religions

Article

Christianity Cultivated Science with and without Methodological Naturalism

Michael N. Keas

Lecturer in History and Philosophy of Science, Biola University, La Mirada, CA 90639, USA; mkeas@icloud.com

Abstract: Many people assume ceaseless conflict between natural science and Christianity, but the real conflict has been between scientism and Christianity. Scientism is the view that only the sciences (especially not theology) generate knowledge or rational belief. I show how Christianity generated rational beliefs that contributed to the rise of science. This science-fostering rational belief included rationales for when to practice methodological naturalism, and when to study nature without that restriction. Both practices cultivated science, though in different ways. This historical difference is of enduring value for recent debates about metaphysical naturalism (atheism), creationism, theistic evolution, and intelligent design.

Keywords: methodological naturalism; scientific naturalism; medieval science; historical science; origin science; scientism; Darwinian evolution; theistic evolution; intelligent design; William Whewell; X Club

check for updates

Citation: Keas, Michael N. 2023. Christianity Cultivated Science with and without Methodological Naturalism. *Religions* 14: 927. https://doi.org/10.3390/rel14070927

Academic Editors: John A. Bloom and Christine A. James

Received: 9 May 2023
Revised: 15 June 2023
Accepted: 17 June 2023
Published: 18 July 2023

1. Introduction

"The idea of a ceaseless conflict between" natural science and religion "seems to be an integral part of the public consciousness." (Elsdon-Baker and Lightman 2020, p. 3). So observe two scholars in a recent academic anthology about science and religion. These historians argue that this conflict thesis substantially misrepresents the facts, while at the same time, noting that it is "more ingrained in the scholarship than previously imagined", and the "only way to root it out is to pursue a multidisciplinary reenvisioning" of science and religion studies (Ibid., p. 10). I contribute to this multidisciplinary reenvisioning within the domain of the history and philosophy of science. It has already been shown that the real conflict has not been between *science* and Christianity, but between *scientism* and Christianity (Plantinga 2011; Keas 2021). Scientism is the view that only the sciences (especially not religion) generate knowledge or rational belief.[1] I show how Christianity generated rational beliefs that contributed to the rise of science. This science-fostering rational belief included rationales for when to practice methodological naturalism, and when to study nature without that restriction. Both practices cultivated scientific progress, though in different ways. This historical difference is of enduring value for recent debates about metaphysical naturalism (atheism), creationism, theistic evolution, and intelligent design.

"Nothing has come to characterize modern science more than its rejection of appeals to God in explaining the workings of nature. Numerous scientists, philosophers of science, and science educators have made this claim". So announced the leading historian of science Ronald Numbers 20 years ago. He argued that this *science without God* principle, commonly called methodological naturalism, is a widely practiced "method of choice for understanding nature" that owes much to a long line of devout Christians who helped formulate it and prove its utility in the growth of science since the Middle Ages (Numbers 2003). According to some recent studies, ancient Christians began with *God without science*, or not much science, and ended up producing—in concert with other factors—late medieval *science without God*.[2] Unlike the old conflict thesis, the *science without God* thesis debunks the popular claim that Christianity produced 1000 years of medieval anti-science—the so-called "Dark Ages".

Many will cheerfully accept the new view's trade-in offer: Christianity is absolved of alleged Dark Ages anti-science, in exchange for recognition of Christianity's contribution to methodological naturalism and other features commonly associated with modern science. Many Christian theistic evolutionists especially recommend this historiography when it is attached to a particular lesson.[3]

The lesson is this: Enlightened Christians will methodologically, not philosophically, join hands with the majority of scientists (including atheists) in reconstructing the history of earth's organisms in a manner similar to Charles Darwin, who still believed in God when he published his *Origin of Species* in 1859 (he later converted to agnosticism) (Brooke 2010b). Embracing such methodological naturalism, regardless of your religious or non-religious worldview, allegedly puts you on the right side of history—to best practice science.[4]

To evaluate the merits of this lesson, and to better understand the history of science-Christianity relations, we will study the development of methodological naturalism—and its negation—in a few prominent phases of the history of science. We begin with recent analyses of methodological naturalism offered by philosophers of science. With these distinctions in hand, we will examine history to see methodological naturalism, and its denial, playing various intellectually virtuous roles in science.

2. Methodological Naturalism

There are multiple versions of methodological naturalism to recognize. Philosopher of science Sandy Boucher clarifies the important distinction between intrinsic methodological naturalism (IMN) and pragmatic methodological naturalism (PMN) (Boucher 2020), which he traces back to the Belgian atheist philosopher Maarten Boudry.[5] Here is my definitional summary of Boucher and Boudry:

> IMN: Science, as a way of knowing nature, excludes supernatural explanations of nature.
>
> PMN: Because scientists, *qua* scientists, have evaluated supernatural explanations of nature and found them inadequate, scientists no longer consider supernatural explanations as live options for scientific theory.

Boudry and his coauthors recommend PMN due to IMN's "failed strategy of ruling the supernatural out of science by philosophical fiat"—mere stipulation. They define supernatural as "processes and causes that transcend the spatio-temporal realm of impersonal matter and energy, and to phenomena arising from the interaction of those entities with the material universe." (Boudry et al. 2012, p. 1152). Given that Boudry and his co-authors would identify *themselves* as "phenomena arising from the interaction" of "impersonal matter and energy", they should allow for Richard Dawkins' admission (to Ben Stein in the documentary *Expelled*) (Expelled: No Intelligence Allowed 2008) of the possibility of smart aliens as the creators of earth's life. Such *naturalistic intelligent design* should be a legitimate scientific hypothesis within the methodological restrictions of IMN and PMN. However, if *intelligent design* (ID) means *God did it*, then ID is beyond science, if we accept the boundaries provided by IMN and PMN. We will return to ID because of its frequent mention in relation to methodological naturalism by many of my fellow historians-philosophers of science.

Boudry and his coauthors make an observation that is part of their rationale for preferring PMN over IMN.

> Not surprisingly, IMN is typically embraced by philosophers sympathetic to religion, by theistic evolutionists and religious liberals intent on safeguarding an epistemic domain for religious faith . . . , as well as by atheists who try to disarm the perceived conflict between religion and science . . . . In a way reminiscent of Stephen Jay Gould's principle of non-overlapping magisteria (NOMA) . . . , IMN seems to embody the modern *modus vivendi* between science and religion (Boudry et al. 2012, p. 1153).

However, Boudry and his coauthors argue this strategy for keeping religion safely separate from science by means of IMN is illegitimate because it amounts to "ruling

the supernatural out of science by philosophical fiat"—mere stipulation. There are yet other worries.

Philosopher of science Timothy (Tiddy) Smith (Smith 2017) argues that although IMN and PMN have merit, neither gets the full story correct. Methodological naturalism (MN) merely stipulates that "only natural cognitive faculties may be used" to justify theories about nature. Appeal to divine revelation or other "supernatural methods" is off-limits within science. In sum, MN "construed as an epistemological thesis, is a commitment to public methods, and this commitment is no kind of metaphysical prejudice". I call this MN version *epistemological methodological naturalism* (EMN). Smith argues that such an understanding of MN "is not a thesis about what may or may not be conjectured [as an explanation] by scientists [as is the case with IMN and PMN], but about how scientists may or may not justify their theories". Based on Smith's work, we may define epistemological methodological naturalism.

> EMN: Only publicly accessible methods using natural human faculties can justify theories of nature.

Theories of nature refer to explanations within the natural sciences. Smith's EMN aims to describe a central methodological trait of natural scientific inquiry, not to function as a rigorous demarcation between the natural sciences from other disciplines. EMN expresses a minority viewpoint of the meaning of MN, but considering this view is illuminating. Smith summarizes his argument for the incompleteness of IMN and PMN—and the superiority of EMN.

> To recap, the pragmatic defense is correct that supernatural explanations are testable, have been tested and have often failed in the scientific arena. Yet on the other hand, the pragmatic defense gets wrong the historical claim that methodological naturalism was eventually adopted as a rule of thumb [after the progressive failure of supernatural explanations]. The intrinsic defense also gets something right, insofar as science is a discipline with an explicit, a priori, anti-supernatural bias. But, the intrinsic defense doesn't square with the observation that science apparently can test and has tested supernatural explanations (Ibid., p. 327).

Smith's *history of science* critique of PMN is largely in tune with the most persuasive arguments to date—the majority historical interpretation as advanced by scholars such as Ronald Numbers and Peter Harrison, which I partly accept, and contest, below.

Smith's EMN, and coordinated critique of other versions of MN, give intelligent design (ID) more latitude to be recognized as a *scientific* research tradition. In his words: "Yet in the minimal sense of being publicly justified only by appeal to public methods, ID is, by the lights of the thesis argued here, scientific." Smith considers ID a "failed research program" within science, although he does not endeavor to demonstrate this. While the "motivation for defending ID is almost always religious", this "does not entail that the defenses of the theory must themselves be." (Ibid., p. 335). This is a nuance about ID that many historians and philosophers of science have overlooked. It is one way ID can be distinguished from creationism.[6] To appreciate Smith's EMN permitting ID to be scientific due to its non-religious defensibility, digest this recent description of ID.

> Intelligent design—often called "ID"—is a scientific theory which holds that some features of the universe and living things are best explained by an intelligent cause rather than an undirected process such as natural selection. ID theorists argue that intelligent design can be inferred by finding in nature the type of information and complexity which in our experience arises from an intelligent cause (Luskin 2021).

In the following episodic historical survey of the foundations of science, we will search for these three major versions of MN: intrinsic, pragmatic, and epistemological. We will explore the relationship of MN, and its negation, to religion, non-origins science, origins

science, ID theory, Darwinism, and various shades of metaphysical naturalism (atheism) and agnosticism—approximately in that order.

3. Greco-Roman Thinkers Cultivated Science with and without MN (Mostly without)

Until recently, many scholars have long claimed that a wide array of ancient Greek and Roman philosophers rejected the relevance of the gods and anything capricious or unpredictable in their study of nature, thus establishing the principle of MN, and thereby also giving birth to natural science. That is the historiography of science promoted by an influential group of 19th-century (Victorian) British scientists and polemicists. According to this now-discredited story, natural science was invented by ancient pagan Greeks, declined in medieval Christian Europe, and then was restored in the scientific revolution of the 16th and 17th centuries (Harrison and Roberts 2018; Stanley 2014b, p. 244).

In contrast to this view, Daryn Lehoux documents how most ancient Greco-Roman theories of the natural world included divinities interacting with nature in various governing and shaping roles. Most of the Presocratic natural philosophers took this approach, as did Plato and Aristotle. Lehoux further notes that the most influential ancient physician-philosopher Galen detected "a purposive divine agency behind the flawless design of human and animal bodies". Seneca posited "divine rationality as central to how the world works", and Ptolemy wrote in his *Almagest* (the most influential pre-modern science book) "that 'the first cause of the first motion of the universe . . . can be thought of as an invisible and motionless deity', gesturing back, one suspects, to Aristotle's account of the prime mover." (Lehoux 2019, p. 24). Some of these ancient thinkers traced the world's history back to a primordial stage that included uncreated matter, but that approach still does not fit the Victorian naturalistic stereotype of the history of science, as Lehoux explains.

> If the matter from which the cosmos is formed is sometimes said, as in Plato, to have been pre-existing, that does not entirely "naturalize" the account, at least insofar as divine agency is still responsible for the shape and characteristics of the world. A supernatural entity of one sort or another is clearly interacting with the system, and "the natural order" itself is seen to be non-self-starting. The chain of natural physical causation, that is, is seen as insufficient to explain its own beginning (Ibid., p. 27).

Lehoux concludes that "some of the biggest names in early science unabashedly" touted "divine causation in the cosmos, not just coincidentally or metaphorically, but deeply and centrally" in the practice of nature studies (Ibid., p. 29). He gives a prominent example. In the *Physics* Aristotle argues daily star motion is caused by the prime mover, which contains the cosmos. Stellar motion, in turn, causes the four terrestrial elements (fire, air, water, and earth) to move in ways that, along with the internal tendencies of each terrestrial element, largely explain natural changes—generation and corruption—in our immediate natural environment. In the *Metaphysics*, Aristotle explicitly identifies the prime mover of the *Physics* as divine—a conception that had been lurking in the *Physics* (Ibid., pp. 28–29). Thus, Aristotle's main account of natural causation invokes divine agency. Aristotle, like the vast majority of ancient pagan Greek thinkers, did not restrict their study of nature by an MN-like rule, Lehoux concludes. He documents this conclusion by reference to great thinkers such as Plato, Aristotle, Galen, and Ptolemy.

What about the few ancient cases in "science where naturalism in our sense seems to be more clearly and explicitly" displayed? Even here, the 19th-century MN science origin narrative is faulty. Lehoux's analysis of the ancient atomists makes this point well.

The Epicurean atomists argued all of nature could be explained by the interaction of invisible atoms. Their interactions—triggered by a random uncaused *swerve* mechanism—are due to collision and rebound. All of this was conceived to be independent of the gods, whose only role was to passively provide us with moral exemplars. Although this godless scientific theory had no role for capricious unpredictable anthropomorphic deities, ancient atomism traded personal capriciousness for impersonal capriciousness. The outcome, ex-

plains Lehoux, is that the "universe becomes unpredictably arbitrary in ways no naturalist should be willing to bear". He elaborates:

> Where the ancient philosophers who invoke divinities do so, nearly universally, to account for nature's regularity, complexity, and beauty, the one school we have found to be pure naturalists, the Epicureans, are the one school who allow for just this kind of capriciousness—the random, uncaused swerve—in the cosmos. It may not be a personalized kind of capriciousness (just the opposite), but for all that it is exactly the kind of explanation that "pure naturalism"—if such a thing even exists—was designed to avoid (Ibid., p. 36).

At the beginning of this section, we asked whether ancient Greek and Roman philosophers rejected the relevance of the gods and anything capricious or unpredictable in their study of nature, and thereby established the principle of MN, and thus also gave birth to science. This Victorian *MN origin of science* story fails to fit the overall pattern of Greco-Roman natural philosophy. Epicurean atomism, the closest case for a match to MN, turned out to be very unusual and also an awkward fit for the *MN origin of science* narrative traditionally aimed at *eliminating unpredictability* in nature.[7]

As we transition from Greco-Roman to Judeo-Christian perspectives, we will encounter an expanded set of options for rational progress in the study of nature. This will include a new kind of MN, which despite—or because of—its differences from modern MN, was much more friendly to science than the ancient pagan MN that had produced the Epicurean view of unpredictable natural events. Even so, there is some continuity in that both the non-Epicurean Greco-Roman and the Judeo-Christian traditions appealed to divinity in ways that often supported a view of predictable natural regularities that encouraged scientific investigation.

4. Medieval Christians Cultivated Science with and without MN: Progress, Diversity

Had he known the corrective historiography in Section 3, physicist Stephen Hawking might have been prevented from misconceiving some of the early stages of science in relation to Greco-Roman and biblical religion. He claimed that the earliest explanations of the cosmos invoked capricious and unpredictable divinities as the cause of events in nature. Although this is true of many cultures, there are many components of the Greco-Roman and Judeo-Christian traditions that did not promote this science-inhibiting perspective. Hawking claimed: "Gradually, however, it must have been noticed that there were certain regularities." (Hawking 1998, p. 188). Hawking seems to have been unaware that belief in the Judeo-Christian God actually supported the idea of the cosmos as a knowable and predictable lawful system, which is foundational to science. Here is one of the key texts:

> Thus says the LORD, who gives the sun for light by day and the fixed order of the moon and the stars for light by night . . . If this fixed order departs from before me, declares the LORD, then shall the offspring of Israel cease from being a nation before me forever (Jeremiah 31:35–36, ESV).

Christopher Kaiser's analysis is helpful.

> The term translated here as "fixed order" (NRSV) is the Hebrew word, *hoq*, meaning a royal decree or law. It is translated as *nómos*, the Greek word for law, in the Septuagint, and as *lex* in Jerome's Latin translation, the Vulgate. The biblical and theological use of these terms played a huge role in the development of the idea of cosmic natural law inherited by modern science (Kaiser 2007b, p. 48).

Building on this Judaic foundation, Theophilus, the Christian bishop of the Syrian city of Antioch (died ca. 185), recognized that "an earthly king is believed to exist . . . by his laws". Although most people never personally encounter a king, they can infer his existence by observing the orderly society such a king governs. By analogy, Theophilus argued, God is known "by his works", including "the timely rotation of the seasons . . . the various beauty of seeds, and plants, and fruits", and various "species of quadrupeds, and birds, and . . . the instinct implanted in these animals." (Dembski et al. 2008, pp. 91–92). Drawing

from their Jewish roots, ancient Christians recognized that lawful nature reflects a God who reigns as the maker and ruler of all. Medieval Christians developed this science-fostering idea further.

The standard Victorian MN story of science's origin, reflected in Hawking's misconceptions above, has been recently challenged by historians of science who have focused on the European Middle Ages and subsequent developments. These scholars have documented Christianity's important contribution to MN and other features of science (Harrison and Roberts 2018). Some of these medieval Christian science-fostering rational beliefs approximately constituted MN, but often they were importantly different, as I will now show.

4.1. Adelard of Bath (ca. 1080–ca. 1150)

One of the earliest candidates for a Christian advocate of MN is the Englishman Adelard of Bath. He is particularly remembered for his book *Natural Questions*, a dialogue with his skeptical "nephew", which constitutes a study of plants, animals, meteorology, astronomy, and human anatomy-physiology-psychology. He opens his book with an investigation of how plants routinely sprout from the soil *without* humans planting seeds or any known seeds existing in the soil, even after putting the soil through a sieve and placing it in a bronze pot. He ignores the possibility of plant seeds *unknown* to the investigators as the cause of this reoccurring sprouting phenomena, which is how his contemporary Peter Abelard (and we) solve this puzzle. Instead, Adelard of Bath addresses only two possible causes for such sprouting: (1) It is the immediate "effect of the wondrous divine will" (miracle),[8] and (2) it is the effect of an elemental capacity within soil that has existed ever since God first created this natural capacity. He argues for the second option with this proviso:

> I am not slighting God's role. For whatever exists is from him and through him. Nevertheless, that dependence [on God] is not [to be taken] in blanket fashion, without distinction. One should attend to this distinction, as far as human knowledge can go; but in the case where human knowledge completely fails, the matter should be referred to God. Thus, since we do not yet grow pale with lack of knowledge, let us return to reason.[9]

Adelard thought God miraculously created the original natural order of plant life. Once in existence, God maintains this natural order in such a way that, using our God-given human reason, we discover natural causes for these routine effects. However, when, after persistent effort, human reason fails to find natural causes for something, then we "should" (*epistemic*, not moral, "should") *reasonably* conclude that we have encountered the foundation of that natural order—the point at which God miraculously created it. In this study, Adelard is not focusing on the origin of plants, but on the routine causes of plant sprouting. Thus he says, "let us return to" reasoning about such ordinary natural causation.

Supernatural explanations are appropriately invoked at the edge of such nature studies, where we can reasonably infer the origin of a natural system. However, supernatural causes are inappropriate for explaining routine causal relationships within the ordinary operation of nature. This perspective about when to—and when not to—invoke supernatural causation, helped cultivate natural science, as seen in Adelard's *Natural Questions* dialogue.

The natural order examined in this part of his dialogue is not the whole cosmos, but only plant life. Adelard argues that we can rationally discern (at the edge of this domain of study) that God miraculously created plant life long ago. He also acknowledges that we can discover how plants routinely grow out of the soil without the direct intelligent action of God or humans. If Adelard had been addressing here the entire universe as a natural order, then his deliberations would have more resembled adherence to MN. However, Adelard only addressed reoccurring plant processes here. Later, he investigates other domains of reoccurring natural phenomena. Because he was *not* investigating *origins* in the "day of creation" (as Adelard expressed it), his investigative guidelines are quite different from MN. Typically MN only makes a significant difference in regard to the study of how things originate, rather than how things routinely operate. So we see a Christian frame

of mind contributing to science-fostering belief without MN as the majority of scholars now conceive it (IMN or PMN). Adelard of Bath's contemporary Peter Abelard also largely avoided MN as he developed a different approach to nature in its relationship to God, which nevertheless also laid some of the foundations for science.

4.2. Peter Abelard (1079–1142)

Peter Abelard's essay on God's creation of the world in "six days" (*Hexaemeron*) interprets the opening chapter of Genesis as communicating fundamentally different kinds of creative work organized in a six-day literary format that was not intended as strictly chronological teaching. Day one is about the origin of the cosmos in its initial primordial condition, full of potentiality for further specification by subsequent divine action. Historian Richard Dales observes: "Abelard posits an absolute beginning, a creation by God in which He first planned rationally in His own Mind what He was going to do, and then without any intermediaries He did it." (Dales 1992, p. 268). Consequently, humans, because they are made in God's image, are capable of knowing the order of nature that God created and sustains. Abelard further explicates this science-friendly belief by arguing humans can *rationally discern* the difference between God's initial creation of things (miracles) and our detection of ordinary natural causes (how things are sustained by God).

> When we now seek or assign a force of nature or natural causes in any outcomes of things, in nowise do we do it according to that first work of God in the disposition of the world, where the will of God alone had the power of nature in those [things] then to be created or arranged; but only after the work of God completed in six days. We usually identify a force of nature in the aftermath, when those things are in fact already so prepared that their constitution or preparation would be enough to do anything without miracles. Hence we say that those things which occur though miracles are rather against or beyond nature than according to nature, since that former preparation of things could not suffice for doing it, unless God were to confer some new power on these things, just as he was also doing in those six days, where his will alone worked as the force of nature in each thing to be made. If indeed he were also to work now [miraculously] as he did then, we would say at once that this is against nature, as for instance if the earth were spontaneously to produce plants without any sowing [of seed]. . . . Hence we call nature the force of things bestowed on them since that former preparation, sufficient thenceforth for something to be born, that is, to be made [non-miraculously].[10]

Notice Abelard makes similar points as his contemporary Adelard of Bath about the present natural order (in contrast to its original creation), but he disagrees with Adelard with regard to the natural cause of routine plant sprouting. This is due to seeds, not the elemental properties of soil. That was a reasonable step forward in nature studies, even though it took place within a theological treatise on the six days of creation, in conversation with God's subsequent sustaining of natural regularities. In the absence of later sharp university disciplinary boundaries between theology and nature studies, Abelard laid the foundation for *reasonably inferring the difference* between God's initial creation of particular natural things and our detection of ordinary natural causes that reflect God's faithfulness.

Recall Adelard of Bath asserted that when "human knowledge completely fails" to detect a natural cause of some effect, then "the matter should be referred to God", declaring it a miracle. This sounds as if the inference to direct divine intelligent causation is an argument from ignorance—when human reason "completely fails". However, Adelard of Bath's point here was subtly different. He argued that when, in a particular case, human reason completely fails (*after much effort*) to identify a natural cause, then it is *reasonable* to infer divine intelligent causation. Peter Abelard had a more explicitly positive way of framing the ability of human reason to distinguish between an event that is directly caused by God's intelligent action (miracle) and an effect that is caused by the ordinary course of nature as sustained by God. Both of these medieval explications of nature in relation to

God were science-friendly, and both fell outside the strict parameters of MN as typically conceived today.

Adelard and Abelard productively studied nature without MN restrictions, perhaps in part because they worked before the rise of universities with institutionalized disciplinary boundaries that sharply separated theology, natural philosophy, and other academic disciplines.

4.3. Boethius of Dacia (Late 13th Century): Did the Universe Have a Beginning?

Boethius of Dacia was a leading philosopher at the University of Paris liberal arts faculty about 1270–1275. Reflecting his university environment, he strongly demarcated academic liberal arts reasoning (including mathematics and natural philosophy) from Christian theology in his treatise *On the Eternity of the World*. He argued there is no way within natural philosophy, or the other liberal arts, to prove or disprove the universe came into existence a finite time ago. Some of his reasoning to this end appears identical to the MN-constrained study of nature.

To appreciate Boethius' argument, realize that he employed largely Aristotelian natural philosophy to conclude something comes into being *naturally* only when pre-existing matter acquires what Aristotle called a *form*. Such an event is generation, not creation. The natural world has within itself the capacity for only generation, not creation, Boethius argued.[11] He also briefly recognized other kinds of liberal arts reasoning beyond natural philosophy, such as mathematics and metaphysics. However, he concluded that these other disciplines in the university liberal arts program, like natural philosophy, are incapable of definitively establishing whether or not the universe had a beginning (Ebbesen 2020; Boethius of Dacia 1987, pp. 46–67). Part of his rationale for this conclusion was the following restrictive rule internal to Aristotelian natural philosophy: "Whatever the natural philosopher denies or concedes *as* natural philosopher, this he denies or concedes from natural causes and principles." (Boethius of Dacia 1987, p. 52). This sounds like an early Christian articulation of MN, especially if one identifies MN as either IMN or EMN,[12] but not PMN.

Let us see why from the Section 2 definitions.

> IMN: Science, as a way of knowing nature, excludes supernatural explanations of nature.
>
> PMN: Because scientists, *qua* scientists, have evaluated supernatural explanations of nature and found them inadequate, scientists no longer consider supernatural explanations as live options for scientific theory.
>
> EMN: Only publicly accessible methods using natural human faculties can justify theories of nature.

Boethius' restrictive rule corresponds fairly well with IMN. As to EMN, consider this: The "natural causes and principles" Boethius adopted from Aristotle, thanks to Church-funded university education, were *publicly accessible methods* made operable using *natural human faculties* that had been trained by the natural philosophy masters in universities across Christendom (Europe). Thus, Boethius' rule internal to Aristotelian natural philosophy might also be said to fit within EMN parameters.

However, doubts remain about the medieval MN thesis that identifies Boethius' rule as MN—understood as IMN, and perhaps also EMN. Although Aristotle's ahistorical theory of non-origins (the eternity of the world) belonged to natural philosophy as partly Christianized within medieval universities, most Western intellectuals since the time of Newton, for progressively good experimental and other rigorous empirical-conceptual reasons, have *not* recognized much of Aristotle's natural philosophy as legitimate scientific knowledge. So Boethius' exercise in natural philosophy regarding Aristotle's eternal world argument has long been regarded, for excellent reasons, as failing to measure up to the basic standards of the natural sciences—the very standards baked into the definitions of MN, whether IMN, PMN, or EMN. All three major versions of MN are about scientific theories of nature that are radically different from, and vastly superior to, Aristotle's

natural philosophy. Such doubts about the medieval MN thesis are expressed in the title and content of Michael Shank's recent essay "Naturalist *Tendencies* in Medieval Science" (title emphasis is mine). He identifies medieval natural philosophy approaches that are "akin to"—not identical to—"what we now call methodological naturalism." (Shank 2019, p. 38). Such a qualification should be seriously considered because it comes from a leading historian of medieval science.

Philosopher of science Stephen Dilley, who recognizes Boethius' restrictive rule as MN, offers additional criticism of Boethius' approach, including a point about the absence of a pragmatic justification for MN—the very thing insisted upon by PMN.

> Why not . . . provide an argument for his definition [of MN] or adopt a more supple pragmatic justification for methodological naturalism? After all, it appears as if Boethius has simply displaced, rather than solved, the problem: the heart of his view is that natural philosophy doesn't conflict with revelation because it is constrained in scope, but this constraint—which allegedly solves his problem—stands as a brute, unjustified assertion. So Boethius has cloaked rather than dispelled the difficulty (Dilley 2007, p. 45).

Dilley concludes Boethius asserts MN without pragmatic justification. This is part of the historical evidence against the historical-philosophical PMN thesis. Such historical criticism shows that early articulations of MN-like rules, such as the one from Boethius, did not surface due to a perceived inadequacy of competing supernatural explanations of nature, as PMN alleges. Indeed, medieval Christian intellectuals virtually never suggested that the routine operation of nature should be explained by miracles. This respect for the God-sustained integrity of natural regularities was an important ingredient for the growth of natural science.

However, given Aristotle's ahistorical conception of nature, the natural principles assumed to be governing the routine operation of nature *also* implied a beginningless account of nature—although Boethius wisely argued natural philosophy is incapable of either proving or disapproving Aristotle's beginningless cosmos. Because medieval academics largely adopted Aristotle's ahistorical non-origins conception of nature for the purposes of carrying out natural philosophy, they typically also sharply demarcated such natural philosophy from theology in order to maintain the independent integrity of both academic fields—a demarcation that sometimes resembled MN. Aristotelian natural philosophy implied a beginningless cosmos (though this was debated in medieval natural philosophy), but Christian theological discourse supplied good reasons for believing in the creation of the cosmos "by reason of a higher cause which is the cause of the whole of nature", as Boethius expressed it (Boethius of Dacia 1987, p. 52). This bifurcated academic landscape was reflected by, and further reinforced by, the newly constructed university regulations that sharply distinguished the professional duties of natural philosophers from those of theologians.[13]

Thinking outside the Aristotelian philosophical box, Boethius acknowledged as factual that the cosmos had a beginning due to the action of the *first cause*, namely God's creative command. Boethius and the vast majority of medieval university faculty accepted the putative biblical teaching of a cosmic beginning. Some also developed philosophical arguments for nature's origin, which some considered beyond reasonable doubt, such as those associated with the cosmological argument for God's existence. Regardless, medieval intellectuals did not typically experience great pressure to reinterpret the Bible so as to accommodate a beginningless universe. Counterfactually, we could imagine such interpretive pressure due to the influence of the deliverances of natural philosophy operating within the confines of strict MN, but this does not well represent what happened in the Middle Ages.

By contrast, MN in the modern study of biological origins *did* create cultural pressure to reinterpret the Bible to accommodate Darwinism or some other version of naturalistic origins.[14] Part of the medieval–modern difference is due to the fact that, in the late 18th and early 19th centuries, there arose empirical scientific methods to reconstruct the history

of nature. However, the medieval study of the eternity or beginning of the world lacked empirical methods, and it also did not possess any sense of nature having had an empirically detectable history, due to the medieval tradition of closely following Aristotelian philosophy.

The eternity of the world controversy was mainly an exercise in what *we* would now call philosophy, rather than natural science (although some Aristotelian natural philosophy was adapted and integrated into modern science). So MN as a major science-difference-making rule of *empirical origin (historical)* science did not exist in the Middle Ages. Nevertheless, we have encountered an early MN-like rule that fostered the growth of science by establishing some of the disciplinary features distinguishing natural philosophy from the other liberal arts, and from theology.[15]

However, for the purposes of long-term scientific growth, disciplinary distinctions needed to be held in creative tension with rational progress through *unification*, which is a widely recognized trait of reputable scientific theories—a theoretical virtue (Keas 2018). From antiquity until the time of Johannes Kepler (1571–1630) and Isaac Newton (1642–1727), astronomy had been considered a branch of mathematics (the liberal art of geometry), *not* a branch of natural philosophy. Drawing from intellectual resources for the unity of the heavens (planets and fixed stars) and earth in Judeo-Christian theology, early modern scientists decisively integrated astronomy into a more unified successful science as indicated by the title and contents of Newton's 1687 book: *The Mathematical Principles of Natural Philosophy*.[16] Newton's grand unification was built on Kepler's earlier partial unification of the heavens and earth, which had appealed to observational and theological challenges to Aristotle's immutable (ahistorical) heavens. The documented appearance of new stars (subsequently recognized as supernovae explosions) in Kepler's lifetime supplied one of the observational challenges. As to theology, Kepler in his Copernican astronomy textbook, proclaimed the "truth concerning the mutable nature of the heavens." (Kepler 1952). He alluded here to Psalm 102:25–26, in which both heaven and earth are said to "wear out like a garment".

4.4. Jean Buridan (ca. 1295–1358)

Let us consider another teaching master at the University of Paris arts faculty, Jean Buridan. Did he practice or promote MN? He is considered one of the greatest natural philosophers of the Middle Ages. In his *Questions on Aristotle's Meteorology*, he outlines the appropriate way to reason about events in (roughly) what we today call earth's atmosphere.

> There are several ways of understanding the word "natural." The first [is] when we oppose it to "supernatural" (and the supernatural effect is what we call a miracle) . . . . And it is clear that meteorological effects are natural effects, as they are produced naturally, and not miraculously . . . . Consequently, philosophers explain them by the appropriate natural causes. But common folk, ignorant of these causes, believe that these phenomena are produced by a miracle of God, which is usually not true (Zupko 2008, p. 215).

Buridan thought meteorological phenomena are usually, but *not always*, natural (non-miraculous) events. Notice the *absence* of *strict* MN within his meteorology. However, natural philosophers, due to an academic division of labor specified in university regulations,[17] focused on what Buridan and many other academics called the "common course of nature" (*communis cursus naturae*), rather than "supernatural cases" (*casus supernaturalis*) (Biard 2001, p. 80). University theologians were officially tasked with studying the latter. In practice, these professional boundaries were somewhat flexible.

Buridan, as a master in the faculty of arts (not theology), reasoned (emulating Aristotle) "that the heavens are not naturally (*naturaliter*) generable or corruptible." (Ibid., p. 79). This meant that the part of the universe beyond the terrestrial region is incapable of major natural change (generation or corruption), and even more so incapable of a natural origin. In short, there are natural limits to what is possible in the common course of nature. Based partly on this reasoning, Buridan could make a reasonable inference to an intelligent cause, as opposed to a natural unintelligent cause, of the origin of the cosmos. In his scientific (not

theological) treatise *Questions on the Physics*, Buridan argued the natural order we observe originated from the designing choices of God the creator.

> Every order that is good and right in the operations and dispositions of natural beings arises primarily, principally, and originally from that best end for the sake of which everything else exists and acts or is acted upon in its first intention, viz., from God himself (Buridan (1509) as cited in Biard (2001), p. 82).

Besides noting the order of nature is contingent on God's original choices in creating, Buridan also analyzed how the choices of free intelligent agents such as humans are beyond (but interact with) mere bodily instinctual behavior and other natural events (Biard 2001, pp. 87–90). So Buridan crafted a nuanced view of how intelligent agency—both divine and human—is distinguished from nature but interacts with it. Such interaction of intelligent agency with nature sometimes does not fit well within MN constraints.

However, there is yet an additional MN-relevant pre-modern Western tradition of distinguishing two major classes of natural events—a deep distinction now unfamiliar to us. Buridan, like most medieval intellectuals (following Aristotle), did not consider rare or unique events in nature to be part of the common course of nature. Due to their alleged high degree of unintelligibility, such unusual events were thought to be beyond the domain of natural philosophy (Grant 1993, p. 89; Daston and Park 1998). This is part of the reason why medieval natural philosophers were not inclined to develop a discipline devoted to reconstructing the sequence of unique and rare events that constitute nature's history, as geologists would do in the late 18th and early 19th centuries. Medieval university theologians, most of whom had studied natural philosophy before theology, had a similar Aristotle-induced disinterest in nature's history, except notably for an interest in the origin of the cosmos. However, such cosmic origin discussion, which routinely arose while debating Aristotle's case for an eternal universe, did not attempt to *empirically* detect event sequences in the history of nature. Aristotle's cosmos had *no* history because any change in nature was thought to be cyclical, rather than leading in any particular direction. Aristotle's eternal universe was an ahistorical theory of non-origins.

Divine action in salvation history (e.g., prophecy and the mission of Jesus) and human action in the sequence of civilizations both produced lingering effects (e.g., extant documents and artifacts) that medieval intellectuals thought they could examine in order to reconstruct *human history*. However, there was no parallel development in medieval natural philosophy to reconstruct *nature's history*. The first empirical origin science, geology, did not arise until the late 18th and early 19th centuries. This modern development in science can be partly explained by a methodological crossover from the perspectives of *human history* to the task of reconstructing *nature's history.*

Medieval MN-like rules, such as in the work of Boethius, helped foster natural philosophy as a discipline that typically addressed different subjects than theology, and usually used different methods. Some of medieval natural philosophy would count for what we now call science, and so the MN question legitimately arises here. MN in this context did not challenge theology, but rather insured professional space for natural philosophers to love God with the exercise of their God-given cognitive capacities. Although foundational for science in its distinction from theology in this period, medieval MN-like restrictions made only a modest difference in the actual practice of science. This conclusion will make more sense when we compare it with the far greater difference that MN, and its negation, have been making in scientific practice since the 19th century. This has taken place in the empirical origin (historical) sciences, especially in biology (Sections 5 and 6).

Let us return to the observation that medieval intellectuals, following Aristotle, were not inclined to develop the origin sciences partly because they did not consider rare or unique events in nature to be part of the common course of nature that natural philosophers typically studied. However, some medieval intellectuals did study rare events in nature, but in a manner that was not embedded within the science of nature's history. Let us examine one of the most influential studies of this sort.

4.5. Nicole Oresme (ca. 1320–1382)

Buridan's younger contemporary, the natural philosopher and theologian Nicole Oresme, wrote *On the Causes of Marvels* (*c*.1370), which is about unusual and puzzling events and entities in nature. Oresme opens his book with this aim:

> To show the causes of some effects that seem to be marvels and to show that the effects occur naturally, as do the others at which we ordinarily do not marvel. There is no reason to have recourse to the heavens, the last refuge of the wretched, or to demons, or to our glorious God as if he would produce these effects directly, more so than those effects whose causes we believe are well known to us (Hansen (1985), pp. 136–137 as cited with an improved translation in Shank (2019), p. 54).

Oresme recognizes *some* (he does not say *all*) unique events or rare human experiences of sight, hearing, taste, touch, etc., are demonstrably the result of ordinary natural causes, which are subject to God's providence. Astrological influences or supernatural interventions (miracles beyond divine providence) are not appropriate explanations for the "marvels" he chooses to study, so he insists. This resembles MN, though not as strongly as Boethius articulated it.

As to unique events, he writes: "we should properly assign to particular effects particular causes, but this is very difficult unless a person looks at effects one at a time and their particular circumstances." He gives examples of such singular events: "Why Sortes [Socrates] is poor and Plato is rich, why an animal died at such a time, . . . why the crop failed in this field." (Hansen 1985, pp. 136–137). However, in this treatise, he mainly focuses on how to explain rare experiences of human sensation. "People marvel at such things only because they rarely happen," he explains (Ibid., pp. 160–61). For example, he explains how in rare circumstances "a thing can appear to our sight as larger or smaller than it is," and "a thing at rest can appear to be moving or vice-versa." (Ibid., pp. 138–39). In his later commentary on Aristotle's *On the Heavens*, Oresme used the reasoning in the last example to show how experience and reasoning cannot determine whether the sun revolves daily around earth, or the earth rotates daily on its axis to generate the equivalent appearance (Grant 2001, p. 200). Galileo Galilei (1564–1642) later extended this argument to make a case for the latter. So Galileo made productive use of earlier Church-funded research.[18]

Oresme's study of natural oddities largely avoided nature's history. He knew God created us with the sensory capabilities and rational capacities needed to detect and explain the optical and other illusions treated in his book. However, he did not aim to gather facts about nature that would enable him to reconstruct and explain the historical sequence of the first appearance of humans on earth relative to the first appearances of other life forms. If he had done so, and if he had insisted upon the methodological rule of invoking only unintelligent natural causes for explaining such sequential biological history, then that would have clearly constituted MN as most scholars now conceive it. Nevertheless, like most medieval European intellectuals, Oresme understood that the ordinary natural causes of nature's routine operations glorify God, because he initially created this natural order, and constantly sustains it. Consequently, Oresme recommended something like MN as an appropriate guide for much of nature studies. However, he never stated MN as a universal rule for the study of natural philosophy, as Boethius appears to have done. Nevertheless, he studied nature using some of the approaches now considered scientific.

Part of the reason for this difference between Oresme and Boethius lies in the fact that Oresme did not demarcate natural philosophy from theology as sharply as did Boethius. Historian Edward Grant notes Oresme's conclusion that "many things in the Gospels and in the articles of faith are no less reasonable than are many things in philosophy." (Grant 1993, p. 94)." Grant further observes that for Oresme "the world had a beginning not only because God had created it, but also because the attribution of a beginning to it was compatible with reason." (Ibid., p. 104). This exercise of reason to infer a cosmic beginning resembles the *absence* of MN. Although medieval university faculty generally acknowledged the rationality of Aristotle's case for a beginningless universe, they concluded that the cosmos began as a creation of God from nothing (ex nihilo) physically prior to our cosmos. Drawing

from Aristotle, they understood that nature does not have the capability to bring itself into being. Thus, the cosmic beginning was not considered part of the "ordinary course of nature", and so supernatural causation—alongside Aristotle's beginningless view—was on the table for rational deliberation by the lights of Oresme and most other medieval university faculty. In short, medieval Christian intellectuals sometimes contributed to the study of nature without MN in this manner.

Peter Harrison argues for the Christian contribution to MN and natural science broadly conceived during the Middle Ages and beyond. He is the editor of a recent anthology aimed at establishing this thesis. Although I have already shown some of the ways in which the medieval-MN part of that project is somewhat problematic, this volume contains much valuable historical analysis. For example, in the introduction, Harrison declares the following about some recent philosophical analyses of MN (specifically PMN) with misconceived appeals to the history of science.[19]

> Recent philosophical discussions that stress the historical failure of "supernatural explanations" when compared with "naturalistic explanations" [of nature] fail to take cognisance of the way in which this distinction functioned in the past. No significant medieval natural philosopher ever argued that supernatural explanations might offer an account of how nature usually operates. Indeed one reason for making the distinction was to make possible the identification of miraculous events, which become visible only against the background of the regularities of nature which were themselves attributable to divine providence (Harrison and Roberts 2018, p. 9).

The medieval study of how nature usually operates came with the expectation that theorists would routinely invoke natural causes operating under God's providence—not miracles. However, the origin of the cosmos, the origin of humanity, and certain other episodes were understood to have involved, in addition to God's providence, direct miraculous acts of God in history. However, natural sciences capable of empirically reconstructing nature's history, did not arise until the late 18th and early 19th centuries. It then became possible to entertain MN as a science-difference-making, though debatable, guide to inquiry.

Many of my arguments for how medieval Christians contributed to natural science with and without MN also pertain, with qualifications, to early modern scientific developments prior to the first empirical origin sciences of the late 18th and early 19th centuries.[20] For example, see Edward Davis' essay on Robert Boyle (1627–1691) where he identifies Boyle's allegiance to MN in the non-origin sciences of his day while allowing for the even more major difference-making effects of MN (and its repudiation) in the origin sciences since the 19th century.[21] Given space limitations we will proceed immediately to the late 18th and early 19th centuries. We will skip over the intermediate stages in order to focus on the *earliest mature* empirical origin (historical) sciences, and the eventual rise of MN as the majority view within those scientific disciplines.

5. Geology: The First Science to Detect Nature's History with and without MN

Natural science has come to be devoted to two kinds of knowledge: *how things work* and *how things originated.* Each of these aims is achieved through a somewhat different set of investigative tools. The first concern, how things work, was mostly the focus of nature studies before the late 18th century when geology became the first scientific discipline to acquire rigorous empirical methods for investigating how things originated.[22] Christian intellectuals contributed to this remarkable development in ways that sometimes were, and sometimes were not, accompanied by MN.

Although James Hutton (1726–1797) is often called the father of geology, historian Martin Rudwick has shown that the formation of geology as a reliable study of earth's history required a break from Hutton's eternalistic ahistorical Aristotelian approach. Hutton is remembered for his belief that earth has "no vestige of a beginning, no prospect of an end". This expression captures Hutton's Aristotelian-deistic perspective according to which

earth only shows signs of being subject to endless cycles that go in no particular direction, rather than going through unique phases of history leading up to the present. However, geology required a directionalist (developmental) view of history to get started. Rudwick received the History of Science Society's highest award in 2007 for his scholarship that tells how Christianity provided some of the key ingredients that enabled the origin of geology.[23] The Judeo-Christian idea of history was especially influential.

A Judeo-Christian view of history includes an absolute beginning followed by unique stages of development toward a purposeful end. In the Western tradition, this understanding of history largely replaced the ancient Greek idea of endless repeating cycles, which was especially associated with Aristotle. This Christian view informed the study of religious and secular history, both of which provided patterns of inquiry that guided early modern attempts to reconstruct earth's history. For example, early geologists used fossils as markers of earth's historical record in much the same way as human artifacts, such as coins, were important chronological indicators in archaeology. Fossils became known as nature's coins (Rudwick 2005, pp. 7 and 642).

Rudwick identifies Jean-André de Luc of Geneva (1727–1817) as a pivotal character in the rise of geology. De Luc called himself a Christian philosopher in contrast to Enlightenment deists and atheists. He realized many possible histories of the earth are consistent with the natural laws God created, so in order to discover the actual history one must engage in field observation of the earth's layered formations, not merely experimentation aimed at detecting natural laws. He called this kind of study *geology*. Rudwick concludes: "It is no coincidence that de Luc's system was the most strongly geohistorical, because of all these *savants* he was the one most explicitly committed to the historical perspective of biblical religion, a perspective he aspired to extend to the whole of geohistory." (Ibid., p. 643).

More recently Rudwick has noted that the Judeo-Christian scriptures,

> far from obstructing the discovery of the Earth's deep history, positively facilitated it. To borrow a metaphor from biology, they *pre-adapted* their readers to find it easy and congenial to think in similarly historical terms about the *natural* world that formed the context of human action and, so believers claimed, of divine initiative (Rudwick 2021, p. 4).

Epistemological methodological naturalism (EMN) was ignored at a fundamental level by the influence of the Judeo-Christian view of directional history (a meaningful unrepeated sequence of contingent events) on the formation of geology as a discipline. According to EMN, only publicly accessible methods using natural human faculties can justify scientific theories, including their deeper conceptual content. However, it is also possible to conceive of multiple secular and religious worldviews converging on a similar public idea of directional history, so as to detach geology from a specifically Judeo-Christian version of this idea in a rational reconstruction of the history of geology. However, this rational reconstruction would not change the actual historical pathway by which the Judeo-Christian vision of directional history shaped geohistorical theory. So at least some of the major participants in the foundation of geology did so without the restrictions of EMN.[24]

Early reputable geologists such as De Luc might retrospectively be said to have practiced IMN (science as a way of knowing nature excludes supernatural explanations of nature) for the purposes of geohistory, but often not in regard to the origin of life and major new kinds of life (where miracles were often deemed reasonable explanations). Rudwick summarizes De Luc's general view of geology: "The causes of physical events were assumed to be natural throughout, yet those natural causes were set in a context of overarching divine 'providence' (Rudwick 2021, p. 76)."

He notes further that De Luc's contribution to geology has been

> grossly neglected by historians. The reason for this is no mystery. De Luc's system has been ridiculed and dismissed because he admitted, indeed emphasized, that his geotheory was an integral part of a Christian cosmology that he set against

> the deism or atheism of other Enlightenment *philosophes*. But he was not an intellectual lightweight, nor was he a biblical literalist; he deserves to be treated as seriously by modern historians—even if they do not share his religious beliefs—as he was by his contemporaries (Rudwick 2005, p. 151).

So De Luc is a prominent example of a modern scientist who worked largely within the parameters of IMN for the purposes of geology, but who did not observe the restrictions of EMN in how he appropriated the Judeo-Christian idea of developmental history to shape geohistorical theory. Many other early geologists likewise followed this pattern. Knowing when, and when not, to follow various versions of MN, was one of the keys to this episode in scientific progress. Thanks in part to this wisdom from the Judeo-Christian tradition, geology came into being as a distinct discipline of the natural sciences.

6. Biological Origin Sciences with and without MN: The Big Difference This Makes

"But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws." This is the first sentence in Charles Darwin's *On the Origin of Species* (Darwin 1859). This frontispiece quotation is from the prominent scientist and Anglican priest, William Whewell. Based on such evidence, we might expect that these two towering intellectuals were strong public advocates of MN throughout their careers. The real story is more complex and interesting.

6.1. William Whewell (1794–1866)

William Whewell helped pioneer the integrated study of the history and philosophy of natural science and was one of the first scholars to deeply understand scientific progress by means of the theoretical virtue of unification (Section 4.3).[25] He also was a leading expert in tide theory,[26] and was deeply conversant in scientific fields such as geology, mineralogy, physics, and astronomy (he pioneered the *circumstellar habitable zone* to assess the feasibility of extraterrestrial life based on a planet's temperature, derived from its distance from its host star).[27] He was a founding member (1831) and president (1841) of the British Association for the Advancement of Science (BAAS), he served as president of the Geological Society (1837–1839), and he made broad academic contributions as a long-time Master of Trinity College in the University of Cambridge. Leading Whewell scholar Laura Snyder has noted that at the 1833 Cambridge meeting of the BAAS, at which time Whewell dramatically announced his pioneering meaning of the word *scientist*, the BAAS was "firmly established" as "a scientific force in the nation. It also helped seal Whewell's reputation as a leader of the scientific establishment." (Snyder 2011, p. 147). It is no wonder Darwin appropriated Whewell.

Darwin's *Origin* quote was from Whewell's *Astronomy and General Physics Considered with Reference to Natural Theology* (Whewell 1833), which was the most successful book in the Bridgewater Treatises. This handsomely endowed book series was devoted to excavating the evidence for God in nature. Appropriately, Whewell's Bridgewater Treatise featured a frontispiece with this famous utterance from Isaac Newton: "This most beautiful System of the Sun, Planets, and Comets, could only proceed from the counsel and dominion of an intelligent and powerful being." Two years before Whewell's Bridgewater, "Brewster's *Life of Newton* had introduced the British reading public to the religious side of Newton, which had been downplayed by French writers on Newton (who tended to be atheists themselves)." (Ibid., p. 200). Darwin similarly aimed to opportunistically adapt the natural theology tradition of Newton and Whewell for his own purposes. Leading historian of science John Hedley Brooke concluded that "there was opportunism in Darwin's appropriation of this passage since Whewell would have balked, and did so, at its application to the creation of human beings." (Brooke 2010a, p. 265). I will go further than Brooke and show how Whewell did not promote MN in the biological origin (historical) sciences. Neither did Darwin in print, until later editions of his *Origin*.

Whewell argued for both the collective unity and individual peculiarity of various branches of knowledge such as the social sciences, human history (including the origin of Gothic architecture addressed in his monograph (Whewell [1830] 1842), geology, and biology. As to their individuality, each discipline "in a great measure" has "its own peculiar fundamental principles." (Whewell 1847, vol. 2, p. 19). Historian-philosopher of science Richard Yeo summarized Whewell's overall analysis as identifying "unity of epistemological process, while recognizing the integrity of different areas of inquiry," such that, in the progress of knowledge, "new domains of knowledge were associated with new fundamental ideas." (Yeo 1993, pp. 242–43, 252–53). Accordingly, Whewell argued that just as chemistry cannot legitimately be reduced to physics, likewise biology cannot be reduced to these more basic disciplines. To attempt such a reduction would obscure many instances of the reasonable inference to *final cause* in biology, he maintained.

Whewell argued certain arrangements of organismal parts point to a scientifically detectable intelligence that guided their construction. This is an inference to "design and intention" (Whewell 1833, p. 342), which he also called final causes (Ibid., pp. 307–19)—echoing Aristotle and citing the "Christian Virtuoso" (and chemistry pioneer) Robert Boyle (1627–1691). Edward Davis, a leading Boyle scholar, recognizes Boyle as "the father of modern intelligent design" theory because Boyle had argued that "design principles—what Aristotle had called 'final causes'—have a proper place within natural philosophy"[28] (i.e., what Whewell often called *science*). Whewell went further than Boyle because he more fully articulated the logic of design inferences, and the repudiation of MN, within the newly emerged biological origin sciences.

Whewell acknowledged that since Francis Bacon (1561–1626) it had become clear that sometimes "reasoning from final causes had been pushed too far". However, "it is certain" that the inference to purposeful design (final causes) in "the structure of animals" is well founded because the "most eminent physiologists in all ages" have converged on this conclusion (Whewell 1866, p. 357). Furthermore, this majority-acknowledged design inference outside the parameters of MN helped them make yet other key discoveries. Whewell cites examples such as "Harvey's discovery of the circulation of the blood"[29] and "Cuvier's restoration of extinct animals" from fossil evidence, which established the reality of extinctions for the first time. "These authors tell us that" they were guided by design-theoretic reasoning outside MN restrictions, Whewell argued. Critics of the design inference to purposeful origins in biology would have to face this question posed by Whewell: "Was it a false, an unreal principle that thus led them to some of the most important scientific truths which we possess?" (Whewell 1866, p. 357). In short, working outside the restrictions of MN can be, and often has been, a useful avenue to progress in the life sciences.

To further substantiate the scientific legitimacy of the inference to intelligent design in biological origins, Whewell pointed to the work of Marie François Xavier Bichat (1771–1802), a French pathologist and anatomist who pioneered the study of tissues in human anatomy. Bichat showed that each kind of tissue is susceptible to particular dysfunctions or diseases. Building on Bichat's work, Whewell argued that biology is the only natural science in which we encounter disease (studied in pathology) in the sense of failure to actualize a purposeful function that certain anatomical parts were designed and intended to perform. Whewell quoted Bichat: "Physiology is to the movements of living bodies, what astronomy, dynamics, hydraulics, &c., are to those of inert matter: but these latter sciences have no branches which correspond to them as Pathology corresponds to Physiology."[30] Whewell clarified Bichat by writing regarding non-biological processes that "we have no conception of what they *ought to do*". Gravity, for example, never "acts in a *diseased* manner." Echoing Bacon's caution regarding final causes, Whewell observes that gravity and other non-biological processes never fail "in their purpose" because "we do not conceive them as having any purpose which is answered by one mode of their action rather than another". However, anatomical parts studied in biology act "for the preservation and development

of the system in which they reside. If they do not do this, they fail, they are deranged, diseased." (Whewell 1858, p. 247).

Animal anatomy is quite different from crystals, Whewell emphasized. The law-governed physical processes that produce the regular repetitively angled surfaces of crystals are never said to be diseased or dysfunctional. He then showed how this difference supports the inference to intelligent design in biology.

> The regular form of a crystal, whatever beautiful symmetry it may exhibit, whatever general laws it may exemplify, does not prove design in the same manner in which design is proved by the provisions for the preservation and growth of the seeds of plants, and of the young of animals (Whewell (1840), vol. 1, p. 629 as cited in Yeo (1986), p. 277).

Although Whewell thought God created the general laws governing crystallization, natural laws capable of generating radically new biological structures are insufficiently supported by evidence. MN more appropriately applies to the physical sciences than to biology. Darwin's opportunistic quote of Whewell obscured this difference. Whewell, unlike Darwin, thought that natural science legitimately invokes direct divine intelligent intervention to account for the origin of biological organisms that possess fundamentally new anatomical and physiological features. Whewell did evaluate the alternative hypothesis that these events occurred by natural unintelligent causes but announced:

> It may be found, that such occurrences as these are quite inexplicable by the aid of any natural causes with which we are acquainted; and thus, the result of our investigations, conducted with strict regard to scientific principles, may be, that we must either contemplate supernatural influences as part of the past series of events, or declare ourselves altogether unable to form this series into a connected chain (Whewell 1858, p. 277).

Notice how Whewell framed the comparison between intelligent design and natural causes as a legitimate scientific evaluation process within the study of biological origins. In so doing, Whewell clearly articulated and promoted the scientific study of biological origins without MN.

Despite the extensive evidence to the contrary, some have suggested that Whewell embraced MN within all the origin sciences, including biology. In support of this view, they cite the following Whewellian passage: "The mystery of creation is not within the range of her [geology's] legitimate territory; she [geology] says nothing, but she points upwards."[31] Some quotations of this passage supply *nature* rather than *geology* in brackets, but given the context, her/she refers to geology.[32] This passage has a more limited meaning within the field of geology, echoing De Luc's view (Section 5). Michael Ruse makes a similar mistake about this passage when he claims it is about "science on origins" generally—expressing MN even in the study of biological origins.[33]

Let us dive deeper into Whewell's recommended pursuit of biological origins without MN. Following the pattern of how the founders of geology appropriated ideas from the study of human history,[34] Whewell analyzed biological origins by adapting methods that he extracted from his own technical monograph on the development of Gothic architecture. In that monograph, he was able to rigorously reconstruct some of the key steps in the origin of Gothic architecture. For example, he noted that a square area within a building can be covered with a vaulted ceiling by constructing intersecting *semicircular* vaults of equal height (see Whewell's Figure 1).[35] However it is impossible to cover a rectangular space with a vaulted ceiling in this same manner. The Romanesque churches that had preceded Gothic churches used only semicircular arches and thus were limited to square spaces and other associated architectural constraints. A vaulted ceiling over a rectangular space, with openings of equal height, is made possible by using *pointed* arches on at least two sides (Figure 2).[36] This new step in the logic of architectural design was a key event that helped trigger the origin of Gothic churches. In this innovation physical-spatial principles worked in tandem with aesthetic principles.[37] Whewell described Gothic churches and

their architectural precursors as a series of systems of interdependent parts. He explained that the sequence of coordinated changes that occurred made possible the new Gothic style, noting some changes would necessarily have preceded other changes.

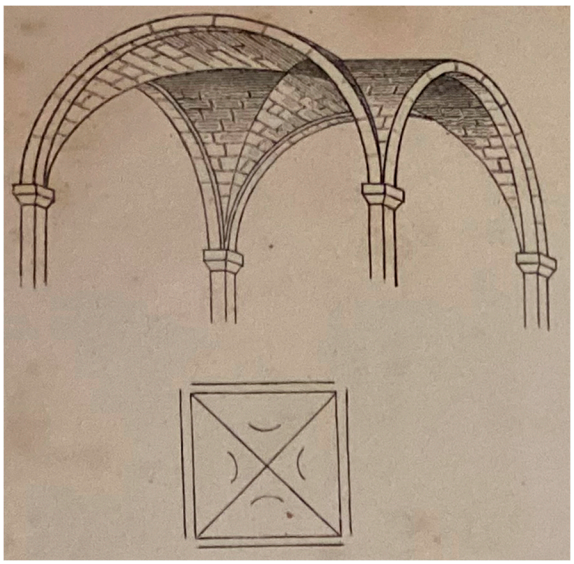

Figure 1. Square floor space covered by four semicircular vaults. Figures 1 and 2 are courtesy History of Science Collections, University of Oklahoma Libraries.

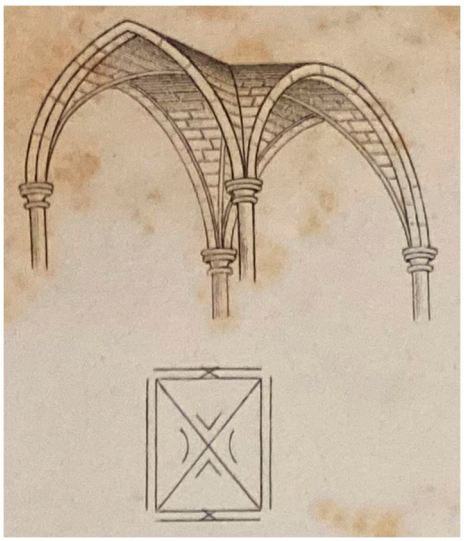

Figure 2. Rectangular floor space covered by two semicircular vaults and two pointed vaults. In the top-down view sketch the two shorter sides enabled by pointed arches are highlighted with Xs in Whewell's book as reproduced here.

A recent study of Whewell's architectural history in relation to the foundation of biological origins science shows how Whewell established that the "story of a historical lineage is a story of transmission and alterations of a coherent set of possibilities." (Quinn 2016, p. 15). In so doing, Whewell showed how to engage in causal reasoning in "historical science in the absence of general laws about contingent historical claims." (Ibid., p. 11). General laws sometimes play a role in reconstructing natural and human history, but it is a subsidiary role according to Whewell. Philosophers of science today typically agree with Whewell on these points about historical reasoning in biology.

Using this framework of historical reasoning, Whewell concluded that many historical events in the appearance of organisms on earth had intelligent (and more specifically

supernatural) causes (Whewell 1840, vol. 1, p. 164). These events differ from "the common course of nature"[38] Whewell proclaimed, employing the science-fostering medieval Christian concept tracked in Section 4. Even so, Whewell insisted that origin hypotheses in biology be evaluated on scientific, not theological, grounds (Quinn 2016, p. 14). The logic of these biological design inferences enabled scientists to "ascend to a past state, by considering what is the present state of things, and what are the causes of change." (Whewell 1845, p. 97).

Whewell explained how our present empirical experience of the cause-and-effect structure of the world provides clues that enable us to reconstruct the history of nature. He further developed the logic of the inference to intelligent design in biological origins by an analysis of how one human infers the existence of other intelligent agents, especially other humans.

> How are we led to elevate, in our conceptions, some of the *objects* which we perceive into *persons*? No doubt their actions, their words induce us to do this. . . . We feel that such actions, such events must be connected by consciousness and personality; that the actions are not the actions of things, but of persons; not necessary and without significance, like the falling of a stone, but voluntary and with purpose like what we do ourselves . . . (Whewell 1833, p. 345).

Whewell explains that belief in the existence of other persons is warranted because it is based on one's own experience of how thought, purpose, and choice operate. Note further how Whewell relates such intelligent agency detection to the inference to intelligent design in biological origins. In reference to the coordination of physical requirements for earth's habitability in conjunction with the coordination of anatomical parts necessary for biological functions in organisms, Whewell concluded that this system points to the "intention, wisdom, and goodness of a personal creator". Whewell also emphasized that such intelligent design inferences in biology are not "unphilosophical" (an archaic way of saying unreasonable or unscientific). He justified the reasonable status of these biological design inferences by noting that the "process corresponds most closely with that on which rests the most steadfast of our convictions, next to that of our own existence, the belief of the existence of other human beings." (Ibid., p. 346).

Whewell explained that the design inference is also well supported by the evidence for natural limits to biological change.

> There may thus arise changes of appearance or structure, and some of these changes are transmissible to the offspring: but the mutations thus superinduced are governed by constant laws, and confined within certain limits. Indefinite divergence from the original type is not possible; and the extreme limit of possible variation may usually be reached in a brief period of time (Whewell 1857, p. 479).

Whewell never dismantled his own account of the legitimacy of design inferences in biology, even in the wake of Darwin's *Origin*. In his last publication that addresses this topic, he responded to the memorable passage in Darwin's *Origin* in which Darwin had speculated about how a nerve might become sensitive to light, and how, coordinated with other related changes, this unguided process could produce an eye.[39] Whewell called this Darwin's "gigantic fabric of hypotheses, of which the basis is a *suspicion* that any nerve may become sensitive to light." (Whewell 1866, p. 358). Notice below how his criticism of Darwin's eye origin speculation shows how Whewell exhibited no obedience to MN in his reasoning to intelligent design in biological origins.

> The inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, for the correction of spherical and chromatic aberration, are all on the imaginary road from a bit of nerve to a complex eye; and therefore Nature has travelled on this road to the complex eye. This, it is confessed, seems absurd, but yet this is the doctrine insinuated. But the difficulties are not yet half stated. For, besides all this, and running parallel with these gradations of the optical adjustments, we have a no less complex system of muscles for

> directing the eye: some of them, as the pulley-muscle, dwelt on by Paley, such as resist the tendencies of their neighbours; and the numerical expression of these correspondencies of the gradations of the optical and the muscular adjustment of the eye is to be multiplied into itself for every organ of the animal, in order to give the number of chances of failure to success in this mode of animal-making (Ibid).

For this to have occurred without intelligent design is scientifically unreasonable, he concluded. Scientists would have to muster "a large swallow that can gulp down" (Ibid). Darwin's eye origin story, because of the absence of sufficient reasons to embrace it. This was Whewell's final assessment of Darwin's theory. Sadly, before this essay went to press, Whewell died after he fell from his horse (Snyder 2010, p. 323).

6.2. Charles Darwin (1809–1882)

Let us return to the intriguing connection between Whewell and Darwin in regard to MN. After reading John Herschel's June 1841 review of Whewell's *Philosophy of the Inductive Sciences*, Darwin made this note to himself in his private notebook: "I MUST STUDY Whewell on Philosophy of Science." Despite Darwin's "MUST STUDY" all-capitalized emphasis, several historians think he never read any of the three editions of Whewell's masterpiece that appeared from 1840 to 1858 (those available before Darwin's 1859 *Origin*)—nor any later editions of Whewell's multivolume book.[40] This means Darwin failed to read Whewell's most extensive contribution to how scientists can legitimately reconstruct the history of life on earth—without MN.[41] We have seen how Whewell, a pioneering philosopher of science and widely respected science practitioner, did not promote MN in the biological origin sciences. Rather he promoted *methodological pluralism*: openness to both natural and intelligent causes for explaining the history of the appearance of life on earth.

Methodological *pluralism*, not methodological *naturalism*, appears to have been the leading view in the life sciences on the eve of Darwin's *Origin*. Whewell, who was familiar with the work of a huge number of scientists, states that "the best naturalists" had rejected the "transmutation" theory of the origins of species due to the evidence for "rigorous limits" to natural biological change (Whewell 1857, pp. 477–78). This understanding of biological origins entailed detecting *both* unintelligent natural causes for limited transmutation, and intelligent causation for the origin of major new kinds of life. This is methodological pluralism, not MN.

Nineteenth-century methodological pluralism in the biological origin sciences is a remarkable achievement of meta-theoretical freedom and tolerance for intellectual diversity within Western culture.[42] The present essay highlights some of the Judeo-Christian and specifically Whewellian underpinnings of this legacy. Its enduring value for recent debates about biological origins is this: Follow the evidence wherever it leads, rather than prejudge the range of possible outcomes by MN. Darwin thought otherwise, first affirming MN privately, and then in broad public daylight—bucking majority methodological pluralism.

Although Darwin broke ranks with the methodological pluralism majority, few scholars have noticed that the first three editions of Darwin's *Origin* did not explicitly advocate MN—though private correspondence shows Darwin had already embraced it.[43] Stephen Dilley has located Darwin's first printed explicit invocation of MN in the fourth edition of the *Origin* (Dilley 2013), which was published in June 1866, about three months after Whewell died on March 6, 1866. Darwin would likely have known of the death of his highly influential acquaintance [44] and intellectual opponent with respect to origins. In 1866 (in the fourth edition of the *Origin*), Darwin advocated MN in his discussion of homologous organismal parts.

> On the ordinary view of the independent creation of each being, we can only say that so it is—that it has pleased the Creator to construct all the animals and plants in each great class on a uniformly regulated plan; but this is not a scientific explanation (Darwin 1866, p. 513).

This passage is rendered similarly in the first three editions,[45] but they lack the final phrase—"but this is not a scientific explanation".

Dilley's most striking conclusion about Darwin's increasing deployment of MN in the later editions of the *Origin* is that he thereby aimed mainly at winning evolution converts and ostracizing special creation, "rather than making a strong empirical and philosophical case per se for his position." (Dilley 2007, p. 20). In other words, Darwin's explicit invocation of MN was more rhetorical than epistemic. In support of this point, Dilley identifies a glaring inconsistency in Darwin's treatment of special creation: "A theory that is genuinely immune from scientific analysis [because it breaks the MN rule] cannot be rendered more or less probable by scientific analysis"—both of which Darwin incoherently attempted to do (Dilley 2013, p. 28). Finally, Dilley observes that "Darwin did not entirely cleave God from his science, including in later editions of the *Origin*. Several scholars have argued the *Origin* relied on theology in significant ways."[46] So the later editions of the *Origin* were inconsistent in their adherence to MN in multiple ways.

The timing of Darwin's first explicitly published use of MN is significant. He adopted this new public polemic in 1866 shortly after the death of Whewell—a world-class expert on what counts as a scientific explanation. This campaign may have been Darwin's second highly consequential opportunistic act in regard to Whewell (and the X Club likely influenced Darwin's MN proclamation, as shown below). As noted above, Darwin's first major opportunistic move with regard to Whewell was to quote Whewell's Bridgewater Treatise in a way that was out of sync with Whewell's overall contribution to the philosophy of science, especially as it pertains to origin of species by means of natural events and/or by means of intelligent causation. Whewell clearly opted for a methodological pluralism that embraced both kinds of causation for reconstructing the history of earth's organisms. MN was for Whewell an unjustified artificial constraint on theory construction and evaluation within biological origin science. How did this majority pluralistic methodological stance become a minority position in biology? We turn to that story next: the rise of MN to majority status during the late 19th century.

6.3. Darwin's Bulldogs: The X Club from 1864 to 1882, and the Rise of MN to Majority Status

MN gained many new adherents through the efforts of Darwin and a network of friends known as the X Club. The most influential X Club member, Thomas Henry Huxley (1825–1895), was also known as "Darwin's bulldog". Huxley acquired this whimsical title due to his polemical efforts in support of Darwin, though he disputed some of Darwin's evolutionary mechanisms. The X Club's evolution advocacy was part of a larger Victorian social reform movement Huxley retrospectively called scientific naturalism in 1892. Huxley thereby rehabilitated the earlier history of the movement, when it was known by terms such as "scientific materialism".[47] Victorian *scientific naturalism*, the softer term many recent historians favor,[48] promoted MN, MN-structured science education (Stanley 2014a, pp. 243–48), scientism, and often metaphysical naturalism (atheism) or more modest "agnosticism"—an ambiguous we-lack-knowledge-of-God label Huxley coined in 1869 (Dockrill 1971, pp. 461–77; Lightman 2002, pp. 271–89). The X Club, which met in London restaurants from 1864 to the 1880s, was at the center of this movement.

Historian Ruth Barton discovered that in the 1860s the X Club was "sometimes described as a clique, indicating that their power was not regarded as legitimate." (Barton 2018, p. 448). She also found that sometimes they were "secretive and conspiratorial." (Ibid., p. 214). The X Club's last major Darwin-bulldog achievement was to have Darwin buried beside Issac Newton in Westminster Abbey in 1882.[49] Stephen Hawking's body was added to the Abbey collection in 2018 as a symbol of the importance of "science and religion work[ing] together."[50]

The X Club's advocacy of scientific naturalism aimed to decouple the synergy between natural science and Christianity documented above and in Section 7. Matthew Stanley, a leading Huxley scholar, put it this way: "The triumphalist story of scientific naturalism—that science only became modern once it cast off the albatross of dogmatic

theology—was precisely the story promoted by the X Club." (Stanley 2014b, p. 244). Its leaders emphasized that in origin science one should disregard the possibility of supernatural causation. That is clearly MN. So the X Club functioned as Darwin's and MN's bulldogs.

Stanley further explains:

> The key to this naturalization strategy was for Huxley to tell a new story about the history of science. By naturalizing theistic science, he was able to argue that science had *always* been naturalistic. That is, by naturalizing the tradition of theistic science, he was able to remove it from history completely, making naturalism the obvious and solitary way to do science (Stanley 2014a, p. 256).

Huxley attempted to tell the story of the rise of natural science without any positive contributions from Christianity. He also helped eclipse the legacy of William Whewell, who had cultivated the integrated field of the history and philosophy of science to show that methodological and metaphysical naturalism have not been the only guides to science.

Until recently, historians have largely assumed that by the 1870s Christian intellectuals had mostly ceded scientific authority to the promoters of scientific naturalism. From the point of view of that flawed historiography, the debate appeared to be between scientific and religious authorities. However, Bernard Lightman has recently shown how the

> historical actors saw the debate as taking place between two sets of scientific authorities. In other words, Christian intellectuals were not willing to give up "science"—they refused to recognize Huxley and his allies as the sole scientific authorities who alone could speak on behalf of "science" and who alone defined its boundaries and determined its larger implications (Lightman 2016, p. 189).

Despite such thoughtful Christian critique, scientific naturalism and its core MN mode of inquiry, achieved majority status by the turn of the century. Part of the reason for this transformation was that some members of the X Club and its larger network of friends composed an account of the history of science that made it appear as if they were on the right side of history.[51] What important patterns in the history of science and Christianity did they miss? Let us highlight a few examples beyond what we have already encountered in Sections 3–6.

7. Christianity Generated Other Rational Beliefs That Contributed to Natural Science

The highly influential Church Father Saint Augustine (354–430) expressed confidence in our ability to read the "book of nature" because it is the "production of the Creator".[52] He instructed we should proceed "by most certain reasoning or experience" to discern the most likely way God established "the natures of things". This latter phrase became a popular medieval book title for works following Augustine's investigative approach.

For example, the English monk Bede (673–735) studied astronomy in the tradition of Augustine and Ptolemy. Historian Bruce Eastwood called Bede's book *The Nature of Things* (ca. 701) "a model for a purely physical description of the results of divine creation, devoid of allegorical interpretation, and using the accumulated teachings of the past, both Christian and pagan." (Eastwood 2013, p. 307). Note how Bede's Christian worldview was compatible with the analysis of the natural world as a coherent and knowable system of causes and effects.

The institution in which scholars have investigated nature for many centuries is also noteworthy—the university. This medieval invention began with the University of Bologna in 1088, followed by Paris and Oxford before 1200, and more than 50 others by 1450. The papacy supported this remarkable intellectual development. Universities provided additional stimulus to the medieval translation movement already under way, in which Greek and Arabic texts were rendered in the common European intellectual tongue of Latin. This movement greatly outperformed the comparative trickle of imperial Roman translations. If European Christians had been closed-minded to the earlier work of pagans, as the Dark Ages myth alleges, then it would be difficult to explain this huge appetite for translations.

The Franciscan cleric and university scholar Roger Bacon (ca. 1220–1292) read much of the newly translated work of earlier Greek and Islamic investigators, including Euclid, Ptolemy, and Ibn al-Haytham (ca. 965–1040). By evaluating them and introducing controlled observations (now called experiments), Bacon substantially advanced the science of light (Lindberg and Tachau 2013, pp. 503–4). Subsequent authors summarized and reevaluated Bacon's work, transmitting it through books used in university instruction. That is how it came to the attention of the Lutheran polymath Johannes Kepler (1571–1630), whose account "helped spur the shift in analytic focus that eventually led to modern optics."[53]

Christianity played a significant part in the development of such experimental methods aimed at disclosing the nature of things. The Christian belief in the divine freedom of the creator undercut the view, established by Plato and Aristotle, that the structure of the cosmos is a necessary one. Christians insisted that God could have created a universe quite different from the one Aristotle imagined, and so testing multiple hypotheses by experiment was an effective way to determine which set of natural laws God actually created to govern our cosmos (Davis 1999, pp. 75–95; Hannam 2009).

As we peer deeper into the foundations of natural science, we see Christianity cultivated a balance of both humility and confidence in human knowledge. Our confidence is derived from the orderliness of God's world, designed for discovery by his human image bearers. Belief in God as the universal lawgiver encouraged investigation of nature to discover natural laws, as the monumental achievements of Kepler, Galileo, and Newton demonstrate.

At the same time, human fallibility was one of the most persistent themes in the Bible. The Christian doctrine of the Fall of Adam and Eve, and our status as finite creatures, provided an explanation for the difficulty of human reason in achieving certainty about the cosmos, with a consequent emphasis on the testing of hypotheses. Many medieval and modern scientists embraced this balance of confidence and humility (Harrison 2007).

Galileo, Kepler, and many other early modern scientists were guided by the traditional Christian metaphor of the "book of nature". They sought to convey the idea that God wrote two books that are consistent with one another: nature and the Bible. Nature is largely written in the language of mathematics, many of these scientists argued, and so it can be read only by those who know this language. Galileo argued this in his book *The Assayer*. He wrote:

> Philosophy [natural science] is written in this all-encompassing book that is constantly open before our eyes, that is the universe; but it cannot be understood unless one first learns to understand the language and knows the characters in which it is written. It is written in mathematical language (Finocchiaro 2008, p. 183).

Similarly, Kepler believed mathematical ideas exist eternally in God's mind. God selected some of these principles to govern his creation. Because God created humans in his image, we have the intelligence needed to discover those natural laws, and in so doing, humans "share in his own thoughts".[54] Such Christian beliefs contributed to the foundations of science.

Darwin and his X Club supporters did not recognize the history we just outlined. They also ridiculed the miracles of the Judeo-Christian tradition as intrinsically anti-scientific. Such criticism failed to recognize the very notion of a miracle—understood as a rare supernatural event that is *only detectable* against a *backdrop of regularity*—would be inconceivable without the companion science-fostering idea of nature's regularity, to which the Judeo-Christian tradition had substantially contributed. A notable example of this misconceived materialist critique of miracles is in Darwin's autobiography, where he declared his belief "that the more we know of the fixed laws of nature the more incredible do miracles become." (Darwin 1959, p. 86). Had Darwin heeded his own private notebook declaration ("I MUST STUDY Whewell on Philosophy of Science"), he would have been better equipped to avoid this misconceived critique of miracles and to recognize the positive influence of theistic ideas on science that Whewell had documented.

8. Methodological Naturalism: Then and Now

Let us reassess Tiddy Smith's recent proposal to transcend some of the historical-philosophical inadequacies of intrinsic and pragmatic methodological naturalism (IMN and PMN), which prompted him to recommend epistemological methodological naturalism (EMN). MN, as conceived within the EMN perspective, stipulates that "only natural cognitive faculties may be used" to justify theories about nature. Recall that Smith had proposed: "Methodological naturalism is not a thesis about what may or may not be conjectured [as an explanation] by scientists [as is the case with IMN and PMN], but about how scientists may or may not justify their theories."

Smith's MN (EMN) seems to exclude from natural science the seminal work of Galileo and Kepler (and many others) who developed their theories of nature on the foundational idea that God wrote two books that are consistent with one another as complementary modes of divine revelation: nature and the Bible. Nature is largely written in the language of mathematics, they proposed, and so it can be understood by theory-making crafted by those who know this quantitative language of divine revelation. Conversely, if we conceive of the human ability to decode the mathematical structure of nature as merely "natural cognitive faculties" at work, then that would justify including the work of Galileo and Kepler within the boundaries of natural science as conceived within MN (especially EMN).

However, this move disregards the categories of the actors themselves—the self-conception of leading early modern scientists such as Galileo and Kepler. These scientists understood their cognitive faculties as created by God so as to enable them to decode the mathematics of nature as the revelatory language of God. Kepler specifically understood it this way: Because God created humans in his image, including our ability for mathematical conceptualization, we have the cognitive tools needed to discover the mathematically-structured laws of nature, and in so doing, humans "share in [God's] own thoughts." Accordingly, in the dedication to his *Epitome of Copernican Astronomy*, Kepler identified himself as a "priest of God, the creator of the book of nature."[55] Kepler understood his scientific discoveries, such as of the three laws of planetary motion (as they are now called in science textbooks), to have been episodes of receiving divine revelation.[56] Smith's account of MN (EMN) prohibits divine revelation as a source for scientific theorization (Smith 2017, pp. 322, 327, 329). Kepler violated Smith's MN!

What about the other two major versions of MN: IMN and PMN? Darwin inconsistently vacillated between IMN and PMN.

> IMN: Science, as a way of knowing nature, excludes supernatural explanations of nature.
>
> PMN: Because scientists, *qua* scientists, have evaluated supernatural explanations of nature and found them inadequate, scientists no longer consider supernatural explanations as live options for scientific theory.

Today many scholars remain stuck in Darwin's dilemma as identified by Dilley and further developed in the present essay. This dilemma is summarized by restating with bracketed interpolations a previous quotation of Dilley aimed at Darwin's treatment of creationism: "A theory that is genuinely immune from scientific analysis [because it breaks MN understood as IMN] cannot be rendered . . . less probable by scientific analysis [that allegedly justifies rejection of creationism by MN understood as PMN]." Darwin and many of his ideological successors have incoherently attempted both. They have engaged in such inconsistent critiques of creationism and intelligent design.

This inconsistency is less surprising given Darwin's use of MN had both epistemic and *rhetorical* functions. As we have seen in Dilley's analysis, Darwin's increasing deployment of MN in the later editions (1866 and beyond) of the *Origin* was aimed mainly at winning evolution converts and ostracizing creationism, "rather than making a strong empirical and philosophical case per se for his position." (Dilley 2013, p. 20).

Because intelligent design theory does not violate Smith's MN (EMN), EMN is unlikely to become the leading version of MN in the present climate of opinion. Nevertheless,

Smith's historical-philosophical critique of the two other major versions of MN (IMN and PMN) will be difficult for scholars and scientists to ignore—once exposed to Smith's formidable rationale, as enhanced in the present essay.

Another under-appreciated scholar in today's MN debate is the Canadian philosopher Robert Larmer. Echoing important distinctions I have made above for historical-philosophical analysis of MN, Larmer observes that "appeals to supernatural agency are not typically found regarding how things work, but rather how they come to exist in the first place." The former branches of science are *nomological* (explicating the repetitive common course of nature as medieval Christians conceived it), while the latter is *historical* (reconstructing unique contingent origin events in the history of nature). With this distinction in mind, Larmer quips:

> The fact that turtles are easy to catch hardly provides warrant for thinking that cheetahs will be easy to catch, and the fact that natural explanations in nomological science have enjoyed great success, scarcely warrants the assumption that explanations in terms of natural causes in historical science will enjoy the same degree of success (Larmer 2019, p. 19).

Emulating William Whewell's logic of intelligent design inferences in biology, SETI scientists since the 1960s have aimed to detect signals from space that display a pattern requiring alien intelligence to explain. Given Richard Dawkins' openness to a space alien intelligent cause of life's origin on earth (Section 2), this illustrates how SETI cannot legitimately be characterized as an *agent*-oriented inquiry that is totally separate from the *natural* (especially chemical-biological) origin sciences. This point strengthens Larmer's observation that potential alien design inferences are widely deemed acceptable in science "because they are not presumed to challenge a naturalistic account of how conscious intelligent agents originated." Only when the "design would have to be attributed to a supernatural intelligent agent" is the inference to design "judged to be only apparent and not genuine." (Ibid., p. 20). Larmer rightly identifies this argumentative move as arbitrary and unconvincing, despite the various campaigns to dignify it with the MN label.

9. Conclusions

We have seen how Christianity generated rational beliefs that contributed to the rise of natural science. This science-fostering rational belief included rationales for when to practice MN, and when to study nature without that restriction. Medieval Christian intellectuals sometimes promoted MN, or something like it, in the study of how things work in nature. The main difference this made was to more clearly distinguish theology from natural philosophy (roughly natural science). This promoted scientific progress. In most cases, MN did not make a big difference in the practice of science itself until its use, and its negation, competed for adherents in the biological origin sciences since the 19th century.

Whewell, speaking for the majority of scientists before Darwin's 1859 *Origin*, recommended methodological pluralism, not MN, in the study of biological origins. Methodological pluralism positioned scientists to remain open to detecting both natural and intelligent (even supernatural) causes in the history of life's appearance on Earth. Darwin and the X Club led the effort to replace methodological pluralism with MN. This campaign, in combination with other factors,[57] succeeded in making MN the majority view in the study of biological origins by around the turn of the century.

MN became a big difference-making methodological proposal within the study of biological origins ever since theorists developed rigorous empirical techniques for reconstructing this domain of nature's history in the 19th century. However, the big difference MN makes here is contestable—whether it promotes, or hinders, the discovery of the truth about biological origins.

If the majority of scientists today were to push aside MN as illegitimate in biological origin science, as a minority of them currently do (embracing instead methodological pluralism), this would not prohibit or discourage scientists from searching for natural

causes of the progressive appearance of organisms on earth. This point is illustrated well by the work of Whewell—a proxy for the majority view among scientists prior to the X Club's influential MN lobby. The current majority status of MN with regard to biological origins is a contingent fact of history, not the inevitable result of rational progress. The illusion of the latter owes much to the faulty historiography disseminated by the X Club, which has been subsequently perpetuated in popular science writing.

The present essay has excavated and repaired the historical-philosophical playing field so it no longer illegitimately predisposes us to accept the MN metanarrative as inevitable rational progress in all domains of the natural sciences. In light of this accomplishment, Larmer's diagnosis shines all the brighter.

> The issue is not whether it is legitimate to look for natural causes of phenomena, but rather whether science must or should in all circumstances confine itself to attempted explanations in terms of natural causes, no matter how inadequate such attempted explanations prove (Larmer 2019, p. 21).

William Whewell, the eminent scientist-scholar who helped pioneer the very term *scientist*, would agree.

Funding: I am grateful for support from the Mellon Foundation Travel Fellowship Program at the University of Oklahoma.

Data Availability Statement: Not applicable.

Acknowledgments: I thank the journal editors and reviewers for their assistance. I also thank Robert Bishop, Edward Davis, Stephen Dilley, Enezio E., James Hannam, Robert Larmer, Kerry Magruder, and James Ungureanu.

Conflicts of Interest: The author declares no conflict of interest.

Dedication: For the admirable fellow historian of science Ronald Leslie Numbers (1942-), whom I have known since our first phone conversation in 1983 concerning my placement in a Ph.D. program. I owe much to Ron for his encouragement and advice at many junctures in my career over the past 40 years. Here is one memory: enjoyable conversation with Ron and other historians of science who were invited to the 2014 conference he organized, which was aimed at preparing the essays subsequently published in *Newton's Apple and Other Myths About Science* (Harvard University Press, 2015). Due to circumstances, he was unable to comment on the present essay, which interacts with his influential essay (Numbers 2003) on the same topic. In a 7 June 2023 personal email, he wished me "good luck" on my essay.

Notes

1 For purposes of this essay, I identify science without reference to any theological premises that may have been used within explanations of nature. Such theological premises, depending on their characteristics, might conflict with Christianity, or certain branches of Christianity. For example, Cornelius Hunter has argued that a theological form of naturalism, which he calls theological naturalism, operates internally within some scientific arguments, particularly in origin science. He defines theological naturalism as a set of theological traditions mandating naturalistic explanations in science. For example, he identifies a utilitarian theological premise: God would create to ensure optimal utility in *each* kind of organism *without* tradeoffs due to other design criteria such as aesthetics (including whimsical beauty) or ecological integration for higher level order (the ecological tradeoff example is mine, not Hunter's). This utilitarian theological premise is found in a leading evolutionary biology argument influentially expressed by Stephen Jay Gould: "Odd arrangements and funny solutions are the proof of evolution—paths that a sensible God would never tread but that a natural process, constrained by history, follows perforce," (Gould 1980, p. 20), as cited in (Hunter 2022, p. 7). See also the following works: (Hunter 2002, 2007, 2021).

2 (Harrison and Roberts 2018). This anthology updates and expands Numbers' seminal "Science without God" essay (2003), arguing that Christian intellectuals contributed to science and methodological naturalism (or its rough archaic science-without-God equivalent), but that this largely occurred within a Christian theological framework. So, the essayists generally aim to show that this admirable medieval and early modern achievement was *not* "without God" in a broad sense.

3 Such a lesson justified by a similar historiography is in (Bishop 2013). Bishop argues that in nature studies, methodological naturalism has been, for good reasons, the typical orientation of Christians since the Middle Ages.

4 For a longer lesson in allegedly good science in the same issue of the Christian journal that published Bishop, "God and Methodological Naturalism," see (Applegate 2003). Applegate offers practical and theological reasons for methodological naturalism.

[5] (Boudry et al. 2010). On 18 February 2017, Boudry tweeted his atheism colorfully: "No self-respecting university should have a Faculty of Theology. Even a Faculty of Astrology would make more sense. At least stars exist." Accessed on 13 March 2023 at https://twitter.com/mboudry/status/835817310141235200. Boudry underappreciates the university as a medieval invention within Christendom in which about a third of the undergraduate curriculum was devoted to the study of nature (and mathematics) as a means to cultivate reasoning more broadly. The Church funded this towering cultural achievement, as documented in (Grant 2001).

[6] At least in the recent American context, creationism is largely understood to be an endeavor to correlate particular understandings of the first chapters of Genesis in the Bible to the findings of modern science. As Stephen Meyer explains, "Creationism or Creation Science, as defined by the U.S. Supreme Court, defends a particular reading of the book of Genesis in the Bible, typically one that asserts that the God of the Bible created the earth in six literal twenty-four hour periods a few thousand years ago." By contrast, "The theory of intelligent design does not offer an interpretation of the book of Genesis, nor does it posit a theory about the length of the Biblical days of creation or even the age of the earth. Instead, it posits a causal explanation for the observed complexity of life." (Meyer 2006).

[7] One reviewer suggested that Neo-Darwinian random mutations are just as impersonally capriciousness as Epicurean randomly swerving atoms, and so it is inconsistent to argue that Epicureans (but not also Darwinians) do not fit the *MN origin (and progress) of science* narrative, which traditionally aimed at celebrating the *elimination (or reduction) of unpredictability* in nature. However, in evolutionary theory since Darwin, the capriciousness of random variation is counterbalanced by non-random mechanisms such as natural selection and other natural laws. So Lehoux's argument still has merit even after qualifying it in response to this reviewer's insightful comment. One might also note two opposing inclinations within evolutionary theory today: (1) emphasize frequent convergence on similar molecular-anatomical structures due to non-random natural law constraints, or (2) emphasize the overall contingency and unpredictability of evolution as famously expressed by Stephen Jay Gould in his book *Wonderful Life* (Gould 1989, p. 45) in which he said evolution is "a staggeringly improbable series of events, sensible enough in retrospect and subject to rigorous explanation, but utterly unpredictable and quite unrepeatable. Wind back the tape of life to the early days of the Burgess Shale; let it play again from an identical starting point, and the chance becomes vanishingly small that anything like human intelligence would grace the replay." A similar tension between random and non-random accounts of nature is seen among ancient Greek thinkers.

[8] (Adelard of Bath 1998, p. 93). This text of *Questions on Natural Science* (*Quaestiones naturales*) is based on more manuscripts than previous editions. The other dialogues addressed to his "nephew" are a treatise on the liberal arts that constitute philosophy (*On the Same and the Different*) and a manual on the upbringing and medication of hawks (*On Birds*).

[9] (Ibid., pp. 97–98); the translator supplied the interpolations in brackets.

[10] (Abelard and Zemler-Cizewski 2011, p. 55). Zemler-Cizewski supplied all the interpolations in brackets, except for my two interpolations: miraculously and non-miraculously.

[11] (Boethius of Dacia 1987). Boethius interacts with Aristotle's idea of an eternal uncreated cosmos.

[12] (Dilley 2007, p. 41), concludes regarding Boethius: "The proscription of references to supernatural causes or principles from natural philosophy just *is* methodological naturalism." Dilley largely identifies MN as IMN, though he appears to see the utility of engaging EMN.

[13] For a similar argument see (Shank 2019).

[14] (Turner 2010). Turner on p. 104 concludes that, by the late 19th century, many religious writers thought it necessary to promote "a new theology compatible with the new science" of biological origins driven by MN. This development "fostered conflict, as more traditionally minded religionists attempted to defend older opinions that stood in contradiction" to MN-guided biological origins science. (Moore 1979), gives a prominent example of a theological novelty that traditional theologians contested: The Catholic scholar Saint George Jackson Mivart (1827–1900), one of the most influential theological commentators on evolutionary theory, believed that the "human body was derived from" a natural God-guided evolutionary process, "but the soul, the source of mankind's rational and ethical nature, appeared de novo by creative fiat." Moore further notes that five years after Mivart published this conclusion, Pope Pius IX conferred on Mivart the degree of doctor of philosophy (1876).

[15] Grant, *The Nature of Natural Philosophy*, pp. 49–90, argues that some of the Aristotelian philosophical principles condemned by the bishop of Paris in 1270 and 1277 stimulated non-Aristotelian conceptions of nature that produced scientific progress in the medieval and early modern periods. Boethius' career at the University of Paris was in its final stages around the time of these condemnations. In this controversial milieu, he framed his MN-like rule to protect his professional space as a natural philosopher, while also affirming his theological orthodoxy.

[16] Newton's title in its original Latin was *Philosophiae Naturalis Principia Mathematica*. For the helpful role of Christian theology in this development, see (Kaiser 1997).

[17] Natural philosophers were tasked with studying natural, not supernatural, events. In view of this university requirement, Buridan wrote: "In natural philosophy, we ought to accept actions and dependencies as if they always proceed in a natural way." However, Buridan in practice did not strictly follow this advice. Buridan, *Questions on the Heavens (de caelo)*, book 2, question 9, as cited in (Grant 2012, p. 42).

[18] This point is extensively documented in (Heilbron 1999).

19 Prominent among such misguided literature is Boudry et al. (2010, 2012) discussed in Section 2. For a response to these essays, see (Harrison 2018).

20 For an assessment of the presence of MN during the scientific revolution, see (Harrison 2019). On p. 70 he writes: "One of the shortcomings of early modern natural philosophy was its limited capacity to shed light on the origins of the earth, the geological changes that it had undergone in the past, and those that would befall it in the future. Newton, for example, insisted that the scope of natural philosophy extended only to 'the present frame of nature' and not the creation of the world, nor its eventual destruction."

21 (Davis 2023). Referring on p. 6 to natural philosophy *not* focused on *origins*, Davis writes that "Boyle rejected miracles in natural philosophy: there he accepted methodological naturalism." However, Davis also notes on p. 14 that Boyle's work has legitimately provided the basis for what is now called the theory of intelligent design (ID) with regard to *biological origins*. Such ID proponents, Davis observes, share Boyle's "view that mechanistic science gives rise to powerful arguments for an intelligent designer" when "they use current scientific knowledge of what mechanistic processes *can* do to identify aspects of nature that (in their view) *cannot* be explained by unintelligent causes alone . . . ." This entails the repudiation of MN in the study of biological origins, which was implicit in Boyle's work and explicit in ID today.

22 Earlier natural philosophers addressed some origins questions (e.g., the cause of the cosmos, earth, and life), but with only rudimentary investigative techniques.

23 (Rudwick 2005, p. 171), "No naturalist could now [about 1825] claim, with any credibility, that life had maintained an ahistorical stability or steady state, still less a recurring cyclicity, of the kind that Hutton, long before, had conjectured for its physical environment." Rudwick's book is a comprehensive study of the origin of geology, not just a treatise on geology and religion.

24 A possible objection to this conclusion would be to identify the Christian contribution to geohistory as science-engaged philosophy rather than an *argument within science* and to argue that only the latter is legitimately restricted by any form of MN. However, this objection misses the mark. In this case, the scientists structured their *arguments within* science by means of emulating a Christian view of directional history.

25 Whewell used the term consilience to roughly refer to what is now more commonly called unification. (McMullin 2014). For an elaboration of unification in contrast with other theoretical virtues, see Keas, "Systematizing the Theoretical Virtues."

26 (Ducheyne 2010). Ducheyne notes that Whewell was a respected practicing scientist (especially in tide theory) in addition to his main expertise in the history and philosophy of science.

27 (Crowe 2016). Here on pp. 437–45, and in a forthcoming essay, Crowe shows how Whewell pioneered astrobiology's *circumstellar habitable zone* (Whewell called it the "Temperate Zone of the Solar System"). Whewell established this life-friendly zone on the physics of the rapid diminution of heat at further distances from a host star—the inverse square law for stellar radiation discovered by Whewell's close friend, the leading astronomer John Herschel. In our solar system, the inner planets are too hot for complex life, and the outer planets are too cold. Whewell recognized this is based on natural laws governing all solar systems, making potentially habitable planets (based on temperature for liquid water) *rare* compared to what had been imagined previously.

28 (Davis 2013). Davis notes that Boyle contributed to "'Boyle's Law,' the inverse relation between the pressure and volume of gases that is a standard part of a basic chemistry course."

29 For an assessment of Harvey that is similar to Whewell's, see (McMullen 1998).

30 (Whewell 1858, p. 246). Whewell quotes Bichat's *Anatomie Générale*.

31 (Whewell 1857, p. 488, this is identical in the 1st ed. of 1837, p. 588).

32 Ibid. Here is the context for the quotation. Whewell writes of "the impossibility of accounting by any natural means for the production of all the successive tribes of plants and animals which have peopled the world in the various stages of its progress, as **geology** teaches us. That they were, like our own animal and vegetable contemporaries, profoundly adapted to the condition in which they were placed, we have ample reason to believe; but when we inquire whence they came into this our world, **geology** is silent. The mystery of creation is not within the range of her [geology's] legitimate territory; she [geology] says nothing, but she points upwards." (emphasis is mine).

33 (Ruse 2010). See https://todayinsci.com/W/Whewell_William/WhewellWilliam-Quotations.htm (accessed on 11 March 2023) or an example of the error of *nature*, rather than *geology*, in brackets.

34 Similar to the historian of geology Rudwick, Whewell declares that "the geologist is an antiquary [historian] of a new order," due to "a real and philosophical connexion of the principles of investigation" of human history and geology. "The organic fossils which occur in the rock, and the medals which we find in the ruins of ancient cities, are to be studied in a similar spirit and for a similar purpose . . . . The history of the earth, and the history of the earth's inhabitants, as collected from phenomena, are governed by the same principles . . . . In both we endeavor to learn accurately what the present is, and hence what the past has been. Both are *historical* sciences in the same sense." (Whewell 1857, pp. 398–402).

35 (Whewell [1830] 1842, plate I, Figure 1).

36 Ibid., plate I, Figure 3.

37 Whewell considered the aesthetic criterion of *highly coordinated vertical* lines (as opposed to Romanesque *horizontal* orientation with a lower degree of coordination) to be the main "formative principle" of Gothic architecture, "which gave unity and consistency

to the new style, and disclosed a common tendency in the changes which had been going on in the different members [i.e., physical components] of the architecture. And the very fact of this character being, when once applied, so manifest and simple a mode of combining the parts of the structure into a harmonious whole, shows how much of genius there was in the discovery" (Ibid., pp. 10–11). He hinted at an underlying aesthetic theory to this aesthetic judgment: "Now in order to consider a work of art as beautiful, we must see, or seem to see, the relations of its parts with clearness and definiteness. Conceptions which are loose, incomplete, scanty, partial, can never leave us pleased and gratified, if we are capable of full and steady comprehensions" (Ibid., p. 9). Given that Whewell deployed much of his architectural history logic to the history of life on earth, he would have surely appreciated the subsequent discovery of both the *aesthetic* and *physical survival* value of compact seed arrangements in certain flowers which exhibit Fibonacci (or similar mathematical regularities) in their spiral arrangements of seeds. (A Fibonacci sequence is one in which each number is the sum of the two preceding ones: e.g., 1, 2, 3, 5, 8 . . .). There are multiple beautiful Fibonacci or Fibonacci-like arrangements that embody mathematically elegant solutions to seed arrangements that cannot be fully reduced to mere Darwinian physical survival value. The scientific theories that recognize this in flowers exhibit beauty as a trait of a good theory (theoretical virtue), which has recently been defined: A theory that "evokes aesthetic pleasure in properly functioning and sufficiently informed persons." Keas, "Systematizing the Theoretical Virtues," 2762. Beautiful mathematical relations in our theories of natural laws (e.g., gravity) and biological structures (e.g., Fibonacci seed arrangements) have often been taken to have epistemic value in scientific reasoning itself (Ibid., pp. 2772–75).

38 (Whewell 1845, p. 62). Whewell considers here detecting events "out of the common course of nature; acts which, therefore, we may properly call miraculous."

39 (Whewell 1866, pp. 357–58). He roughly quotes Darwin's *Origin*, 1st ed., pp. 186–87, omitting the words in brackets, and paraphrasing a few tiny portions—all without altering Darwin's essential meaning: "Several facts make me suspect that any sensitive nerve may be rendered sensitive to light"; "[Reason tells me, that if] numerous gradations from a perfect and complex eye to one very imperfect and simple, each grade [being] useful to its possessor, can be shown to exist; [if] further, the eye does vary, if only slightly, and its variations are unlimited; and if any variation or modification in the organ be ever useful to an animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection [, though insuperable by our imagination,] can hardly be considered real."

40 Darwin, "Books to be Read" list, as cited in (Ruse 1975); Quinn, "Whewell's Philosophy of Architecture," 17, notes the "absence of any discussion" of Whewell's *Philosophy* "from Darwin's correspondence and notebooks." He concludes that this "is strong evidence that Darwin did not read the book."

41 Darwin thoroughly annotated his copy of Whewell, *History of the Inductive* Sciences (1837), so he likely read it carefully. This is documented in footnote 29 of Ruse, "Darwin's Debt to Philosophy." Whewell's (1837) *History* had much less coverage of MN-defying biological design inferences than Whewell's (1840) *Philosophy*.

42 I thank Kerry Magruder for noting some affinities between my account of methodological pluralism and Charles Taylor's treatment of *secularism* as *pluralism* rather than naturalism or materialism (Taylor 2007). Magruder highlighted for me how Taylor successfully argues *against* the historiography of secularism as a relentless increase in materialism, which amounts to a *subtraction account*, in which religion is progressively marginalized and subtracted from public visibility.

43 In an 1856 letter to the prominent theistic evolutionist Asa Gray, Darwin dismissed special creation as unscientific: "For to my mind to say that species were created so and so is no scientific explanation, only a reverent way of saying it is so and so." (Darwin 1897, p. 437).

44 (Quinn 2016, p. 17) mentions that "Darwin and Whewell were on good terms and discussed scientific matters. Many of these conversations occurred as the two walked home from J. S. Henslow's weekly scientific gatherings. Additionally, Whewell and Darwin would have met regularly through the Geological Society from 1837 to 1838."

45 (Darwin 1859, p. 435, 1860, p. 434, 1861, pp. 466–67). These first three editions render the passage: "On the ordinary view of the independent creation of each being, we can only say that so it is;—that it has so pleased the Creator to construct each animal and plant."

46 (Dilley 2013, p. 24). See Dilley's footnotes for examples of such scholarly judgments.

47 (Lightman and Dawson 2014, p. 1). Dawson and Lightman establish that "in the prologue to his *Essays upon Some Controverted* Questions (1892), Thomas Henry Huxley offered a retrospective defense of what he called the 'principle of the scientific Naturalism of the latter half of the nineteenth century.'" They note that Huxley's term, which he refashioned from earlier usage, was "certainly preferable to the considerably more contentious term *scientific materialism* coined by his close friend [and prominent X Club member] John Tyndall twenty years earlier."

48 Dawson and Lightman, *Victorian Scientific Naturalism*; (Harrison and Roberts 2018; Lightman and Reidy 2016; Brooke 2018).

49 (Barton 2018, p. 282). Barton notes that the honorific Abbey burial of Darwin was pulled off principally by X Club connections to the Royal Society and the official science representative to parliament.

50 This was announced by the Dean of Westminster at https://www.westminster-abbey.org/abbey-news/professor-stephen-hawking-to-be-honoured-at-the-abbey, accessed on 30 January 2023.

51 Another related factor was the rise of liberal Christianity, which minimized the supernatural within Christianity. See (Ungureanu 2019).

52 St. Augustine, *Contra Faustum Manichaeum* 32.20, as cited in (Harrison 2006).

[53] (Smith 2014), inside jacket synopsis.

[54] *Johannes Kepler Gesammelte Werke*, 13:309, letter no. 117, lines 174–9, as cited in (Kaiser 2007a, p. 175). See also (Keas 2019, chp. 10).

[55] Kepler's textbook dedication, as translated in (Kepler and Baumgardt 1951).

[56] Kepler's conception of receiving divine revelation while doing science is articulated in passages such as these: "For He Himself has let man take part in the knowledge of these things and thus not in a small measure has set up His image in man. Since He recognized as very good this image which He made, He will so much more readily recognize our efforts with the light of this image also to push into the light of knowledge the utilization of the numbers, weights and sizes which He marked out at creation. For these secrets are not of the kind whose research should be forbidden; rather they are set before our eyes like a mirror so that by examining them we observe to some extent the goodness and wisdom of the Creator." Johannes Kepler, *Epitome of Copernican Astronomy*, as cited in (Caspar 1993, p. 381). Kepler recognized "a divine ravishment [being cognitively carried away by God] in investigating the works of God." (Kepler 1952, pp. 849–50).

[57] For some of the other factors (especially liberal Christianity that diminished the role of supernatural causation), see (Ungureanu 2019).

References

Abelard, Peter, and Wanda Zemler-Cizewski. 2011. Corpus Christianorum Continuatio Mediaevalis. In *An Exposition on the Six-Day Work*. Turnhout: Brepols, vol. 15.

Adelard of Bath. 1998. *Conversations with His Nephew: On the Same and the Different, Questions on Natural Science, and on Birds*. Edited by Charles Burnett. Cambridge: Cambridge University Press.

Applegate, Kathryn. 2003. A Defense of Methodological Naturalism. *Perspectives on Science & Christian Faith* 65: 37–45.

Barton, Ruth. 2018. *The X Club: Power and Authority in Victorian Science*. Chicago: University of Chicago Press.

Biard, Joel. 2001. The Natural Order in John Buridan. In *The Metaphysics and Natural Philosophy of John Buridan*. Edited by J. M. M. H. Thijssen and Jack Zupko. Leiden: Brill, pp. 77–95.

Bishop, Robert. 2013. God and Methodological Naturalism in the Scientific Revolution and Beyond. *Perspectives on Science and Christian Faith* 65: 10–23.

Boethius of Dacia. 1987. *On the Supreme Good, on the Eternity of the World, on Dreams*. Translated by John F. Wippel. Toronto: Pontifical Institute of Mediaeval Studies.

Boucher, Sandy. 2020. Methodological Naturalism in the Sciences. *International Journal for Philosophy of Religion* 88: 57–80. [CrossRef]

Boudry, Maarten, Stefaan Blancke, and Johan Braeckman. 2010. How Not to Attack Intelligent Design Creationism: Philosophical Misconceptions About Methodological Naturalism. *Foundations of Science* 15: 227–44. [CrossRef]

Boudry, Maarten, Stefaan Blancke, and Johan Braeckman. 2012. Grist to the Mill of Anti-Evolutionism: The Failed Strategy of Ruling the Supernatural Out of Science by Philosophical Fiat. *Science & Education* 21: 1151–65.

Brooke, John Hedley. 2010a. 'Laws Impressed on Matter by the Creator'? The *Origin* and the Question of Religion. In *The Cambridge Companion to the "Origin of Species*. Edited by Michael Ruse and Robert Richards. New York: Cambridge University Press, pp. 256–74.

Brooke, John Hedley. 2010b. Darwin and Religion: Correcting the Caricatures. *Science & Education* 19: 391–405.

Brooke, John Hedley. 2018. The Ambivalence of Scientific Naturalism: A Response to Mark Harris. *Zygon* 53: 1051–56. [CrossRef]

Buridan, John. 1509. *Quaestiones Super Octo Physicorum Libros Aristotelis*. Paris: Impensis D. Roce, ll. 13, fol. 39^{rb}.

Caspar, Max. 1993. *Kepler*. Translated by C. Doris Hellman. New York: Dover.

Crowe, Michael J. 2016. William Whewell, the Plurality of Worlds, and the Modern Solar System. *Zygon* 51: 431–49. [CrossRef]

Dales, Richard C. 1992. *The Intellectual Life of Western Europe in the Middle Ages*, 2nd ed. Leiden: E.J. Brill.

Darwin, Charles. 1859. *On the Origin of Species*, 1st ed. London: John Murray.

Darwin, Charles. 1860. *On the Origin of Species*, 2nd ed. London: John Murray.

Darwin, Charles. 1861. *On the Origin of Species*, 3rd ed. London: John Murray.

Darwin, Charles. 1866. *On the Origin of Species*, 4th ed. London: John Murray.

Darwin, Charles. 1897. *The Life and Letters of Charles Darwin*. Edited by Francis Darwin. New York: Appleton.

Darwin, Charles. 1959. *The Autobiography of Charles Darwin 1809–1882*. Edited by Nora Barlow. London: Collins. Available online: http://darwin-online.org.uk/content/frameset?itemID=F1497&pageseq=1&viewtype=text (accessed on 11 March 2023).

Daston, Lorraine, and Katharine Park. 1998. *Wonders and the Order of Nature, 1150–1750*. New York: Zone Books.

Davis, Edward B. 1999. Christianity and Early Modern Science: The Foster Thesis Reconsidered. In *Evangelicals and Science in Historical Perspective*. Edited by David N. Livingstone, D. G. Hart and Mark A. Noll. Oxford: Oxford University Press.

Davis, Edward B. 2013. The Faith of a Great Scientist: Robert Boyle's Religious Life, Attitudes, and Vocation. Available online: https://biologos.org/articles/the-faith-of-a-great-scientist-robert-boyles-religious-life-attitudes-and-vocation (accessed on 5 December 2022).

Davis, Edward B. 2023. Robert Boyle, The Bible, and Natural Philosophy. *Religions* 14: 795. Available online: https://www.mdpi.com/2077-1444/14/6/795 (accessed on 13 March 2023).

Dembski, William A., Wayne J. Downs, and Fr Justin B. A. Frederick. 2008. *The Patristic Understanding of Creation: An Anthology of Writings from the Church Fathers on Creation and Design*. Riesel: Erasmus Press.

Dilley, Stephen Craig. 2007. Methodological Naturalism, History, and Science. Ph.D. dissertation, Arizona State University, Tempe, AZ, USA.
Dilley, Stephen. 2013. The Evolution of Methodological Naturalism in the Origin of Species. *The Journal of the International Society for the History of Philosophy of Science* 3: 20–58.
Dockrill, David William. 1971. T. H. Huxley and the Meaning of 'Agnosticism'. *Theology* 74: 461–77. [CrossRef]
Ducheyne, Steffen. 2010. Fundamental Questions and Some New Answers on Philosophical, Contextual and Scientific Whewell: Some Reflections on Recent Whewell Scholarship and the Progress Made Therein. *Perspectives on Science* 18: 242–72. [CrossRef]
Eastwood, Bruce S. 2013. Early-Medieval Cosmology, Astronomy, and Mathematics. In *Cambridge History of Science: Volume 2, Medieval Science*. Edited by David C. Lindberg and Michael H. Shank. Cambridge: Cambridge University Press.
Ebbesen, Sten. 2020. "Boethius of Dacia," Stanford Encyclopedia of Philosophy. Available online: https://plato.stanford.edu/entries/boethius-dacia/ (accessed on 14 March 2023).
Elsdon-Baker, Fern, and Bernard V. Lightman, eds. 2020. *Identity in a Secular Age: Science, Religion, and Public Perceptions*. Pittsburgh: University of Pittsburgh Press.
Expelled: No Intelligence Allowed. 2008. Documentary film directed by Nathan Frankowski. Available online: https://www.youtube.com/watch?v=V5EPymcWp-g (accessed on 5 December 2022).
Finocchiaro, Maurice A. 2008. *The Essential Galileo*. Indianapolis: Hackett Publishing.
Gould, Stephen Jay. 1980. The Panda's Thumb. In *The Panda's Thumb*. New York: W. W. Norton.
Gould, Stephen Jay. 1989. *Wonderful Life: The Burgess Shale and Nature of History*. New York: W. W. Norton.
Grant, Edward. 1993. Jean Buridan and Nicole Oresme on Natural Knowledge. *Vivarium* 31: 84–105. [CrossRef]
Grant, Edward. 2001. *God and Reason in the Middle Ages*. Cambridge: Cambridge University Press.
Grant, Edward. 2012. *The Nature of Natural Philosophy in the Late Middle Ages (Studies in Philosophy and the History of Philosophy)*. Washington DC: Catholic University of America Press, vol. 52.
Hannam, James. 2009. *God's Philosophers: How the Medieval World Laid the Foundations of Modern Science*. London: Icon Books.
Hansen, Bert. 1985. *Nicole Oresme and the Marvels of Nature: De Causis Mirabilium*. Toronto: Pontifical Institute of Medieval Studies.
Harrison, Peter, and Jon H. Roberts. 2018. *Science without God?: Rethinking the History of Scientific Naturalism*. Oxford: Oxford University Press.
Harrison, Peter. 2006. The Bible and the Emergence of Modern Science. *Science and Christian Belief* 18: 118.
Harrison, Peter. 2007. *The Fall of Man and the Foundations of Science*. Cambridge: Cambridge University Press.
Harrison, Peter. 2018. Naturalism and the Success of Science. *Religious Studies* 56: 1–18. [CrossRef]
Harrison, Peter. 2019. Laws of God or Laws of Nature? Natural Order in the Early Modern Period. In *Science without God?: Rethinking the History of Scientific Naturalism*. Oxford: Oxford University Press, pp. 58–76.
Hawking, Stephen. 1998. *A Brief History of Time*, 10th anniversary ed. New York: Bantam Books.
Heilbron, John L. 1999. *The Sun in the Church: Cathedrals as Solar Observatories*. Cambridge: Harvard University Press.
Hunter, Cornelius. 2007. *Science's Blind Spot: The Unseen Religion of Scientific Naturalism*. Grand Rapids: Brazos Press.
Hunter, Cornelius G. 2002. *Darwin's God: Evolution and the Problem of Evil*. Grand Rapids: Brazos Press.
Hunter, Cornelius G. 2021. Evolution as a Theological Research Program. *Religions* 12: 694. Available online: https://www.mdpi.com/2077-1444/12/9/694 (accessed on 6 June 2023).
Hunter, Cornelius G. 2022. The Theological Structure of Evolutionary Theory. *Religions* 13: 774. Available online: https://www.mdpi.com/2077-1444/13/9/774 (accessed on 7 June 2023).
Kaiser, Christopher B. 1997. *Creational Theology and the History of Physical Science: The Creationist Tradition from Basil to Bohr*. Leiden: Brill.
Kaiser, Christopher B. 2007a. Science-Fostering Belief—Then and Now. *Perspectives on Science and Christian Faith* 59: 171–81.
Kaiser, Christopher B. 2007b. *Toward a Theology of Scientific Endeavour: The Descent of Science*. Ashgate Science and Religion Series. Aldershot: Ashgate, vol. 48.
Keas, Michael N. 2018. Systematizing the Theoretical Virtues. *Synthese* 195: 2761–93. Available online: https://link.springer.com/article/10.1007/s11229-017-1355-6 (accessed on 5 June 2022).
Keas, Michael N. 2021. Evaluating Warfare Myths About Science and Christianity and How These Myths Promote Scientism. *Religions* 12: 1–13. Available online: https://www.mdpi.com/2077-1444/12/2/132 (accessed on 11 June 2023).
Keas, Michael Newton. 2019. *Unbelievable: 7 Myths About the History and Future of Science and Religion*. Wilmington: ISI Books.
Kepler, Johannes, and Carola Baumgardt. 1951. *Johannes Kepler: Life and Letters*. New York: Philosophical Library, pp. 122–23.
Kepler, Johannes. 1952. Epitome of Copernican Astronomy. In *Great Books of the Western World*. Translated by Charles Glenn Wallis. Chicago: Encyclopedia Britannica, vol. 16.
Larmer, Robert. 2019. The Many Inadequate Justifications of Methodological Naturalism. *Organon F* 26: 5–24. [CrossRef]
Lehoux, Daryn. 2019. 'All Things Are Full of Gods': Naturalism in the Classical World. In *Science without God?: Rethinking the History of Scientific Naturalism*. Oxford: Oxford University Press.
Lightman, Bernard. 2002. Huxley and Scientific Agnosticism: The Strange History of a Failed Rhetorical Strategy. *The British Journal for the History of Science* 35: 271–89. [CrossRef]
Lightman, Bernard. 2016. Science at the Metaphysical Society: Defining Knowledge in the 1870s. In *The Age of Scientific Naturalism*. Edited by Bernard Lightman and Michael S. Reidy. Pittsburgh: University of Pittsburgh Press, vol. 10, pp. 187–206.

Lightman, Bernard, and Gowan Dawson, eds. 2014. *Victorian Scientific Naturalism: Community, Identity, Continuity*. Chicago: University of Chicago Press.
Lightman, Bernard, and Michael S. Reidy, eds. 2016. *The Age of Scientific Naturalism: Tyndall and His Contemporaries*. Pittsburgh: University of Pittsburgh Press.
Lindberg, David C., and Katherine H. Tachau. 2013. The Science of Light and Color, Seeing and Knowing. In *Cambridge History of Science: Volume 2, Medieval Science*. Cambridge: Cambridge University Press.
Luskin, Casey. 2021. What Is Intelligent Design? Available online: https://intelligentdesign.org/articles/what-is-intelligent-design/ (accessed on 30 March 2023).
McMullen, Emerson Thomas. 1998. *William Harvey and the Use of Purpose in the Scientific Revolution: Cosmos by Chance or Universe by Design?* Lanham: University Press of America.
McMullin, Ernan. 2014. The Virtues of a Good Theory. In *The Routledge Companion to Philosophy of Science*. Edited by Martin Curd and Stathis Psillos. New York: Routledge, pp. 561–71.
Meyer, Stephen C. 2006. A Scientific History and Philosophical Defense of the Theory of Intelligent Design. *Religion-Staat-Gesellschaft* 7: 203–47.
Moore, James R. 1979. *The Post-Darwinian Controversies*. Cambridge: Cambridge University Press.
Numbers, Ronald L. 2003. Science without God: Natural Laws and Christian Beliefs. In *When Science and Christianity Meet*. Edited by David C. Lindberg and Ronald L. Numbers. Chicago: University of Chicago Press, pp. 265–86.
Plantinga, Alvin. 2011. *Where the Conflict Really Lies: Science, Religion, and Naturalism*. Oxford: Oxford University Press.
Quinn, Aleta. 2016. William Whewell's Philosophy of Architecture and the Historicization of Biology. *Studies in History and Philosophy of Biological and Biomedical Sciences* 59: 11–19. [CrossRef]
Rudwick, Martin J. S. 2005. *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution*. Chicago: University of Chicago Press.
Rudwick, Martin J. S. 2021. *Earth's Deep History: How It Was Discovered and Why It Matters*. Chicago: University of Chicago Press, 2021.
Ruse, Michael. 1975. Darwin's Debt to Philosophy: An Examination of the Influence of the Philosophical Ideas of John F. W. Herschel and William Whewell on the Development of Charles Darwin's Theory of Evolution. *Studies in History and Philosophy of Science Part A* 6: 166. [CrossRef]
Ruse, Michael. 2010. Intelligent Design Is an Oxymoron. *The Guardian*, May 5. Available online: https://www.theguardian.com/commentisfree/belief/2010/may/05/intelligent-design-fuller-creationism (accessed on 10 March 2023).
Shank, Michael H. 2019. Naturalist Tendencies in Medieval Science. In *Science without God?: Rethinking the History of Scientific Naturalism*. Oxford: Oxford University Press.
Smith, A. Mark. 2014. *From Sight to Light: The Passage from Ancient to Modern Optics*. Chicago: University of Chicago Press.
Smith, Tiddy. 2017. Methodological Naturalism and Its Misconceptions. *International Journal for Philosophy of Religion* 82: 321–36. [CrossRef]
Snyder, Laura J. 2010. *Reforming Philosophy: A Victorian Debate on Science and Society*. Chicago: University of Chicago Press.
Snyder, Laura J. 2011. *The Philosophical Breakfast Club: Four Remarkable Friends Who Transformed Science and Changed the World*. New York: Broadway Books.
Stanley, Matthew. 2014a. *Huxley's Church and Maxwell's Demon: From Theistic Science to Naturalistic Science*. Chicago: University of Chicago Press.
Stanley, Matthew. 2014b. Where Naturalism and Theism Met: The Uniformity of Nature. In *Victorian Scientific Naturalism: Community, Identity, Continuity*. Edited by Gowan Dawson and Bernard Lightman. Chicago: University of Chicago Press.
Taylor, Charles. 2007. *A Secular Age*. 1999 Gifford Lectures. Cambridge: Harvard University Press.
Turner, Frank M. 2010. The Late Victorian Conflict of Science and Religion as an Event in Nineteenth-Century Intellectual and Cultural History. In *Science and Religion New Historical Perspectives*. Edited by Thomas Dixon, Geoffrey Cantor and Stephen Pumfrey. Cambridge: Cambridge University Press.
Ungureanu, James C. 2019. *Science, Religion and the Protestant Tradition: Retracing the Origins of Conflict*. Pittsburgh: University of Pittsburgh Press.
Whewell, William. 1833. *Astronomy and General Physics Considered with Reference to Natural Theology*, 2nd ed. Christian Apologetics Book in the Bridgewater Treatise Series. London: William Pickering.
Whewell, William. 1840. *The Philosophy of the Inductive Sciences*. London: J. W. Parker.
Whewell, William. 1842. *Architectural Notes on German Churches*, 3rd ed. Cambridge: J. and J.J. Deighton. First published 1830.
Whewell, William. 1845. *Indications of the Creator: Extracts Bearing upon Theology, from the History and the Philosophy of the Inductive Sciences*. London: J. W. Parker.
Whewell, William. 1847. *The Philosophy of the Inductive Sciences, Founded Upon Their History*, 2nd ed. London: J. W. Parker, vol. 2.
Whewell, William. 1857. *History of the Inductive Sciences from the Earliest to the Present Time*, 3rd ed. London: John W. Parker, vol. 3.
Whewell, William. 1858. *History of Scientific Ideas: Being the First Part of the Philosophy of the Inductive Sciences*, 3rd ed. London: John W. Parker, vol. 2.
Whewell, William. 1866. Comte and Positivism. *Macmillan's Magazine* 13: 353–62. [CrossRef]

Yeo, Richard R. 1986. The Principle of Plenitude and Natural Theology in Nineteenth-Century Britain. *The British Journal for the History of Science* 19: 263–82. [CrossRef]
Yeo, Richard R. 1993. *Defining Science: William Whewell, Natural Knowledge, and Public Debate in Early Victorian Britain*. Cambridge: Cambridge University Press.
Zupko, Jack. 2008. Buridan and Skepticism. *Journal of the History of Philosophy* 31: 191–221. [CrossRef]