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Introduction

The glass of science is half empty. Researchers across the globe are fixated on all that we do not know *yet*. It was the same one hundred years ago, and more than one hundred years before then too. Every once in a while, progress arrives.

Ah ha! Something clicks in someone's head. Everything falls into place. The result is nothing short of magical. What had once been invisible suddenly seems to have been hiding in plain sight. Inspiration happens to all of us—writers, artists, scientists, as well as ordinary people. The gap between knowledge and imagination is not as inscrutable as it has been made to appear. It is consequential long after the moment when these first ideas evaporate and practical concerns take over.

By previewing a world of wonders long before the curtains are drawn and the show begins, we can sit in on the rehearsal of our own scientific and technological future. The antechamber of discovery is a place where ideas are forged before they see the light of day. It is the incubator that shapes science before it is tested. When the spectacle of our achievements includes the trials and tribulations that led to them, knowledge looks different.

How can we explain the trajectory of science and technology that has taken us from the steam engine to the microchip, or from the early automata of the Scientific Revolution to the artificial intelligence of today? Scientists wake up every morning, drive to the lab, write papers, teach courses, train colleagues, sometimes receive prizes and accolades, retire, and die. Sociologists and anthropologists have carefully followed them every step of the way. This path has a clear logic that works in piecemeal fashion, yet somewhere along the way something greater than the actors themselves seems to break in. Scholars have been fascinated by moments of discovery in science, when genius scientists have a brilliant eureka idea.

Breakthroughs often arrive when least expected. What was once impossible no longer is.

New experiments and technologies are first conceived in the minds of scientists. They are thinkable long before they become feasible. When scientists are hard at work, their minds are frequently up in the clouds.

The surprising nature of discovery and invention may lead us to suspect that something akin to an unconscious force connives behind the boundaries of reason and drives their development from outside. Discovery has its own twisted, fascinating, and at times terrifying history. It also has its own highly developed technical vocabulary. Scientists often use the word "demon" during the most preliminary phases of their research. It designates something that is not yet fully known or understood. These demons are not religious, supernatural, monstrous, or merely evil. They refer to something that defies rational explanation and may stump or break a hypothesis or a law of nature. Their function is not primarily metaphorical or figurative. They are technical terms whose definition can be found in almost any dictionary.

The *Oxford English Dictionary* defines "demons" in science as "any of various notional entities having special abilities, used in scientific thought experiments." They are frequently mentioned eponymously "with reference to the particular person associated with the experiment" and follow a pattern originating with René Descartes, the seventeenth-century thinker known for inaugurating the Age of Reason.[1]

Descartes's demon opened up the floodgates to many others, continuing up to this day. New names are added as soon as they become part of the argot of the laboratory. "Laplace's demon" followed on the heels of "Descartes's demon" and became a model for new calculating machines that could potentially determine the precise position and movement of all particles in the universe to know all of the past and even the future. These two demons soon faced stiff competition from the Victorian creature named "Maxwell's demon," who could wreak havoc with the usual course of nature. As science grew in prestige and complexity, many other demons were invoked and named after Charles Darwin, Albert Einstein, Max Planck, Richard Feynman, and others.

Figuring things out often involves invoking demons as a useful category to articulate and fill in the gaps of existing knowledge. When confronted with a particularly difficult problem, or when the universe is not working the way it should, scientists immediately start suspecting a perpetrator. Be-

sides being given the last name of the scientist who first started thinking about the enigma, the culprits are often anthropomorphized as they become blueprints for future technologies. Researchers sometimes refer to them as *he*, other times as *she*, and often as *it*. As scientists imagine demons with competing abilities and picture them collaborating with or fighting against each other, they inspire the creation of ever-more-complex technological arrangements. Prototypes are constantly upgraded. New versions are right around the corner, soon to be released.

A variant spelling, "daemon," has yet another meaning in science. In the context of computing technology, it designates "a program (or part of a program)" running inside a computer. The term can be interpreted as an acronym, either for "Disk And Execution MONitor" or for "DEvice And MONitor." When you perform a search in your computer, lines of code called "daemons" are used to find the match you are looking for. When you log into the internet or use your smartphone, myriads of such daemons are put to work smoothing the process of communication between you, your device, and the devices of others. Today these daemons are central to the communication infrastructure around us.[2]

Such a *façon de parler* is eerily consequential. Dictionary entries reveal an open secret within a close-knit community: scientists are demon experts. Practitioners across fields agree that "science has not killed the demons" and that studying them can be extremely useful.[3] To know the world, to make it better, to overcome insurmountable difficulties and dead ends, scientists routinely look for them. How did they become part of scientists' vernacular? What broader consequences come with this mode of inquiry? What aftereffects do these practices have on the development of world history? What, if anything, relates these definitions to the original term, one derived from the ancient Greek δαιμόνιον? Is there any connection between them and the demons associated with hell and the devil?

Most dictionaries include similar entries. In them, demons no longer appear as opposite to angels. Nor are they interchangeable with any of the other creatures of religion or folklore. They are grouped with other similar creatures. The technical use of the word shows us why the religious, figurative, and literary understanding of demons remains so pertinent today.

The progress of science and technology has been marked by investigations into the possible existence of a fine and motley crew, a veritable troupe of colorful characters with recognizable outfits, proclivities, and

abilities who can challenge established laws. To catch them, scientists think like them.

SCIENCE IS STRANGER THAN FICTION

Since ancient times, poets and literary authors have given us evocative narratives of demons. Some feature them as personifications of evil, while others associate them with benign forces, including at times our inner voice or our moral consciousness. Classical and modern literature, horror films and comic books are rife with demons and devils who travel indiscriminately from highbrow to lowbrow popular genres.

Lucifer, Beelzebub, and Sathanus are some of the most prominent demons of religion. Socrates's is one of the best-known demons of philosophy. Literature has many: Dante's Lucifer, Shakespeare's Prospero, Milton's Satan, Goethe's Mephistopheles, and Shelley's Frankenstein are some of the most well known. These demons share certain characteristics with science's demons, but not all. The latter no longer have any of the physical identifying marks that would connect them to the demons of old: they have nothing in common with those furnished with short horns, long tails, and cloven hoofs. The clichés associated with black magic and evildoers do not fit them. Their form is different. Nonetheless, science's demons share many underlying characteristics with the demons of old. While no longer *isomorphic* with them, they remain *isofunctional* in key respects. For this reason, they are daunting, outperforming their predecessors in unexpected ways.

By focusing almost exclusively on the demons of lore, legend, or religion, we have forgotten to watch for the demons in our midst. The nineteenth-century French poet Charles Baudelaire was exceptional for refusing to accept the demystification of the world by scientific and secular means. His work called on readers to remain attentive to the real power wielded by figures deemed to be largely symbolic. In a poem initially titled "Le Diable," he described the evil one's latest ruse: "The devil's finest trick is to persuade us that he does not exist."[4]

Technologies are frightfully diverse. What do *x* and *y* have in common? When thinking about all the things that get categorized under the label "technology," I am often reminded of the riddles that begin with that question. Only a few things so categorized have metallic gears and pistons. They may be organic or chemical, living or inert, tiny or huge, or they may not occupy fixed areas at all. Some are clearly useful, others not at all. What can

a telescope possibly have in common with a calculator? Is there a basic characteristic that can be used to describe what steam engines, for example, share with lines of code?

Of the innumerable things and systems that we commonly group in the broad category "technology," many have been associated, at one time or another, with the demonic, the magical, or the fantastical. While the very idea of modern technology is one that is frequently at odds with a belief in the power of the supernatural, too many thinkers consider technology in those terms. How can we make sense of such contradictions? Something else in technology must give rise to these associations. That "something else" is the topic of this book.

THE DEMON OF TECHNOLOGY

"What have I done?" A stroll through the history of science and technology shows us that innovations often beget regret, determination can turn into hand-wringing, and initial exhilaration gives way to soul-searching. The literature of the history of science is full of retrospective memoirs written by scientists who all confronted the same question after they saw how their research had been put to use.

Knowledge gives us power, leaving us to cope with the additional complication that power by itself does not discriminate between good and evil. Even our most advanced technologies have not brought us all the benefits we hoped for. We live in fear that our most cherished innovations in science and technology might fall into the wrong hands and be used for the wrong ends. Even in the best-case scenarios, when science and technology are developed for virtuous and honorable purposes, new developments can be quickly adapted for destructive ones. All that is needed to turn something good into something horrible is a slightly larger dose, an incremental increase in quantity, or an imperceptible change of context. Pesticides have been used in gas chambers against innocent people, fertilizers can be used to build bombs, space rockets can deliver weapons of mass destruction, vaccines are easily adapted for biological warfare, the cure for genetic diseases can become the basis of eugenic interventions, the same implement can be used to heal or to hurt, and so on. What was once a solution can become a tool for perpetuating a crime. A dream can turn into a nightmare in a heartbeat.

The picture of technological development that emerges is not entirely good. The sword of knowledge cuts two ways. We have thought about the

dangers of knowledge in this way since it first appeared as a concept in history. The biblical account of the expulsion of Adam and Eve from the Garden of Eden describes knowledge as something transgressive and even demonic. A creature associated with the Devil, craftier than any of the other wild animals, tempts Adam and Eve to bite into forbidden fruit.

> When the woman saw that the fruit of the tree was good for food and pleasing to the eye, and also desirable for gaining wisdom, she took some and ate it. She also gave some to her husband, who was with her, and he ate it.[5]

Since these words were first written down sometime in the fifth or sixth centuries before the Christian era, they have been repeated over and over again. They are especially central in Judeo-Christian traditions, yet their influence on other cultures has been profound.

To this day, an unbridled desire to acquire knowledge—to gain wisdom—continues to be considered transgressive and sometimes even sinful. In other translations of this famous passage, Adam and Eve are described as eating from "a tree to be desired to make one wise." The words used to describe the serpent have been variously translated from the Hebrew *arum* as "wise," "intelligent," "clever," "cunning," "shrewd," "subtil," "crafty," "astute," and "wiley." Why are intelligence and wisdom so directly tied to sinfulness and lawlessness in this biblical passage and beyond?

The biblical account of Adam and Eve was preceded by earlier myths with similar themes. The myths of Prometheus and Icarus are perhaps two of the best known from a list that goes on and on. The idea of technology as a double-edged sword was already explored in the myth of Hercules and his poisoned arrows. After these were used successfully against his enemies, they inadvertently returned to kill their unwitting creator. Yet another famous tale of ancient times that speaks to the dangers of technology is the Hebrew story of the Golem. In the story, a lump of clay was given life, and though it mostly behaved according to the wishes of its creator, one day it did not, leaving a trail of rampant destruction and ruin. Similar themes motivate the stories of Talos, an artificial soldier made of metal; Galatea, who was created by Pygmalion to be larger than life; and Pandora, who was responsible for opening Zeus's box of evils.

Stories exposing the moral dangers of science and technology used similar tropes in medieval times. Demons, devils, and contracts made with them became more prominent. In the sixth century, the example of the life of the cleric Theophilus of Adana was used to highlight the perils of exchang-

ing one's soul for the promise of complete and total knowledge. The medieval legend of Faust reminded its listeners that signing a pact with the devil in exchange for unlimited knowledge could have dire consequences. The Elizabethan play of that name by Christopher Marlowe brought those themes to the theater. These kinds of stories frequently feature characters who, like Adam and Eve, are tempted to explore more and know more—sometimes learning too much, being fatefully attracted to forbidden or secret knowledge. In the nineteenth century, Johann Wolfgang von Goethe's celebrated *Faust* gave new life to old Christian and medieval myths. Goethe's novel soon became a sensation throughout a continent that was being rapidly transformed politically, scientifically, and technologically. *Frankenstein; Or, The Modern Prometheus* by Mary Shelley was so imbued with these antecedent themes that she even subtitled her work with a reference to the ancient myth. Less celebrated authors pursued similar themes, sometimes echoing unsophisticated, prosaic, and commonplace beliefs about the dangers of knowing too much.

Why have these themes persisted throughout millennia? The descriptions of the entrepreneur-inventor Elon Musk are typical of the genre. When speaking at the Centennial Symposium for MIT's Aeronautics and Astronautics Department in 2014, he described AI as a powerful means for "summoning the demon."[6] Is there something in it—or in science and technology—that is inherently dangerous and wonderful at the same time? Why do we think that curiosity killed the cat? In other words, is there something about the quest for knowledge that is almost always *demonic*?

If we look at the technologies that science's demons have inspired, we get a surprisingly coherent view of science's most celebrated successes. In the seventeenth century, the philosopher René Descartes was fascinated and terrified by a host of new innovations around him, such as automata, and by new entertainment techniques that blurred the boundary between reality and spectacle. In their context, he described a creature who could take over our senses to install an alternative reality and developed an entire philosophical school designed for defending ourselves against this being. Those early technologies are quaint compared to the ones of today, yet Descartes's demon still comes up in conversations among scientists and engineers who are interested in the challenges brought about by new virtual reality technologies or who are invested in this research area. A search for demons, even some quite old ones, still drives the development of ever more perfect models. Virtual reality is one example out of many.

The history of demons permits us to see something that most social or political histories miss: the arch of modern science and technology being raised across the world. Science's demons were typically first sought after in places we now count as significant sites of historical transformation. In the Dutch Golden Age, they provided lessons about the limitations of our senses and the power of reason. In Revolutionary France, they gave scientists hope that certain natural laws were ultimately immutable and stable. In Victorian England, they showed a growing number of practitioners how to cope with industrialization. Demons played key roles in Continental Europe during World War I, in Britain and America during World War II, and in a handful of American universities during the Cold War. By the end of the millennium, enterprises where they were studied were truly global, with research taking place in select laboratories from Helsinki to Tokyo. These studies were central to the development of mechanics, thermodynamics, relativity, quantum mechanics, and cosmology. The study of demons then spread to the life sciences, where they were seen as providing the necessary oomph that jump-started life itself from its lowly origins in brute matter. They then played key roles in evolutionary biology, molecular biology, and neuroscience. Eventually, they left the desk of theoretical physicists and the laboratory benches of experimentalists to affect economic theory and monetary policy.

Not every fork is a trident, nor every bowl a cauldron. Many technologies are considered magical and fantastical without being thought of as demonic. Some celebrated thought experiments do not feature demons at all. Most descriptions where one aspect of science or technology is seen as demonic typically stick only for a short period of time before being dropped and transferred promiscuously to describe something else entirely. It is only when research is new, innovative, mysterious, and potentially transformative across broad swaths of culture and society that it is described thusly. In the case of epoch-making, world-altering technologies, we are hard-pressed to find examples that have *not* been described as demonic, in one way or another, at one time or another.

IMAGINATION

Our imagination works wonders, and many scholars have dedicated themselves to studying it. Yet its role in science is often assumed to be secondary. It is traditionally considered to be a "private art," too unruly to study, off limits to rational inquiry, inchoate, slippery, obscure, and perhaps even un-

recoverably unconscious.[7] While scholarship on thought experiments has grown in recent years, most scholars still consider them to be lesser than, or essentially distinct from, the "real" deal experiments performed in laboratories and research centers.[8] The role of the imagination in science continues to be portrayed as an inconvenient id hiding behind science's ego, as something that takes place primarily outside of the lab and slyly and occasionally sneaks in, as an embarrassing sibling or bastard child of the arts and the humanities showing up uninvited.[9] But its power does not stop when scientists enter the lab or write down their equations. The entire enterprise of science—from theory to experiment to public communication—is thoroughly permeated with our imagination. When we think, reason, and make decisions, we simultaneously think ahead, far and beyond.

From a distance, we can see just how much our imagination shapes technology. The great writer Victor Hugo excelled in seeing connections between the technologies of his era and imaginary creatures of yesteryear. He asked his reader to consider how steamboats had tamed the oceans much as Hercules had tamed the Hydra, how locomotives appeared to breathe fire like dragons, and how hot-air balloons were much like the griffins once imagined to roam through the air. "We have tamed the hydra, and he is called the steamer," he wrote in *Les Misérables* (1862), before continuing: "We have tamed the dragon, and he is called locomotive; we are on the point of taming the griffin, we have him already, and he is called the balloon." He envisioned future technologies as being shaped by these age-old myths. "The day when this Promethean work shall be finished," he continued, "when man shall have definitely harnessed to his will the triple chimera of the ancients, he will be the master of the water, the fire, and the air."[10]

Castles in the sky are rarely empty. A beautiful princess may be trapped in a tower, a hunchback may live in the bell tower, or a troll may be asleep under the bridge. Our imagination is almost limitless, but it is not infinitely so. "Even in the fairytale," the philosopher Ernst Bloch reminds us, "not everything runs smoothly."[11] Imaginary creatures cannot randomly break any and all norms and laws. They must stay in character. They cannot just go any which way and act in any way they please. Creatures of our imagination lead us into certain prescribed futures. Our fate might change if we choose to enter the dungeon, peer under the bridge, sleep in the princess's bed, climb the high tower, or summon a demon.

Not all imaginary creatures have been equally useful to science. Demons are by far the most common creature that populates the modern scientific imagination. References to them vastly outnumber allusions to monsters,

ghosts, werewolves, zombies, fairies, witches, unicorns, elves, giants, dragons, sirens, basilisks, hippogriffs, dracs, exotica, and so many others. Like the others, they too are representatives of universal archetypes, symbolic figures who help us express universal feelings, such as dread and fear, that are prevalent across history and culture. Yet to understand the development of science and technology, it is necessary to distinguish them from other imaginary creatures more carefully. Demons' particular ancient lineage makes them valuable for thinking about the natural world. They cannot be placed in the same basket as any other creatures. For example, while unicorns have a recent use among venture capitalists to designate unusually successful startups, they are rarely mentioned in the technical literature of science. Elves and giants, which are mostly creations of the pre-Christian mythology of the Norse and other Germanic tribes, are sometimes invoked by scientists to describe what the world looks like at different scales. Their use in technical science literature, however, is sparse. The same can be said of vampires, which are mostly of nineteenth-century eastern European origin, or of the ghouls and goblins of European folklore. Although the general category of the monstrous was very important for the development of science during medieval times, its role in modern scientific practices is minor. None of these creatures feature as prominently in modern science as demons.

A DEMON-FREE WORLD

If it is unsurprising to see techno-science's critics highlight its demonic qualities, it is even less surprising to see that techno-science's advocates think about demons and the imagination differently. Science is often portrayed as a weapon against all sorts of pseudoscientific and superstitious beliefs that have been peddled by quacks or impostors and fanned by the forces of religion and superstition. Carl Sagan, famed cosmologist and popular science author, celebrated science for just this reason. His best-selling book *The Demon-Haunted World* (1996) described the scientific method as "the fine art of baloney detection" that permitted scientists to brush away irrational beliefs and other falsehoods from this world.[12]

Sagan was right. When the unreal suddenly appears to be real—or worse, when real and unreal appear to blur—our imagination can be tempered by putting it to the test. The laws of nature provide us with constraints we can apply to check our beliefs and corral our runaway imaginations. They hold us back. As tough as brick and mortar, the laws of nature limit our imagin-

ings and force our most audacious plans to fall in line with practical realities. Experiments can help. If you think you have seen a demon, you better think twice. Were you agitated, delusional, or inebriated? If that impression is not dispelled after ruling out mental causes that might have fooled you into thinking you saw a demon, you can create an experiment to rule out other causes. Turn on the lights. Check the window. Look for suspicious footprints. Prepare to catch the culprit during a future visit. Spread flour on the floor of your room to see if anyone has tiptoed in. If you find no evidence ever again, then it is extremely unlikely that a bipedal being was the culprit.

Throughout the history of civilization, we have developed clear ways of testing our beliefs. By varying conditions to eliminate false hypotheses, sensible folk act just like scientists, using experimental techniques to get to the bottom of things and arrive at the truth. The trial-and-error reasoning that characterizes sound, rational thinking has been tremendously effective at eliminating a host of hypothetical beings whose existence is thus proven to be so improbable that we might as well scratch them off the list of things to search for. A scientist brandishing a telescope or microscope, holding a test tube or swan flask, or analyzing a petri dish, all to eliminate false hypotheses, is acting much like a valiant knight slaying a dragon or a demon.

Yet it is not so simple. Scientists routinely look for new particles, forces, materials, states of nature, laws, and new combinations thereof. Enthralled by the incredible and unbelievable, they set off on voyages of discovery. Among themselves, they often describe their enterprise as a search for demons that are not yet completely understood or eliminated by current experiments. "If we knew beforehand what we'd find, it would be unnecessary to go," admitted Sagan. "Surprises—even some of mythic proportions—are possible, maybe even likely," he concluded.[13] How can it be that scientific laws characterized by certainty, precision, and finality are improved upon, refined, and sometimes even overturned? How does new knowledge arise from determinate laws?

A contradiction lies at the heart of science. Our imagination is necessary for obtaining new knowledge. We can celebrate *homo sapiens* for having learned how to plan and calculate as no other species before it, and *homo faber* for having used tools better than any of its predecessors, yet we seem to have forgotten that both were initially motivated by the creator of creativity: *homo imaginor*. The back-and-forth commerce between the real and the imaginary is what permits us to create new knowledge. Scientific laws

are sturdy, but they are not fixed, and our imagination is the best tool we have for extending and improving on them. Science grows when researchers push it to new limits, striving to become smarter than the smartest, bigger than the biggest, smaller than the smallest, slower than the slowest, and faster than the fastest.

Scientists know full well that the fact that something has not yet been found does not mean it will never be. To make this point, the philosopher A. J. Ayer felt authorized to invoke the search for the abominable snowman as an example. "One cannot say there are no abominable snowmen," he warned, because complete proof of their inexistence across all time and space is practically impossible to come by. "The fact that one had failed to find any would not prove conclusively that none existed," he concluded.[14] The gates to the Parthenon of the Real remain wide open.

The search for new entities is not blind. Trails run cold. Experienced scientists know where it is most profitable to look, what new discoveries might look like, what properties they might possess, and what they might be capable of. Well-funded research programs focus on topics that are most worthy of investigation. Luck, goes a well-known saying, favors only the prepared.[15] It takes years and years of education and training to become prepared, and hours after hours of study to master all the preexisting literature on a given topic. Before setting out to discover the fundamental laws of nature, scientists equip themselves carefully, much like voyagers sailing off on long journeys. But luck also favors those who dare to imagine. An essential part of the work of all young scientists consists in working hard to sharpen their imagination.

Where is our imagination taking us? The science of today, it is also commonly said, is the technology of tomorrow. Yet the relation of science to technology throughout history has not been so direct or transparent. Scientist themselves are often in the dark about the repercussions of their research. Sometimes the closer they are to the topic the further they are from understanding its broader impact.

The physicist Max Born gave us one of the most honest renditions of scientists' blind spots when it comes to the impact of their research. Reflecting on his own contributions, he admitted that "anyone who would have described the technical applications of this knowledge as we have them today would have been laughed at." The path taken by the development of technology in the last centuries has gone beyond anyone's wildest dreams. During Born's youth, "there were no automobiles, no airplanes, no wireless

communication, no radio, no movies, no television, no assembly line, no mass production, and so on."[16] Scientists working in the fields most relevant to new technologies can be completely blind to the changes about to take place right under their noses. Writers of speculative science fiction who are intent on imagining future worlds miss future developments just as much. If a path cannot be traced back to scientists' conscious actions and intentions, how else can we understand the development of technological innovations? The interconnection between science and technology is so complex, and their development throughout history so confounding, that it quickly raises another question. What comes before both?

For centuries, scientists have been transfixed with studying a particular set of demons. By imagining what they can or cannot do, they have figured out some of the most important laws of the universe. When scientists developed the law of energy conservation, they imagined powerful demons that could break it. When developing the theories of thermodynamics, they imagined tiny demons who fiddled with individual atoms and could overturn entropy. When they developed the theory of relativity, they considered faster-than-light demons that could wreak havoc in the universe in unpredictable ways. When they looked deep into atoms at the level of the quantum, they considered whether demons might be interfering in the bizarre paths taken by photons or electrons that were affecting atomic decay, transmutation, and the release of previously unknown sources of energy. The demons that are still under investigation possess sufficiently credible characteristics that experts continue to consider how and if they might pass for real.

The jury is still out when it comes to some of the fundamental questions associated with these strange creatures. The most die-hard demons—those that have survived centuries of investigation—have so far stumped the cleverest elimination methods of resourceful researchers. Weak and clumsy demons have been culled from the batch, but strong and nimble ones slip like lucky fish through the holes of the most up-to-date experimental techniques. As science helps us sift illusions and irrational beliefs from the real laws of nature, scientists' search lists have grown as they explain what nature can do, where its limits lie, and how its boundaries might be pushed.

The nature of logic, virtual reality, thermodynamics, relativity theory, quantum mechanics, computing, cybernetics, artificial intelligence, information theory, origin-of-life biochemistry, molecular biology and evolutionary biology, DNA replication and transcription—all have been advanced by

reference to demons. The discovery of seemingly unrelated things—molecules, atomic bombs, computers, DNA, neural networks, lines of code, quantum computers—was part of an epic effort to find and understand them.

Modern demons arrived with modern thought, which they made into their comfortable home. In some descriptions, demonkind has deft fingers and sharp eyesight. In others, demons hold photon-emitting torches or flashlights; some of them are capable of forming families, and yet others are described as organized in an army or a society. Some shriek wildly, and others are good-natured and polite. They lurk in a demondom that is often dark, chaotic, and well insulated, as is the inside of a computer. In all of their shapes, forms, and guises, these creatures share one consistent quality: they appear intent on either aiding us in living a good life or preventing us from doing so, an ideal often designated by the Greek term *eudemonia*. It no longer surprises me that the ancient term for "the good life" was made by combining the prefix *eu-*, for "good," with the word *demonia*, for "demons."

What follows is a history of science's demons, some imaginary and some real, some impossible and others less so, and through it a history of the universe *as we have come to know it*, filled with mystery and possibility.

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