaginable. An optical atomic clock can measure time to one-quadrillionth of a second. Some events occur among subatomic particles – for example, the emission of a gluon from a quark – on a time scale of a *yoctosecond*, that is, one septillionth, or one trillionth-trillionth, of a second [$10^{-24}$s, written as 1 over 10 followed by 24 zeros]. The phase transition in the development of the universe that is known as "inflation," which was the onset of a process of exponential expansion, occurred from $10^{-36}$ seconds after the Big Bang to sometime between $10^{-33}$ and $10^{-32}$ seconds thereafter. Put into words, we are talking here about a timeframe that amounts to various fractions of one trillion-trillion-trillionth of a second. According to the theory of inflation, the Universe grew by a factor of $10^{60}$ in less than $10^{-30}$ seconds.

As to matter or mass: In 2013 the Planck Satellite, designed to measure the background cosmic radiation that is a legacy of the Big Bang, gave the following figures for the constituents of the universe: 5% is "ordinary" matter/energy, observable by us as stars, planets, galaxies, and so forth. A further 27% is "cold dark matter" – matter

than cannot be observed by the usual "signal" of its electromagnetic radiation – which we presume on theoretical grounds must exist, although we don't know what it actually is made up of; its existence is inferred from its gravitational effects on matter in deep space. By far the largest share of the total, a whopping 68%, is referred to as dark energy, and again, with respect to what exactly we think this too is, we are pretty much clueless; its existence is inferred from the rate at which the universe is expanding.

And yet, when we turn from the external vastness of the universe and peer into the "insides" of all matter, we find, almost entirely, just empty space! The two building-blocks making up the nucleus of atoms, the particles known as the proton and the neutron, are $10^{-15}$ meters in size, that is, a fraction of a meter written as 1 over 10 followed by 15 zeros. The proton's mass is $1.67262158 \times 10^{-27}$ kg; the diameter of a proton is .85 fm (femtometer, which is one quadrillionth ($10^{-15}$) of a meter. The electron is a kind of ethereal entity, far smaller than a proton, with a mass that is calculated as $9.1 \times 10^{-31}$ kg [written as 9.1 over 10 followed by thirty-one zeros]. But whereas the electron is thought not to be made up of any subcomponents, both protons and neutrons are themselves composed of much smaller subatomic units known as quarks – in other words, their own interiors are mostly empty space.

Quite possibly there are still tinier units within: In what is known as string theory, the size of the oscillating strings that are hypothesized as being the ultimate foundation of all elementary particles are conceived in terms of a unit known as the "Planck length," which is $1.616199 \times 10^{-35}$ meters; this is equivalent to $10^{-20}$, or one sextillionth, of the diameter of a proton, and one of the scientific commentaries describes it, with perhaps unintended irony, as "an extremely small length."

Dimensions in time and space of such ludicrously small and large magnitudes cannot be represented concretely in the ordinary human imagination. The ultimate reality that is portrayed in contemporary astrophysics is one where the basic units of time and space are, paradoxically, both so immense and so vanishingly small as to defy the ability of most of us to think about them. At the tiniest levels, these invisible

particles and forces produce a universe of truly vast dimensions, only a miniscule portion of which we can see with our naked eyes. Even the simple concepts of time and space – actually, for science, the unified concept of spacetime – have an aura of irreducible mystery surrounding them: What does it really mean to be told that the more distant are the lights our telescopes pick up, the further back in time we are taken, that we are seeing with their aid stars and galaxies as they were billions of years ago?

Thus, in point of fact both the old monotheisms and modern physics, featuring the equally invisible realms of souls and subatomic particles, respectively, utterly baffle ordinary understanding. At bottom, both are equally incomprehensible stories and therefore both must be taken entirely on faith. In what respect do they differ then? Essentially, religion allows us to believe that the universe we inhabit was made *for us*; science does not. That is all.

The "Big Bang" in which our universe came into being marks the beginning of time (and thus one cannot ask what happened "before" it). And with the reference to this event we are again in the realm of the literally unimaginable. The mention above of the detectable contents of space (the 5%) suggests by extrapolation that the sheer total mass of the universe is rather large. The magnitudes involved are simply staggering, as is illustrated by the gigantic columns of dust and gas out of which stars are continuously being formed: For example, the region of currently active star formation known as the Eagle Nebula, some 6,500 light-years distant from us (featured in the famous Hubble Telescope shot known as "The Pillars of Creation"), which is only one of countless similar

regions of space, contains columns of dust and gas rising from it that are 100 trillion kilometers high.

And yet it is thought that, at time of the initial singularity, at the instant before the Big Bang, the *entire* mass of the universe was compressed into a single point of infinite density and temperature so small as to be incomprehensible on a human scale. It is sometimes said that the dimension of the totality of mass before the Big Bang was "roughly" a million billion times smaller than a single atom – and remember, the diameter of an atom is just a few trillionths of a meter! The apparently "solid" stuff of an atom is only the tiny constituents of its nucleus, that is, a ball of protons and neutrons, and the nucleus is 10,000 times smaller than the entire atom (which includes its ephemeral electrons). What this implies is that the apparent solidity of matter conceals a vast emptiness within.

In view of the intellectual puzzles already presented, it is perhaps advisable to skip over some other current scientific conjectures about the natural home in which we humans dwell, such as the idea that we ourselves and our surroundings are mere holographic projections of another reality, or that there is a near-infinity [$10^{500}$: 10 followed by 500 zeros] of universes, not just the one we think we occupy.

The underlying idea about the development of our universe through time in discrete stages, such as inflation and the appearance of the first galaxies about one billion years after the Big Bang, is that our universe *evolved* into its current state purely as a result of the operation of its own "natural" forces and their laws of behavior. The known characteristics of the mass-energy transformations that succeeded one another over time during the past 14 billion years are, in terms of the reigning scientific theory, sufficient to explain many – but by no means all – of the obvious characteristics of the universe we inhabit today. The fact that current theory and observations in astrophysics cannot account for 95% of the universe means only that they this theory is incomplete, not that it is simply incorrect: Typically, later and more complete explanations

incorporate earlier ones as special or limited cases, as in the case of Einstein's and Newton's conceptions of gravity.

When a fuller explanation has been achieved, as it will be, its basic building-blocks will be the same as the ones already known: spacetime and the quanta of matter/energy. Any more complete theory must make new predictions about the behavior of matter/energy that can be measured by instruments and verified by repeated observations. And one must always look to the "bottom line": Whereas the account so far is acknowledged to be incomplete, it also explains well an enormous body of accumulated evidence obtained and verified by rigorous methods. *There is, in short, no seriously competitive alternative approach to explaining the nature and origins of the universe*. This universe described by modern science is self-originating and self-sustaining, and if it is not eternal, that is because there is no necessity that it should be.

The same goes for us. What we call "life" evolved on planet earth as a special case of the same matter/energy dynamics that created and sustains the larger universe: For example, our bodies are composed of atoms that have all been recycled countless times and that were originally forged long ago in exploding supernovae and neutron stars. Some probabilities were involved, but there was no necessity in the unfolding of the original chemical syntheses occurring spontaneously on our young planet that led eventually to the appearance of the eukaryotic cell (some two billion years after the earth's formation), on which all complex life-forms are based. Nor was there any necessity in the progression of those life-forms, over the succeeding two billion years, as is shown by the periodic great extinctions during the last 500 million years of the earth's

history; among other possibilities, another random collision of a massive asteroid with the earth could have ended the whole experiment, possibly for good.

Nothing illustrates better the brute fact of chance in evolution than what is known as the "Cretaceous–Paleogene extinction event," some 65-66 million years ago, caused by the massive asteroid which created the huge undersea Chicxulub crater off the coast of Mexico. Both the asteroid impact itself and the other events it triggered, including volcanic eruptions and climate change, resulted in the extinction of something like 75% of all the species then existing, including all of the non-avian dinosaurs. Until this time there were no mammals larger than rats, since the emergence of larger species had been inhibited by the top predators, the terrestrial dinosaurs. The succeeding period is known as the Cenozoic Era, or "the age of mammals," which over time became the dominant animal group on earth. Had this asteroid missed the earth, or collided with it much later, all of subsequent mammalian evolution would have been different, perhaps radically so, and modern humans might never have come into being.

In the later stages of mammalian evolution, neither the appearance of various *Homo* species out of our common ancestor with the chimpanzees, five to seven million years ago, nor the more recent success of *homo sapiens,* over the course of the last 300,000 years, in out-competing various descendants of *Australopithecus* and of other predecessors such as *homo erectus* and *homo heidelbergensis,* including our close cousins the Neanderthals, was inevitable. The appearance on earth of the marvelous intelligence that fashioned this scientific story was a chance affair. And someday it will disappear again.

The modern scientific basis of this story is inherently linked with technology, for were it not for continuous improvement in measurement instrumentation, in experimental and analytical methods, and in the composition of materials, scientific advance would have soon ground to a halt. In this approach there is a simple rule: Whatever is said to exist must have a magnitude (mass/energy) that can be measured and whatever is theorized must generate predictions about observations that can be

made. The most famous example in the public mind was the experimental proof first obtained in 1919 for the bending of light-rays near massive bodies in space, a prediction derived from Einstein's equations of general relativity.

Another famous example is the Higgs Boson, long theorized in the standard model of subatomic physics as the particle that lends mass to matter; the theory also predicted (within a range of values) what its own mass must be. But until it was observed – finally in 2012/2013 – in the ghostly evidence collected by the powerful and extraordinarily complex machines known as particle colliders, which smash subatomic particles into each other at velocities close to the speed of light, its existence (and the viability of the entire standard model itself) was in question. The Higgs Boson example illustrates well the mediating role of technology with respect to advances in modern science: Theory and conjecture, in seeking to drive forward the process of new discoveries about nature, set continuous challenges for the development of novel instrumental and analytical technologies that are capable of making the observations and measurements needed to confirm the theories. Until the new technologies come onto the scene science cannot advance.

It is easy for the happy consumers of new technologies to be distracted by their gadgets and thus fail to notice that the reality described by science is not a very hospitable place, all in all, especially for a creature inclined to worry, even just a little bit, about life after death. Science's universe is, in fact, mostly just cold dust and hot gas, spread across a space so vast – by comparison with the size of the human form – as to be literally unimaginable. The nearest star beyond our own Sun is Alpha Centauri,

which is a bit more than 4 light-years (40 trillion kilometers) away. Whether there are other habitable planets out there, capable of sustaining life-forms similar to ours, is unknown, perhaps even unknowable, but it is likely, just on the basis of probabilities. However, given the distances involved, it is extremely unlikely that we will ever learn of the fact and less likely still that we will be in contact with their inhabitants.

Even if we did: So what? The universe we share with them will eventually suffer one of two fates: It will either grow frightfully cold, dark and lonely, through accelerating expansion, or the expansion will stall and reverse itself, whereupon a furious heat-death will consume everything in it. Life as we know it is the rarest thing in the universe and when all the inhabitants of planet Earth vanish, as they must one day, it will be rarer still. By one billion years from now our sun's own evolution, dictated by the physics of stars, will have caused it to grow hotter, hot enough to boil away all liquid water on earth and bake the ingredients in the earth's crust into a solid metallic sheet.

Even if some human descendants are still around to witness the event – an unlikely prospect for such an aggressive and insecure ape as we are – the sun's searing heat will mark the end of this relatively brief experiment with life in one small corner on the fringes of the universe: not with a bang, but with a whimper. All without ever having had any evident purpose or meaning; without any plausible reason to think that we humans are "special" in any way (except in our own estimation); with no particularly remarkable result, just a recycling of the atoms formerly constituting human bodies and all the cultural artefacts they crafted into alternative molecular configurations; gone without a trace, with nothing at all left to mark the past, present, and expected future of human civilization, except the strange capsules we once propelled into the void of empty space, proclaiming our wish for contact with someone, anyone; without a hope or a prayer, just a deep satisfaction that for a short while we had been blessed by nature with a brain of such remarkable power and ingenuity that the extraordinary complexity of the universe which gave birth to us stood at least partially revealed before it.

This perspective is far too bleak for most people, even if they don't think they could do without the technological blessings wrought by science. But in a real and ironic sense it also shares with its religious counterpart a deeply mysterious character, despite its hyper-rational mode of representation. On the simplest, intuitive level, the idea that the matter of the earth we experience as reassuringly solid is, in point of fact, mostly a vast empty desert is almost impossible to grasp in any practical sense.

Consider also the neutrino – a vanishingly tiny particle with exceedingly small but nonzero mass – as it whizzes unimpeded, at velocities close to the speed of light, trillions of them at a time, straight through planet earth: right through our bodies, through the lithosphere (including the crust we stand on), the asthenosphere, the mantle, the outer core (liquid iron), and the inner core (solid iron), and out the other side again, *without touching anything (except extremely rarely)*. Its path through the earth was once described by a commentator on a BBC scientific program as being "like a bullet passing through a bank of fog." It is impossible for most of us to imagine just what this particle actually *is*.

Every one of the magnitudes that modern physics refers to – the speed of light, the dimensions of the universe, the size of subatomic particles, the yoctosecond, the idea that in the instant before the Big Bang everything in the universe could be condensed into a single point of infinite density far too small to be imagined by our ordinary brains – defies imagination. The scientific conception of reality simply blows away common sense and the capacity of understanding possessed by the vast majority of human beings who have ever lived or will live in this universe.

And it gets worse, for when physicists get down to work, they do not even use ordinary language, or any language familiar to most persons, when expressing their thoughts. Instead, they rely on a symbolic mathematical/geometrical notation that is itself, to most of us, no more comprehensible than would be the ancient Semitic language that Jesus of Nazareth spoke in everyday life (Aramaic) or the Greek used by the authors of the Gospels – which Jesus probably wouldn't have understood – when they were making up the New Testament many decades after his death. (The conceit that modern-day English-speaking evangelicals think they know the literal "meaning" of a Biblical text is hilarious, but that's neither here nor there at the moment.)

Here is a famous example of scientific notation, from the Wikipedia entry on Einstein's field equations of general relativity, which may be written in the form:

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}\,R + g_{\mu\nu}\Lambda = \frac{8\pi G}{c^4}T_{\mu\nu}$$

where $R_{\mu\nu}$ is the Ricci curvature tensor, $R$ the scalar curvature, $g_{\mu\nu}$ the metric tensor, $\Lambda$ is the cosmological constant, $G$ is Newton's gravitational constant, $c$ the speed of light, and $T_{\mu\nu}$ the stress-energy tensor.

In these equations are described the fundamental nature of the four-dimensional spacetime we apparently inhabit. It is likely that only a tiny fraction of all the humans who will ever walk this earth would ever know what is meant by them (although a few will at least recognize the numbers 8 and π). But at least we have John Wheeler's elegant and concise translation to help us: "Spacetime tells matter how to move; matter tells spacetime how to curve."

Is the type of belief we hold about the "truth" of modern science any different from the belief in a spiritual reality (Jewish, Christian, or Muslim) or, for that matter, a belief in elves and goblins?

Of course, no one is precluded from believing both stories and many profess to do so, although certain inescapable curiosities present themselves immediately in such an exercise. For example, what was the creator-deity doing for all those years before the appearance of these precious humans? To be precise: Assuming that the origins of Judaism are to be found in the first millennium BCE, how was the deity occupying its time for the approximately 13,800,000,000 years prior to that? In fact, the timeframe for the origins of all three monotheisms fits well within the margin of error for the dating of the universe's formation (13.799±0.021 billion years ago). And why create so much space, if the only drama of interest in the whole universe is the deity's constant hectoring of a few misbehaving mammals which were set down on a pathetically small hunk of rock on the outer edge of a quite ordinary galaxy?

True, an ordinary mortal is not allowed to interrogate the deity, especially about its plans and purposes – only Satan gets away with that – but, still, it's all a bit puzzling. And why wait for the Jews to figure out the divine plan, which leaves all those human souls created in earlier millennia sitting in limbo? (Not even the Catholic Church can any longer figure out how limbo is supposed to work.) Perhaps the only good answer is that for an eternally-existent being 14 billion years goes by in the blink of an eye. Still, it is a bit disappointing that the deity didn't wait for just a little bit longer to reveal Itself to all of us, until the Internet was available, so that we could all subscribe to the Divine Blog and Tweets – except that, like the Government of China, the established churches would be loath to allow the deity to have direct, uncensored communication with individual believers.

Belief in both is relatively easy for the scientist-religionist: One can simply affirm that the deity designed and enacted the natural laws by means of which the universe as a whole, and we in particular, evolved – although why it took so long is none of our business. True, the deity's existence violates the dictum of Occam's Razor, which advises us "not to multiply entities unnecessarily," because it just replaces one insoluble mystery (where the point of infinite density before the Big Bang came from) with another (where the deity came from). This minor conundrum is easy to tolerate since it allows one to have a healthy serving of both scientific truth and personal salvation at relatively little incremental cost in terms of time and resources.

It is well known that the Catholic Church tried mightily to maintain control over the interpretation of scientific results, until by the nineteenth century social changes forced it to relinquish its hold. Less appreciated is the common enterprise that has bound them together. A famous thesis, associated with the German sociologist Max Weber, refers to the "disenchantment" of the world resulting from the rise of capitalism, science, and the modern state. The human world was once "enchanted" by and with a multiplicity of spirits – ghosts, goblins, elves, fairies, and all the rest. They were driven out first and foremost by the increasing grip of monotheism and its rationalistic theology, which put the rich and vibrant spirit-world of earlier days on a strict diet: Islam, for example, has in addition to Allah only jinns, angels, Iblis (Satan) and lesser devils as insubstantial entities; Christianity, just the three-person Godhead, angels, saints, Satan and his helpers. For both all other spiritual entities are strictly proscribed by the all-powerful Allah/God. Then modern science came along to finish the job, as immortalized in the reply of the great French mathematician Laplace to Napoleon, who queried the absence of a single mention of the creator-god in his five-volume mechanistic account of the universe's operation: "Sire, I have no need of that hypothesis."

Although modern science collaborated with its early antagonist, Christian monotheism, in ridding the world of most of its traditional spirits, in so far as the capabilities formerly attributed to them were among the presumed causes of natural events, it did not put an end to nature's mysterious aspects. Indeed, the odd thing is that, as the sciences progress, driven onwards by their hyper-rational methods of investigation, the physical world around us seems to get progressively *more* mysterious, not less. Some of these mysteries have to do, as noted above, with the bizarrely tiny dimensions of the ultimate constituents of matter itself. Others appear when the "solidity" of matter vanishes as we smash it to smithereens in the huge particle colliders. The bizarre behavior of sub-atomic particles as described and verified in quantum mechanics (entanglement, superposition, wave-particle duality, etc.) is another source.

Most of the mysteries that defy representation in our imaginations come out of sub-atomic physics, to be sure. There are many others, which might be called marvels rather than mysteries, which challenge the common understanding of the world. In chemistry one thinks, for example, of the three-dimensional self-assembly of the large, complex molecules known as proteins that generate all of our bodily functions. In molecular biology and genetics, the infinitely complex processes involved in information transfer within the genome; in atmospheric science, the modelling of climate system dynamics with many key variables over long time-frames; in medicine, the interaction of myriad risk factors for diseases. One should not even mention the ghostly entities that are played with in higher mathematics.

Most people understand that religion and modern science offer competing explanations of important phenomena by using radically different methods. Most do not expect or require religious dogmas to rest on the same evidentiary standards (in particular, replication of experimental findings) which scientists employ – or so they have heard, at least. The religious mysteries have been around a lot longer, of course, and for the most part are not hard to grasp. We can all imagine a bearded old white man whipping up the solar system and giving life to Adam (just look at the ceiling of the Sistine Chapel); we have seen the pictures of the beam of light entering Mary's ear, explaining the virginal conception; we can all appreciate the attractions of paradise available to the Islamic warriors.

All the hard stuff has vanished into the dim past. How many among the faithful today know that it took centuries for the first Christians to suppress widespread dissent around the dogma of their weird three-part deity, the Triune God – which to the other two Abrahamic faiths, Judaism and Islam, proper monotheisms both, is just a thinly-disguised recrudescence of polytheism?

On the other hand, most of us cannot even imagine how to represent in our minds the mysterious world of matter at the subatomic level: Even reputable quantum physicists have described it with words such as "surreal" and "imaginary." *We cannot visualize this world* (as Einstein complained). We *can* visualize both particles and waves, which is where quantum physics started, with the concept of the photon, the basic unit of light energy, which behaves sometimes like the one (particle) and sometimes like the other (wave). Alas, that was not the end of the matter, for it was later discovered that all subatomic particles behave in similar fashion. Then scientists found that there are not two discrete and different states, but rather a continuum, that is, a continuous spectrum between the two separate states of matter at the smallest scales. Nothing "solid" remains for us to anchor our imagination onto. Our home, the universe, a

physicist explains, “is not made up of particles and waves and beams of light with a definite existence … [but] is aware of all the possibilities at once and trying them out all the time.” Even though that other experiment, where one tries to improve the clarity of one’s thinking by battering one’s head against a brick wall, would appear to be a conclusive demonstration of the contrary.

What are we to do with this fecund science? In a very real sense, we have no choice but to take the whole corpus of generally-accepted science on trust, in part because of the public character of the scientific enterprise. To put the matter bluntly, that enterprise is always evolving, and every new answer is always provisional – but it is simply unthinkable to really imagine that the whole enterprise could be some kind of elaborate hoax. At the simplest level we can all see the evidence in front of our eyes, every day, namely, that our gadgets and medical therapies work (within acceptable parameters of performance). We even have a firm intuition that all of it goes back to work in basic sciences that most of us cannot grasp: No CD-player without laser beams, no lasers without photonics, quantum theory, Einstein’s pathbreaking theoretical papers of 1905 and 1917, and subsequent technological development.

Once in a great while the idea that all or some of modern science might be a hoax rears its head, the most notorious example being the recruitment of a few Nobel-prize physicists in the early years of the Nazi party in Germany in support of the calumny that Einstein’s relativity theory was an expression of “Jewish physics.” The scientific community itself roots out such nonsense efficiently and definitively.

There is more that needs saying about what old monotheism and new science have in common. Both share this curious feature, namely, that the world we apprehend with our senses and ordinary understanding is not the "real" world, but rather an illusion. Although the real is the "first cause" of what we actually experience, in the sense that it makes the reality we apprehend possible, *the real itself is invisible*. For monotheism, what is real are called "spirits," that is, types of disembodied entities, such as souls and devils, some of which can assume visible physical form on occasion, notably in the life of Yeshua (Jesus) on earth. For modern science, the "forces" by means of which everything happens in the 5% of reality that is the visible universe – electromagnetism, gravity, the strong and weak nuclear forces – are entirely hidden from view and have no physical form. (Hidden away yet more cleverly still are dark energy and dark matter, making up the other 95%.)

And the subatomic particles that are the ultimate building-blocks of the matter we can see are themselves visible – for tiny fractions of a second too small to imagine – only as some ghostly trajectories recorded as they are decaying after being smashed into smithereens in the particle colliders. If vibrating "strings" turn out to be the very first level of material reality, one can be virtually certain that we will never actually see one. In this respect monotheism and science alike are content to infer the existence and qualities of their invisible realms through deductive reasoning from both theory and analogy with observable things.

Our contemporary secular society, so beholden to the continued progress of the sciences to feed the insatiable maw that is our need for technological innovation, simply has no choice but to take the truth of scientific findings on trust. (A curious exception is climate science.) The need for faith is thus no less intense now than it was in the Middle Ages; only the object of faith has changed. The vast majority of the believers who are dependent on the institutions which guide faiths and their key personnel – first priests,

now scientists – find themselves in a very weak position. The mysteries of faith are a closed book they cannot comprehend. The responsibilities of those who are supposed to guide them along the one true path are correspondingly enormous, for they know, or ought to know, that their followers have little choice but to take their words on trust. Yet how often in the history of monotheism do we find the simple substitution of lethal force for gentle persuasion: hand in hand, the Holy Book and the sword? The human agents who run the institutions of monotheism could never quite put their trust in the voluntariness of belief.

To ordinary human understanding, science's accounts of the unfathomable mysteries about how the universe functions are, if anything, far more obscure than the contents of the densest theological treatises. Those who guide this enterprise have therefore an even higher level of responsibility toward the uninitiated than priests do. But it turns out to have been near-impossible to specify the nature of the type of responsibility that scientists bear toward the rest of us, in large part because most members of the scientific community have never had the slightest interest in elucidating this point for us. Rather, they have been obsessed with an inward-looking form of responsibility for upholding the integrity of proper method: For example, scientific fraud is understood in these terms, as a deliberate betrayal of the accepted canons for hypothesis-testing, evidence-gathering, and good laboratory practices. The rest of us are not invited to meddle in these discussions.

So, our trust in science and scientists is well-placed. But the potential for the betrayal of trust is always there, and becomes ever more problematic as science advances. This potential has a number of aspects, the most important of which is the idea that the sole determinant of what is or is not legitimate research is that it should be conducted in accordance with the latest accepted protocols on methods. These protocols include ethics, of course, but limited almost entirely to the use of human subjects. With very few exceptions, scientists do not want to be asked to make any other judgements about the possible desirability of either foreseeable or unforeseeable applications of research results in the larger society, especially out into the distant future.

This strategy worked well for a very long time, although it almost broke down in the 1930s, with the juxtaposition of atomic science and totalitarian politics in Nazi Germany. It is unlikely to work very well in the future.

# Sources and References


*TITLE PAGE*.
Figure 1, *Euler's Identity*: https://en.wikipedia.org/wiki/Euler%27s_identity
Leonhard Euler (1707-1783) was a Swiss mathematician and physicist, and this has been described as "the world's most beautiful equation." It was one of the formulae shown to fifteen mathematicians in a neuroscience study using MRI scanning of the brain. The study found that in the subjects' brains the medial orbitofrontal cortex was stimulated; this is part of the 'emotional brain' in which we experience aesthetic pleasure such as music: S. Zeki *et al.*, "The experience of mathematical beauty and its neural correlates," *Frontiers in Human Neuroscience,* vol. 8 (February 2014), pp. 1-12. The quotation from Dirac in Chapter 8 will be found towards the end of this article:
http://journal.frontiersin.org/article/10.3389/fnhum.2014.00068/full

Results of voting: BBC survey asking what was the most beautiful equation ever written:

- The Dirac equation, 22,913 votes, 34%
- Euler's identity, 11,383 votes, 17%
- Pi, 9,060 votes, 13%
- Riemann's formula, 3,615 votes, 5%
- The [Schrödinger] wave equation, 3,318 votes, 5%
- The Euler-Lagrange equation, 2,663 votes, 4%

- Bayes' theorem, 2,590 votes, 4%
- The Yang-Baxter equation, 1,382 votes, 2%

The Dirac equation (in natural units): https://en.wikipedia.org/wiki/Dirac_equation

*EPIGRAPHS.*

Chalmers, David. "The Singularity" (2010) http://consc.net/papers/singularity.pdf.

*Elon Musk, Stuart Russell, and Eliezer Yudkowsky:* Quoted in:
Dowd, Maureen. "Elon Musk's Billion-Dollar Crusade to Stop the A.I. Apocalypse," *Vanity Fair*, April 2017, P. 116: http://www.vanityfair.com/news/2017/03/elon-musk-billion-dollar-crusade-to-stop-ai-space-x

Nicolelis, M. A. L. "Brain-to-Brain Interfaces: When Reality Meets Science Fiction." *Cerebrum*, September 2014: file:///C:/Users/Administrator/Downloads/Brain-to-Brain-Interfaces.pdf

*PART ONE: THE MIND UNHINGED*

CHAPTER 3:

Aczel, A. D. *God's Equation: Einstein, Relativity, and the Expanding Universe*. New York: Delta, 1999.

Ferngren, G. B. (ed.). *Science and Religion: A Historical Introduction*. Baltimore: Johns Hopkins University Press, 2002.

Kennedy, J. B. *Space, Time and Einstein*. Montreal: McGill-Queen's University Press, 2003.

Næss, Atle. *Galileo Galilei: When the World Stood Still*. Translated by J. Anderson. Berlin: Springer, 2005.

Rigden, J. S. *Einstein 1905: The Standard of Greatness*. Harvard University Press, 2005.

Schlagel, R. H. *From Myth to Modern Mind: A Study of the Origins and Growth of Scientific Thought*. Volume I: *Theogony through Ptolemy*. Volume II: *Copernicus through Quantum Mechanics*. New York: Peter Lang, 2001.

Tegmark, Max. *Our Mathematical Universe*. New York: Random House, 2014.

Turok, Neil. *The Universe Within*. Toronto: House of Anansi, 2012.