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The Relationship Between Physics and the West's Philosophy of God

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THE RELATIONSHIP BETWEEN PHYSICS AND THE WEST'S PHILOSOPHY OF GOD

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INTRODUCTION

This thesis will explore the impact that scientific theories – particularly those in the field of physics – have had on prevailing philosophies of God, and illustrate that science and philosophy are not wholly separate, unrelated fields. Some of the most influential philosophical assertions about God have indeed been shaped by ideas that originated in science. Thomas Aquinas' view of God, as well as the proofs that he offered for God's existence, are laden with ideas about the physical structure and phenomena of nature. So, too, do the philosophical writings of Isaac Newton, Rene Descartes, and other Enlightenment thinkers invoke science for both their philosophical foundation and the arguments given in support of the existence – some will assert the necessity – of God in the world. And today's physics, which deals with the quantum world of X-rays, protons, and the speed of light, both highlights and complicates the relationship between physics and theology as it introduces ideas that escaped previous generations of physicists, reshaping a millennia-old discussion about whether God exists, what God is, and how God operates. This thesis will show that physics and the philosophy of God have intersected throughout history, and that Western theology has never achieved independence from physics, while theories in physics, likewise, were not constructed in a Godless vacuum.

It is worth noting from the outset that this thesis will have limitations. First, this analysis of the relationship between God and physical theories will be decidedly and intentionally focused on the West, namely Europe and the United States. A global exploration of these topics would – for this thesis at least – require too much attention to be paid to areas that are peripheral to the topic. A thorough analysis of Eastern religions like Hinduism and Buddhism, for example, would be mandated of such an all-encompassing analysis. So, too, would a historical study of the diffusion of Western thought into the East, a task that would stray from the philosophical aims of this thesis and delve into a study of cross-continental exchanges of people and ideas. This, in turn, would mandate an analysis of the migration patterns of past civilizations and an exploration of linguistic differences between what the West calls “science” and what that word meant to a 15th-century Chinese monk. Thus, the definitions given for a specific period’s view of “physics” or “theology” are admittedly focused on the West.

Another limitation of this thesis – one that is necessary in order to keep the focus on philosophy and not history – is the generalization of beliefs of different time periods. For example, the work of Thomas Aquinas will be linked with the beliefs of Medieval Europe; while Aquinas wielded a great deal of influence over the period’s view of God, and while his work is certainly among the most useful to discover the eminent ideas of the time, he obviously is not representative of *everyone’s* philosophical views of that period. There of course was dissent and disagreement about, for example, God’s place within the teleological structure of the world – or, moreover, whether the universe was structured teleologically in the first place. But just as an analysis of the spread of ideas to Asia would be superfluous to the task at hand, so would a lengthy discussion on the exact influence and scope of these philosophical ideas about God.

CHAPTER ONE

Ancient Physics: Logic's Reign Over the Natural World

There has, to this point, been some ambiguity between the terms "science" and "physics." Much of this is due to the evolution that the definitions of these words have undergone over the past few millennia. Nowhere is the subjectivity of these terms made clearer than in the work of Aristotle, who will be the first thinker taken up by this thesis. When looking at Aristotle's book *Physics*, it is important to realize that "his *Physics* is not physics at all. It is something else. It is a theory of nature, that system of things which allows a plant to grow, an animal to graze, and a man to think, fully as much as it allows the sun to be eclipsed or bodies to be in motion or at rest" (Woodbridge 49). It is beneficial, in light of this broadened definition of physics, for readers "to try the best one can to forget that there ever has been any physics at all" (Woodbridge 49). Aristotle's methods are largely irreconcilable with subsequent versions of physics. This point is paramount to the philosophy of Aristotle, which had an incalculable impact on Western thought.

For Aristotle, "physics" was a study of things that moved – and not just spatial movement like an object falling towards the ground, but also movements by animals and plants. The motion of all natural bodies is caused by something; it was the study of this something – "the mover" – and its origins that Aristotle called "physics." The forces that cause inanimate bodies to move have the same source as the forces that cause plants to grow and impel animals to eat. Thus, Aristotle's physics "stressed the substantial and qualitative aspects of the physical universe…For Aristotle, science is a mental skill in reasoning from premises grounded in sense experience and in intellectual understanding of the universal meanings implicit in that experience" (Aquinas xxvi). This process of reasoning did not require complex mathematical analysis or experimentation, but rather a trust of man's capacity to reason logically from observable phenomena to their causes. For example, every spider makes a web in a similar fashion. Likewise, birds always construct nests in a certain way. These phenomena are plain to the senses, and their regularity proves that some force guides them, a force that facilitates their movement. If there was no controlling force orchestrating natural phenomena, then they would occur in a haphazard, irregular fashion. The regularity of natural phenomena proves that there is an order to what happens naturally, and understanding the cause(s) of that regularity is the goal of Aristotle's physics.

With this vision of nature in mind, Aristotle establishes a unique definition of motion, one that allows him to examine the totality of natural motion, including those of people, plants, and animals. For Aristotle, motion is defined as the realization of actuality by something that was previously in a state of potentiality. In this sense, an apple tree during the winter has the potential to produce apples. When the seasons change and the tree does yield fruit, it is considered motion: the realization of potential. "Aristotle calls motion the 'fulfillment of what exists potentially, in so far as it exists potentially.' The point to be observed here is that the definition rests on a broader theory, that of potency and act, which has dropped out of modern physics" (Aquinas xxvi). Using this definition of motion, it is clear how Aristotle's notion of physics becomes encompassing of things that today may be taken up by different arenas of study.

Aristotle attributes the process by which natural bodies realize their potential to four different types of causes – material, efficient, formal, and final. The *material* cause refers to the matter that is undergoing some sort of motion, whether it is a flower blossoming or a stone falling, in which case the material causes would be either the flower or stone. The *efficient* cause is the source of change or motion that takes place – that which is responsible for the material cause becoming actualized. A sculptor is the efficient cause of marble – the material cause – turning into a statue. But that the reshaped piece of marble is a “statue” would be owed to Aristotle’s *formal* cause, which is a “principle of determination…As matter is the principle of potentiality, of the ability to become other than it is, form is the principle of actuality, of the thing being the sort of thing it is” (Aristotle 71). The form of “statue” is that for which the sculptor strived; this form is what guided his act. The fourth cause is the *final* cause – the purpose or end for which motion occurs. The final cause explains *why* something happens – why the sculptor (efficient) was impelled to create a statue (formal) out of marble (material).

Having articulated these four types of causes, Aristotle then distinguishes between natural and unnatural motion. Unnatural or accidental motion is motion in which material causes are acted upon by an *efficient cause that is external to the matter*. For example, the material cause of a bed is wood; without wood, building a wood frame for a bed is impossible. But there are no naturally-occurring efficient causes to turn a tree into a bed. Instead, only *external* efficient causes could turn the tree into a bed. The form of trees does not cause trees that are potentially beds to actually become beds. The form of bed, however, calls for trees to be used. Thus, the construction of the bed – the transformation of that which is potentially a bed into the actual bed – is an instance of unnatural (sometimes called “violent”) motion because the efficient cause of the bed, which is a human, is external to the tree. The final cause of a tree, the potential that exists within the tree, would never cause the tree to turn into a bed; it does not contain within it the potential for that kind of motion.

Natural motion is the opposite – motion in which *the efficient cause is the form* of the material cause, which in turn helps the material cause realize its potential. The natural motion of a tree will bring it closer to the form of tree. Thus, when undergoing natural motion, trees will grow and blossom and eventually die off because that process is dictated by their form. Therefore, *the form of anything is the end towards which the process of actualization takes it*.

While motions caused totally by external efficient causes still fell under the far-reaching scope of Aristotle's "physics" – like the sculpting of marble or the construction of a bed – it is the *natural* motion of bodies, those initiated by formal efficient causes, with which this chapter will be chiefly concerned. This is because the natural motion of bodies in nature – which was but a branch of Aristotelian physics – would become the main focus of subsequent versions of physics. Enlightenment physics, for example, would never entertain questions about why people are impelled to sculpt or build; those questions belong to some other study. Thus, of all the various types of motion that fall in the arena of Aristotle's physics, the primary focus here is local motion.

Natural local motion – spatial movements brought about by a natural cause – is a process realized through a matter's form, which is understood as a "principle of motion" (Woodbridge 68). "In those things to which it belongs to move, there is an active principle of motion. Whereas in those things to which it belongs to be moved, there is a passive principle, which is matter. And this [guiding] principle, insofar as it has a natural potency for such a form and motion, makes the motion [of the matter] to be natural" (Aquinas 424). The guiding principle is responsible for the motion of all natural bodies, all of which are endowed with a principle of motion, a principle that guides their movement, the realization of their potential.

But if material causes do not the generate their own motion, as Aristotle claims, and are always moved by a form or principle of motion, then what is the relationship between a material cause, which is sensibly being moved, and its formal cause, which is moving it?

> That, moreover, which is thus acted upon by a mover is moved. But this sort of action works by contact, for bodies act by touching. Hence it follows that the mover should also be acted upon, for that which it touches is acted upon….The act of the mobile object, which is motion, occurs because of the contact of the mover. [Aristotle] shows as follows that being moved does not belong to the mover per se. Some form always seems to be the mover….Forms of this sort are causes and principles of motion, because every agent moves according to its form. Hence, since each thing is in act through its form, it follows that form is a moving principle (Aquinas 144).

Because natural things always behave in the same or similar fashion, there must be something in contact with them that allows for motion: a form that is *different than the matter of a body but at the same time together with it* (Aquinas 156). Material causes thus have both matter and form because moved bodies only move through contact with the mover. The mover must either be external to the body – like a person is with a sword or arrow – *or contained intrinsically as a principle of motion*. Thus, the matter of a rock is its shape, size, weight – the readily observable features – whereas its form is something different, something that dictates the rock's motion and natural disposition. The form is different than the rock's physical, tangible characteristics, but at the same time "works by contact" with the rock to generate motion. The function of the matter is to be moved; the function of the form is to cause movement.

Aristotle thus declared that everything that is moved is divisible. He arrived at this conclusion by reasoning that whatever is moved is moved by something, and that any moving body must therefore have two parts: a mover and a thing moved (Fox 232). Without this division of mover and moved, then a material cause must generate its own motion, which, as stated above, is impossible. The necessity of an internal mover – an internal efficient cause – also necessitates that moving bodies be divisible.

It is important to clarify the exact relationship between the mover and the material cause, because understanding this relationship will eventually be integral to understanding the ensuing notion of God's place in the world. According to Aristotle, the mover and the moved are "together." For Aristotle this means that the source of any motion must be "together with that which is moved by it (by 'together' I mean that there is nothing between them.) This is universally true wherever one this is moved by another" (Aristotle qtd. in Fox 230). But Aristotle asserted that this motion must be caused by something that is itself already in motion. He ruled out the idea that the efficient cause is the cause of its own motion by asserting "that being moved does not belong to the mover per se" – that the mover itself must be initiated by something that is already in a state of actualization. In other words, that which creates motion must itself be in motion.

This chain of movers, however, cannot go on to infinity. For suppose, in terms that Aristotle frequently used, that A is moved by B, B by C, C by D, and so on. A could not be set into motion if not for B. But B, necessarily being itself in motion, must be moved by C. Likewise, C is not the cause of its own motion; its movement is owed to D. This regression of causes carries on and on, but it must have started somewhere. And, in a move that helped shape centuries of philosophy to come, Aristotle declared that this starting point must be itself unmoved. He said that this is necessary because if the First Mover was in motion, then it, too, would have to be set into motion by another (Aristotle 156). But of course if it was set into motion by another, then it is not the First Mover. Thus, there is a First Mover, and it necessarily generates its own motion.

There is, according to Aristotle, a logical fallacy in assuming that nature's sequence of motion has no starting point, for if it did not, then what is it that was first set into motion? "Consequently, the series [of movers] must come to a stop, and there must be a definite first mover as well as something which is moved first. It makes no difference that we have derived this impossible consequence from an assumption; for we have taken the assumption as a possibility, and an assumed possibility ought not to yield an impossible consequence" (Aristotle 131). Logic and reason, according to Aristotle, therefore allow us to know that *there is a First Mover capable of generating motion without being set into motion*, and that the First Mover is itself immobile. To argue otherwise would be to assert either that motion can be a cause of itself, or that the chain of motion is infinite, both propositions that are "inadmissible, if not, indeed, self-contradictory and meaningless" (Wheelwright xxxviii). Aristotle was confident that logic is sufficient to show these claims are impossible.

Logic also mandates that this First Mover must contain in it everything that is found in the natural world. For example, if a thing is warm, then it must have received its warmth from a mover that has already actualized a state of warmth. This warm mover also must have been endowed with warmth by something that itself is warm; this chain of warm movers continues indefinitely – but not infinitely. For if it carried on to infinity then there would not be anything that first generated warmth, and without this initial generation of warmth, it follows that the final warm body could not have realized a state of warmth because none of the efficient causes responsible for its actualization would themselves have been actualized. The regression of warm movers must at some point culminate in the First Mover, which, by virtue of the warmth of the series of aforementioned bodies, itself must have actualized a state of warmth. This further highlights the First Mover's immobility because any motion would be bring it closer to actualization. But, since the First Mover is the cause of all motion and already fully actualized, it would be impossible for it to become *more* actualized; it would be impossible for it to move in the Aristoetelian sense. Thus, the First Mover is an Unmoved Mover.

Aristotle also asserted that the First Mover must be eternal and infinite because "motion exists always and unintermittingly" (Aristotle 59), and just as motion cannot originate unless by that which produces motion, so, too, can motion not continue without something else that is also in continuous motion (Aristotle 66). And motion being eternal, the origin of this motion – the First Mover – must also be eternal. Without these attributes – eternalness and infiniteness – then the motion of the natural world would cease; bodies would be unable to actualize because the source of their actualization would not exist. Aristotle raised the issue of destructive properties to help prove the infinity of motion. "Now, destruction being a kind of change [and therefore a type of motion], a destructive power which has effected a [supposedly final] destruction would still be left to be itself destroyed; and thereafter, what is capable of destroying it in turn would also have to be destroyed. But these consequences are impossible. Clearly, then, movement is eternal" (Aristotle 146).

The Unmoved Mover is also necessarily without magnitude. Here magnitude refers to occupying physical space, an impossibility for the Unmoved Mover because, if it had a magnitude, that magnitude would have to be either infinite or finite (Aristotle 150). Infinite magnitude is a logical impossibility, according to Aristotle, and finite magnitude is ruled out because the force of the first cause is infinite; that which is finite in magnitude could not be infinite in force (Aristotle 152). Therefore, the Unmoved Mover is not a place or body, yet it is eternal and is capable of directing the motion of all natural bodies.

Aristotle has thus given a cogent account of the phenomena of the natural world. He has defined motion and accounted for its causes – namely efficient causes that are set into motion by other causes that are themselves already actualized. According to logic, however, there must be a force that facilitates and generates the regularity with which phenomena occur; there must be something that imbues the material causes of nature with efficient, actualizing causes. Aristotle's explanations and conclusions about the natural world – that it culminated in an all-powerful, self-created Unmoved Mover – would set the stage for thinkers like Thomas Aquinas to attempt to reconcile Aristotle's widely-accepted, logic-based synthesis with the tenets of Judeo-Christian theology.

CHAPTER TWO

Medieval Theology: Merging Aristotelian Physics and God

It is important to establish from the outset of this chapter just how much Aristotle's work shaped the ideas of Medieval Europe. There is a book's worth of history that could be discussed here, but in an effort to maintain the philosophical aims of this thesis, an abbreviated historical account will have to suffice.

Opportunity and circumstance collided in the 13th century when Thomas Aquinas was born and Aristotle's writings were reborn. There was a "revival of Aristotle's metaphysical writings through translations and commentaries – [this] led to a gigantic effort, in the 13th century, to gain entrance for reason into the theological foundations of the Christian faith" (Fishler 193). The translations of Aristotle's work, which had first been written about 1,500 years earlier, would have a profound impact on scholars in Europe. At schools around Europe in the 13th century, Aristotle was simply referred to as "the philosopher" (Chidester 227).

As a result, his ideas, which were now translated into a host of languages, gained such prominence that there became a need to merge his logic with Medieval faith. Aquinas was charged by Rome with the task of synthesizing Aristotle for a Christian audience (Chidester 227). He provided such a synthesis with what became "the standard compendium of Christian Scholasticism," his *Summa Theolgiae* (Chidester 229). Aquinas' importance in shaping the Medieval worldview was incalculable. Instead of fearing the logical edicts of Aristotle's philosophy, Aquinas merged those prevailing philosophical ideas with the dominant religion in

Europe, a continent that had recently seen an influx of translations that had popularized Aristotelianism and mandated a reconciliation between philosophy and theology.

One of the key components to Aquinas' marriage of Aristotelian reason and Christian faith is the notion that both reason and faith spring from the same source – the Unmoved Mover, which Aristotle often called the Good, from which all things emanate (Fishler 195). The assuredness that Aquinas had in the fact that both faith and reason had the same source is, in itself, an adoption of Aristotle's philosophy – everything in the universe has a single source, a Creator, meaning that the tenets of both faith and reason will lead people to the Creator (Fishler 198).

Aquinas, therefore, did not view Aristotle as a threat or destroyer of faith. On the contrary, since Aristotle's logic was born of the same source as Aquinas' faith, there must be a positive relationship between the two; "the most rational of philosophies (Aristotle's) must be in accord with the truest and surest of faiths (the Christian)" (Fishler 195). Aristotle would not have thought as he did if not for the Good impelling him to do so; similarly, the inclination that Aquinas and all Christians have towards righteousness is not accidental. It, too, is a guided process, for it could not be an accident that people were impelled to behave and think in a certain manner; man's actualization also must have a cause (Aquinas 119). The uniformity of Christian beliefs, just like the uniformity of natural phenomena, is proof that there is indeed a natural order.

Having accepted that the First (Unmoved) Mover is that which is responsible for both the creation and actualization of the world, Aquinas takes a significant step in adapting Aristotle to a Christian audience: the introduction of the Christian God into Aristotle's teleology (Ward 43). This did not require a doctrinal shift on the part of Aquinas, but simply supplanting the word

"God" for "Final Cause" or "Unmoved Mover." Aquinas could confidently rename the Unmoved Mover "God" because the qualities attributed by Aristotle to his Unmoved Mover are nearly symmetrical to those that Aquinas and Christian theology attribute to God. Therefore, it was actually a convenient move to bring God into Aristotle's teleology. In making this move, Aquinas agreed with Aristotle that there must be a self-created Unmoved Mover because, if there was not, then there would have to be something prior to it; at some point there must be a Mover that exists because of itself. Aristotle's Unmoved Mover is also responsible for the creation of the world because matter and motion must have originated somewhere, and only that which is totally actualized, the Unmoved Mover, has the capacity for this kind of creation. The Unmoved Mover also contains the final cause to which motion strives because it is from the Unmoved Mover that an object or person is endowed with an intrinsic principle of motion, actualization. Thus, nearly all of the characteristics that Aristotle used to describe this source of motion can be applied to the Christian God, and Aquinas seized upon that congruency.

Aquinas' most famous adaptation of Aristotle is his notorious "Five Ways" for proving God's existence and explaining His essence. Aristotle's intellectual fingerprints are all over the "Five Ways," which appeared in the *Summa*. The first argument is based on motion, which is defined as it was by Aristotle, "more broadly than local motion; at the very least [motion] also includes alteration" (Wippel 444). In the First Way, Aquinas almost quoted Aristotle when he wrote that "motion is nothing else than the reduction of something from potentiality to actuality. But nothing can be reduced from potentiality to actuality, except by something in a state of actuality" (Aquinas qtd. in Coakley 361). Aquinas reiterates that motion is caused by something that is in motion, which in turn must be put into motion by something else that is in motion.

But of course Aristotle showed that this sequence of movers cannot go on infinitely; it must culminate in a mover that, unlike all the others, does not need to be set into motion, but rather is capable of generating motion on its own. In a passage that reeks of Aristotelian logic, Aquinas keeps Aristotle's ideas in tact while renaming the Unmoved Mover: "...it is necessary to arrive at a first mover, put in motion by no other; and this everyone understands to be God" (Aristotle qtd. in Coakley 361). Here the logic and ideas of Aristotle are fully in tact, but the moniker of the Unmoved Mover has been infused with Christian theology.

Aquinas accepted Aristotle's declaration that motion is generated by something already actualized, and applied that fact to the metaphysical question: what is it that makes man act thus? Aquinas' arguments, like Aristotle's, transcend "a limited and physical application of the principle of motion [and arrive at] a wider application that will apply to any reduction of a being from not acting to acting" (Wippel 457). God, therefore, can cause man to achieve actuality because within Him is contained all motion and actualization. "Since God moves all things in accord with their nature as moveable beings – for instance, light things upward and heavy things downward – so does he move the will in accord with its condition or nature…" (Wippel 451). Aquinas arrives at this conclusion because, as was said earlier, he believed that both the edicts of logic and man's ability to understand those edicts come from the same source – The Good or God – that impelled men to be righteous. It is not an accident that heavy things always fall to the ground. Similarly, and indeed because of causes that have the same source, it is not an accident that man naturally seeks virtue. The physical world reveals without doubt that there is an order in nature, and man, being a natural being, is subject to the dominion of that which is responsible for nature; for Aristotle it was The Good, but for Aquinas and Medieval Europe it was God.

Aquinas' acceptance of this teleology allowed him to rationalize the Christian notion of providence through Aristotle's philosophy; not as an exception or aberration to the well-ordered universe, but instead as an absolute necessity of it. The idea of providence is on many occasions referenced in the Bible: Ephesians 1:11 says, "God works all things according to the counsel of His will," and Romans 11:36 reads, "For of Him and through Him and to Him are all things, to whom be glory forever" (Bambrough 398). Aquinas of course agreed, and he used Aristotelianism to explain providence logically. He believed that "mere appeal to material causes and blindly acting efficient causes would result in the chaotic destruction of things, not in their preservation and harmonious collaboration" (Wippel 411). Thus, it is not enough to say that God simply created everything in the natural world and let it be, because, unless His creations are in some way guided, nature would behave erratically. Therefore, there are two options for the operations of nature: either everything in nature happens by chance, or everything in nature is guided towards realization, that is, guided towards God. Aquinas rejected the former possibility by asserting that phenomena in nature occur with a regularity that negates the possibility of pure chance (Wippel 415).

> Hence the world must be governed by the providence of an intellect which has instilled in nature the aforementioned ordering to an end....There is evidence of finality in nature on the part of things which lack intelligence. Mere recourse to material and efficient causes and to chance cannot account for the behavior one finds among natural agents and the way in which so many varied natural agents and forces repeatedly work together so as to produce beings which remain in existence themselves and contribute to the existence and well-being of others. Therefore finality in nature points to the influence of intelligence upon such agents. Since these agents themselves lack understanding, there must be some intelligence which transcends the beings of nature and which accounts for the fact that each act for an end (Wippel 412).

The Christian notion of providence – that God actively governs the workings of the world – fits nicely with the physical tenets of Aristotelianism. The doctrine of providence states that all things in nature are under the dominion of God, whereas Aristotle's teleology states that all things are drawn towards "The Good." With Aquinas having renamed The Good "God," there is neither a logical nor metaphysical contradiction with Aquinas' insistence on providence. Aquinas has, through logic, "proved" that providence exists.

Aquinas did not format the beliefs of Christianity to comply with Aristotle's "scientific" or "physical" declarations. Instead, Aquinas used Aristotle's arguments to solidify and illuminate certain beliefs of Christianity. It is impossible to say whether Aquinas' thinking would have matched Aristotle's to such a degree if Aquinas had not been exposed to the newly-translated readings of the ancient Greek. But the symmetry of the men's notions of motion, causes, and intelligibility, among others, allowed for a marriage between the eminent philosophy of the time and the eminent religion of the time. Aquinas' use of Aristotle speaks to the historical developments that have shaped Western philosophy. Indeed, without the rebirth of Aristotle's writings, Aquinas' "Five Ways" would not have had the logical base that made them so convincing. But at a moment in history when Rome was scared what the spread of Aristotle's work may do to Catholicism, Aquinas solidified faith with the logical tenets of philosophy by taking certain liberties with, for instance, the identity of the Unmoved Mover (God) and the essence of the order of nature (providence). Ultimately, Aquinas did not amend Aristotle, but reconciled the Philosopher's pre-Christian thoughts with a set of ideals that Aristotle had no way of knowing. About 1,600 years after Aristotle, Aquinas came along and used him to give Christian theology a philosophical, logical foundation, in the process affecting the way that centuries'-worth of Christians thought about God.

CHAPTER THREE

Classical Physics: Decoding Nature Through Mathematics

Aristotelianism and Aquinas' *Summa* dominated European thought until the late 15th century. The succinct, logical arguments posited by these men provided a convincing melding of Christianity and science, which was widely embraced throughout Europe (Cushing 24). The ongoing influence of Aristotle's physics can be found in a dialogue written by Galileo in 1623 in which he seeks to overthrow Aristotle's natural philosophy by asserting that the Philosopher himself would support emerging Enlightenment ideas. "Is it possible for you to doubt that if Aristotle should see the new discoveries in the sky he would change his opinions and correct his books and embrace the most sensible doctrines, casting away from himself those people so weak-minded as to be induced to go on abjectly maintaining everything he had ever said?" (Matthews 66). Despite the stranglehold that Aristotle once held on man's view of nature, Europeans' ideas of science would change – a lot. And once those changes started, Aristotle's *Physics* and Aquinas' *Summa* became antiquated.

Starting with Nicolaus Copernicus, who was born in 1473, the tenets of physics underwent a startling revolution, which in turn revolutionized the ways that people thought about the natural phenomena. Copernicus and Johannes Kepler laid the foundation of the scientific method that would be championed by the Enlightenment's great thinkers – a chain of men that included Galileo, Robert Boyle, Descartes, and the era's crowning scientific philosopher, Newton. These men dismissed Aristotelian notions of nature – teleology, final causality, intrinsic principles of motion – that had been popularized throughout Europe, and introduced new ways of conceptualizing, observing, and studying the natural world. The implications of these new discoveries and methods could be felt not just in the world of science, but also theology, for once the proofs that Aquinas offered for the existence of God had been deemed outdated, then suddenly the *Summa* – the era's eminent treatise on God – had been invalidated. But like Aquinas, this new set of thinkers would not totally divide science and God; indeed, God attained a lofty role within the worldview that emerged from the Enlightenment. His role, however, certainly changed.

Possibly the biggest departure from Aristotle's worldview and method was the eminence of mathematics in Enlightenment philosophy. Newton prefaced his *Principia* by writing, "I offer this work as the mathematical principles of philosophy, for the whole burden of philosophy seems to consist in this – from the phenomena of motions to investigate the forces of nature, and then from these forces to demonstrate the other phenomena..." (Cushing 93). Galileo also stressed the importance of mathematics for understanding both science and philosophy: "Philosophy is written in that great book which ever lies before our eyes – I mean the universe – but we cannot understand it if we do not first learn the language and grasp the symbols, in which it is written. This book is written in the mathematical language..." (Burtt 75). Notions of *demonstration* and mathematical *symbols* were not at all integral to Aristotle's *Physics*. Aristotle instead relied upon logic and common sense to come to his conclusions about nature, making declarations about the causes of nature that could be "verified" through a logic-based progression of assumptions – for example, that anything in motion must be put into motion by something that is already in motion; from that, according to Aristotle, it necessarily follows that at some point there is a mover that is itself unmoved. Logic proves such. But with the Enlightenment there was a shift from logic to math, and with it came the staunch belief that mathematics could catalyze a true understanding of natural phenomena, and also the causes of those natural phenomena. Mathematics – the language of nature – supplanted logic as the only true way to penetrate and understand the natural world.

Since everything studied by this new physics was to be subjected to mathematical analysis, there were certain properties of natural bodies described by Aristotle that were cast aside. The only attributes of nature that Enlightenment scientists wanted to deal with were those that could be measured and calculated. These were the "ultimate characteristics" of bodies: extension, figure, and motion (Burtt 108). Some of the Aristotelian ideas about the parts of a body – namely that internal, contiguous, ever-present "intrinsic principle of motion" – were impossible to subject to a mathematical analysis. Such properties were therefore cast outside of the realm of physics, which, with Galileo and Descartes especially, became a field of study that only entertained ideas that could be understood through the universal language of mathematics. Descartes wrote, "The view that...there is a certain property in the individual parts of corporeal matter by virtue of which they are borne towards one another and mutually attract one another, is most absurd" (Doney 360). The dismissal of the idea that bodies are endowed with certain teleologically-guided properties and tendencies that reside within them, again, resulted from the impossibility of verifying such hypotheses mathematically. Descartes wrote,

> I openly state that the only matter that I recognize in corporeal things is that which is subject to every sort of division, shape, and movement – what geometers call quantity and I take as the object of their demonstrations. Moreover, I consider nothing in quantity apart from these divisions, shapes and movements; and I admit nothing as true of them that is not deduced, with the clarity of mathematical demonstration, from common notions whose truth we cannot doubt. Because all the phenomena of nature can be explained this way, I think that no other principles of physics need be admitted, nor are to be desired (Descartes qtd. in Doney 355).

Natural bodies, therefore, were stripped of their innate intelligibility. For the natural philosophers of the Enlightenment, bodies became little more than bundles of minuscule atoms – the indivisible, impenetrable building blocks of matter. “That all bodies are impenetrable, we gather not from reason, but from sensation...The extension, hardness, impenetrability, mobility, and inertia of the whole result from the extension, harness, impenetrability, mobility, and inertia of the parts....And this is the foundation of all philosophy” (Newton 4). These “corpuscles” or atoms are the “ultimate parts of matter” and are “rigid and indivisible” (Newton 260). Therefore, local motion results from forces that act on every individual, indivisible particle of a body. And, with these particles bound together, motion is seen not as a phenomenon that belongs simply to a body as a whole, but instead a process in which each of the minute building blocks of matter – which are naturally bound together – experience external forces which, by virtue of the corpuscles being connected, cause the entire body to move (Newton 256).

With math becoming such a key component in the philosophy of nature, the definition of motion predictably underwent a radical change. Aristotle, of course, talked about various types of motion – local motion, changes in quality, and changes in quantity – all of which could be understood in terms of a change from potentiality to actuality. But motion would not be talked about in the same terms once the Enlightenment thinkers reshaped science. Descartes, in his *Principles of Philosophy*, sought to establish a “new and sophisticated” definition of motion in place of what he called the “naive” notion of motion posited by Aristotle (Doney 258). Descartes called for “the denial of [natural bodies’] intrinsic changeability...[because there is] only one form of ‘becoming’ in bodies, and that is extrinsic; viz., motion from place to place” (Doney 354). Now the second two types of Aristotelian motion – changes in quality and quantity – are cast out of the realm of physics. Local motion, or the transfer of a body from one point to another, is the only type of motion that can be subjected to the rigors of mathematical formulas, experimentation, and verifiability.

If bodies do not possess the capacity to themselves generate motion – if there is not what Aristotle called an "intrinsic principle of motion" that exists within all bodies – then there must be something else generating motion, a force (or forces) existing *outside* of bodies themselves. It is these external forces that become a major focus of Enlightenment physics. In Newton's *Principia,* the first two rules of his *Rules for Reasoning* are, "We are to admit of no more causes of natural things than such are both true and sufficient to explain their appearances," and, "Therefore to the same natural effects we must, as far as possible, assign the same causes" (Cushing 94). This is a new way of speaking of "causes"– as forces residing outside of the things being moved. The tweaking of the word "causes" led Newton and his predecessors to assert that a singular cause may be ascribed to a wide array of natural phenomena, based upon the uniformity of those phenomena. Thus, with the Enlightenment came the conviction that it is one, single, uniform force that acts upon bodies when those bodies behave similarly. This is in contrast to the Aristotelian assertion that when bodies act thus, it is *the nature of the bodies* – for the sake of actualization – that catalyzes motion. With this new physics, falling bodies were seen to fall not because it was their essence to do so, but because immutable forces of nature – forces external to the body itself – *forced* them to the ground.

Galileo helped debunk the "Aristotelian dogma" that the rate of fall of a body is proportional to its weight by setting up an experiment to illustrate that bodies' motion is not caused by their natures (Cushing 81). He supposes that there are two stones of the same shape, one large (*M*) and one small (*m*). If, as Aristotle asserts, bodies have a *natural speed*, then the descent of *M* towards the ground will be greater than that of *m* because, with a body's velocity being proportional to its weight, it follows that the heavier one will fall faster (Cushing 81). Galileo then postulated that the two stones are bound together, creating a single "system" with a weight of $M + m$. According to Aristotle, the speed of the heavier stone would be slightly retarded by the smaller one, while the heavier stone at the same time would cause the smaller one to accelerate faster than its natural speed.

> But if this is true, and if a large stone moved with a speed of, say, eight while a smaller moved with speed of four, then when they are united, the system will move with a speed less that eight; but the two stone when tied together make a stone larger than that which before moved with a speed of eight. Hence, the heavier body moved with less speed than the lighter; an effect which is contrary to [Aristotle's] supposition. Thus you see how, from [the] supposition that the heavier body moves more rapidly than the lighter one, I infer that the heavier body moves more slowly" (Cushing 84).

Having proved that bodies do not possess a natural speed – that is, that bodies' motion is dictated by forces external to the body – Galileo set out to prove the uniformity of this force, which, with the Enlightenment thinkers was now called *gravity*. He did so with his famous Leaning Tower of Pisa experiment. It is worth noting that the historical accuracy of this experiment has repeatedly been called into question, namely Galileo's declaration that a larger steel ball reaches the ground before a smaller one "by two finger-breadths, that is, when the larger hits the ground, the other is short of it by two finger-breadths" (Cushing 83). Galileo's error was a failure to accurately account for air resistance, or air's tendency to impede a body's acceleration towards the ground. Air resistance, it would later be discovered, has more of an impact on a body of lesser weight. (Modern mathematical equations that take into account the mass of the steel balls, air resistance, and the height atop the Leaning Tower show that the different balls will land at times more disparate than "two finger-breadths." In reality, there would be a difference of about 3 feet between the balls hitting the ground (Cushing 83).) Thus, while there is a uniform force of gravity, the force of air resistance is more pronounced in the lighter body. But nonetheless, the proof of the uniformity of gravity that this experiment rendered is still valid, even if Galileo took liberties with the results. The bodies falling from the tower – while different masses than one another – fall in the same manner, accelerate at the same rate, and hit the ground at (nearly) the same time. If, as Aristotle believed, bodies moved proportionally to their weight, then the heavier ball would hit the ground well before one that is much smaller. While there was indeed a slight difference in the times that the balls fell from the tower, that difference – in hindsight – is due to air resistance and the possibility of human error. The basic premises of the experiment – that bodies do not fall at a speed proportional to their weight, and that the forces dictating descent are uniform to all bodies – were solidified and have since been proven (although amended with notions of air resistance, etc).

The import that Galileo put on experimentation – and the authority that those experimental results carried – speaks to a shift in how people philosophized about nature. The Enlightenment thinkers usher in a conviction that simply employing logic – as was Aristotle's strategy – does not render valid ideas about nature. Newton wrote, "we gather [our ideas] not from reason, but from sensation" (Cushing 94), meaning that unless something has been witnessed and verified experimentally, then it cannot be admitted into physics. The insistence that these thinkers placed on experimental verification led Newton to decry hypotheses as inadmissible.

> I frame no hypotheses; for whatever is not deduced from the phenomena is to be called an [sic] hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or of mechanical, have no place in experimental philosophy. In this philosophy particular propositions are inferred from the phenomena, and afterwards rendered general by induction. Thus it was that the

> impenetrability, the mobility, and the impulsive forces of bodies, and the laws of motion and of gravitation, were discovered (Newton qtd. in Cushing 94).

Examples of hypotheses abound in Aristotle's physics – for instance, that within each body resides an intelligible force or tendency of motion, which Newton would assert is a hopelessly contentious and unverifiable claim. There is no experimental evidence – and indeed no way to employ induction – for that claim. Despite the logic and clarity that Aristotle's hypothesis about innate intelligibility provided, there is no way to prove such an assertion. And any assertion that is impossible to prove *must not be accepted* as fact about the natural world. Truths about the natural world, by virtue of the mathematical structure of nature, can be proven through experiment; and if such verification is not possible, then the hypothesis in question has no place in the Enlightenment's evidential, experimental concept of natural philosophy (Cushing 84).

After the advent of Enlightenment science, nature was stripped of its intelligibility and infused with rigid, unyielding forces. This wave of natural philosophers introduced new versions of mathematics, new ways to experiment, and new limitations on what could pass as "fact" in the world of physics. They redefined many of the terms that comprise the field of physics – like "motion" and "causality" – and also redefined the ways in those terms applied to the natural world. Aristotle's philosophy about the natural world was not obtuse, and certainly his masterful use of logic helped lend credibility to his ideas about nature. But as logical and seemingly obvious as many of Aristotle's claims were, thinkers like Galileo, Descartes, and Newton were able to concoct what was a more succinct, more cogent way of talking about natural phenomena. Again, it is not as though Aristotle's ideas were childish, but rather that many of the new ideas were simply ingenious. And the concurrent shift in methodology – from a reliance on logic to a mandate of experimental verifiability – was able to further solidify the new physics' claim of superiority over Aristotle's physics.

CHAPTER FOUR

Enlightenment Philosophy of God: The Clockmaker Emerges

The view of God that emerged from the Enlightenment had to account for a revolutionized version of "physics," one that dispelled many of the notions that man previously held about the natural world. And if the natural world is no longer seen in the same way that Aquinas and other Medieval theologians viewed it, then there is a necessary impact on how people think about God, for it was largely through Aristotelian physics that Aquinas solidified the existence, nature, and role of God in the world. Once Aristotelian physics was deemed inferior to this new physics, so too were the "scientific" ideas that were thought to describe God. Galileo, drawing upon some of the ideas and thoughts of his predecessors Copernicus and Kepler, offered "the first comprehensive attempt to picture the whole external world in a way fundamentally different from the Platonic-Aristotelian-Christian view which, centrally a teleological and spiritual conception of the processes of nature, had controlled men's thinking for a millennium and a half" (Burtt 113). This attempt at a new concept of nature of course invoked what Galileo called the language of nature – mathematics – and in the process introduced new ways of thinking about God.

But as different as Enlightenment physics was from Aristotle's, there are indeed some attributes of God that would remain relatively unchanged despite the scientific revolution that had taken place. Many of these positivist scientists unabashedly and unquestioningly adopted traditional notions about God when they stopped discussing science and went about philosophizing about theology. For Newton and others, "God's existence and control was never questioned...” (Burtt 284). Newton himself wrote, “We are, therefore, to acknowledge God, infinite, eternal, omnipresent, omnipotent, the creator of all things, most wise, most just, most good, most holy,” and also, “There is one God, the Father, ever living, omnipresent, omniscient, almighty the maker of heaven and earth, and one Mediator between God and man, the man Christ Jesus” (Newton qtd. in Burtt 285). Thus, even though Enlightenment physicists took pains to ensure that non-mathematical, unverifiable ideas were left out of their science, it is obvious that they did not employ the same empirical approach for discussing God – a figure wholly embraced by Galileo, Descartes, Newton, and nearly all the other intellectual giants of the era.

It is intriguing that these men would concede so readily that there is a God, and moreover that they would dare to hypothesize about the nature of God, when scientifically they wanted to dismiss that which could not be *absolutely proven* mathematically. But these European natural philosophers were, like any philosopher in history, not immune to the prevailing views of the time – just think of Aquinas’ adherence to Aristotelian principles at a time when Aristotle’s writings gained such eminence in Europe. And while Aristotle’s view of nature would be supplanted with one thought to be more intelligible, the 16^{th}-, 17^{th}-, and 18^{th}-century European environments in which these thinkers lived was unmistakably Christian. There were views about God that they were either unable or unwilling to contest.

Plus, in addition to societal factors that may have led the Enlightenment scientists to personally embrace God, simply denying God was too radical of a step for any important thinker to take in Enlightenment Europe (Burtt 148). Indeed, to dismiss God as fictitious or unnecessary for world order may very well have invalidated a European philosopher and made him appear heretical (Burtt 150). As a result, Descartes and Newton openly professed their religious beliefs. Newton, for instance, wrote of God, “We know him only by his most wise and excellent contrivances of things and final causes; we admire him for his perfections, but we reverence and adore him on account of his dominion, for we adore him as his servants" (Newton 44). And Descartes, in his *Meditations*, wrote, "I ought to thank God, who never owed me anything, for what he has bestowed upon me" (Descartes 126). There is this an interesting dichotomy between the tenets of these men's philosophy of nature and their theology, namely that when discussing the former they refuse to admit anything that cannot be proven, and then, with the latter, engage in discussions about the absolutely unverifiable characteristics of God. Whether it was to appease their audience or because of earnest personal convictions, God obtains a lofty seat in the emerging philosophy of nature.

As teleology was dispelled as a rational explanation for the causes of the natural world, so, too, is the notion that local motion is the result of a body being impelled towards God for the sake of realizing that body's potential. As was discussed in the last chapter, that is no longer how natural phenomena are seen to take place. Instead, the phenomenon of motion takes place because the forces of nature affect bodies from the outside; it does not belong to bodies themselves to move towards something. If this is true, however, then what happens to God's role in the world? If He is not situated at the top of this teleology, orchestrating and catalyzing the motion of the universe, then what – if anything – is He doing?

> With final causality dismissed, the idea of God as the Supreme Good towards which all things strive was replaced by God as *First Cause*, understood as the initial link in the chain of efficient causes. With Galileo began the development whereby God was to become merely the original creator of the interacting atoms in which resides all subsequent causality....In Medieval as well as Reformation thought, God's concurrence had been viewed as a very direct and active relationship. As attention focused on natural causes, God's role was gradually relegated to that of First Cause. (Barbour 15)

Here Barbour perhaps oversimplifies the ongoing or "providential" role that God plays in the world – an issue that will be taken up shortly. But this passage does succinctly enunciate the shift, the *inversion*, that Aristotle's and Aquinas' vision of nature undergoes with regard to final causality. The causes of the phenomena of nature were implanted into the world from the outset, and they have never changed. Motion belongs to these forces, which were instilled into the world when God created it (Burtt 150). God is still a cause and ultimately responsible for motion – as in Aristotle's worldview – but not in the same way as before. The regularity with which natural phenomena occur is no longer seen as an effect of God impelling things towards Himself. Instead, the regularity of nature is a product of the constant, immutable forces of nature – a nature *designed*, not constantly *directed*, by God.

After Enlightenment scientists had situated God as the First Cause of all things, they used characteristics of nature to deduce certain attributes about Him. Aristotle also did this when he wrote about the Final Cause. For example, one supposition of Aristotle was that the Final Cause, which Aquinas would call God, was eternal, and that He was without magnitude, allowing Him to – in a sense – be in all places at all times. These traits of the Final Cause are knowable because of the nature of motion: motion is unceasing, eternal, and occurs over an unfathomable expanse of space. Thus, for this constant motion to continue, the Mover facilitating it all must be both eternal and omniscient; nature mandates such (Cushing 150).

Likewise, the Enlightenment's natural philosophers would speculate about the nature of God, looking at the natural phenomena He created as the starting point. Newton, after discussing the mind-boggling intricacies of the solar system, wrote, "This most beautiful system of the sun, planets, and comets could only proceed from the counsel and dominion of an intelligent and powerful Being....This Being governs all things, not as the soul of the world, but as Lord over all...The Supreme God is a Being eternal, infinite, absolutely perfect” (Newton 42). God’s perfection and infinite “counsel and dominion” are necessary attributes of Him because the natural world is infinite and perfectly regular. The phenomena of the world – occurring with clocklike regularity and mathematical precision – could only take place as they do if the designer or First Cause of this system has the infinite dominion and presence to create such a system. Descartes legitimizes this thought process by writing, “For whence, I ask, could an effect get its reality, if not from its cause? And how could the cause give that reality to the effect, unless it also possessed that reality?” (Descartes 116). For example, infinite motion requires an omnipotent God, and infinite space requires an omnipresent God. Therefore, God the First Creator must Himself be endowed with these traits.

Another instance of deducing God’s attributes through nature comes from the Enlightenment’s corpuscular philosophy – the idea that all matter is made up of indivisible, impenetrable particles. “[God] endures forever and is everywhere present; and, by existing always and everywhere, he constitutes duration and space. Since every particle of space is *always*, and every indivisible moment of duration is *everywhere*, certainly the Maker and Lord of all things cannot be *never* and *nowhere*” (Newton 43). This strategy for describing God is not all that different from what Aristotle did more than 2,000 years earlier to describe the Final Cause. Things about the natural world that are seemingly indisputable – that there is constant motion, or that phenomena are perfectly regular – are used to describe the cause or creator of this system. And as Descartes would famously assert in his *Meditations*, no characteristic can exist in something unless its maker was itself endowed with that characteristic.

An intriguing question arises out of this new science: If God is now “relegated” to the role of Maker or First Cause or Creator of the natural world, and if He designed the world in a rigid, predictable fashion, then does God still have a role in this system? Or more simply: Does God actively employ providence in the world? Thinking of God as the First Creator – not the Final Cause – seems to leave little room for providence because the teleological picture of nature that was so well-suited for explaining providence is no longer valid. As a result, some Enlightenment scientists declared that God has been inactive or idle since the creation of the world; the natural forces that He implanted into the world from the outset are all that is needed to facilitate its movements. For example, Gottfried Leibniz – a German philosopher and scientist born in 1646 – asserted that God "created the world so perfect that it can never fall into disorder or need to be amended" (Burtt 113). Thus, God is seen by some as having no *ongoing* influence in the natural world.

That is not to say, however, that He is any less powerful than in the Thomistic-Aristotelian teleology. To the contrary, thinkers like Leibniz and Boyle claimed that God's dominion and wisdom – indeed they use the word *providence* – was "displayed primarily in planning things so that no intervention would be needed. God the Cosmic Legislator demonstrated care for the welfare of the creatures in the perfection of the original creative act....The rule of law, not miraculous intervention, is the chief evidence of God's wisdom" (Barbour 22). Here God's providence is viewed as part of the creation of the world, a creative act that was so perfect and powerful that it is itself seen as an act of providence.

But not all thinkers of this period subscribed to this new, creation-based way of talking about providence. Instead, some held that God still has a hand, so to speak, in the function of natural phenomena. These thinkers, including Newton, believed that "the Deity has formed the Universe dependent upon himself, so as to require to be altered by him, though at very distant periods of time" (Colin McLaurin qtd. Olson 56). In this view, the laws and order of the natural world are still the result of the dominion and creative power of God. *But those laws are sustained through an active involvement*, a sort of maintenance that requires the ongoing intervention of God.

English politician and philosopher Samuel Clark wrote the following, supporting the providential Newtonian system.

> As those men, who pretend that in an earthly government things may go on perfectly well without the king himself ordering or disposing of anything, may reasonably be suspected that they would very well like to set the king aside,...so too those who think that the universe does not constantly need God's actual government, but that the laws of mechanism alone would allow phenomena to continue, in effect tend to exclude God out of the World (Samuel Clark qtd. in Gilson 124).

The manner in which God employs his "government" is absolutely unknown to man, but that He does so is evident by virtue of the world's functionality and also by the very nature of God – namely that He is omnipotent and omnipresent. God's omnipresence led to Newton's hypothesis that there is an ever-present "ether" which permeates all matter and space (Burtt 269). The ether is likened to air, but is thought to be much thinner and finer; it does not impede the motion of bodies, but at the same time is capable of acting as the medium through which God can control nature. This ether – which Newton sometimes called "ethereal spirits" – is a manifestation of God's omnipresence and a vehicle for God's intervention into the natural world (Burtt 272). With this omnipresent ether, God is able at any time and at any place to manipulate the phenomena of the natural world. "Absolute space for Newton is not only the omnipresence of God; it is also the infinite scene of the divine knowledge and control...Absolute space is the divine sensorium. Everything that happens in it, being present to the divine knowledge, must be immediately perceived and intimately understood [by God]....He is the ultimate originator of motion and is able at any time now to add motion to bodies [via the ether]…"(Burtt 261).

For Aquinas, God's providence was necessary because it was providence that dictated and catalyzed the realization of potential; God was the Final Cause, and without His providence the whole universe would lose its order, its guidance. On the other hand, this new picture of nature does not lose cogency if providence is eliminated from it, but wholly rejecting the idea that God is actively involved in the world was not a step that some thinkers could or would take. Even men like Boyle and Leibniz, who dismissed Newton's notion of providence, still subscribed to the idea that God has already employed "providence" through his act of creation. Thus, despite conflicting ideas about what exactly providence is, Enlightenment scientists made sure that the idea remained integral to the phenomena of nature – even if it was no longer mandated by teleology.

The science of the Enlightenment was indeed ingenious. The reduction of nature to forces, properties, and motions provided a more cogent language for discussing natural phenomena than Aristotle did. Aristotle's use of logic gave man answers about eminent questions of nature, but Enlightenment mathematics was able to answer many of the same questions in numbers and symbols, tools that much of the West has embraced as an immutable. It must be pointed out, though, that the credo that helped men like Galileo, Descartes, and Newton discover and clarify many of nature's mysteries was suddenly irrelevant when these thinkers delved into religious topics, specifically about God. Newton's ether is a perfect example. This is the man who declared: "whatever is not deduced from the phenomena is to be called an [sic] hypothesis; and hypotheses have no place in experimental philosophy" Newton qtd. in Cushing 94). But he also says with certainty that there is an invisible ether permeating nature, and moreover that this ether is manipulated by God for the continued fluidity of the natural world. And Descartes, whose method in the *Meditations* was to suppose that *everything* he knows is false (Descartes 108), makes assertions about God that, he says, are “indeed evident by the light of nature” (Descartes 116). But despite sometimes contradicting their own methods, these thinkers changed the way that man thought about nature and, in the process, changed the role that God played in the world. Their influence is in no way confined to the arena of science, for their scientific accomplishments would also revolutionize the way that people though about God.

CHAPTER FIVE

Modern Physics: The Quandary of the Quantum World

Enlightenment theories about gravity, inertia, and celestial orbits remain largely intact through today – modern physics has no clash with the way that classical physics deals with visible natural phenomena. Albert Einstein, one of the giants of modern physics, himself wrote, "[Newton's] clear and wide ideas will forever retain their significance as the foundation on which our modern conceptions of physics have been built" (Einstein 58). Nevertheless, modern physics has proven the ideas of Newton and his predecessors to be, although accurate, wildly incomplete. The physicists of the 17th and 18th centuries failed to account for – or in some cases even consider – the physical phenomena of the sub-atomic world, that of protons and electrons, particles and waves. Indeed Newton could tell us where a cannonball would land if he knew the physical properties of the ball, the amount energy released by the cannon, and the trajectory on which the ball is sent. Yet while Newton and others subscribed to what they called "corpuscular philosophy," which asserted that all bodies are made up of tiny corpuscles or atoms, subsequent advancements in physics illuminated vast shortcomings of the corpuscular philosophy of the Scientific Revolution; it totally failed to give an accurate account of the quantum realm.

Einstein and others began uncovering secrets about nature that had previously gone unnoticed; for example, that the energy contained within any body is equivalent to its mass times the speed of light squared, or $E = mc^2$. This discovery led Einstein to ask, "If every gram of material contains this tremendous energy, why did it go so long unnoticed? The answer is simple enough: so long as none of the energy is given off externally, it cannot be observed" (Einstein

51). Thus, modern physics, or quantum mechanics, delves into the unobservable world, the one that is invisible to the naked eye, where the phenomena that occur were unseen by previous generations of physicists and do not always adhere to the tenets of classical physics. The determinism and rigidity that was thought to describe the natural world suddenly – on the sub-atomic level – does not exist at all.

The "wave function" is a major reason that aspects of modern physics are seen as contradictory to classical physics. Wave functions are a set of probabilities about a given phenomenon; for example, the location of an electron at a certain moment, which would be described by a wave function that *corresponds to the likelihood* that an electron would be in one spot or another. What the wave function renders is that the behavior of things like electrons and neutrons is not deterministic – it is not possible to be *absolutely sure* where a sub-atomic particle will be and when it will be there. After a number of trials, a wave function can tell a physicist where a particle *will probably* be, but not with absolute certainty. This is a stark revelation considering the doctrine that emerged from Newton and his predecessors: the idea that if the properties of a system are known, then mathematics could predict – immutably – the ways in which a given phenomenon will occur. But now, "Every time the physicist asked nature a question in an atomic experiment, nature answered with a paradox, and the more they tried to clarify the situation, the sharper the paradoxes became. It took them a long time to accept the fact that these paradoxes belong to the intrinsic nature of atomic physics…" (Capra 66). Thus, a fundamental shift occurred at the foundation of physics. Classical physics retained its dominion over large-scale, visible, "macro" phenomena, but modern physics proved that the atomic world does not possess that same rigidity. Classical physics is still "right," but so, too, is modern physics, a set of ideas that often runs counter to more than two centuries-worth of natural philosophy.

Why, though, is the wave function limited in its ability to *precisely* predict physical phenomena? If the principles of mathematics had not changed, then what is it about quantum mechanics that prevents it from yielding exact answers, like those of Newtonian physics? A central reason for the non-determinism of quantum mechanics lies in the fact that the observer, the physicist, the one making the calculations and observations, cannot be entirely divorced from the experiment. In classical physics, a person could predict the trajectory and speed of something dropped off of a building – they can observe the event without in any way affecting it; it is independent of what the observer does. But this separation between observer and phenomenon is erased in quantum mechanics (Albert 100).

Heisenberg's Uncertainty Principle annunciates this notion. Heisenberg asserted that knowing the location of an atom negates the possibility of knowing its momentum. Conversely, knowing its momentum necessarily means that its exact location remains unknown. The more that is known about a particle's speed – the more defined the wave function is for the particle's speed – the less that is known about its location, and vice-versa. The conditions of Heisenberg's Uncertainty Principle arise because a physicist cannot passively watch a phenomenon take place.

> Nothing is more important about the quantum principle than this, that it destroys the concept of the world as "sitting out there," with the observer safely separated from it by a 20 centimeter slab of plate glass. Even to observe so minuscule an object as an electron, he must shatter the glass. He must reach in. He must install his chosen measuring equipment. It is up to him to decide whether he shall measure position or momentum [according to Heisenberg's uncertainty principle]….Moreover, the measurement changes the state of the electron. (John Wheeler qtd. in Capra 172).

Heisenberg's Uncertainty Principle is closely linked to a phenomenon called the "collapse of the wave function." This collapse refers to the instant that a measurement is made, when, for example, the location of a particle is pinpointed to an exact spot. When that measurement is taken, suddenly the situation that the measurement is describing has been altered. There is no way to know where the particle was the instant before or after the measurement was taken, nor if the particle's ensuing trajectory would have been the same without the measurement having occurred (Capra 50). The measurer necessarily plays a role in the phenomenon once a measurement has been taken because the entire phenomenon has been reduced to a single point on an entire range of points represented by the wave function. The wave function "collapses" onto that single point (Capra 52).

The Copenhagen Interpretation is the most widely accepted analysis of quantum mechanics and phenomena like the collapse of the wave function and Uncertainty Principle. The Copenhagen Interpretation states that the wave function rendered by a quantum experiment does not itself exist in nature, but is instead a representation or algorithm of nature (Albert 180). This view also asserts that the quantum world cannot be totally divorced from the classical world – that the instruments being used by the experimenter, which obey the tenets of classical physics, are the only way to access the quantum world, and that the very use of instruments that obey classical laws negates the possibility of ever viewing the quantum world unfiltered (Capra 60). The Copenhagen Interpretation, like Wheeler, stresses that peering into the quantum world is impossible unless non-quantum instruments are employed. Thus, the emerging view from the Copenhagen Interpretation is that there are limitations to what can be known and observed about the quantum world. Constructing a wave function is possible, but knowing *with certainty* the location and speed of a particle is not (Capra 69).

One limitation annunciated by the Copenhagen Interpretation is called the "wave-particle duality," a phenomenon that defies classical physics. The wave-particle duality shows that a ray of light, for example, can exist either as a wave or particle, but not both at the same time. This duality highlights the integral role of the observer. When a scientist is studying an electron contained within a wave of light and pinpoints where the electron is, suddenly that electron, which before was but part of a wave, has been reduced to a single point, a particle within a wave, because the observer entered the equation and took a measurement of its location. Before the measurement, the electron could only be understood as part of a wave; *in no intelligible way did it exist as an individual particle, but simply as a wave* (Einstein 778). Once a measurement is taken on individual particles' locations, the wave gives way to a single point. "This is an either-or proposition – something cannot simultaneously exhibit particle and wave properties in a given experiment" (Jean 5). Thus, the building blocks of the quantum world can exist both as waves and particles, but not at the same time. The moment a measurement is taken on a particle that is contained within a wave, the wave disappears. Likewise, a wave cannot be studied except as a whole; locating a particle within the wave, in a sense, destroys the wave (Jean 6).

This begs the question, what is the state of the particle when it is not being observed? Before a measurement has been taken, what are the individual locations of the particles that make up a wave? According to the Copenhagen Interpretation, this is an unanswerable question. Asking what is the location of a particle before a measurement of that particle has been taken is like asking whether or not the number 5 is a bachelor (Albert 38). Before a particle has been measured, it is not an individual particle, but part of a wave. Thus, locating where a particle is within a wave necessarily destroys the wave while illuminating the particle. But, before that measurement was taken, the particle essentially did not exist. And once the measurement is taken and the particle *does* exist, the wave of which it was a part is destroyed because it has been irrevocably altered by the measurement. Therefore, discussing where a particle is or how fast it was moving prior to a measurement is a moot point. In no measurable sense does that particle even exist before it has been observed; once it has been observed, then the wave in which it was located disappears. It is impossible to speak in terms of particle location before the particle has been measured, just like it is impossible to talk about whether or not the number 5 is a bachelor.

One of the eminent philosophical questions posed by modern physics is whether or not the quantum world is indeed unpredictable and random, or, rather, if the science of quantum mechanics is simply limited, not yet able to deterministically predict quantum phenomena *because of shortcomings in the science itself, not a haphazardness of nature*. Indeed, a wave function has never been incorrect, but wave functions also are not deterministic; they are probabilistic. While useful and accurate, they provide answers that are fundamentally different than those of classical physics, a science that stressed a clocklike regularity in nature. Einstein, for one, believed that the world, like Newton and others posited, obeys a rigidity that does not leave room for random events, hence his famous assertion that God does not role dice (Einstein 777).

> Any serious consideration of a physical theory must take into account the distinction between the objective reality, which is independent of any theory, and the physical concepts with which the theories operates. These concepts are intended to correspond with the objective, and by means of these concepts we picture this reality to ourselves. In attempting to judge the success of a physical theory, we may ask ourselves two questions: (1) “Is the theory correct?” and (2) “Is the description given by the theory complete?” (Einstein 777)

Einstein believed that quantum mechanics was correct, but not complete – that the nondeterministic nature of wave functions did not tell the whole story of nature. What he and others thought impeded greater precision in modern physics are known as “hidden variables,” which are unique to the quantum world. In large-scale, easily visible phenomena like the flight of a cannonball or the trajectory of a falling rock, there are indeed variables that can affect the experiment. Wind resistance can slow things down; minute changes in the trajectory of a body can change its flight; alterations in the height at which a rock is dropped will alter its course. While these variables can indeed muddy an experiment if not accounted for, they are not mysteries. Physicists can describe such variables with mathematics, and equations in classical physics can maintain their immutability if these variables are included.

But variables on the micro level, variables that defy man’s power of sight, are not as easily accounted for. “[In any experiment] there will be other air molecules around too, in general, and there will be tiny specks of dust, and imperceptible rays of light, and an unmanageable multitude of other sorts of microscopic systems as well, and all of them together…will *fantastically* increase the complexity of the observables which need to be measured” (Albert 91). Hidden variables, therefore, are something about which physicists have hypothesized, but, to this point, have been unable to fully account for in the world of experimentation.

One of the most perplexing things about variables on such a small scale is that they can come from afar. For example, when a cannonball is flying in the sky, it does not much matter if there is a breeze on the other side of the world. It also does not matter if there are other cannonballs in the air, so long as those other cannonballs do not come into close proximity to the ball being observed. But in quantum mechanics, there exists what is called “non-locality,” the idea that a proton being studied *here* can be altered by a proton’s behavior over *there* (Albert 70).

Even if the protons do not engage one another – or come close, for that matter – they still play a role in how the other behaves (Albert 72).

> So there are non-local influences in nature; but those influences are invariably of a particularly subtle kind. The outcomes of measurements do sometimes depend non-locally on the outcomes of other, distant, measurements...The subtlety of these influences is such that (even though they surely exist, even though the statistics of the outcomes of experiments can't be understood without them) they cannot possibly be…understood non-locally, between two distant points (Albert 72).

Thus, there is a conundrum in quantum mechanics. Does the existence of distant, (thus far) incalculable variables solidify the notion – posited by the Copenhagen Interpretation – that the quantum world is inherently nondeterministic? Or, contrary to that view, do hidden variables suggest that the nondeterministic nature of the wave function could be "overcome" by a better understanding of such variables? The answer to these questions has an obvious impact on the way that people think about nature. Classical physics, of course, suggests that there is rigid regularity to the way that natural phenomena occur. But then again, there are no hidden variables in classical physics. There are indeed variables, but they can be understood and accounted for by mathematics. This bred a confidence in man's ability to understand and predict nature, as well as a belief that the world was designed so that there is no room for variation in natural phenomena. That idea, though, is challenged – if not shattered – by the Copenhagen Interpretation, which claims that *the natural world is naturally nondeterministic*. The belief here is that *the wave function's non-determinism is a result of nature's non-determinism*. Thus, if science's goal is to represent the natural world, then the wave function and all of its probabilistic answers succeed because natural phenomena in the quantum world do not adhere to the rigid tenets of classical natural philosophy. In the quantum world, there is no rigidity, making the wave function the absolute best that physics can do – not just at this moment in history, and not because physicists have a limited understanding of the world. Instead, the wave function is the best that science can do because the wave function is the only way to describe the quantum world, now or in the future, because that world is naturally unpredictable.

Einstein and others, however, want to solidify the worldview that emerged from classical physics: that nature is absolutely predictable, and through science man can understand and calculate exactly how *all* phenomena will occur, even those of the quantum world. Einstein "strongly believed in nature's harmony and his deepest concern throughout his scientific life was to find a unified foundation of physics" (Capra 62), and his conviction that humans beings "still do not know one thousandth of one percent of what nature has revealed to us" (Capra 17) led to his confidence in a more precise science. Thus, for Einstein, quantum mechanics does not prove that nature is unpredictable. It simply proves that physics has yet to fully decode the mysteries of nature.

CHAPTER SIX

Is God Rolling Dice, or is Quantum Mechanics Still Changing?

Quantum mechanics may have a more complicated relationship with theology than any of the previous versions of physics. Indeed, the relationship between modern physics and the philosophy of God has yet to concretize. Not only is quantum mechanics a relatively new science – beginning around 1900 and evolving ever since – but there is not yet a total consensus in the scientific community about the exact nature of quantum mechanics. Are its probabilistic results a limitation, or rather an accurate representation of the non-deterministic way in which the microscopic world really works? That this question still exists in quantum mechanics negates the possibility of deciphering for sure what the theological implications of modern physics will be. But despite the complicated and undetermined relationship that quantum mechanics has with the philosophy of God, the relationship does exist.

If hidden variables are "conquered" and quantum mechanics becomes a system by which man can predict quantum phenomena with Newtonian exactitude, then quantum mechanics will help solidify the Enlightenment worldview that posits that nature operates rigidly and without randomness – that it was built like Newton and his predecessors believed. But if quantum mechanics does not continue to change, if physics has indeed reached the climax of its capacity to predict natural phenomena, then the clockmaker God that Newton confidently said constructed the universe will be replaced by something entirely different.

With where physics stands today, the clockmaker view has been overthrown. The notion that all natural phenomena can be understood and determined with absolute precision through mathematics has, for now, been debunked and replaced by a science that deals wholly with probabilities, not absolutes. This leaves much of the Enlightenment's theology in doubt, because so much of that theology was based upon a science that declared the world to be absolutely rigid, and man's ability to thoroughly understand that world absolutely possible through mathematics. If the quantum world does not subscribe to the same rigidity as the world that man can easily see, then the theology of the Enlightenment has been problematized, if not dethroned. At the very least, God would had to have a bestowed a distinctly different set of rules upon the world that man cannot see. That alone would reshape the view that God designed the universe in a fashion that is unbending, knowable, and perfectly arranged. More dramatically, it may suggest that God does not even exist, certainly, at least, in the manner in which He was thought to exist. If things in nature occur at haphazard, random intervals, then God is not in control as he was believed to be; if He was in control, then why do things in the quantum world happen by chance? Either that world abides by rules unknown to modern physics, or the rules that were thought to control nature do not exist as was believed. *If there is a way to reconcile a random universe with God, then it would require a drastic departure from the theology that emerged from the Enlightenment.*

It will be interesting to see what philosophical and theological changes are brought about by quantum mechanics. Maybe modern physics will continue to advance to the point where even the quantum world can be decoded and predicted through mathematics, allowing for the clockmaker God to still exist and mandating very little change in the way that God is described by Enlightenment physics because the world will still be seen as a machine that does not stray from its design. At this moment in history, though, quantum mechanics suggests that the universe does not operate like that. Instead, phenomena are seen as largely random – events that can be predicted with a set of probabilities, but certainly not with Newtonian exactitude. If that view of natural phenomena is not successfully overthrown by a more exact picture of the quantum world – and indeed some physicists like Copenhagen assert it is not possible to do any better – then the way that the West thinks about God will have to change. Either He imbued the quantum world with different rules than the “macro” world; He works in a way that cannot be deciphered – random and unknown to the scientific and religious communities; or, possibly, He does not exist at all.

CONCLUSION

“Science without religion is lame, religion without science is blind.”

After the foundation of this thesis had been laid, a longtime friend unwittingly highlighted the need for a thorough examination of the relationship between physics and theology. When told of the premise of the thesis – that it would explore how physics has informed the West’s philosophy of God, and vice versa – he quizzically and skeptically said, “That’s kind of a paradox, isn’t it?” But of course, as this thesis has shown, it is not at all paradoxical to discuss the correlation between physics and religion. Physics and Western theology have continuously intersected – and will continue to intersect – because they seek to answer many of the same questions: how the world is structured, what the forces are that govern change and motion, from where those forces emanate, and so on. Thinking of these fields as wholly independent, invariably conflicting entities, like the friend seemed to, is to disregard the ongoing – and at times quite harmonious – relationship that they have shared throughout history. From the time when *Physics* was not really “physics” at all, through today when “physics” has evolved so much that traditional theology has again been problematized, physical theories and Christian theology continue to interact, producing a dialectic that has challenged and shaped both philosophy and physics.

The radically different approaches employed by these fields of study to answer heady questions about the universe – both physical and metaphysical – do not insinuate some sort of disconnectedness. Indeed, as Aquinas claimed almost a millennium ago – and as Einstein reinforced less than 50 years ago – the relationship between physics and theology is not necessarily hostile.

> But science can only be created by those who are thoroughly imbued with the aspiration towards truth and understanding. This source of feeling, however, springs from the sphere of religion. To this there belongs the faith in the possibility that the regulations valid for the world of existence are rational, that is, comprehensible to reason. I cannot conceive of a genuine scientist without that profound faith. The situation may be expressed by an image: Science without religion is lame, religion without science is blind….The further the spiritual evolution of mankind advances, the most certain it seems to me that the path to genuine religiosity does not lie through the fear of life, and the fear of death, and blind faith, but through striving after rational knowledge. In this sense I believe that the priest must become a teacher if he wishes to do justice to his lofty educational mission (Einstein 26).

Thus, as Einstein asserted, and as this thesis set out to prove, it is not only impossible, but indeed *undesirable* to try to understand either physics or Western theology without appreciating the symbiosis that exists between the two. In the West, they are *inherently connected by virtue of their shared goals*. Therefore, whether because of personal religious convictions – like Aquinas – or because of an environment that would not seriously entertain a worldview devoid of God – like the Christian-dominated society in which Newton and Descartes found themselves – *God has never achieved independence from physics, and physics, likewise, has never operated in a Godless vacuum*. Physics and Western religion both seek a true or enlightened conception of our world, and that shared ambition has ensured that they remain in some way attached. Indeed, the nature of that attachment has evolved throughout history, but that it exists cannot be doubted, and that it will continue to exist – in some fashion – is as immutable as gravity.

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