WHEWELL’S WAGER: THE CONTINUING DIALOGUE
OF METAPHYSICS AND PHYSICS IN SCIENCE

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In his library at Trinity College, Cambridge University, around the year 1860, William Whewell (1794-1866) engages in conversation with a company of thinkers on the province of metaphysics and physics, to form a comprehensive scientific belief. In attendance with him are Lord Francis Bacon (1561-1626), Sir Robert Boyle (1627-1691), Sir Isaac Newton (1642-1727, John Henry Cardinal Newman (1801-1890), Professor Alfred North Whitehead (1861-1947), and Pope John Paul II (b. 1920). Whewell proposes a wager: Is there a possible remedy to be found for the schism between the metaphysical and the physical elements of science?

And new philosophy calls all in doubt.

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’Tis all in pieces, all coherence gone.

— The First Anniversary [1611],
by John Donne

Introduction

William Whewell, professor of philosophy, eminent historian, philosopher of science, and Master of Trinity College, Cambridge, trusted that his contemporary practitioners of science were devout Christians who believed that the new science would champion religious belief. He himself contributed to the development of physics in his century, and in 1840 he introduced the term “scientist” into usage. In his writings, he labored to reinforce that biblical accounts could be reconciled with rightly proven scientific theories.

Lord Francis Bacon was a statesman, philosopher of science, and founding father of modern science in England. As the prophet of modern science, he introduced methodology and eliminated the medieval notions of metaphysics. He believed that the new science was not an academic or intellectual enterprise to increase the knowledge of nature, but a practical route to achieve human mastery over nature. Science, after all, should be useful. Order and harmony are mathematical balances in the universe where all causes and effects are reducible to motion in time and space. If one attempts to reason about the origin of space and time, one ends up in the realm of metaphysics; and mathematics is not metaphysics. Science is derived from the light of nature and the dictates of reason, in essence a human undertaking.

Robert Boyle was a natural theologian who found evidence of order and design both in the planetary system and in the laws of physics. He abandoned the dogmatic and metaphysical character of scholastic philosophy in favor of Bacon’s idea of causal knowledge through empirical methods. He held
that some divine ends are coherent to all, and that it would be foolish to reject the theological proofs for the existence of God. Boyle was critical of teleological explanations and pursued a reasoned analysis to sensible facts by exact experiment. As a devout naturalist of the seventeenth century, he had a profound reverence for the Deity. Science was a religious task and he believed that the world would be interpreted religiously. God’s will and character were found in the “Book of Revelation” and God’s works were revealed in the “Book of Nature.”

Isaac Newton stands in the middle of the significant transformation from the providentialism of former religious philosophy to a conceptualization of the future in which God maintains the rational order of the universe. By the eighteenth century, the conception of the world would be stripped of its theological and religious relations. The world would become a set of fixed geometrical motions and divinity will be lost, resulting in the complete despiritualization of nature. New expositions of the cosmos would be expounded in fundamental mechanical laws. All concepts of meaning and purpose would be dissociated from scientific thought. The mechanization of nature would exchange divergent being for convergent experimentation, achieving its final perfection: a world no longer needing God. The difference between the infinite and the finite would become the metaphysical.

Theologian John Henry Cardinal Newman contended that science and theology pursued different and separate methods of investigation. Nature, reason, and revelation come from the same Divine Author. He argued for a unity of knowledge whereby the natural occurrences of science would be found within the supernatural, and the physical and metaphysical would become one. The teachings of God lie within the lessons of the natural world, where its mysteries and miracles are divine messengers.

Alfred North Whitehead, mathematician and philosopher, offered a new and original theory of knowledge about God, the universe, and fundamental reality. Through unique metaphysical views and concepts, he proposed that science and mathematics are used to abstract patterns, and that metaphysics is ultimately dependent upon those patterns. In a constantly changing universe, God is the source of design and the conceptual ordering. Scientific belief in the order of nature emerges from the direct inspection of nature. Science suggests a cosmology, which in turn suggests a religion. Aided by science, the search for evidence of intelligence in the cosmos is a direct link to the divine activity.

At the start of the third millennium, scholar and philosopher John Paul II, influenced by Boyle and other thinkers, holds that faith, as God’s gift to the human person, gathers knowledge of the Creator from the “Book of Revelation.” Reason, using the “Book of Nature,” challenges the natural intellect to question who is responsible for the natural world. He calls for a return to the sources of Christian faith to extract the meaning and significance of the critical questions of our time. Metaphysical reflection on ultimate human questions is joined with scientific research to find a deeper knowledge of the mystery of the universe. The expanding knowledge of the mystery of the divinely created universe, from the molecular to the cosmological, compels scientists to unite their search for scientific truth of the finite with the metaphysical truth of the infinite. This continuing search aims for that which is beyond and higher, and in that quest will expand the human vision of the mystery of God.

We are privileged eavesdroppers on the following Socratic dialogue in Whewell’s library at Trinity College, Cambridge.
Whewell’s Wager

Whewell:

No philosophy of science could be complete which was not also a philosophy of the universe and no philosophy of the universe would satisfy a thoughtful scientist, which did not include a reference to the power by which the universe came to be what it is. Facts are verified by observation of the world and come to be seen as necessary truths within the external world. These universal truths are generated from ideas and are then brought to light from the phenomena in the external world.

For example, gentlemen, let us consider the following speculations: How did things come to be as they are? If there is a Supreme Mind, an Intelligent Cause, which is the cause and foundation of the universe, is this also the source of the truth?

How does man have this knowledge of God, the Supreme Mind?

We begin with what we know, of what is sure knowledge, and how this knowledge can carry us to God. Those laws of the universe, discoverable by the human mind, are the laws of the Divine Mind. The philosophy of each science consists in the development of the fundamental ideas that organize and articulate the propositions of that science. After all, progressive science involves a metaphysical component, comprised of ideas or theories, and a physical component, composed of facts or observations. There is no real distinction between them. Ideas can never be independent from fact; there is a mask of theory over the whole face of nature. The clearness of our very ideas spring forth from the fertile vagueness of metaphysical soil.

Bacon [Boyle and Newton in agreement]:

Nonsense. Scientists of this day have demonstrated that fact can be independent of idea. Furthermore, they have validated that theory is dependent upon observations, but that observations can be independent of theory.

Whewell:

Consider, gentlemen, what I have stated in my editions of The Bridgewater Treatises, namely, that Nature acts by general laws and the resultant interactions are from causes which operate according to fixed and constant rules. Nature is a collection of facts governed by laws; and the knowledge of nature is the knowledge of those same laws. Consider the arguments from St. Thomas Aquinas for the eternity of God. Is not the explanation for the necessary existence of God as First Cause, similarly true? These proofs for the existence of the Deity are in the realm of the metaphysical—a priori, from ideas, and a posteriori, from effect. May not the same be true for the universe?

Boyle:

Some divine ends are coherent to all, so it would be foolish to reject the theological proofs for the existence of God. From the minds of Thomas Hobbes, John Locke, Henry More, Benedict Spinoza—and from you also, Sir Isaac—reasoned analysis leads to sensible facts confirmed by exact experiment. Reason and experience lay the foundation for the “new philosophy” in which the criteria for truth are mathematical and mechanical principles; they are the alphabet in which God wrote the world. These mathematical truths are independent of Revelation, hence, Revelation must be interpreted in a way that does not contradict those principles which are the universal foundations of all knowledge. Mechanics transcends Scripture, and new definitions must be given to metaphysical terms. For instance, form is the mechanical attraction necessary to constitute a determinant body, rather than an essential quality. Nature becomes a system of mechanical laws in a distinct world of matter and motion rather than substance or mystery. Therefore, teleology and the ultimate question of “why” are invalid; for final causality is the immediate “how.”

In reverence for the Deity, I see science as a religious task, and this world should be interpreted religiously. Science and theol-
ogy are part of a larger religious faith in the divine origin and control of the universe. The Deity, as First Cause and Intelligent Being, reveals to us the orderly and harmonious system in the universe and is ever watchful through spiritual forces to hold it together. God, in His Providence, unites the universe through the universal Law of the Author of Nature. The exquisite structure and symmetry of the world, where nature is skilfully contrived and once set by the first design, performs its function without further intervention. God’s ends are within and transcendent to those which are revealed in the discoveries of science. The search for a Final Cause in nature is discoverable in the natural world. Here

How God forms these operations is in the realm of the metaphysical. Reason, by way of careful exploration of the mechanical world, and the rational soul lead to the doorway of the metaphysical.

[Boyle]

the naturalist can find evidence of teleology in the world which the telescope, microscope, and scalpel lay bare. The universal ends of God, the cosmic ends of the universe, and the human and animal ends of physical wholeness are observed. Man has a teleological importance in the cosmic scheme and a unique dignity as a child of God. The body is mechanical, but the soul is rational, unextended, immortal, and immaterial.

Whewell:
Sir Robert, are you a true natural philosopher who seeks knowledge of all the sciences within the rational mind?

Boyle:
Utilizing the experimentalist method, one can discover in the world a natural reli-

gion. If reason were to focus on revelation, the more worthy is the field of endeavor. Religion gains from natural science, for God is the Author of the Book of Nature and the Book of Revelation. There is no conflict between them. The Book of Nature is an introduction to the Book of Revelation, a way to know God through contemplation of His works and the study of His word. Our Naturalist creed has three articles: Deity, Immortality, and Providence.

Whewell:
Is nature a “book” to be read, in which all parts have a definite connection and relation to one another? Can this be explained mechanically rather than mathematically, as Galileo, Copernicus, and Kepler have done?

Boyle:
The Book of Nature was written according to the twelve general principles of universal matter common to all bodies with the power of diversification, which is set into motion by God. The mechanical doctrines of generation, alteration, corruption, and modification have replaced Aristotle’s idea of substantial forms with a corpuscular theory of matter. God is the Prime Mover, and the letters of God’s Book of Nature are mechanical, for the world is God’s epistle to man. How God performs these operations is in the realm of the metaphysical. Reason, by way of careful exploration of the mechanical world, and the rational soul lead to the doorway of the metaphysical.

Newton:
We are religious scientists.

Boyle:
The natural scientist is the hesitant theologian who yearns for the truths of revela-
tion when considering the work of God, both in the mechanical world and in the soul of man. One is compelled to bridge from natural religion to revealed religion and to enter into Christian faith.

Whewell:

Are you separating scientific reasoning and faith?

Boyle:

Natural religion provides the existence of God, but God’s will and character are only to be found in revelation. For revelation is experiential, a kind of divine experiment which encompasses the personal or interior, the historical, which is narrative testimony, and the theological, which is deduced from Scripture. Scripture reveals truths nobler than those of natural philosophy and superior to reason. The Book of Nature, natural theology, may show a part of God’s works; but the Book of Revelation manifests much more in the mystery of the Redemption. Scripture declares the whole counsel of God, but not the whole nature of God. God is the cause of the universe and all creation.

Whewell

Sir Robert, how do you reconcile philosophy and theology with this experimental method?

Boyle:

Experimental science must stand independent from metaphysics, especially the scholastic forms. The habits of explaining phenomena by generalizations in nature, by deference to authority, and by the use of abstract reason without actual observation and experiment, must be cleared away. The method consists of questions or hypotheses and proofs based on probability and reproducibility in which both success and failure are reported and analyzed. The task of the scientist is to utilize, by reason, observation, and experiment, all acquired knowledge, and to link the many and divergent phenomena of the natural world. The consequent knowledge is formulated into a collective maxim and related to a higher cause, so that the physical properties of matter could be deduced from one another.12

Newton:

The mechanical design of looking at nature involves three different types of demonstration or proof. Metaphysical proof, by which conclusions can never be other than true; physical proof, by which conclusions are deduced from physical principles; and moral proof, by which conclusions are based on the truth of prudence and principles of practical philosophy.13 The physical is inferior to the metaphysical and safeguards theological doctrines from scientific contradictions. Moral proofs serve as the basis for ethical arguments.

Whewell:

Do I understand that you are speaking of the concept of design, Sir Isaac?

Newton:

By means of scientific principles, God’s action is seen in the structure and order of the world. Principles that permit one to recognize that the universe is an effect of choice, and not of chance or necessity.14 Natural philosophy, defined in this way, transcends nature and leads one to God.

Boyle:

The design concept allows one to infer design and to investigate the character of that design experimentally by scientific methods. God’s Hand can be read in both man, a sort of microcosm, as well as in the world or macrocosm; the contemplation of both leads one to the multiplicity of the Creator’s wisdom. In the world, design is in the general fabric of nature, animals, and plants; in man, it resides in the body, in the intentions, and also in the soul, the end of these intentions. The design of natural religion is the human mind, the rational soul.15 Man’s rational soul is the immaterial and immortal being; and its nature is known
through introspection, observation, and revelation. The evidence for the action of God in the soul is seen in the rationality, spirituality and immateriality of the human mind. That wondrous mechanism of the integrated body and soul can only be by the Master’s Hand, God’s alone. This is the greatest evidence for the presence of God in the world; such contemplation should forestall questioning any of the doctrines of the faith.  

Whewell:

You will be remembered, Sir Robert, as the “devout” naturalist of the seventeenth century—one who made the world his library and his oratory. But what of this rational soul and the generation of ideas with regard to nature? Would you say it were better to have a little knowledge which is certain and based on experimentation and careful observation, or to construct grand hypotheses of the universe?

Boyle:

The development of science is characterized by the continual competition between distinct views or ideas about nature that are derived from and compatible with the dictates of scientific observation and method. Human knowledge is limited by its tentative and gradual progress; it is small and finite in comparison to the totality of being. The new science needs definitive experimental standards, because hypotheses differ in value and probability of truth. There can be no absolute system of truth, for new information comes without promise of a compatibility with present hypotheses.

Whewell:

Indeed, the ideas and truths in our mind agree with the laws of the universe and the facts of the world, because our ideas are given to us by the same power which made the world and caused them to agree—ideas such as space, giving rise to the laws of geometry as propositions or necessary truths; time, conforming the events of the universe to necessary laws of succession; force and matter, establishing the universal order of the universe; substance, creating the quantitative nature of the universe verifiable by observation of the changes within its quality; and, final causality in organized bodies, governing the laws in organic nature. Thus, nothing happens by chance but only according to the plan, design, or idea of the Divine Mind. The immeasurable distance between the truths in the human mind and those in the Divine Mind is the universe.

[Whewell]

Boyle:

The difference resides in the individual views of the universe and the practice of science in it. Observation and experience define the limits of scientific belief, but not the core of scientific belief. The arbitrary element of personal history and judgment become a formative ingredient that shapes the essence of scientific commitment. Scientific investigation begins with a belief and a desire to find the answers hidden within nature, followed by an effort to forge them into concepts through the might of the human mind. Man’s commitment to this endeavor has fueled the real episodes of scientific revolution.

For example, Copernicus and Newton rejected time-honored theories of astronomy in favor of an incompatible one. Their efforts have transformed the scientific imagination and extended the limits of scientific
discovery. The courage to challenge the rules of methodology and to implant new theories for reevaluation of prior fact is the defining characteristic of a scientific revolution. In our time, mathematics, physics and mechanics have been separated from natural philosophy and an entire constellation of beliefs has been reordered to new principles. This new science is rich in empirical understanding, but it is in search of philosophical understanding.

Whewell:

Ah, but there exist an external, or scientific, and an internal, or philosophical, understanding and knowledge. Laws governing the external mathematical and physical universe as to its identity and order are ruled by the infinite number of ideas within the Divine Mind. Knowledge of the universe is independent of creation and suggests a beginning formed by natural causes from a former substance. The progress of scientific knowledge derived from the observation and speculation in the physical sciences depends upon conforming the objects and events of the universe to the ideas within the human mind. Intellectual progress is the idealization of facts.

Internal knowledge, however, is man's personal and moral nature. According to Aristotle, man is a practical and speculative being who acts and contemplates. In the depth of that contemplation, there is an aspect of action that is inevitably distinct, being either right or wrong. In order to create moral beings as part of the universe, the Supreme Mind or Intelligent Cause has given human beings the idea of right and wrong. Choices and actions belong to each being as the personal expression of that being, or human nature. Human beings have both a law on these subjects written on their hearts, and a conscience which accuses or excuses them. Thus, humans are knowingly the subjects of Divine Law. This earth is the scene of moral trial, and moral advances are made by improving the state of things and produc-

ing good through ideas of justice and benevolence. Moral progress is the realization of ideas.

[He pauses briefly before changing the course of his reflection.]

Let us consider the role of metaphysics through history. Initially, metaphysics was the unifying thread of wisdom that composed the entirety of knowledge in every field. This is a belief system that unites man, the universe in which he dwells, and the Master Designer of that universe. Both man and nature occupy a central and interdependent place within the universe according to that Design and share a kinship/guardianship with the Eternal Designer. Nature is intelligible to the mind of man. Therefore, one studies the grand pattern, or universal nature of Being, through the various sciences together in a conclusive whole.

For instance, before the Newtonian age, science was equivalent to natural philosophy and the greatest philosophers were the greatest scientists. Philosophy dominated science. But science then came into its own. Geometry was the link between antiquity and modernity in science. Plato expanded the Pythagorean idea of numbers and used geometry to illustrate ideas in which the ultimate elements of the cosmos were spatial concepts. In the Middle Ages, geometry predisposes to a fuller mathematical interpretation of nature. This line of thinking was extended in the fifteenth and sixteenth centuries with the insertion of algebraic symbols and equations for scientific investigation. Galileo, Copernicus, and Kepler used geometrical reductions to establish the relativity of mathematical values in the interpretation of nature. The purpose of the method was to isolate the phenomenon, to intuit its elements, and to translate it into a mathematical form. The final resolution of the fact apprehended by the senses became a mathematical “form,” and mathematical harmony became the new version of causality. God as the great Geometrician had created the world in mathemati-
cal terms. The real world was a world of quantitative characteristics where the differences were in number only; all certain knowledge was mathematical. Aristotle's nature as a world of common sense experience gave way to verifiable mathematical hypotheses drawn from the observed world.26

In the seventeenth century, science developed its own criteria of truth and cast doubt and suspicion on the faith of the Christian religion. After your work, Sir Isaac, any reconciliation of Christianity with science called for the adjustment of Christian beliefs to conform to the conclusions of modern science.27

Newton:

Thought is a Divine gift, but it cannot of itself come to knowledge; it requires the perceived motions within nature for its expression. Presently, that expression is mathematical. Metaphysics applied to the categories of physical space and motion is now a purely mathematical concept. Reality in the universe involves bodies moving in space and time.28 Aristotle determined space as contained, not extended; and as enclosed, not limitless. For Aristotle, nature was qualitative to a final cause. But Galileo, Copernicus, and Kepler gave nature an independent mathematical existence, in which causality was the motion of the atoms and their unique mathematical changes. Nature is a self-contained mathematical machine determined by the motions of matter in space and time.29

Boyle:

Further, Descartes showed us that mathematics is the unique door to the secrets of nature and knowledge. Teleological and mechanical—this was metaphysical dualism! How are man and nature to be justified as separate, yet constrained by the same laws? Mathematics tells us of boundaries and interactions but not of substance; it abstracts from physical objects to the extension of space. Defined by res extensa, the real world is extended, independent of thought, and mathematical in quality; res cogitans, the philosophical, rational and conceptual knowl-

dge of essence and substance has been lost.30 God has been relegated to the first cause of motion, and the continuation of that motion was the working of a great mathematical machine by His general concourse. Is the “how” more imperative than the “why”? Without the essence of pure thinking, can the links in the great chain of Being be connected mathematically? Another circle broken!

Whewell:

The richness of post-Newtonian mechanics yielded the scientific discoveries of gravitation and centripetal movement of the celestial bodies, infinitesimal movement, and quantitation of force and mass—or by some thinking, inertia. In turn, scientists have unified experimental and mathematical methods and separated positive scientific enquiry from questions of ultimate causation. Newton attempted a metaphysical groundwork for man with mathematics and the nature of space, time, and matter as the new being.31 However, reductionist ideas prevailed. Now all valid explanations must be in terms of small, elementary units that occur in regularly changing relations; ultimate causality is found in that motion.32 The enquiry into being is replaced by the search for the right method to reach truth. Methodology, in preparation of the conditions necessary for the attainment of knowledge, has become the new way of science. The world is observed in a new mechanical framework that defines the content of the questions to be raised. Philosophy and science are equivalent and open to judgement by the same principles. Eventually, this redundant sequence has permitted science to separate from and dominate the philosophy of nature.33

[He turns toward Bacon.]

What say you, my Lord?

Bacon:

If all activity and change are motion, Professor, I would ask, then, is not thinking a kind of motion? And are not those mental
processes most easily expressed by geometrical mechanics? If Thomas Hobbes is correct, then there is no reality in universal essences or being; essence without existence is a fictitious ingredient of the mind. Reasoning is a series of patterns or images; and are not the most elemental patterns mathematical? Externally these images are motions confined by space whose extension is defined geometrically. Ah, now that, Master Whewell, is causality! Particular being, in the present, is in nature; in the past, it is in the memory; and in the future, nonexistent, for it is a myth in the mind. Being is reducible to a material quality of the senses.

Boyle:

Now if Henry More were here—nay, if all the Cambridge Platonists were at hand, we would be told that not only matter but spirit also must be extended. Furthermore, spirit can impart motion to matter. Extended spirits occupy space and have a dimension wherein the soul lies. More has written that the phenomena of the world cannot be explained by mere mechanics, that there must be a substance distinct from matter. Extended spiritual substances are in accord with our own purposes, for they set our will in motion, and, as "spirits of nature," maintain the diverse parts of the material universe in a non-mechanical unison.

Bacon:

More is a lost medieval mystic who believes in Plato's anima mundi and the universal soul of the world. What motion can exist beyond the very laws that define motion? Order and harmony are the mathematical balances in the universe, not a higher order that is rational, purposeful, and supreme. Space is mathematical, not divine. If God is an extended Being, beyond the mathematical definition of space and time, is He not also a metaphysical myth?

Newton:

Elementary mathematics teaches us to measure in fundamental units and render exact numerical forms of a definite known quantity. This implies a constancy in nature and presupposes the existence of God, the Efficient Cause of all things. The will of God is expressed in the world of matter, perhaps through some ethereal spirit as an active agent within nature that unites nature in an orderly and purposive system. Space and time have potentiality and support the omnipresence of God in an infinite and homogenous absolute entity independent of bodies, motion, and human knowledge.

Boyle:

In his relationship with nature, gentlemen, man retains a teleological importance in this cosmic scheme and relies on Providence. His worth and unique dignity ultimately rest in being a child of God. Man’s body is mechanical, but he has a rational soul, a soul that is unextended, immaterial, and immortal. Some Divine ends are readable by all, others transcend our intelligence, and truly the reach of human knowledge is humble compared to the totality of being. Certain knowledge is more valuable than the greatest speculations of the universe; careful observation and experimentation reveals genuine knowledge. I speak from the most profound reverence for the Deity and point to the order, adaptation, and beauty in the universe as proof of its divine origin and control. This divine Intelligence is the Being that maintains the har-
mony in the universe, and His Providence is exercised in its exquisite structure and symmetry. This is His general concourse. The universe as a whole is not mechanically explicable, but only religiously so.

Whewell:
But what has caused this divergence between science and that great wonder of being? The new scientific metaphysics claims an ultimate reality that is causal and attainable to man’s mind. It is contained in the concepts of space and time. The change lies in the interpretations of reality, causality, and the human mind. What has changed? Firstly, the real world is no longer one of substances defined by a myriad of qualities, but now a world within of atoms defined by mathematical laws, not by Aristotelian qualities. Secondly, causality is no longer a matter of forms and final causes but rather explained in the reductionist tomes of simplest elemental particles. Further, the human mind is a center of mechanically generated sensations and ideas with no union to the Supreme Intelligence. Our enlightened scholastic faculties have been reduced to the mechanical motions of images set in a mosaic of elemental particles. Bah! Soon modern beliefs will have been reduced to the mechanical motions of images set in a mosaic of elemental particles. Bah! Soon modern beliefs will have been reduced to the mechanical motions of images set in a mosaic of elemental particles.

This Divine Intelligence is the Being that maintains the harmony in the universe, and His Providence is exercised in its exquisite structure and symmetry. This is His general concourse. The universe as a whole is not mechanically explicable, but only religiously so.

[Boyle]

scientific thinking categorized by the event it is contemplating as a structured mass of mathematical analysis. What a blow to the universal drama of thought! And what of the diverse and unstable moral paradigm?

This was to become fact in the form of scientific materialism, Immanuel Kant’s new metaphysics, and the process philosophy of Professor Whitehead, here amongst us.

The medieval ideas of space and form gave us boundaries. The new methods and logic of science have taken away these limits and cast us into boundless and hollow mathematical reductionism. The heart of philosophy has a similar void, which is the loss of the spirit of metaphysics. The breath of philosophical life, that light which grants a glimpse of the genuine ways of arrangement that nature has to offer to our understanding, has been reduced to an instrument for the mathematical conquest of the world.

Bacon [to Whewell with emphasis]:
Let us reconsider this matter, Professor. All causes and effects are reducible to motion in time and space, not to little drafty places in our corpus. There is no perfection or Deity involved in these laws, merely elementary units of mass whose behavior can be expressed in the form of equations. There are no explanations except for scientific laws. This is motion’s value and empirical destiny. If we attempt to reason about space and time and their origin, we quit the region of science and end up in the realm of metaphysics, and then are we not like Milton’s fallen angels, where one "finds no end in wandering mazes lost."

Whewell:
If there is value in the universe, is there not a place for teleology? Does this not account for its nature as value?

Bacon:
Value in the universe implies that the universe is an intelligible and rational one;
a rational structure of nature is the foundation of our modern science.43

**Newton:**

Professor Whewell, to ascertain this value of yours, a new metaphysics must be constructed.

**Whewell:**

You have come to the heart of the wager, Sir Isaac.

**Newton:**

Yes, perhaps; but in the mind, the conception of nature or the physical world is in terms of space, time, and mass. God's existence and His relation to the universe will be unmasked by science in the nature and function of the aether. Man, as being, has a perceptual and knowing contact with this physical universe; man as anima, or soul, has contact with the sensory impulses experienced within the sensorium of the brain.44 Here he experiences God, the Originator of the objects man encounters as images.

I have no tolerance for hypotheses as deductions from observed phenomena and have concluded the *Principia* with a classic rejection of them.45 There is no *a priori* certainty that the secrets of the universe can only be divulged by mathematical means: as heir to Boyle's method, I concur that experimental verification must support true reasoning. After all, an experiment is a question put to nature by a natural philosopher who must determine the language that nature understands.46 For Aristotle the language was sensory and metaphysical; for Galileo it was mathematical and physical. Copernicus, Kepler, and Borelli heard it in the order of physical phenomena. During this period, the efforts of the human mind in the search for truth were both spiritual and intellectual, but the mathematical is the foundation of this new and revolutionary metaphysics.47

The foundational principle is simplicity; there is uniformity in nature. Diverse natural effects, expressed by the same equation, must be regarded as the product of the same forces. Empirically, the qualities of bodies are universal to all bodies; and by experimental philosophy, empirical data is true until proven otherwise. Deductive logic is not scientific because it is not drawn from external phenomenon. Science is the body of absolute and certain truth about the events of the physical world. For the present, the nature of the forces in motion is beyond experimental verification and can only be reduced to mathematical laws. Ultimate nature is unknown; we seek to know how it acts, not what it is. This is a rather positivist stand, but exact knowledge is more valuable than speculative knowledge, and therein lies the value in the universe.48 Teleology is in the unconditional surrender of nature to the mind of man. After all, are we not just irrelevant spectators of this vast mathematical system of motion which comprises the world of nature?

**Whewell:**

What of your spirituality, Sir Isaac? How do you perceive the Deity in your scheme?

**Newton:**

Space is geometry and time is the continuity of numbers. All sense is relegated to the sensorium. As for the external universe, well it is a quantity of mathematical computable motions existing in mechanical regularity under the influence of definitive forces.49 The law of gravitation has united astronomy and mechanics into a singular mathematical science of matter in motion.

**Whewell:**

For these very ideas, along with that of absolute space, Bishop Berkeley in 1710 labeled you an atheist. He also writhed under the incorporation of this idea into the Cartesian geometrical machine.50

**Newton:**

I appended the second edition of the *Principia* in 1713 with the *General Scholium*. The original concepts of absolute space and

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**THE BOSTON THEOLOGICAL INSTITUTE**

215
time were extended to moving in God, the Creator of all things, who has absolute domi-

nion and control of these events. Further, in the *Opticks*, I have defined space as the

Divine Sensorium in which the universe exists and the will and intellect of God com-

prehends and guides the physical world. Absolute space is the Divine knowledge and

control of the omnipresent God, who by His will forms and reforms the universe within His boundless sensorium. God is the ultimate Originator of motion, and both real and absolute motion result from the expenditure of Divine energy. My dear sir, this is the essence of Newtonian spirituality.

Metaphysics is becoming more and more an antithesis to science these days. It is now considered nonsense and eliminated from the view of the world. Yet, progressive science involves a metaphysical component and a physical component, with no real distinction between them.

[Whewell]

Boyle:

Religion is a separate discipline from science, but dependent upon the Creator’s Hand in the universe.

Newton:

Religion is a realm different from that of science, yes; for the conclusions of religion cannot be proved nor disproved by scientific standards. Every step of natural philosophy aims closer to the First Cause. The knowledge of God is not detached from the world science seeks to know. Religion and science are fundamentally different interpretations of the universe. The sphere of science is dependent on the Deity who leads the reverent mind to a fuller assurance of His reality and to a willing obedience to His commands. I have written as many theological treatises as scientific dissertations, and I believe that religion is basic to science. However, one must also experience religion apart from science, and science apart from religion.

Whewell:

I would say, Sir Isaac, that you are a pious Christian who seeks design and intelligence in the universe.

Newton:

Once again, in the *Optiks*, I have shown undeniable evidence of intelligent purposes in the universe and cosmic order. Ultimate causality is the direct operation of God in the production of motion. Master Whewell, your teleology is merely the simplicity of nature and planetary movements of the celestial system. God is responsible for the intelligent order in things that makes them worthy of reverent contemplation.

The world could not have arrived out of chaos by the mere laws of nature. After the Deity’s first handiwork, is the world of nature independent of God for continued existence and motion? I think not. The Creator’s power and dominion are always at work in the daily cosmic economy. He prevents the fixed stars from collapsing together in the middle of space and He continually and providentially reforms the world to sustain its incomparable beauty, order, and harmony. This cannot be preserved by space, time, and mass alone; it requires the continual effort of that Divine will which freely chose this order and harmony as the ends of His first creative toil.

Whewell:

From these reflections emerges a theory of necessary truth. Science, through the scientific method, contains the fundamental
ideas that are the sources of necessary truths, or the associations upon which the existence of the science itself depends. These necessary truths, as propositions, have reference to empirical realities that are proved to be true in the course of experience. The resultant fundamental ideas are the principles that the mind contributes to knowing and provides as the subjective forms for interpreting experience into knowledge and truthful statements. In this way, the philosophy of each science consists in the development of the fundamental ideas that organize and articulate the propositions of that science. Empirical facts are judged to be necessary laws when they are idealized and empirical truths become necessary and universal.

Whewell [musing to himself]:

Metaphysics is becoming more and more an antithesis to science these days...especially since the inductive epochs of Copernicus and Newton. It is now considered nonsense and eliminated from the view of the world. Yet progressive science involves a metaphysical component and a physical component, with no real distinction between them.

Newton truly stands in the middle of a significant transformation from the providentialism of earlier religious philosophy to the relegation of God to maintenance of the rational order of the universe. By the eighteenth century, his conceptions of the world will be stripped of their theological and religious relations. The world will become a set of fixed geometrical motions, Divinity will be lost, and the result will be the complete despiritualization of nature. I doubt Newton had this in mind. I wonder if he anticipated it.

In the future, this new conception of the cosmos, as an indefinite and infinite universe, identified by its fundamental laws, will equalize all ideas of being. Scientific thought will eventually disregard all concepts of value—perfection, meaning, and purpose—to the obscurity of being. The mechanization of nature will exchange divergent being for convergent experimentation, and its final perfection will put forth a world no longer in need of a God. The difference between the infinite and the finite is the metaphysical.

Newman [to Whewell]:

As a fellow Trinitarian, sir, I believe that by our reason and by that instrument, the dialectical method, we can arrive at true knowledge of a unified science. The liberation of modern science from theology by the middle of the nineteenth century, after all, is not of interest to all theologians. Many are trying to promote a more inward and spiritual practice of religion. The Roman Catholic Church grounds faith in the dogmatic authority of the Church, rather than in knowledge attained from natural theology or physical science. However, imagination and feelings must be kept under the discipline of reason, to balance the intellectual with the spiritual so that the human mind may give assent to God.

Lord Bacon would have us believe that atheism and science were united from the beginning with the Greeks, and that religion was the ruin of science. He further claims that one must judge by pure evidence and, in that case, physical science is not theology. Final causes and the existence of God are separate from physical science and established laws. It is true that science and theology do pursue different and separate methods of investigation. Induction is the instrument of physics and deduction is the instrument of theology. Nature, reason, and revelation come from the same Divine Author, whose works cannot contradict each other. Thus, knowledge forms a whole, and it may be perceived when the natural occurrences of science are found within the supernatural. The metaphysical and the physical are a unity. One is found within the other, as Aristotle described in his superior and natural sciences.
Bacon:

Certainly, Your Eminence, no new truth can be gained by deduction. Newton, by pure induction, has revolutionized astronomy and physics. What can be gained outside of experimentation? Mathematics, not metaphysics. Is not physical science to serve man? Theology must be derived from God; science is derived from the light of nature and the dictates of reason. In essence, science is born of man.

Newman [to Bacon]:

In revelation, the manifestations of the Almighty exist in the teachings of the natural world, my Lord, but are not taught by nature. Your science is impatient of mystery and doubtful of miracles. It remains fixed in its laws and stays within the material system from which it began. The end of your quest for knowledge is mechanical, beginning and ending with matter, not philosophical and forging deeper into the mind. You pursue science but not the nature of science, and there is where your quest fails as a philosophical process and why it cannot be an end in itself. This is science without metaphysics.

We know God in the cosmos and in the universe of the human heart—cor ad cor loquitur—through the personal dialogue and friendship between man and God. The material world, the individual soul, and human history are the natural messengers concerning God. And their assertions are received through inductive inference, which is a harmony between the methods of probable reasoning and metaphysics. God both hides and reveals himself in nature. Just, as science is an ongoing enterprise, so also is this dialogue in nature an ongoing enterprise.

Bacon:

Do you deny, your Eminence, that the meddling theologians have trespassed upon the scientist’s field of investigation? Physical science and the knowledge gained from it are to serve man in the innumerable inventions that promote the ease of life. Knowledge is power, not argument or ornament. It must lead to action, not to contemplation. Man’s goal is to master nature and thereby enlarge the powerful human empire. Human understanding is infused by the will and the passions; these are the machines that drive science, not ideology and contemplation. With science as the master, a new social order will come to be in which everything is possible to man.

Newman:

Every new discovery has occasioned the scientists to dismiss God from the universe. There is no mention of Thomas Aquinas or the weight of the arguments for the existence of God, whom it is easier to dismiss as Creator, and concentrate on His Creation, the universe. Scientists are impatient, yet they tolerate insufficient and often absurd interpretations that lead to shallow generalizations or flippant judgments in which the mind responds without sufficient data. The object of knowledge is truth, facts which are related and stand together. All knowledge forms the whole, which is everything, contemplated by the human mind in a system of knowledge without limits. It is gained slowly, for this whole is the universe. Science is only a partial view of the mind from abstractions founded in the relations of things rather than the things themselves. Science ranges and classifies facts, traces effects to a cause, and transfers knowledge from memory to philosophy. No science fully can enlighten the mind to the whole; the universe is so intimately knit together that we cannot separate portions except by mental abstractions. And what is mathematics, but abstractions separated from the whole? The Creator is the One, the Being of the whole, separate from it, yet so intimately implicated within it that we cannot fully contemplate it without contemplating Him.

Bacon:

Do I detect the insurgent strain of metaphysics, your Grace?
Whewell:
The wager has been defined.

Newman [to Bacon]:
Is there not a mental formation in the method of science, my Lord? And is not the practice of that formation founded in man’s nature? Then, there must be a unity of knowledge, founded in man’s nature and the necessity of things, from the great moral works to the course of daily life. It is the habit of using an idea by intellect and by sense. It is philosophy! The essence of science is the formation of scientific knowledge after an intellectual digestion, that is brought into the whole. As a habit of mind, this breadth of thought takes in the great universe, moral and material, sensible and supernatural, and is surpassed by the thought of its Maker. He is the One, the Whole, the Being who gives birth in the mind to numerous and distinct truths, each more mysterious than that found in this universe of space and time. Formation, unity, truth, and science all reside within and generate from the Whole. Ideas take on life in the mind, my Lord, and that life is metaphysics.

Whewell:
The dialogue to this point, gentlemen, has questioned the separation of physical science and metaphysical knowledge. Is there not a way to start a new program to integrate metaphysics, physical science and even cosmology?

Whitehead:
When one studies the history of science to our time, I believe there is a ground for developing a unity. Firstly, mathematics has given us the unique notions of spatiotemporal pattern, in presuppositions for modern science to express itself. The infusion of patterns into natural occurrences with stability and modification, is the necessary condition for the realization of experience. Relationships and examples of patterns are key to the relativity of existence and how things are connected. In the physical world, science and mathematics are used to abstract patterns from particulars and actualities. Metaphysics is ultimately rooted in the character of such actualities, or actual occasions, that are dependent upon patterns. Nature is observed through the senses and initially is independent of thought. The knowledge of nature is reached by way of fact, which begins in the senses and ends integrated into thought. This experience is an active entity that is related to other entities and by comparison results in recognition or knowledge.

Whewell:
This new metaphysics, then, encompasses the mathematical and the conceptual from the senses, but does it include the philosophical, the spiritual or the religious?

Whitehead:
True, this new mentality has altered the imaginative content of the mind, so that old stimuli provoke new responses, leading to a more balanced mind. The universe never rests; the actual entity who does the conceptual ordering is God, the source of all possibility and the world’s original design. The medieval scholars insisted upon the rationality of God, and modern science is a derivative of that theology. Faith in reason and in the

Scientists are impatient, yet they tolerate insufficient and often absurd interpretations that lead to shallow generalizations or flippant judgments in which the mind responds without sufficient data.

[Newman]
order of nature springs from the direct inspection of nature, knowing that nature includes the harmony of logical reality as it lies upon the universe and the aesthetic achievement that stands before it.\textsuperscript{80} Science suggests a cosmology; and cosmology suggests a religion.\textsuperscript{81} One must enlist the aid of science to search for evidence of intelligence or life in the cosmos and then relate that activity to the Divine activity.

But science must also be philosophical so that it may criticize its own foundations. Induction, as Lord Bacon, here, introduced it, presupposes metaphysics and rests upon

The discussion to this point has questioned the separation of physical science and metaphysical knowledge. Is there not a way to start a new program to integrate metaphysics, physical science and even cosmology?\textsuperscript{[Whewell]}

rationalism; that is, proceeding from particulars—or phenomena—to relations and interactions between particulars.\textsuperscript{82} But the great forces of nature as observed in the drama of the universe were abstracted to measurable quantities to fit the mathematical systems. Scientific thought is a closed circle of abstraction, and philosophy is the critic of that abstraction.\textsuperscript{83}

Whewell:

But what of the natural world, surely it is not just a machine; then we are back with the Newtonian worldview. The world is not devoid of intelligence and life, but it is a circle, tracing the path of human life, the globe of the earth, and the sphere of the heavens. It is disorder and not clarity that comes from the mechanistic fracture of the circle.\textsuperscript{84} I maintain that there remains a cosmic unity, coherence, and a true wisdom in the universe.\textsuperscript{85}

Whitehead:

Within the new systematic metaphysics of diverse entities, there is a coherent set of concepts, albeit experiential, including God, that combine the aesthetic, moral, and religious interests with those emanating from nature and science. The concentration is one of "becoming" not one of "being."\textsuperscript{86} Reality is the process of coherence seen in specific patterns that are interdependent and interactive. Reality is participation. The interaction is communication where each level receives from a previous one and influences the next pattern of activity. In practice, this is information; specific relations defined by their immediate context. Nature is a community not a machine.\textsuperscript{87}

Whewell:

If information theory is contextual, what gives a message a specific meaning?

Whitehead:

A given sequence of symbols, whether transmitted by genes, memory, symbolic language or by cultural artifacts, is coded, transmitted, decoded, and interpreted for a specific meaning. The context determines the processing system that is selected from an open system of possibilities, and the sequence pattern instructs the information processing.\textsuperscript{88} It is a flexible process that is continually being redesigned.

Whewell:

Did I hear design? If information is an ordered pattern, what is the source of the order in the pattern? Is pattern also design?

Whitehead:

Information has a mathematical design, for instance in quantum theory, where the mathematics involves a set of familiar equations that denote an observation.\textsuperscript{89} The key component of design is information; but as to the nature of the intelligence of that design, and hence that information, even science has failed to provide an explanation.\textsuperscript{90}
Whewell:
Then one can say that mind and intelligent design are not for mechanical forces or chance, but are necessary causes for an intelligent system. Creation, then can be interpreted as God’s input of pure information in the articulate design of the universe.91

Whitehead:
Yes, in the sense that every entity, or information, is a unique synthesis of the patterns that form it; and the interacting networks are summoned forth by God.

Whewell:
The project of metaphysics into modernity has taken a very analytical turn. But what of the unity of faith, reason, and metaphysics? All attempts to reconcile a belief in scientific theory and a belief in God seem to abandon God in the ultimate cosmic process.

John Paul II:
Consider, firstly, St. Augustine of Hippo. In bringing the doctrine of Creation into clear focus as a relationship going beyond the material world, he describes it as a total bringing “to be” and the sustaining and affirming of the existence of the universe.92 The Creator is not temporal or defined by a temporal process. Creation proceeds indefinitely and sustains all things; the design, information, and intelligibility we discover are a reflection of the Divine mind. The stability in nature is a part of God’s process and it makes natural science a possibility. That process is the relationship between nature and the ideas to which they are a witness.93 The source of the information perceived as intelligent design is God’s process and purpose in the distinct act of knowing and willing. God has woven capacities into the character of the world from its first appearance; it reflects His purposes and He can be seen through it.94 All things come from the Creator’s hands. The searching is for the truth and knowledge that first lies within, before it can be revealed externally in the natural sciences.

The unity of science and religion must begin with a metaphysical unity. For it is in unity that the human mind is driven toward understanding. And such understanding for science and religion will be achieved when faith and reason are again united in a common structure. The metaphysics of the one will illuminate the many and make sense of the whole.95

Whewell:
What is the source of this metaphysical unity and how is it achieved?

John Paul II:
Objective and universal truth and the reflection of being together comprise the metaphysical unity, each an essential condition for the other. The way to achieve it is through dialogue between persons, that unique form of exchange which responds to the human desire to know the truth.96 There is a central relationship between faith and reason, science and philosophy, and their mutual journey in the search for truth. The answers to the question of meaning reside in fundamental truths which can only be discovered through a progressive, perpetual journey of the human mind and heart to a relationship with God. The path to truth in scientific inquiry is also a way to the truth of the workings in the natural world. The laws of nature testify to the Laws of Divine Providence. The truth does not reside in the

Within the new systematic metaphysics of diverse entities, there is a coherent set of concepts, albeit experiential, including God, that combine the aesthetic, moral, and religious interests with those emanating from nature and science.

[Whitehead]
thinker, although the human person has a natural inclination for truth.97

But this attainment of truth must have a clear direction. Faith, as God’s gift to the human person, places divine truth within the mind to shepherd reason and promote a true evolution within the reason. The first stage of truth from the “Book of Revelation” is read in the “Book of Nature” with the aid of human reason and can lead to knowledge of the Creator.98 Reason must search for the understanding of Revelation in light of faith, just as with the researches in natural theology. For nature testifies to the God revealed in Scripture and has created a deep distrust of reason and the demise of metaphysics.101

Whewell:

How do you propose to renew this metaphysical spirit in the ongoing scientific enterprise? And what is the value of this metaphysics to the human person in a scientific age?

John Paul II:

There must be a ressourcement, a returning to the sources of the Christian faith to extract their meaning and significance for the critical questions of our time. A spiritual and intellectual communion also calls for a return to the passion for truth and the knowledge of the universal absolutes of meaning. The human being is immersed in a set of truths and values derived from belief and from personal questioning.102 The realm of scientific truth, at this point, is taken as true, without further inquiry for verification. By nature, the human being believes and trusts, forming a richer experience in relationship with others.103 This yearning for interpersonal and scientific truth calls for an entrusting relationship between truth and those with whom the experience is shared. A similar relationship exists between revealed truth and philosophical or scientific truth in the fulfillment of reason. A rational foundation for belief and for seeking truth is in place whereby reason may rise to a higher plane of thought for the perception of being and transcendent truth.104 Reason fuses divine revelation with the human “Book of Nature,” where it finds meaning and a form of knowledge that is unlimited. Faith then augments and perfects reason.105 Metaphysical reflection on the ultimate human questions are joined with scientific research to find a deeper knowledge of the mystery of the human being and, by extension, the universe.106

Because we question, we are by nature philosophers. Speculative inquiry, which is

Any exclusion of metaphysics from the study of the physical universe denies the dependence of every creature upon God and subverts the meaning of human life and of all the universe. The created world is not self-sufficient.

[John Paul II]
characteristic of both theology and scientific research, demands disciplined thought to achieve true knowledge of all created realities. The right use of reason must render one able to articulate this knowledge in concept and in argument.\textsuperscript{[107]} Metaphysics, which has objective truth as its foundation, unites the human person, the world, and being. In studying the truths of revelation and the created order, the knowledge gained by faith and reason in concert uncovers truths and discerns truth from opinion, as in the natural knowledge of God. Philosophy and scientific speculation are not autonomous, for reasoning to abstract levels of truth and to seek metaphysical questions integral to the philosophy of being requires courage and faith.\textsuperscript{[108]} Any exclusion of metaphysics from the study of the physical universe denies the dependence of every creature upon God and subverts the meaning of human life and of all the universe. The created world is not self-sufficient.\textsuperscript{[109]}

Certain and rapid advances of scientific knowledge in the physical and biological world have led to a fragmentation of knowledge. The unity of the entire story is gone and only a set of facts and theories remain to interpret the world, a condition which separates the human from the transcendent.\textsuperscript{[110]} In reality, to study order there must be order and direction within the reason for intelligence is not confined to observable data alone, but can with genuine certitude attain to reality itself as knowable.\textsuperscript{[111]} In this way, reality and truth transcend the empirical and factual data in a metaphysical dimension.

**Newman:**

His Holiness has reinforced the modern distinction between \textit{scientia}, or scientific knowledge, and \textit{sapientia}, the wisdom of metaphysics.

**Whewell:**

What of pure mathematics and quantum theory, where only what is observable and measurable can be truly known and where unity is of the observer and the observed phenomenon?

**John Paul II:**

The boundaries of the physical world are not analytical; they are metaphysical, and they are grounded in questions which have been pondered since the beginning of time.\textsuperscript{[112]} Within scientist and non-scientist alike, there exists a capacity to encounter reality and being and to know truly the metaphysical dimension of truth. It is found beyond phenomenon and experience in the unified vision of knowledge, in God.\textsuperscript{[113]} This belief is the essential element of sincere and authentic dialogue and the call to unity; to believe otherwise is an impoverishment of human thought. The expanding knowledge of the awesome mystery and dynamic work of the created universe, from the molecular to the cosmological, enjoins scientists to combine their search for scientific truth of the finite with the metaphysical truths of the infinite. This is a continuing search that aims for that which is beyond and higher; and in that quest will expand the mystery and humanity’s vision of God.

**Whewell:**

Professor William Wallace has connected the long history of faith and science.\textsuperscript{[114]} Professor Charles Taylor has contrasted the past five centuries of the necessary encounter of religion and society in a secular age.\textsuperscript{[115]} This takes us up to the moment of the illuminating and historic 1999 debate between physicists Sir John Polkinghorne and Nobel laureate Steven Weinberg, on the new scientific evidence for design in our expanding universe. It was sponsored by the American Association for the Advancement of Science.\textsuperscript{[116]}

Thus, discovery wins the wager and dialogue is the remedy of the prophetic and symbolic breaking of the circle of birth, death, and eternity.\textsuperscript{[117]}

She, who by making full perfection grow.

Peeces a Circle, and still keeps it so...

—\textit{The Second Anniversary}[1612] by John Donne\textsuperscript{[118]}
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Endnotes:

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5. Ibid., p. 173.
6. Elkana, p. 381.
7. Aquinas, p. 76.
10. Ibid., p. 193.
12. Ibid., p. 70.
13. Ibid., p. 72.
19. Ibid., p. 15.
22. Ibid., p. 386.
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29. Ibid., p. 87.
30. Ibid., p. 113.
31. Ibid., p. 20.
33. Ibid., p. 4.
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37. Burtt, op. cit., p. 150.
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42. Liang, p. 19.
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44. Burtt, op. cit., p. 223.
45. Newton, p. 314.
50. Ibid., p. 240.
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53. Ibid., p. 293.
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58. Cosselett, p. 17.
61. Ibid., Lecture IV, p. 169.
66. Collins, p. 370. Translated as “heart speaks to heart.”
67. Ibid., p. 370.
68. Morley, p. 197.
70. Ibid., p. 165.
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75. Ibid., p. 118.
76. Ferré, p. 265.
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83. Ibid., p. 82.
85. Donne, p. 44.
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88. Ibid., p. 291; Shannon: Wiener.
90. Meyer, p. 137.
91. Polkinghorne, p. 77-78.
92. McMullin, pp. 49-79.
93. Ibid., p. 46.
94. Augustine, p. 234.
97. Aquinas, p. 760.
100. John Paul II, op. cit., p. 331.
101. Ibid., p. 333.
102. Ibid., p. 326.
103. Ibid., p. 327.
104. Ibid., p. 329.
105. Aquinas, p. 64.
107. Ibid., p. 335.
108. Ibid., p. 337.
110. Ibid., p. 339.
113. Ibid., pp. 340, 342.
114. Wallace, pp. 1-44.
115. Taylor.
117. See Manley’s commentary on “The Anniversaries,” in Donne, p. 46.
118. Donne, p. 107, lines 507-508.
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