PHYSICS AND FUNDAMENTALISM:
Science as the continuation of religion by other means

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ABSTRACT: Science inherited many of the values, notions, and purposes of post-medieval Christian culture. Its first exponents were literally creationists. Modern science propounds a new creation story, a new means of salvation, a new priesthood, and a new scholasticism. Theoretical aspects of modern physics, as opposed to empirical, continue subtly to express a theological worldview and stance toward the natural world. As in religion, fundamentalism in physics insists unduly upon simple ultimate truths in a unified vision.

1. Introduction

The root meaning of the word *nature* suggests self-generation, a reality that establishes and maintains itself independent of outside agents, whether human or divine. As such, nature is primordial and autonomous, in contrast to technology and the humanly made world. According to our Christian heritage, however, the natural world is neither primordial nor independent of outside agency. It is not self-generating, but created *ex nihilo* by divine fiat. Such a nature has only the derived reality of an artifact. Accordingly, it is separate from its creator in the way that the artifact is separate from the artisan and in the way that the material world is separate from mind. The monotheistic conception of God signified an estrangement not only of subject from object but also of mankind from nature. The physical world did not reflect mankind's true being, which is spiritual, and the Earth was not our true home, which is otherworldly. Life in nature was rather a punishment, the wilderness into which the soul was expelled from an ideal Garden.

In some non-Indo-European cultures, in contrast, the natural world is conceived as a seamless whole, in which people are an integral part.[1] This belief is reflected in the absence within such cultures of a program for deliverance from mortality or a goal of ascent to a higher reality. Their religions were not preoccupied with a concept of salvation or another world where their real destiny unfolds. However, if *this* world is not our true home, then the significance of what we do here lies in some other realm. What happens to the planet or to our physical bodies and those of others is only of secondary consequence.

The image of nature thus has a political, ecological, and even moral dimension. As a category of civilized thought, nature continues to represent the wild, the untamed and chaotic, that which exists independent of us and on which we are dependent. It can pose a threat to social order and to the human project of mastery. The perception of wilderness as a dangerous no-man's-land doubtless served to rationalize early urban

[1] See Dewart (1969 and 1989).

concentrations and the need for civilized conduct in close quarters. The contemporary image of nature as a remote outback, appended to urban centers of power, serves to reassure modern society concerning the ecological consequences of consumerism and unlimited growth.

The world as a whole was once thought to resemble a living organism, with its own powers of agency, not merely the passive inertness to which the philosophy of mechanism has reduced matter. Nature was autonomous: self-creating and self-defining, as well as self-maintaining and self-reproducing.[2] In the Christian culture of early modern Europe, the *philosophes* held instead that God imposed order on natural chaos, just as rulers imposed it in the human realm. Identifying with the divine mind, they believed nature comprehensible because the mind of its architect was mirrored in their own gift of reason. This conformed to the heritage of patriarchal religion, in which God stands as a projection of the masculine psyche. Men could contemplate and discuss the rational design of nature, as from one engineer to another, by ignoring its manifestly irrational aspects, thus bridging the gulf between God and Man, intellectually if not morally. The important thing was nature's design, and not nature itself: the idealized essence, the blueprint.

2. From creationism to determinism

Inheriting the medieval fascination with machines, and confronted with the rediscovery of ancient knowledge, the early scientists channeled their creationist ideas into the philosophy of mechanism. The Greeks had discovered the power of deduction, which became the basis of mechanism and determinism.[3] Viewed abstractly, machine, deterministic system, and deductive system are interchangeable concepts. This discovery became the basis of the scientific ideal of formalization: to axiomatize every branch of knowledge as a deductive system, based on fundamental definitions and expressed as mathematical equations. Essentially, this became a program to mechanize the search for knowledge.

A machine is an artifact as well as a deductive system. This doubled the appeal of the machine metaphor for nature, since it dovetailed with the idea that the machine must have a maker. The Christian reading of Aristotle had transferred all teleology and creative power in nature to the masculine creator God, the maker of the world machine.[4] Though Aristotle had analyzed nature in terms of four types of cause, which included teleology, the early scientists retained only 'efficient' cause—a perturbation from outside the system. The system itself can be viewed as a machine, which is set in motion by an external cause. In the case of the world, the obvious first cause was God.

Even today this vision of nature prevails. Efficient cause is the underlying basis of determinism, which still requires a first cause to initiate a mechanical chain of events within a system considered inherently passive. While the role of first cause is no longer

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[2] Theoretical biologists Humberto Maturana and Francesco Varela coined the term *autopoiesis* for this autonomy of living organisms.

[3] Indeed, they were interested in machines, but mainly on a theoretical level, owing to a prejudice against manual labor, for which they relied instead upon slaves.

[4] Deason (1986), p177

attributed to God, it remains problematic in science. It may be deferred through further deterministic analysis or ignored altogether; or else the theorist assumes the causal role by writing initial conditions into the equations. In truth, however, it is the *equations* that are deterministic, not nature itself.

The relation of theorist to theoretical model imitates that of the (divine) creator to his creation. The question of the inherent creativity of nature itself remains outside the bounds of that framework; it has only been forced upon science by the indeterminism of the quantum realm and by the issue of a boundary to the whole universe as system. The idea that nature is unbound at the deepest level by causal principles is "both thrilling and scary," since it "fails to satisfy the demand for sufficient reason—for answers to every question we might ask of nature."[5]

The philosophy of mechanism was deeply informed by the religious heritage of science. To divorce teleology from nature may have been a reasonable choice for a budding science that hoped to apply mathematics to a limited range of relatively simple phenomena. But it was also a *theological* choice, aimed to preserve divine potency against pagan notions of powers inhering within the natural world itself.[6] After all, a world that could design itself had no need of a designer-creator.

Preliterate goddess religions had revered nature directly, rather than an abstract principle *behind* nature. According to the Bible, however, a God separate from nature had declared the world into being, by an act of fiat, as in "Let there be light." This concept of creation merged with the Greek concept of *logos* as the rational principle behind nature.[7] The Greeks had generalized the concept of *logos*, which originally meant any reasoned text, to mean reasoned thought itself. Thus, early Christians interpreted the *logos* as God's reasoned text: the *divine word*. Henceforth, there were *two* records testifying to the Creation: the Bible and the natural world itself. Since God authored both the world and Scripture, these stand in a special relationship as twin sacred texts. In Christian Europe, the natural world was referred to as the "Book of Nature," complementing the Bible as a guide to divine will.[8] Holy writings and the natural world were alternative expressions of God's message and purpose for humanity.

Together with the Greek notion of *logos*, the Judaic emphasis on scripture provided a powerful basis for understanding nature metaphorically, and thus for the textual exegesis that came to dominate medieval theology and natural history.[9] Such an understanding—of the Bible as both written history and as legal covenant—dovetailed with medieval fatalism. ("It is written" equals "it is destined.") As distinguished from oral preaching, the *text*—in principle fixed for all time—became the early template for

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[5] Smolin (2013), p148-9

[6] The dependency of atoms on divine will was established by having their motions imparted by God at creation. Cf. Deason (1986), p178-9: "Unlike other ancient philosophies of nature, atomism… offered no basis for rationality or purpose in this world. For this reason the revival of atomism in Christian Europe was not a serious possibility until… the introduction of [the doctrine of] God as a cosmic lawgiver, who imposed laws on atoms for the purpose of creating an orderly universe… and cleared the way for the establishment of a mechanical worldview."

[7] Barbour (1997), p241. According to Lindberg (1986), p23, the first major Christian apologist held Christ to be the divine *logos*, identified with the power of reason.

[8] Menuge (2003)

[9] Bono (1995), p11

the deterministic philosophy. While speech flows in one direction, irreversibly and ephemerally, a text can be searched out of order, at will, and essentially outside time. Hence, the reversibility of deterministic systems.

Science inherited from the Greeks the idea of nature as deductive system, on the model of geometry. From the biblical tradition it inherited the parallel idea of nature as a text to be deciphered. (A deductive system *is* a text.) Both these notions reflect a belief that the world is the result of an intentional creative act—whether by God or by the scientist. Together they would affect the treatment of nature in science and by society for generations to come.

It is understandable that nature would appear mechanical to an age obsessed by the benefits of machines. The archetype is even more abstract in the present era: the *universal* machine—the digital computer—which generalizes and formalizes the concept of machine. Just so, the *effective procedure* or *algorithm* generalizes and formalizes systematic logical treatment. The equations of physics are such algorithms. A side effect of the widespread influence of computers is that many people now understand nature in terms of computation. Some even hold it to *be* a computer.

To be sure, mathematics has been indispensable to science since the time of Galileo, who proclaimed the "book of nature" to be written in the language of mathematics. Yet such undeniable utility stops short of the neo-Platonic claim that nature *itself* is but a "mathematical structure," or that the physical world is *nothing but* computation or mathematics. In truth, nature can be described mathematically only to the extent and in the ways that it resembles a machine. And that is the extent to which it is a sheer product of human definition. Rather circularly, this resemblance comes of a particular way of looking, which focuses on those aspects of natural reality that can be readily treated mathematically.

However, it is only a cartoonish vision of nature that resembles a machine. Such a vision is inconsistent, since it holds that the universe arose through deterministic processes, yet ultimately by lottery. To understand this paradox, consider that that the notion of chance had been purified of intentionality in classical physics, whereas the notion of determinism continues implicitly to invoke it. While God traditionally "determined" the nature of the world in a causal sense, scientific investigation "determines" the nature of the world in an epistemic sense. In both cases an intentional agent is involved. The truly random event—such as encountered in the quantum realm—is undetermined in both senses. The scientist can with precision observe statistical patterns of events after the fact, but cannot predict individual events.

Human beings are understandably wary of things they cannot control or predict. Randomness has long been associated with the darkly unreliable side of nature. In the medieval worldview, chance represented a portentous intrusion into the divinely rational order of things. Gambling, which is age-old, inspired the study of probability; yet superstition around the notion of chance helps to explain why probability was so late in receiving formal mathematical treatment and why it still involves persistent confusions.

Scientists seek to model processes in a way that renders them predictable. Scientist and layperson alike may invoke physical causation as a rationale for observed correlations, building confidence that these will reliably continue into the future. Thus, causation is often thought of as a metaphysical power that *makes* things occur, while what is actually verifiable is statistical correlation among events that have *already*

occurred.[10] Expressing such correlations mathematically gives the psychologically satisfying illusion that mathematical laws "govern" physical patterns. But to assume that mathematics has causal power, or exists independently of nature, gives the false impression that the world is a byproduct of first principles, such as a created universe would be. Hence, Plato and Pythagoras were more compatible than Aristotle with early Christian dogma, which expected a fit between reason and the world as a creation of the divine Mind. Renaissance mathematics encompassed sheer number mysticism along side a quantitative approach to nature. The ancients had impressed upon the early scientists the ideal of rationalism, so that Kepler followed Plato in trying to assimilate the planetary orbits to the five regular solids, and also thought the year should be exactly 360 days. Similarly, Galileo had insisted on exactly circular orbits. The rational and the ideal lie at the heart of determinism, the mechanist philosophy, and what I call deductionism, which is the belief that nature not only conforms to a deductive system but literally *is* one.

3. Nature as text

The context for reading the Book of Nature was the eschatology of medieval Christianity. Nature was first studied with an eye to the miraculous and portentous; like scripture, the Book of Nature was read for its prophetic value more than out of dispassionate curiosity.[11] Medieval people were more interested in locating their generation within the biblical count-down toward apocalypse than in the physics of a world that was not destined to endure. Protestant movements, however, brought a shift in attitude away from such allegorical understanding and toward the study of nature bearing intrinsic interest independent of human spiritual destiny, if not independent of material benefits. Scripture too was interpreted more literally, less symbolically.

Like Islam, Protestantism tended to reject the image, associated with Catholic icons, in favor of the written word. Protestant natural philosophers rejected the priesthood and hierarchy of the Church, and with it slavish devotion to past scholarship. They wanted to read and interpret the Bible for themselves—and likewise the Book of Nature. They sought a fresh break from the convoluted metaphysics of scholasticism, whose unverifiable speculations seemed to have little bearing on ordinary life. Printing brought bibles to the masses, who rejected the clerical interpretation of Scripture on their behalf and sought direct personal access to its meanings. In a period when one could

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[10] The idea of the inherent probability of a *single* event is problematic in real situations. One can speak meaningfully of the prior probability of a single event only when the context is formally well defined, as in the case of an idealized coin toss or role of dice, which are mathematically definable situations. The notion that a single event is associated with a prior probability is unfounded when it does not refer to such a mathematical idealization. Any estimation of its probability can only refer to the context of a series of recorded past events—a statistic. It is merely by convention that, *in the absence of further information*, a future event has a "fifty percent chance" of happening. The probability of any event that has actually occurred is 100 percent!

[11] Even later, Berkeley (1710) would write: "And it is the searching after, and endeavouring to understand those signs instituted by the Author of Nature, that ought to be the employment of the natural philosopher, and not the pretending to explain things by corporeal causes...."

nevertheless pay dearly for a "wrong" interpretation, it now seemed safer to focus on obvious literal meanings. This attitude transferred to the study of the Book of Nature.

The vision of the world as *text* is closely related to that of the world as *artifact*—indeed, as a machine built by God. All artifacts, including texts, are endowed by definition with the reality assigned by their creators and users, and only incidentally with material reality. Like other artifacts, including machines, a text is a finite, self-enclosed product of definition. It contains no more than was explicitly inscribed by its author along with deductions that follow. If *nature* is a text, then it should be as predictable as a machine, as searchable and decipherable as other texts, and subject to the more literal interpretation that Protestants applied to Scripture. Even Galileo proposes to replace the allegorical *why* of religion with the *how* of mathematical description.[12] In part to exonerate himself from political implications of his own writings, Galileo craftily extols nature as a book that can be read "directly," for which interpretation is irrelevant.[13] In any case, the medieval practice of referring primarily to texts for information about nature, rather than to nature itself, eventually gave way to a newfound respect for facts that could only be ascertained by actual observation—by directly reading the Book of Nature for oneself. On the other hand, by the beginning of the 17th century, some Protestants in their zealous literalism had begun to regard the Bible as an infallible source of knowledge about nature,[14] re-blurring the line between science and religion. Even Newton and some of his contemporaries acknowledged no essential difference between their scientific and biblical studies.

Unlike speech, a text is a *thing*. While originally a record or reconstruction of speech, and normally read in order, a text need not be considered a linear sequence, but may be deconstructed passage by passage, manipulated, or taken out of context. As an abstraction, it exists outside time—in this respect resembling the closed reversible system of physics. For, narration, like causality, makes time flow in a single direction.[15] (Indeed causality *is* a narration: a story about the relationship of things in time.) Yet, a text as a free-standing entity can be read out of order and may be considered a closed logical system, without external reference. It may be scanned for internal structure, pattern, or logical relation, apart from flow, direction, context, or meaning. Ultimately, it may be considered a mere collection of zeros and ones.

To prophesy is to move freely backward and forward in time, *as within a text*. In the narrative of history, as in a text, relations within the content are already fixed—which is the essence of determinism. Real passage of time is conflated with biblical narrative as an ageless historical record, so that the ability to search the Book of Revelations, for example, is conflated with the ability to search actual time. The ideal of objectivity is to occupy a place outside nature and time, like God, and as an author stands in relation to a

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[12] He was the first to introduce the terse style that would thereafter characterize scientific texts—thus expressing a watershed between the medieval and modern mentality. See: Koestler (1960), p186.

[13] Bono *op cit*, p195: "Rather than argue the relative merits of the *texts* written by Galileo and his scholastic opponents, Galileo instead cleverly alters the very ground of the comparison. Philosophy, for Galileo, is no longer a discourse fashioned by human beings... Rather, it is a text 'written in this grand book, the universe'."

[14] Barbour *op cit,* p13.

[15] Taleb (2007), p70.

text or a tinker in relation to a machine. As God became removed from his creation in Deist thought, so the scientist assumed the mantle of a disembodied observer outside the experimental system that is to be "controlled" like a machine. Events are predictable in a deterministic system because in truth it is a deductive system, a machine, a product of definition fixed like a text. Whether the text is the Book of Nature, a Shakespeare script, or a mathematical theory in physics, texts are determinate and searchable in a way that nature is not. To put it bluntly: the only truly deterministic systems are deductive systems.

Throughout the early modern period, proponents of contentious scientific ideas circumvented conflict with Church authorities by the device of considering their proposals to be merely hypothetical fancies, not concerning literal truth in the way church doctrine was supposed to. While motivated by a circumspect diplomacy, this convention set the stage for the modern concept of the scientific model: a hypothetical proposal that is obliged to accord with experiment but not with church doctrine. However sincere or insincere, the religious arguments of early scientists lent credibility to the new sciences and helped to gain their acceptance.[16]

4. Nature as deductive system

Whether the text is written by God or by the theoretical physicist, the advantage of presuming nature itself to resemble a text, a deductive system, or a machine is the promise that it can be exhaustively, if not uniquely, formalized.[17] Hence, it should be predictable, literally by formula. Scientific models and experimental set-ups are "nomological machines."[18] Mathematical theories are at once texts and deductive systems. The reason for the strong emphasis on mathematics in physics, and in other sciences that take physics as their paradigm, is that quantification coordinates theory with measurement in such a way that the behavior of well-defined systems can be predicted. Mathematical treatment works to the extent that natural realities correspond to those well-defined systems that are the actual objects of scientific study: namely, mathematical models. To that extent it is a self-fulfilling prophecy. Whether or not mathematics is the language of nature, as Galileo proposed, it is certainly the language of science.

The deductionist ideal was inherited from the Greeks, who proposed that nature could be reduced to a simple scheme and that the only reliable knowledge was deductive, on the model of Euclid's axiomatic geometry. The deductive program in modern science was first fully expressed in Newton's *Principia*, presented as geometric proofs in the style of Euclid. It imbues Einstein's later thought, whose confidence in mathematical formalism was inspired by the successes of General Relativity.[19] Einstein's deductionist

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[16] Prigogine and Stengers (1984), p47

[17] On the other hand, one motivation for postmodern deconstructionism (which insists that reality should be interpreted as though it were a text) may be to restore the latitude of interpretation that cannot be supposed in a strictly realist view of nature.

[18] A term coined by philosopher of science Nancy Cartwright.

[19] Barrow (1991), p244.

ideal[20] set the standard for subsequent physics and cosmology in the search for a "theory of everything," perhaps reaching its current pinnacle in string theories. An axiomatic approach is encouraged by textbooks, which teach physics in terms of logical rather than historical development. This revisionism makes the laws of nature seem falsely simple and even inevitable.[21] While a theory—and perhaps even a whole science—can certainly be axiomatized, this approach also creates the impression that nature *itself* can be axiomatized, in a definitive story that stands outside time, having erased all traces of historical process or dispute. A deductive system is by nature timeless, eliminating dependency on the particulars of the real world or empirical discovery. However, time is the very essence of nature, and the independent reality of nature consists in just such particularity. Granted that, there can always be unaccountable change and new discovery.

5. The denial of natural autonomy

We have traced the religious origins of the deductive program, which leads science to systematically confuse mathematical theory with nature itself. This program continues to unfold in the quest to derive physical laws, physical constants, and even initial conditions from fundamental theory. An essentially religious idealism underlies the metaphysical notion that the universe itself is a computer, simulation, sheer information, or a sub-branch of mathematics. Such anti-materialist ideas continue to permeate science, perennially contradicting its ostensible materialism. Science, in fact, has always borne this internal tension between the empirical and the analytic, the senses and reason. From the very beginning it was skeptical in regard to the senses, and devalued the autonomy and immanent reality of nature, which are thus rendered subservient to human, when not divine, reason and will.

In Plato's view, the mind is the stronghold of order and perfection, while the body and the material world generally are imperfect, unruly, chaotic, and subject to decay. This anti-materialism appealed to the otherworldly and ascetic mentality of medieval Christianity and helped to shape it.[22] For Aristotle, substance and form were simply dimensions of the being of things. Kant would later say that aspects of form are imposed by the human mind. For the early moderns, inheriting medieval Christianity, form was clearly imposed by the mind of God. Thus, matter needed no internal principle of change or self-organization, indeed no reality of its own. The laws of nature guided passive

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[20] Einstein himself (1954), p274, writes that: "nature is the realization of the simplest conceivable mathematical ideas. I am convinced that we can discover, by means of purely mathematical constructions, those concepts and those lawful connections between them which furnish the key to the understanding of natural phenomena… Experience remains, of course, the sole criterion of physical utility of a mathematical construction. But the creative principle resides in mathematics. In a certain sense, therefore, I hold it true that pure thought can grasp reality, as the ancients dreamed." Note that he does not say "the sole criterion of *truth"*!

[21] Barrow *op cit* p156

[22] Aristotle's idea of the soul was little more than the essence of the mortal body (in modern terms, DNA). Plato's idea, in contrast, was completely non-material—an idealized subject—which better fit the Christian doctrine of the immortal soul with an afterlife.

matter to behave according to divine decree, governing matter in much the way that human laws govern the affairs of men.[23]

Accordingly, the new scientists considered teleology to be imposed on nature rather than immanent within it. They no longer thought of nature itself as striving toward any end of its own.[24] The idea of God as final cause, the supreme end toward which Creation aims, was gradually displaced by the idea of God as first cause, initiating a chain of efficient causes in a domino effect. The Aristotelian idea that natural things possess their own innate reasons for existing was displaced by the idea that nature as a whole is a mechanical artifact, designed and set in motion for human benefit by the provident hand of God.[25]

The fact that God permeated space hardly meant that he was to be identified with it or anything within it. Thus, Newton informs us that "this Being governs all things, not as the soul of the world, but as lord over all." This was a direct comment on the preferred Platonic notion of the soul, in contrast to Aristotle's. Boyle expressed similar sentiments. Both insisted on a radical distinction between creator and creation, opining that powers accredited to nature would only detract from the glory of God.[26]

6. The continuity of religion and science

While medieval Christianity had devalued nature and its study as pointless or even sinful, the post-Reformation attitude saw in the material world signs of divine will that could and should be studied as a religious duty. But without the twin theological assumptions—that the mind of God is manifest in nature and is commensurable with human rationality—there would have been little rationale for the study nature. Early scientists, whether Catholic or Protestant, bartered religious conformity in exchange for sanction by religious authority for their rational scientific pursuits. Bacon's appeal for a "direct" approach to nature was consistent with the Protestant approach to biblical study. The method he had in mind avoided the pitfalls of knowledge passively derived from the senses or accepted on faith: the scientific method of careful experimentation. Creative flights of imagination were to be grounded in clever interventions to "interrogate" nature, actively provoking answers through experiment. Bacon's enterprise was both religious

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[23] According to Giere (1999), p87-9, the question of whether the laws of nature expressed divine will was debated within Britain even into the third quarter of the 19th century. Only after Darwin's influence were the laws of nature separated from divine will.

[24] Barbour *op cit* p29

[25] Osler (1996). There was some debate concerning the reliability of the cosmic machine. One could argue that machines needed far less maintenance than livestock or crops, for example. An idealized machine "devised by a perfect engineer" [Menuge (2003), p94] should carry on by itself forever. On the other hand, Newton acknowledged that the "system of the world" might require occasional servicing, since matter was imperfect. Note that *domesticated* creatures require care, whereas wild nature does not. The referent for the early scientists' concept of nature was pastoral—the domesticated English garden and European countryside, which did require care and which would become increasingly dominated by urban landscapes and industrial installations. Nor would a modern person necessarily agree with the assessment of technology as trouble-free.

[26] Deason *op cit*, p180

and humanist. The aim was to restore mankind to its rightful station prior to the Fall, and society could do this by pursuing the biblical dominion over nature through technology. The transcendent being of God, separate from the world as mind is separate from body, implied that nature could and should be studied, manipulated, and feely exploited for human purposes. It was therefore graver than inappropriate to revere nature itself as divine. And mankind's alienation from nature, formerly a punishment, could now be turned to advantage. It mirrored the divine status above nature, authorizing human (that is, male) imitation of divine creative powers. Thus, knowledge and power superseded moral virtue as the new basis for salvation.[27]

Puritans in particular esteemed reason, mathematics, and physics as studies leading to the appreciation of a rational God.[28] Unlike the ancient Greeks and contemporary scholastics, they valued the manual labor of experiment. They accepted mechanism as founded on reason, precluding blind faith, mystical heresies, pantheism, alchemy and astrology.[29] Their belief in predestination disposed them to immutable laws of nature and determinism.[30]

Despite their competition from the early modern period to the present day, religious faith and reason have a common basis in accepted premises. The axioms of faith were embraced through tradition, scholarship, textualism, historical accident, or simply imposed politically. Those of reason were grounded in direct experience, intuition, logic, and common sense. While blind faith had to be embraced whether or not it made sense to the individual—and despite the blatant fact that it contradicts other creeds—reason could make sense to all and provide a basis for consensus. Yet, reason can only operate on premises first accepted on faith.

There is thus much continuity between the Christian view of nature and the secular scientific view that evolved from it. The line is fine between the quest for godliness and the quest for god-like powers; between the faith-based biblical dominion over Creation and the reason-based domination of nature through technology. The gradual transfer of creative authority from God to Man is portrayed on the ceiling of the Sistine Chapel, passing as a spark between the fingers of Adam and God, who appear nearly as equals. It is unclear which has reached out to bring life to the other.[31] Thus, the emergence of modern science was more or less continuous with its religious roots, and grounded in precepts held in common. *Theory* and *theology*, after all, derive from a common linguistic root. Furthermore, the early practitioners of science were devout males, just as were the leaders of the church. Science not only sprang from religious soil, but also took on some of the characteristics and goals of theology. It became an alternative means of spiritual inquiry, an alternative form of revelation, and an alternative

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[27] Bono *op cit*, p236. Cf. also Jacob (1976), p17-18: "The ordered, providentially guided, mathematically regulated universe of Newton gave a model for a stable and prosperous polity, ruled by the self-interest of man… it allowed them to imagine that nature was on their side; they could have laws of motion and keep God; spiritual forces could work in the universe; matter could be controlled and dominated by God and by men."

[28] Merton *op cit,* p425-428.

[29] Barbour *op cit*, p145

[30] Merton *op cit*, p468

[31] Nasr (1996), p174. The young Michelangelo was privy to humanist discussions in the household of the Medici.

path toward salvation. Mathematical prediction superseded prophecy. Material technology superseded the spiritual technology set forth in dogma and ritual. Man could manipulate nature directly, rather than importuning on God through prayer. Eventually science replaced the bible as a creation story.

The human mind seems adept at a kind of speculation driven by the need for tidy principles, categories, and relations. This need for self-contained systems of thought, which I have called deductionism, is a common ingredient of theology and of scientific theory alike. Both presuppose the separation of mind and body and a preference for mental constructions over brute facts. The scientist, as creator of theory, shares with God, the creator of matter, a point of view outside nature and a spiritual or mental identity different in essence from the material objects of study. Both science and religion are driven by the quest to transcend immediate sensory experience and the limitations imposed by material nature. Theology, we have noted, is the counterpart of scientific theory, insofar as both assert positive ideas about what exists. Both aim at certainty and downplay human agency in creating allegedly objective knowledge.

7. Fundamentalism in physics

The human tendency to create dogmatic systems of thought is hardly restricted to religion.[32] In physics, as in faith, fundamentalism is the search for ultimately fundamental principles and entities. Within science more broadly, it is the belief that physics thus provides the reductive foundation for all other disciplines, which gives it a certain dictatorial authority.[33] This special role of physics distinguishes it from other branches of science, precisely because of its focus on a single unified and ultimately fundamental truth.[34] The empiricism of high-energy physics is strictly experimental, whereas other sciences, such as astrophysics, are more observational and broader in their focus.[35] The entities of high-energy physics are by definition artifacts of elaborate experiments, often designed specifically to test the central theory.

Regardless of the religious beliefs of contemporary scientists, they have inherited a tradition of thought that holds the natural world itself to be a literal artifact, by virtue of which it lacks intrinsic reality of its own but is also necessarily comprehensible. While science appears to be grounded in materialism and empiricism, a major thread of its approach to nature is idealist if not outright theological.[36] This is the deductive thread that

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[32] According to Wikipedia, while the connotation is usually religious, fundamentalism indicates an "unwavering attachment to a set of irreducible beliefs" that are taken as literally true.

[33] For example, the fundamentalist view is that dark energy is the most important scientific problem of our time [White (2007), p14]. Since dark energy cannot be dealt with in the laboratory, its effects can only be observed astronomically. Hence theoretical physics tends to co-opt funds that might go to other observational programs.

[34] White (2007), p1: "Fundamentalists prize the depth of their research, seeing it as a means to abstract from the complexity of the world a Truth which embodies the ultimate foundation of the physics of particles and fields, thus, by extension, of all physics, chemistry and biology."

[35] Ibid, p6.

[36] Davies (1995): "Of course, many scientists don't recognize that in accepting the reality of an order in nature—the existence of laws 'out there'—they are adopting a theological world view."

draws upon the Pythagoreans, Plato, and the heritage of Greek rationalism—which would reduce all knowledge to axiomatic systems—and which dominates theoretical physics today. Leibniz took for granted the divinely "pre-established harmony" between mathematics and the physical world, which would in modern times be renamed "the unreasonable effectiveness of mathematics." Today this deductive and idealist thread is reflected, on the one hand, in the perennial expectation that science is converging on a complete and final theory; on the other, in the notion that the essence of physical reality is ultimately *non*-physical, residing in a quasi-material vacuum or a completely non-material substratum such as mathematics, computation, or "information." Such articles of faith express an ancient skepticism in regard to the reality of the world, readily adopted by Christianity. At the same time, they express a perennial optimism that nature is not simply a mystery one encounters, but can be proactively and exhaustively known by virtue of its inherently rational design, just as Christian theology had taught the founding fathers. It is hardly a coincidence that physics and religion make parallel claims to a singular transcendent truth. For, the scientific ideal of truth descends from the Christian ideal of revealed truth in tandem with the Greek ideal of deductive truth. While modern secular scholarship views religion as a cultural and historical product, science resists outside efforts to similarly "secularize" its hold on truth, just as religious believers themselves rarely view their beliefs in such a light. Science, like religious faith, tends to exempt itself from critical self-examination on that level—which is taken up by sociologists, anthropologists, and historians and philosophers of science.

The very fact of there being mathematical laws of nature at all is hardly surprising, since scientists deliberately select patterns that can be expressed by computable functions. This choice is simply taken as self-evident, with little consideration for patterns that it might exclude. But such sins of omission lead to trouble in physics, when hard-nosed and pragmatic determination to complete a self-consistent fundamental theory displaces deeper reflection on the issues and entities concerned.[37] Theorists render space n-dimensional in theory, only to brood over the coincidental fact of three dimensions in ordinary experience. They posit factors that operate in isolation, and are surprised by the complexity and improbable "fine-tuning" that result from artificially re-combining them. They assume matter to be simple and passive, and then are puzzled how such a mechanical system could organize itself to come to life and consciousness. They create baroquely elaborate (string) theories that cannot be tested.

The dualism of inert matter and governing laws grew out of the ancient distinction between substance and form and the religiously grounded distinctions between object and subject, matter and mind, world and spirit. The inability of the religious worldview to account for the evolving order of the physical universe first became apparent in the life sciences and in conflicts between the biblical account of Creation and archaeological, fossil, and geological records. The problem for science was (and remains) to explain how the complexity of matter, of life, and of mind could arise from the passive inertness and simplicity of inorganic matter—which the early scientists thought could only degenerate without divine maintenance. The problem so conceived is rigged from the start, for 'mechanical system' and 'inert matter' are *assumed* from the outset to lack the required

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[nb 36 cont.] However, "order in nature" and "laws out there" are not the same thing. A platonic view of laws *is* essentially theological, but a view of laws as empirical description is not.

[37] See: Smolin (2006)

properties. On the basis of such engrained biases, it is no easier to imagine how the suite of 'symmetry breakings' that are supposed to account for the particle zoo could take place "spontaneously"—that is, unguided by pre-existing laws. Yet, to assume the prior existence of laws is sheer dualism and metaphysics; it bears no advantage over assuming instead a ubiquitous potential for self-organization.

The duality of laws and initial conditions is a modern echo of the dualism of mind and matter institutionalized in religion.[38] Matter passively "obeys" mathematical laws, but only when the initial or boundary conditions are written into the equations by the divine or human hand. For the early physicists, God obligingly imposed both the laws and the initial conditions. More secular theorists would later specify these themselves, claiming the freedom to create alternative worlds on paper (or in computer simulation). The notion of law is still widely considered transcendent rather than inherent in the stuff of the world. The Second Law of Thermodynamics, for example, applies only to artificially isolated closed systems.[39] The problems of improbability this engenders are built into an outdated mechanical view of matter paired with transcendent laws to "govern" it.[40]

Perhaps the notion of divine intervention inspired modern theorists to believe they could themselves arbitrarily set initial conditions, natural constants, and even the laws themselves, so to speak by "twiddling a knob."[41] The theoretical universe is then taken to be a sort of machine whose controls can be adjusted to make a different world, varying in such features as vacuum energy density, gauge symmetries, the values of elementary forces, charges, and masses, metric signature (whether various dimensions are considered positive or negative), and even the number of spatial dimensions.[42] A purely *conceptual* space of any number of parameters defines a "landscape" of possible universes, in which even established power laws can take different exponents. One can then speak of a "local area" within the landscape, consisting of universes resembling our own. Just how many angels can dance on the head of a pin?

There is no physical (or even metaphysical) basis for identifying such conceptual tools with physical reality. On the contrary, the theoretical unpredictability of fundamental constants, initial conditions, and natural laws themselves, mirrors the inscrutable divine freedom of choice in how to detail the world that the early scientists deemed necessary to uphold the supreme power of God over his creation. This is nothing other than the fundamental indeterminism of nature, which renders it immanently real,

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[38] Initial conditions present a double dilemma: on the one hand, they cannot be derived from theory; on the other, if they *could* be so derived it would imply that nature is nothing more than a deductive system, a set of equations to fit on a tee-shirt. However, initial conditions would pose less of a problem if the present state of the world were robustly independent of them.

[39] If the values of natural constants cannot be derived from theory, perhaps it is because they do not depend on easily isolated factors, just as there are no truly isolated systems. Fine-tuning may mean simply that single factors cannot be changed in isolation without a drastically different outcome. "Single factors" characterize machines, not organisms—and perhaps not the universe either. There is no reason to suppose such precarious one-dimensional dependency in nature, where multiple factors normally operate together and not in isolation.

[40] Bruiger (2016)

[41] Davies *op cit*.

[42] Leslie (1989), p76

mysterious, and resistant to human definition.[43] Natural laws may be simple and precise, because they are products of human thought. The detailing of the world, however, is complex and messy. Though God may not have created the world, it is certain that we did not either.

Physics (and science in general) continues to struggle with the consequences of its own fundamentalism—articles of faith about the natural world, many of which are carried over from the religious heritage of early science. These have included the belief that inorganic matter is inherently mechanistic and incapable of self-organization; the exclusive focus on efficient causation; the exclusion of personal subjectivity from scientific description; the belief in transcendent laws; the placement of the observer outside the system observed (just as God is outside nature); the concept of determinism as a reflection of divine fiat; the stock concept of the closed reversible system (the world as an artifact); the belief that the world is and should be ultimately simple and comprehensible; and scientific deductionism, which reflects the self-contained *text* of the Book of Nature.

8. Conclusion

Modern science has come full circle, displacing religious dogma only to substitute its own hair-splitting doctrines, equally removed from ordinary life and accessible only to an initiated elite. Its key concepts are beyond the untrained person's grasp. Its authentic texts are in no vernacular but in the esoteric jargon of higher mathematics. It has its own priesthood to interpret its doctrines to the laity. While the scientific spirit has uncovered genuine mysteries, these are not so much answered in ordinarily meaningful terms as they are buried in an avalanche of technical research and technological spin-off. The modern citizen accepts the benefits of scientific research without needing to understand their theoretical underpinning, just as the medieval Christian accepted the benefices of the Church without needing to grasp the finer points of theology. Just as modern religious groups may offer bible study classes for those who wish to understand the theology of their faith, many scientists do engage in outreach through popular writing, attempting to explain difficult theoretical ideas. While these may seem to be vastly different undertakings, they have in common that the precepts conveyed are generally presented as truths rather than human inventions.

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[43] One does not evade this circumstance (of unpredictability) by positing a "multiverse" as a larger context. The principle motivation for the multiverse is to explain naturalistically the seeming improbability of *this* universe, by allowing it as a rare random occurrence out of a huge sample, or else as an effect of cosmic natural selection [Smolin (1997, 2013)]. But the same arguments would apply in turn to the multiverse. The idea of randomly occurring (and therefore improbable) parameter values corresponds to a situation of unstable equilibrium. It would be more fruitful to look for situations of *stable* equilibrium—like a marble in a basin—attractor states insensitive to initial conditions. Rather than an explanation designed to overcome specious improbabilities ("fine-tuning"), one should seek an explanation in which the nature of the system is that all initial conditions tend toward the state in question.

The resurgence of religious fundamentalism globally, and the responses of scientists to creationism, should be understood against a background of historical continuity and common ground between religion and science. Given the pivotal influence of Christianity on the development of science, resurging antagonism between religious and scientific communities should be assessed in the context of shared assumptions and values. The first scientists, after all, were unblushing creationists! Even in late 19th century, many scientists took an interest in spiritualism, with an idealistic regard for science as an ethical pursuit.[44] Some even hoped to scientifically demonstrate a spiritual basis for material reality.[45] And some contemporary Christians have come to regard the "new physics" as an ally of their faith, hoping to undermine what they perceive as the materialism of the old Newtonian worldview.

The challenge to science of the Intelligent Design movement is not to show how "blind chance" can produce emergent phenomena that look designed by an agent outside nature. It is rather to show how natural phenomena that look like blind chance can actually be the result of agency *within* nature. Toward that end, we labor against a longstanding psychological investment in our identity as *the* active agents, in contrast to allegedly passive and simple matter. If we seek a mature understanding of our place in the cosmos, however, we must cease to demean nature's power in order to assert our own. Accordingly, one goal of a revised science would be to demonstrate that a cosmos as apparently unlikely as ours would be nearly inevitable in the light of deepened understanding of processes of self-organization. Another possible outcome could be a scientific explanation of consciousness itself, whose elusiveness until now may simply reflect the self-imposed limitations of science as we know it.[46]

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[44] Powers (1982), p58
[45] Stewart and Tait (1873), p5, quoted in Powers *ibid*, p89
[46] See Bruiger (2017)

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