Science and Theism: Concord, not Conflict*

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It is widely held that the belief in supernatural entities, like God and the soul, is incompatible with a modern, scientific viewpoint. This bit of conventional wisdom is seldom backed up by careful argument. I will do my best in this essay to reconstruct some plausible arguments for the claim that science undermines the rationality of religious belief. In response, I will examine closely the actual historical relationship between religion and science in Western history, as well as the question of whether these historical connections are merely contingent accidents or are rooted in the very essences of science and theism. I will argue that, contrary to the popular view, the past success of science supports the truth of theism, and that the future success of science will depend on the perseverance of theistic conviction.

I. What is Science?

Before getting down to business, we shall have to try to get clear about what exactly is at issue. I think the meaning of "theism" is relatively clear, although it clearly refers to a fairly large family of beliefs. To count as a theist, one would have to believe that there is

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a personal being (construed as unitarian or trinitarian) who has unlimited power and intelligence, who is fundamentally good and trustworthy, and who is responsible for the creation of the rest of reality. This personal being would have to be at least capable of making contact with us and conveying information to us. In contrast, the meaning of "science" is not nearly so clear. Who exactly are "scientists"? When did science begin? What is the essence of scientific work? There are no settled answers to these questions, making the issue we are to address elusive.

Etymologically, the word *science* is drawn from the ordinary Latin word for *knowledge* (*scientia*). If *science* simply meant *knowledge*, then there would be no justification for a separate chapter on the relationship between theism and "science" since the entire collection of essays is concerned with the question of whether we can know theism to be true. So, science must refer to some special form of knowledge. For our purposes, there are four definitions of science that seem most relevant:

> *Definition 1*: *Science* refers to the exponential explosion in knowledge of all kinds experienced in Europe and connected parts of the world over the last several hundred years, necessitating the re-evaluation of all prior beliefs.
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> *Definition 2*: *Science* is a social institution that has developed in Europe and connected parts of the world over the last several hundred years, consisting of a new priesthood, a "magisterium of fact" (in Stephen Jay Gould's ominous phrase), supplanting—or at least severely limiting—the magisterial role of the Church.
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> *Definition 3*: *Science* represents a radically new and vastly superior way of knowing, embodied in something called "the scientific method," which was discovered or invented in Europe during the seventeenth century.

Definition 4: Science is the history of the inexorable advance of materialistic philosophy against all rivals, including theism.

I won't dispute the reality of the fact that Definition 1 points to—namely, that there has been a breathtaking and accelerating expansion of human knowledge in recent history. Nor shall I dispute that such expansion of knowledge calls for a careful reassessment of long-held beliefs, however venerable. However, the fact that theism should be reassessed in light of recent discoveries does not entail that theism has been cast into doubt. We may find that recent discoveries have no impact on the reasonableness of theism, or even that they strengthen our theistic convictions. I shall leave the details to other contributors to this volume, but let me record my own conviction that the new knowledge we have acquired recently, including evidence of the Big Bang, anthropic coincidences, the fantastic complexity and functionality of biological systems, the deepening intractability of naturalistic explanations for the origin of life and of consciousness, support theism. Indeed, the evidence for theism has never been so clear and strong as it is now.

It is sometimes thought that our displacement from the center of the universe by Copernicus somehow contradicted at least Christian theism, but this seems to be based on the erroneous assumption that everything believed by ancient Christians was taken by them as equally essential to their theology. Ancient Christians knew that the earth was spherical and that the universe is immensely large in comparison to the earth. And although they all believed (until about the fourteenth century) that the earth was the center of the universe, they didn't think that there was anything special about being there, since it was hell, rather than the terrestrial surface, that lay at the very center. From the

ancient perspective, it was the periphery of the cosmos, and not the center, that took pride of place. The outermost sphere was the source of all terrestrial life and motion. The center was a kind of sump in which all that was gross and base settled.[1] In fact, one could argue that it was the poet Dante, rather than the astronomers, who first displaced the earth from its position in the center, for in the last part of the *Paradisio* (from the *Divine Comedy*), it is revealed to be an illusion of our finite perspective that places the earth, rather than God himself, at the center of things.

Definition 2 also picks out a real historical fact. There are now hundreds of thousands of professionals who call themselves "scientists," and they are organized into university departments, laboratories, research centers, and professional associations, very few of which existed a little over one hundred years ago. In addition, there is a superstructure of communications and funding that make the institution of "science" extremely powerful, perhaps uniquely so. However, we cannot pronounce doom upon theism on the basis of this fact alone. The country in which the institutions of science are most developed and well entrenched, the United States, is also one of the world's most religious countries—and a country whose religious life is overwhelmingly theistic.

Moreover, we should be concerned with, not only what will be, as a matter of sociological fact, but with what should be. Organized science may be growing in cultural power, but it does not follow that it is acquiring greater authority over all questions of fact. The institutional growth of science has great potential both for good and for ill. The vast superstructure of science has enabled an accelerated advancement of learning, but it also heightens the danger of intellectual totalitarianism. A priesthood of science,

[1] See Dennis R. Danielson's "The great Copernican cliché," *American Journal of Physics*

increasingly hierarchical in structure and claiming a unique and unchallenged magisterium of fact, can pose a threat to freedom of thought—a threat just as dangerous as that posed by the secular power of the Church in the Middle Ages. In the interests of pluralism, we philosophers must adopt a critical—and even at times adversarial—relationship toward the pronouncements of "science" on key questions of human existence, including the existence of God. Too often philosophers have instead adopted a sycophantic attitude, acting as cheerleaders for official Science rather than as sympathetic critics.

II. The Positivist Myth of the Uniqueness of Science

In contrast to Definitions 1 and 2, Definitions 3 and 4 are grounded not in fact but in mythology. Definition 3 presupposes that "science" is unique, a radically new and unprecedented way of knowing, codified as "the scientific method." This myth of the uniqueness of science comprises three principal theses of positivism:

> *Thesis 1*: The scientific method was the creation of a small group of 17th century investigators, who broke decisively from the Aristotelian-scholastic past, and who began, for the first time, to interact with the world in a distinctively scientific way.
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> *Thesis 2*: The scientific method they discovered is uniquely objective and trans-cultural, consisting of an impersonal method—in effect, the construction of an investigative mechanism—that reliably generates knowledge, depending in no way on the history, ideology, or private insight of the practitioner.

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Thesis 3 : The credibility of this scientific method as a revealer of truth has been abundantly validated by the pragmatic successes and technical powers it has engendered.

All three of these theses have been decisively refuted by contemporary historians and philosophers of science. Pierre Maurice Marie Duhem, the eminent French physicist and historian of science, discovered the medieval and Renaissance precursors to the new physics of the 17th century, especially the development of impetus theory and other alternatives to the Aristotelian notion of natural place by Jordanus de Nemore, Jean Buridan, Nicholas Oresme, and da Vinci, among others. Duhem's remarkable body of work revealed the fundamental continuity that underlay the discontinuities in the refinement of physical theory.[2] Historians and philosophers of science have also

[2] Unfortunately, most of Duhem's work has not yet been translated into English. The major works in French are *L'évolution de la Mécanique* (Paris: A. Hermann, 1903), *Les origines de la Statique* (Paris: A. Hermann, 1905-6), *Études sur Léonard de Vinci* (Paris: A. Hermann, 1906-1913), and the ten-volume *Le Système du Monde; Histoire des Doctrines Cosmologiques de Platon à Copernic* (Paris, A. Hermann, 1913-1959). Selections from these are available in the following English translations: *To Save the Phenomena: An Essay on the Idea of Physical Theory from Plato to Galileo*, trans. Edmund Doland and Chaninah Maschler (Chicago: University of Chicago Press, 1969); *Medieval Cosmology: Theories of Infinity, Place, Time, Void and the Plurality of Worlds*, trans. Roger Ariew (Chicago: University of Chicago Press, 1985); *The Evolution of Mechanics*, trans. Michael Cole (Alphen an den Rijn: Sijthoff & Noordhoff, 1980); *The Origins of Statics*, trans. Grant F. Leneaux, Vicotor N. Vigliente, Guy H. Wagener (Dodrecht: Kluwer Academic, 1991). A good survey of Duhem's significance is provided by Stanley L. Jaki in *Uneasy Genius: The Life and Work of Pierre Duhem* (The Hague: Nijhoff, 1984). More recent treatments of the relationship between religion and the origin of science, such as Christopher Kaiser's *Creation and the History of Science* (Eerdmans, Grand Rapids, 1991) benefit both from Duhem's pioneering work and from later refinements and corrections. For example, Duhem underestimated the importance of Robert Grosseteste, Roger Bacon and the perspectivists, and Thomas Bradwardine and the "Oxford calculators" of Merton College. See A. C. Crombie, *Robert Grosseteste and the Origin of Experimental Science* (Oxford, 1953), and *Augustine to Galileo* (Oxford, 1961); Max Jammer, *Concepts of Mass in Classical and Modern Physics* (Cambridge, Mass., 1961), Chapter 4. See also: Carlos Steel, "Nature as Object of

discovered that the scientific method is not a timeless and impersonal mechanism, but, instead, personal factors, such as aesthetic judgment, cultural perspective, and the actual history of science play an ineliminable role.[3]

Science is thus not a radically new way of knowing discovered in the recent past. As W. V. O. Quine has observed, the difference between science and common sense is a matter of degree, not kind.[4] Scientific theories persuade us of their truth, when they do, by engaging our common sense, and not merely by an appeal to the brute fact of their pragmatic and technical successes. As Bas van Fraassen and other scientific anti-realists have convincingly argued, pragmatic success alone is no guarantor of the truth of scientific conjectures' the technical fruit of scientific research can be explained by seeing science as an effective search for technical fruit and not for the truth.[5] Unlike anti-realists, I believe that science does, for the most part, provide us with knowledge of the real world. However, this knowledge is attained, as is all other knowledge, through the normal exercise of our natural faculties of observation and reason. Defenders of a scientific theory must marshal evidence and arguments for their claims in the public

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Science: On the Medieval Contribution to the Science of Nature," *Nature in Medieval Thought: Some Approaches East and West*, ed. Chumaru Koyama (Brill, Leiden, 2000), pp. 125-152; E. Grant, *The Foundations of Modern Science in the Middle Ages* (Cambridge University Press, Cambridge, U. K., 1996); J. M. M. H. Thijssen, "Late Medieval Natural Philosophy: Some Recent Trends in Scholarship," *Recherches de Theologie et de Philosophie medievales* 67(2000):158-190.

[3] See for instance Michael Polanyi, *Personal Knowledge: Toward a Post-critical Philosophy* (New York, Harper & Row, 1964); Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1966), Paul S. Feyerabend, *Against Method* (London, Verso, 3rd. ed., 1993); and Imre Lakatos, *The Methodology of Scientific Research Programmes* , ed. John Worrall, Gregory Currice (New York: Cambridge University Press, 1978).

[4] *Ontological Relativity and Other Essays* (New York, Columbia University Press, 1969), p. 129.

[5] Bas C, van Fraassen, *The Scientific Image* (Oxford, Clarendon Press, 1980).

forum: they should not expect, and we should not offer, an uncritical, mindless deference to scientific claims. When we are simply overawed by the technical prowess of scientific culture, we partake in a kind of superstitious cargo cult, like the Pacific islanders who worshipped Western traders as gods.

There is no such thing as "the scientific method." There are, on the one hand, a cache of rules of thumb, platitudes, and homely advice, drawn from common sense and tradition, and, on the other hand, sets of specific methods and approaches that define specific research programs in science. Examples of the former include: subject your conjectures to rigorous testing, don't accept authority blindly; rely where possible on firsthand observation; be precise and careful. Examples of the latter are: batteries of statistical tests for significance, double-blind tests for medical treatments, and reliance on well-established scientific instruments—from scales and thermometers to mass spectrometers and radio telescopes. As Etienne Gilson argued in *Methodical Realism* ,[6] each domain of fact calls for its own characteristic set of methods of inquiry. Just as it was inappropriate for medieval Aristotelians to apply biological methods to physics, so too is it inept for the social and biological sciences to be distorted by a "physics envy".

Much of philosophy of science in the mid-20th century was taken up in a quixotic attempt to find a line of demarcation between science, on the one hand, and metaphysics and commonsense knowledge, on the other. Every such attempt to find necessary and sufficient conditions for counting something as "scientific inquiry" or as a "scientific theory" ended in utter failure. The usual candidates—verifiability, falsifiability, testability, repeatability, quantifiability, operationalizability—all turned out to be at best

[6] Christendom Press, Port Royale, Va., 1990.

rules of thumb, useful guidelines to bear in mind, but far from characterizing all and only the scientific ideas.

At the risk of beating a dead horse, let me take just one example of these attempted demarcations—that of falsifiability—since the falsifiability criterion seems to be widely held by working scientists as the *sine qua non* of genuinely scientific theory. There are at least three reasons why this cannot serve as a delimiter of genuine science. First, it is clear from history that scientists, practicing good science, do not immediately throw away a well-established theory at the first sign of trouble, including even falsified predictions by the theory. It is clear, even in hindsight, that a rigid adherence to falsificationist dogma would have stymied scientific progress through the premature rejection of theories that appeared to be in conflict with experimental results. For example, the deviant orbit of Uranus appeared to contradict Newtonian predictions, until the planet Neptune was discovered and Newtonian theory vindicated.

Second, as Duhem and Quine both demonstrated, no theory is ever simply falsified by a result. Instead, each theory is tested in conjunction with a host of auxiliary hypotheses, the falsity of any of which could be responsible for a negative result. In a sense, it is not individual hypotheses, but the whole body of scientific theory that is being tested with every observation and measurement. The task of finding the responsible party when a negative result is encountered can never be reduced to a mechanistic recipe. Finally, since no empirical result is ever absolutely conclusive, it is also impossible to falsify anything absolutely, since an absolute falsification would have to be based upon an absolutely conclusive foundation.

This is not to deny that there is real value to Karl Popper's bromides. We really are tempted to hold on too long to familiar and cherished ideas, to resort too often to *ad hoc* rescues, and to insulate a favored theory against challenge by definitional monkey business. However, it is not always and absolutely wrong to cling to a theory in the face of recalcitrant results; what is wrong is lack of balance and moderation, taking a legitimate conservatism too far. A good scientist seeks an Aristotelian Golden Mean between a hidebound conservatism and an erratic instability.

By failing to take into account these subtleties, a dogmatic falsificationism can do real harm. An uncritical insistence on falsifiability introduces a bias into scientific research that favors the quantitative over the qualitative, the atomistic and analytical over the holistic and synthetic, efficient causation over final causation, and the postulation of sub-human agencies over human and superhuman ones. It can lead, worst of all, to a supercilious disdain for metaphysics.

If science really were a distinctive mode of knowing, demonstrably superior to common sense and all other methods, we might be under a kind of intellectual duty to base all of our beliefs on science alone. However, since science cannot be demarcated from the rest of knowledge, our ordinary ways of warranting beliefs are under no such cloud of suspicion and remain innocent until proven guilty.

III. The Materialist Myth of the Unity of Science

Definition 4 of science assumes that the history of science, beginning with Thales and Democritus in ancient Greece and including our recent past, has been one long train of

successes on the part of an increasingly materialistic and reductionistic theory of the world. Resistance to this program of explaining everything in terms of physical forces and micro-particles has been futile, as one competitor after another has been thrown out in defeat. Theism is virtually the last holdout, and theologians have been forced repeatedly into a strategic retreat, surrendering ever-greater swaths of territory to the materialists as reductionistic science brings more and more phenomena under its sway, rendering God more and more an extravagant hypothesis for which we have no need. An intelligent student of intellectual history, surveying an unbroken string of victories on the part of the materialsts over their supernaturalistic opponents cannot help but find theistic speculations incredible.

So I think it must seem to the proponent of Definition 4. But one shouldn't believe a word of it. Such a cartoon-like and melodramatic oversimplification of the history of science impedes our understanding of its real significance. The history of science has not been a one-sided victory of materialism over all its rivals. The real story is a good deal more complicated—and more interesting.

If we look simply at very recent history, we find that the confident prediction in the 1950's of unity-of-science enthusiasts like Hilary Putnam and Paul Oppenheim has not been borne out.[7] We have not found ways to derive the laws of biology, psychology and the other so-called "special sciences" from the master science of fundamental physics; in fact, new discoveries have made any hope that we might do so seem ever more far-fetched. Information and other non-physical entities play an ever-larger role in

[7] "Unity of Science as a Working Hypothesis," in *Minnesota Studies in the Philosophy of Science*, ed. H. Feigl, M. Scriven, G. Maxwell (Minneapolis: University of Minnesota Press, 1958), 3-36.

biology, cognitive psychology and linguistics. Even doctrinaire materialists within philosophy have largely abandoned any claim that mental properties and events can be reduced to physiology and physics, with various forms of "non-reductive materialism" becoming the predominant fashion.[8] Even the reductionistic strategies within the philosophy of mind that do remain—namely, the variations on Putnam-Lewis functionalism—do not respect the kind of unity of science envisaged by Putnam and Oppenheim in 1958, since they try to reduce mental properties, not to physical properties expressible in the language of real physics, but to properties expressed in a language enhanced with sophisticated logical features (like higher-order quantification) and metaphysical relations (like causation and necessity) —a language that is very remote from the actual practice of physicists.

When we step back to look at the history of science over the entirety of its course from ancient Greece to the present, we find that a materialistic tendency is only one of four major strands that have contributed substantially to the present shape of scientific theory. The four traditions are (1) a Platonic-Pythagorean mathematical realism, (2) Aristotelian teleo-mechanism, (3) neo-Platonic and hermetic speculation about occult powers and vital principles, and, finally, (4) Democritean (atomistic) and Empedoclean (non-atomistic) versions of materialism. It is by no means the case that the fourth tradition has been the predominant influence on modern science; in fact, it is arguable that the Platonic-Pythagorean mathematical realism has been far more significant, and each tradition has made indispensable contributions. For an excellent survey of the history of science that carefully follows each of these threads, I recommend Nancy

[8] Compare the Putnam-Oppenheim piece with Jerry Fodor's "Special Sciences: The

Pearcey and Charles Thaxton's *The Soul of Science: Christian Faith & Natural Philosophy*.[9] Much of what I say on this subject is drawn from their insightful book.

Ancient atomism had proved a scientific cul-de-sac, effectively fruitless after the time of Archimedes and never producing a theory of motion. Mathematical physics became possible only when Christian thinkers, influenced by Plato's *Timaeus* and, even more importantly, the *Wisdom of Solomon* from the Septuagint (which taught that God has "disposed all things in measure, number and weight"),[10] turned to the study of natural phenomena with a faith in the mysterious, even mystical, power of mathematics to reveal the essence of reality. The influence of such Christian Platonism is unmistakable in the pioneering work of Roger Bacon and the other Franciscans at Merton College, Oxford,[11] as well as in the thinking of later giants, like Galileo, Copernicus, Kepler, and, ultimately, Newton. It was a common interest in neo-Platonism that led Newton to Kepler's neglected work. Prior to this audacious attempt to find mathematical order in the world, nature had seemed, not orderly, but a "buzzin', blurrin' confusion," in William James's memorable phrase. In fact, these Christian thinkers went far beyond their Platonic roots in coming to expect absolute precision in the world. Unlike Plato's demiurge, who did his best to order recalcitrant matter, the Christian God created matter itself and could, therefore, be expected to have successfully imposed a perfectly exact form upon it. Kepler's discovery of elliptical orbits, for example, depended on a difference of eight minutes in the orbit of Mars.

Disunity of Science as a Working Hypothesis," *Synthese* 28 (1974): 97-115.

[9] (Wheaton, Ill., Crossway Books, 1994).

[10] *Wisdom of Solomon* 11:21. This was the most widely quoted Scripture in the Middle Ages, according to Duhem.

Although the arteriosclerosis of Aristotelian orthodoxy did retard, for a time, the progress of physical science (as the Galileo episode illustrates), we must not overlook the positive contribution of the teleological approach to nature.[12] In medicine and anatomy, the progress achieved by Andreas Vesalius and William Harvey depended, not only on their willingness to go beyond Aristotle, but also upon their continuing to build on the foundations that Aristotle had laid. Harvey discovered the circulation of the blood because he believed in a divine architect who had created all things "for a certain purpose, and to some good end."[13] Such teleological thinking has proved indispensable in biology until the present day.[14] To identify a protein as an "enzyme" or a DNA molecule as a "code" is to use irreducibly teleological concepts, as is any reference to adaptations or disease.

Even in physics, the teleological tradition lives on in the form of so-called "variational principles," including the least action principles of Leibniz and de Maupertuis and Fermat's least time principle of refraction. All of Newton's optics and mechanics can be derived from William Rowen Hamilton's formulation of least action. Both Einstein's equations of relativity and Schrödinger's equations for quantum

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[11] Roger French and Andrew Cunningham, *Before Science: The Invention of the Friars' Natural Philosophy* (Scolar Press, Hants, England, 1996).

[12] "Teleology" refers to the assumption that some things in nature have characteristic or proper functions or purposes, e.g., hearts have the purpose of pumping blood, eyes the purpose of enabling sight, nerves the purpose of carrying sensory and motor signals, etc.

[13] Quoted by Hugh Kearney, *Science and Change, 1500-1700* (New York: McGraw-Hill, 1971), 86-7.

[14] See F. J. Ayala, "The Autonomy of Biology as a Natural Science," in *Biology, History and Natural Philosophy*, ed. A. D. Breck and W. Yourgau (New York: Plenum Press, 1974), 7; Jacques Monod, *Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*, trans. Autryn Wainhouse (New York: Knopf, 1971), 9; E. W. Sinnott, *Cell and Psyche: The Biology of Purpose* (New York: Harper & Row, 1961), 46; T.

mechanics can be derived from similar minimum action principles.[15] In addition, modern thermodynamics owes its central concept of a stable equilibrium to Aristotle's idea of natural place. In one case after another, the teleological form of physical theory has proved to be both simpler and more fruitful than a-teleological alternatives.[16]

Neo-Platonic, hermetic,[17] and even magical and kabbalistic[18] traditions played a significant role in the rise of modern science, especially chemistry and the physics of electromagnetism. It has often been noted that the acceleration of scientific progress in the 17th century coincided with a new interest in magic.[19] These mystical traditions lead researchers to look for hidden powers in matter, especially powers of attraction and repulsion, as illustrated by William Gilbert's early studies in magnetism. The Paracelsian tradition inspired Jean-Baptiste von Helmont (1579-1644) to make significant discoveries in chemistry, including the discovery of gas.[20] Most importantly, Newton's postulation

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Dobzhansky, "Chance and Creativity in Evolution," in *Interrelations: The Biological and Physical Sciences*, ed. R. T. Blackburn, (Chicago: Scott, Foresman, 1966), 159.

[15] W. Yourgrau and S. Mandelstam, *Variational Principles in Dynamics and Quantum Theory*, 3rd ed. (Philadelphia: Saunders, 1968).

[16] Jim Hall, "Least Action Hero," *Lingua Franca* 9 (October 1999): 68.

[17] The "Hermetic" tradition is embodied in an ancient text, the *Hermeticum*, attributed to Hermes Trismegistus, supposedly an Egyptian priest and mystic of the second millenium B. C. Modern scholars believe the text was written by a Greek Neo-platonist between 100 and 300 A. D. The hermetic text was prized by Renaissance magi, such as Marsilio Ficino, Pico della Mirandola, and Giordano Bruno.

[18] The Kabbala tradition originated in Jewish circles in early medieval Spain. It was based upon the invocation of angels and other spritiual principles through the manipulation of the Hebrew alphabet.

[19] See Francis A. Yates, *Giordano Bruno and the Hermetic Tradition* (New York: Random House, 1964); Charles Webster, *From Paracelsus to Newton: Magic and the Making of Modern Science* (New York: Cambridge University Press, 1982).

[20] Walter Pagel, "The Position of Harvey and van Helmont in the History of European Thought," *Toward Modern Science*, ed. Robert M. Palter (Noonday Paperback, New York, 1961), II, p. 185ff.

of a universal force of attraction had unmistakable roots in this same strand of thought,[21] as is witnessed by the virulent hostility to the idea among contemporary Cartesian materialists.

A similar neo-Platonic *Naturphilosophie* made significant contributions to biology throughout the eighteenth and nineteenth centuries, as exemplified by the work of Buffon and Lamarck in biology and Hans Christian Oersted, Sir Humphrey Davy, and Michael Faraday (the discoverers of electromagnetism) in physics. In fact, materialism in the modern sense was not a significant factor in Western thought until the materialist movement in Germany in the 1840's. This movement was, at least initially, crude and naïve, inspired by political and cultural factors, rather than by a profound understanding of science.[22] If the materialist myth of the unity of science were correct, the scientific revolution should have occurred in mid-19th century Germany, not in the 16th and 17th centuries.

Modern quantum mechanics displays the marks of both aspects of the Platonic heritage: the primacy of exact mathematical formalism and the rejection of the necessity for mechanistic explanation. This latter aspect of quantum theory is most evident in its embrace of causal non-locality, instantaneous action at a distance—a consequence of Bell's theorem. The distance between the atomism of Democritus and Epicurus and the mathematically rigorous, holistically intertwined world of modern quantum theory could not be greater. The four essential features of ancient materialism, viz., the absence of

[21] Due in part to the Cambridge Platonists, John Smith (1618-1652) and Henry More (1614-1687), who had a formative influence on Newton during his undergraduate years at Cambridge. In addition, Webster documents that Newton owned editions of the work of Paracelsus and van Helmont.

mathematical realism, the insistence upon explanation in terms of paradigmatic physical interactions, like collisions, pushings, pullings and other localizable events, the rejectionof teleological explanation, and a commitment to ontological pluralism (the priority of the Many over the One), are all excluded by quantum theory. The latter can represent the triumph of "materialism", rather than its utter annihilation, only if the term "materialism" is evacuated of all meaning. Materialists have succeeded in the misrepresentation that science has vindicated "materialism" only by repeatedly redefining the essence of materialism to fit whatever the latest scientific theories say.

In fact, the form of materialism that had the most profound effect on science was not an atheistic or agnostic materialism drawn immediately from Empedocles or Lucretius, but a specifically theistic and Christian materialism. The materialist myth overlooks the fact that, for the most part, modern materialism and theism have been allies and not adversaries. A number of Christian thinkers worried that over-reliance on the Platonic and Aristotelian approaches would undermine respect for God's freedom, sovereignty and immediacy, all of which are prominent themes in Judeo-Christian theism. Duhem, for example, dates the beginning of the scientific revolution at March 7, 1277, when Étienne Tempier, bishop of Paris, condemned a set of theses of Aristotelian physics as wrongfully imposing limits on God's omnipotence. Duhem saw this act as a call to Christians to apply their intellects to the development of a new physics. Tempier's condemnation of Aristotle coincided with the rise of a new voluntarism in theology,

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[22] Frederick Gregory, *Scientific Materialism in Nineteenth Century Germany* (Boston: D. Reidel, 1977).

which meant that Christians had to rely on observation and experiment to discover how in fact God had exercised his sovereign freedom.[23]

Boyle and Newton stood at the culmination point of this new kind of Christian materialism. Robert Boyle saw God as the direct and free establisher of the laws of motion. These laws depended solely and perfectly on his will, without any intermediaries or prior constraints. Boyle promoted an atomistic, corporeal theory of the world because he regarded the neo-Platonic tendency to introduce intermediary spiritual forces into our picture of the world as detracting from the honor of God as the sole author and governor of nature. For Boyle, the universe was not God, but rather a perfectly consistent artifact. This theme in Boyle reflects the larger "disenchantment of the world" effected by Christianity and widely noted by sociologists and anthropologists. By seeing nature as a fellow-creature of God, rather than as the habitation of the semi-divine, Boyle helped to open nature to rational investigation.

Newton echoed these sentiments. He rejected the introduction into science of the neo-Platonic or Stoic World-Soul as a potential source of confusion between God and his creation.[24] At the same time, both Newton and Boyle rejected a full-fledged materialism of the kind promoted by Cartesians, since, as was said above, real influences from the Platonic tradition of vital principles remained. In particular, Newton was influenced by the Cambridge Platonists, who looked for exact mathematical laws and evidence of

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[23] In *Divine Will and Mechanical Philosophy: Gassendi and Descartes on Contingency and Necessity in the Created World* (Cambridge University Press, Cambridge, U. K., 1994), Margaret Osler argues that Gassendi's empirical approach to nature was grounded in just such theological voluntarism.

[24] Eugene M. Klaaren, *Religious Origins of Modern Science* (Grand Rapids: Eerdmans, 1977), 135-151.

super-material forces in nature. Newton saw the universe as a riddle or cryptogram set by God.[25]

Philosophically, theistic materialism is a more coherent position than atheistic materialism, for the theist has an explanation for the three central facts that atheistic materialists must accept as brute facts, in fact, as extraordinary coincidences inexplicable by their principles. First, the atheist has no explanation for the unity of the physical universe: why the stories of the various participants in the world must cohere into a single, consistent world history. Second, the atheist has no explanation for the amazing consistency, across space and time, of the relatively small number of natural kinds we observe. What makes one electron, photon or quark so much like another at one time, when there is such a vast number of them, and what makes each so stable over long stretches of time? Finally, as I will discuss in greater length in the next section, the atheist has no explanation of how human beings come equipped to understand the physical world's fundamental principles.

The notion that there has been significant conflict between science and theistic religion is the product of propagandists of the early 20th century, especially John William Draper[26] and Andrew Dickson White,[27] neither of whom is defended by credible historians today. In fact, the truly remarkable thing about the explosive growth of modern science is that it happened in Christian Europe in the later medieval and early modern period, rather than at other times and places, with societies that were richer, more

[25] John Maynard Keynes, "Newton, the Man," in *Essays in Biography*, 2nd ed., (London: Rupert Hart-Davis, 1951), 310.
[26] *History of the Conflict between Religion and Science* (New York: D. Appleton, 1902).
[27] *A History of the Warfare of Science with Theology in Christendom* (New York: D. Appleton, 1908).

populous and better organized (such as Rome, China, India, central America, or the Islamic empire). Many historians have concluded that the impetus of Christian theism provides the answer to this puzzle.[28]

Theism provides a complex and subtle view of the world, in contrast to the narrow preconceptions of the materialist. Western theism exhibited a kind of genius in establishing a balance and creative tension among quite disparate traditions, maintaining the polarities of atomism and teleology, vital forces and spatial relations, reason and empiricism. This ability of the theist to weave together a more adequate science from what had in the past remained unmixable ingredients is exemplified perfectly by Leibniz. Leibniz's conception of the vivacity of matter drew equally from Platonic mathematicism, Aristotelian teleology, neo-Platonic vitalism, and corpuscular materialism, and this conception was the direct ancestor of our modern notion of energy, which has been at the center of theoretical physics ever since. Far from hindering the progress of science, theistic metaphysics has inspired its most fruitful ideas.

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[28] Alfred North Whitehead, *Science and the Modern World* (New York: Macmillan, 1925); Michael Foster, "The Christian Doctrine of Creation and the Rise of Modern Science," *Mind* 43 (1934): 446-468; and "Christian Theology and the Rise of Modern Science I and II," *Mind* 44 (1935):439-483 and *Mind* 45 (1936):1-27; Christopher Kaiser, *Creation and the History of Science* (Grand Rapids: Eerdmans, 1981); A. R. Hall, *The Scientific Revolution, 1500-1800: The Formation of the Modern Scientific Attitude* (Boston: Beacon Press, 1954); Joseph Needham, *The Grand Titration: Science and Society in East and West* (Toronto: University of Toronto Press, 1969), 327; Stanley L. Jaki, *The Road of Science and the Ways to God* (Chicago: University of Chicago Press, 1978); Eugene M. Klaaren, *Religious Origins of Modern Science* (Grand Rapids: Eerdmans, 1977); Loren C. Eiseley, *Darwin's Century: Evolution and the Men Who Discovered It* (New York, Doubleday, 1958), 62; Margaret Osler and Paul Lawrence Barber, eds., *Religion, Science and Worldview* (Cambridge University Press, Cambridge, U. K., 1985); Margaret Osler, *Rethinking the Scientific Revolution* (Cambridge University Press, Cambridge, U. K., 2000).

IV. The Dependency of Science Upon Theism

Far from undermining the credibility of theism, the remarkable success of science in modern times is a remarkable confirmation of the truth of theism. It was from the perspective of Judeo-Christian theism—and from the perspective alone—that it was predictable that science would have succeeded as it has. Without the faith in the rational intelligibility of the world and the divine vocation of human beings to master it, modern science would never have been possible, and, even today, the continued rationality of the enterprise of science depends on convictions that can be reasonably grounded only in theistic metaphysics.

There are seven elements of Western theism, each of which provided a necessary condition for the engendering of modern science

1. The belief in the intelligibility and mathematical exactitude of the universe, as the artifact of a perfect Mind, working with suitable material that it has created *ex nihilo*, and the closely connected Hebraic conception of God as a law-giver. The idea of a law of nature was first explicitly formulated in the fourth century by Basil of Caesarea in his *Hexaemeron* (Six Days), applying the Biblical model of God as lawgiver to the Greek picture of an ordered cosmos.
2. A belief in the fitness of the human mind, created in the image of God, to the task of scientific investigation, conceived of as a *vocation given byGod*.[29]

[29] Kepler: "I give you thanks, Creator and God, that you have given me this joy in creation, and I rejoice in the work of your hands. See I now have completed the work to

3. The need for observation and experiment to discover how in fact God has exercised his sovereign freedom and absolute omnipotence in crafting and legislating for the creation, a freedom incompatible with the complete determination of the divine will by *a priori* constraints. Recall Duhem's view of the significance of Tempier's condemnation of Aristotelian physics for neglecting this very thing. In addition, Duhem argues that the omnipotence of God led to medieval speculation about the possible existence of many worlds like the earth, leading the way for the Copernican and Galilean revolutions.
4. The conception of nature as a divine Book, parallel to the Bible. The two-book model was a favorite theme of Galileo, Kepler, Bacon and others. Historians have discovered fruitful interaction between scientific theorizing and the development of biblical hermeneutics in the late Middle Ages, Renaissance, Reformation and Counter-Reformation.[30]
5. The *dis*enchantment of the world by theism, clearing away the potentially discordant divinities and semi-divinities of polytheism and animism. This abolished the ontological gap between the heavens and the earth (Aristotle's sub-lunar and super-lunar realms), making possible Newton's unification of the explanation of motion.
6. The linear view of time, beginning with creation and passing through the unique, unrepeatable events of "the divine comedy," in place of the otherwise ubiquitous

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which I was called. In it I have used all the talents you have lent to my spirit." Quoted in Kaiser, *Creation and the History of Science,* 127.

[30] See Peter Harrison, *The Bible, Protestantism and the Rise of Natural Science* (Cambridge University Press, Cambridge, U.K., 1998), and Kenneth J. Howell, *God's*

conception of a cyclical Great Year. This enabled Christian theists to conceive of the possibility of unprecedented progress in scientific knowledge and technical efficacy, in contrast to the endemic resignation and pessimism of antiquity.

7. The elevation of the dignity of matter and of manual work, a consequence of the theological doctrine of the Incarnation, especially given Jesus' occupation as a carpenter. Modern science was possible only when investigators became willing to dirty their hands in workshops and laboratories, and only when they began to see all material things, which have been created by God, as good in themselves.

The scientific materialist might respond to this by admitting that, as a matter of historical happenstance, modern science was in fact spawned by theological conviction, but all seven of these principles can now be stripped of their theological baggage and allowed to stand on their own. We now know, by sight and historical experience—and not by faith—that the universe is mathematically intelligible and that the human mind is somehow up to the job of understanding it. We are no longer haunted by visions of inexorable fate or of a pandemonium of spirits, and so science no longer requires the tutelage of religion. We have, scientifically speaking, come of age and may now put aside such childish things as theology.

However, this sanguine view does not stand up to careful philosophical scrutiny, as Alvin Plantinga has shown in his *Warrant and Proper Function*.[31] There Plantinga demonstrates that scientific materialism, without a designer who intended man to be equipped with an aptitude for truth, leads inexorably to an epistemological catastrophe,

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Two Books: Copernican Cosmology and Biblical Interpretation in Early Modern Science (University of Notre Dame Press, Notre Dame, Indiana, 2002).

[31] (New York, Oxford University Press, 1993). On this, see chapter 10.

the "epistemic defeat" of all the materialist's aspirations for knowledge. I will give here only an oversimplified summary of Plantinga's argument, since it is impossible (at least for me) to be clearer or more concise than Plantinga himself. The materialist has no real option but to believe that humanity is solely the product of an undirected and unplanned Darwinian process—random changes culled by natural selection. Natural selection cares only about behavior that promotes survival and reproduction: it has no interest in truth as such. There is no good reason to believe that an aptitude for truth is the only way, or even an especially likely mechanism, for producing survival-enhancing behavior. (For example, human beings may generally come to believe their fellow-humans have intrinsic dignity and worth and that objective moral values and their attendant obligations exist. Given naturalism, these beliefs would be false—even if holding such beliefs helped humans better to survive[32] The knowledge that the causal pathways leading to our present beliefs lacks any intrinsic propensity to promote truth gives us a compelling and indefeasible reason for doubting all the deliverances of our cognitive faculties, whether of perception, memory, logical reasoning, or scientific inference. Hence, the scientific materialist cannot reasonably, in the end, claim to know that the results of science (or any other mode of human knowledge) are in fact true.

In an essay published in 2000,[33] I laid out an argument that resembles Plantinga's in certain respects. I argued that it is impossible, if materialism is true, for any scientifically formed belief about fundamental physics to be knowable or even to be true.

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[32] See Paul Copan's essay on the moral argument in this volume.

[33] "The Incompatibility of Naturalism and Scientific Realism," in *Naturalism: A Critical Appraisal*, ed. William Lane Craig and J. P. Moreland (London: Routledge, 2000), pp. 49-63. See also chapter 15 and section 17.5 of my book, *Realism Regained: An Exact*

The materialist must adopt a causal or information-theoretic account of the meaning of the propositions of scientific theory, and a similar account of the nature of knowledge (along the lines of the semantic and epistemological theories of Dretske, Papineau or Millikan).[34] These accounts require a tight connection between semantics and epistemology: it is impossible for our theories to carry information about the world unless our inferences to theories are largely reliable. Since simplicity, symmetry and other quasi-aesthetic qualities of theories play an indispensable role in our theoretical practice,[35] our inferences to scientific theory cannot be reliable unless there is a causal explanation for the connection between simplicity and truth. However, no materialistic account of such a causal connection is possible since any causal explanation of the linkage between simplicity and truth would have to involve reference to a factor that caused the fundamental laws of the world to be simple, and any cause of the fundamental law of matter must itself be immaterial. Hence, the materialist cannot consistently believe either that science provides us with knowledge, or that our scientific theories are really about the world (in that they fairly accurately and truly correspond to nature).

The argument depends crucially on the point made earlier—that aesthetic judgments about simplicity and elegance provide a screen through which theories must

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Theory of Causation, Teleology and the Mind (New York, Oxford University Press, 2000).

[34] Fred I. Dretske, *Naturalizing the Mind* (Cambridge, Mass.: MIT Press, 1995); David Papineau, "Representation and Explanation," *Philosophy of Science* 51(1984): 550-72; David Papineau, *Philosophical Naturalism* (Oxford: Blackwell, 1993); Ruth Garrett Millikan, "Biosemantics," *Journal of Philosophy* 86(1989): 281-297.

[35] See, for example, Steven Weinberg's discussion of the role of such criteria in recent developments in physical theory: Steven Weinberg, *Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature* (New York, Vintage Books, 1993), 133-165. See also Mark Steiner, *The Applicability of Mathematics as a Philosophical*

pass before we can take them seriously.[36] However, the argument does not depend on supposing that the relevant standards of aesthetic judgment are entirely innate or *a priori*. The materialist is in trouble, even if, as Weinberg puts it, "the universe acts as a random, inefficient and in the long-run effective teaching machine . . ."[37] What is crucial is that, for these aesthetic criteria to guide us reliably toward new discoveries about the fundamental laws, the fact that the undiscovered laws share learnable aesthetic characteristics with the ones we already know must not be a brute coincidence. Real reliability, as opposed to dumb luck, requires a causal mechanism that makes the mechanism reliable. In this case, such a mechanism would have to have impressed a specific, learnable aesthetic deep structure upon all the fundamental laws of nature. Such a mechanism cannot itself be a material cause, since we are supposing that something is responsible for the fundamental laws of matter, and only something supra-material could do that. This transcendent Something needn't be a God, but the fact that It imposes what is recognizably a rationally-ordered form of beauty (Weinberg's chapter is entitled "Beautiful Theories") surely suggests that there is something personal about this cosmic law-giver. Even a materialist as inveterate as Weinberg begins to sound quite theological at this point:

> It is when we study truly fundamental problems that we expect to find beautiful answers. We believe that, if we ask why the world is the way it is and then ask why that answer is the way it is, at the end of this chain of explanations we shall find a few simple principles of compelling beauty.

Problem (Harvard University Press, Cambridge, Mass., 1998) for other examples of the remarkable fruitfulness in science of aesthetic and purely mathematical analogies

[36] Weinberg says exactly this in *Dreams of a Final Theory*, 148-9, 165.

> We think this in part because our historical experience teaches us that as we look beneath the surface of things, we find more and more beauty. Plato and the neo-Platonists taught that the beauty we see in nature is a reflection of the beauty of the ultimate, the *nous* [Greek for the mind or understanding]. For us, too, the beauty of present theories is an anticipation, a premonition, of the beauty of the final theory. And, in any case, we would not accept any theory as final unless it were beautiful.[38]

In addition, the argument doesn't depend on supposing that we are infallible in our scientific judgments. All that is required is that we are (in terms of *objective* probability) just better than chance at picking out candidates for serious attention. Even a slightly-better-than-chance aptitude for scientific truth would require a supernatural explanation.

Plantinga's argument and mine complement one another. Plantinga argues that the materialist has no adequate explanation of how we are so constituted to learn truth, while I argue that the materialist has no adequate explanation of how the fundamental laws of nature are so constituted as to be learnable through experience.

Our arguments do not cast doubt on the actual reliability of scientists, even materialistic scientists, at making actual discoveries of the laws of nature. Nor are we claiming that the materialistic scientist must violate the canons of Bayesian rationality. The materialist has a perfect right to use subjective priors that are biased toward simplicity, and this bias may indeed make the materialist reliable in the pursuit of truth. The problem for the materialist concerns the question of whether he can reasonably claim to know that these discoveries are genuine, to be warranted in his conclusions. Lacking

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[37] Ibid., 155.

any explanation for his reliability, other than appeal to dumb luck, the materialist occupies a position that is untenable for the purposes of asserting claims to scientific knowledge.

Materialism, therefore, can draw no support whatsoever from modern science, since scientific realism entails that materialism is false, and, if scientific theories are treated as mere useful fictions, science would have no bearing on the truth or falsity of materialism at all. Materialists must find support for their position elsewhere.

By contrast, theists can point to the success of science as the confirmation of their metaphysical position, the verification of a daring prediction made by theists hundreds of years ago.

Conclusion

There is a price to be paid for scientific realism, for the conviction that our scientific theories provide models of the real world, models that we have some reason to believe may be approximately correct. This price is our admission that the physical realm does not exhaust reality, but that it is instead the artifact of a reasonable God who has fitted us to the task of investigating it.

It has been argued that theism must disrupt scientific inquiry by letting a "divine foot in the door," forcing us to take seriously the possibility of the undetectable interference of supernatural agents in all experimental setups. Such worries about a ubiquitous Cartesian deceiver, it is argued, can propel the theist into exactly the sort of epistemological meltdown that Plantinga claimed is the fate of the materialist.

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[38] Ibid., 165,

However, this worry is a mere bugbear. There is no reason for the theist to take seriously at all the possibility that God might be mischievously playing tricks on us in our laboratories or field studies. It is true, however, that a theist should take seriously the possibility of an exceptional miracle, an event inexplicable in terms of the finite powers and propensities we can study scientifically—not promiscuously, but only when there is good theological or philosophical reason to do so. However, opening the door to the miraculous is not the same as opening the door to rank irrationalism. It does not mean adopting an attitude of credulity to every wild and marvelous story—this was certainly not the case for the first modern scientists, who were theists. Given the rational order of the natural world, we have reason to expect that any miracles will also form a coherent and rational order. They won't be mere parlor tricks to dazzle and amuse; they would instead exhibit the same kind of economy, elegance, and rational meaning that we find elsewhere in creation. In his classic work, *Miracles*,[39] C. S. Lewis argued that the miracles of the New Testament are of exactly this character, but that is a matter for another essay.[40]

[39] *Miracles: A Preliminary Study* (New York, Macmillan, 1947).
[40] See Francis Beckwith's discussion of miracles in this volume.