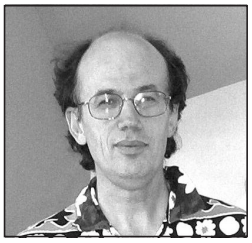
Foundations of the Dialogue between the Physical Sciences and Theology

Ross H. McKenzie



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A theoretical physicist gives an appreciative but critical review of recent work by Alister McGrath on the dialogue between science and theology. Some of the important areas of dialogue that have been identified include the explicability and rationality of the physical world, the "fine-tuning" of the universe, and the faith involved in going from "inference to the best explanation." Realist perspectives are important (and controversial) in both physical science and theology. An important idea, advanced by Torrance, is the parallel between the constraints imposed by physical reality and revelation, independent of the observer and "common sense." Some concerns are raised about McGrath's treatment of modern physics, the role of postmodernism, the evangelical perspective, and the fidelity to the agenda of Thomas Torrance. Finally, some words of exhortation are given to all writing on the relationship between science and theology.

I will give an extended review of a recent book by Alister E. McGrath entitled The Foundations of Dialogue in Science and Religion.

There is an increasing interest in the relationship between science and theology. Until a few decades ago they were popularly perceived as being "at war" and "contradictory." There are now popular books appearing with titles such as *The Mind of God*, *The God Particle*, and *The Physics of Immortality*. This has been partly fueled by the public success of Stephen Hawking's *A Brief History of Time*. Even atheistic scientists such as Richard Dawkins are writing books that use religious imagery and are full of discussion about God, creation, and design. In universities, the increasing interest is reflected in new undergraduate courses, new journals, new conferences, new research centers, new academic positions, and new scholarly books. This interest is partly being stimulated by the large amount of funds that the Templeton Foundation is injecting into such ventures. The purpose of this article is to give the perspective of an academic who does research in theoretical physics and who approaches theology from an evangelical perspective. To keep the discussion focused, I will give an extended review of a recent book by Alister E. McGrath entitled *The Foundations of Dialogue in Science and Religion*.[1] Most of the issues I raise are relevant to other work in the field.

McGrath has recently made four important contributions to the field: (1) a textbook for introductory courses on the subject,[2] (2) the book under review, (3) a biography of Thomas F. Torrance (one of the most influential writers in the field),[3] and (4) the first two volumes of a trilogy on the subject.[4] The first was used in a new course that I recently taught with five other lecturers at the Bible College of Queensland.[5] McGrath has backgrounds in both science and theology. He is best known as the prolific author of many books on theology (ranging from the popular to the academic; from history to biography to modern evangelicalism). He has an impressive ability to take large amounts of complex material and present an overview that is clear but not superficial or simplistic. He is currently a professor of historical theology at Oxford University and the principal of Wycliffe Hall. Yet, he also has a D.Phil. in molecular biophysics. Furthermore, his contribution to this subject is of particular

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interest because most writing on the subject at the academic level is not written from an evangelical perspective.

Although publishers and authors sometimes claim that their books are meant for almost everyone, I think this book is primarily meant for academics working in theology and the philosophy of science. However, in the interest of promoting real dialogue, I hope that having the response of an active theoretical physicist will be useful.[6] I think the book is a worthwhile and commendable contribution which is significantly better than much writing on the subject. At the end of the book McGrath states: "It might be helpful to think of this volume as an attempt to justify a sustained intellectual engagement between two highly important aspects of human life and thought." I think he has achieved this goal admirably.

Personally, I found the book immensely stimulating, particularly because it motivated me to start reading Torrance, Barth, and Calvin. This has influenced the way I approach my research and teach religious education at the local primary school. Specifically, the areas for dialogue that McGrath has identified are significant and appropriate. Yet, I wish to raise some concerns about the treatment of theoretical physics, the role of postmodernism, and the evangelical perspective and to question whether the book really does advance the agenda of Thomas Torrance, as claimed. I hope the reader will see how these concerns turn out to be interrelated. Before raising them, I will briefly summarize the contents of the book that are relevant to them, taking note of some of the many positive contributions. In striving to be constructive, I will conclude with some suggestions as to the way forward in this complex field.

Overview

McGrath gives three considerations that shape the book: (1) the rise of postmodernism; (2) the growing dissatisfaction with foundationalism in philosophy; and (3) the perpetuation of outdated stereotypes such as the "conflict" model. McGrath suggests that the book develops the agenda set out by Thomas Torrance in *Theological Science* (1969), who emphasized similarities between science and theology at the level of method: the ways in which reality is apprehended, investigated, and represented.

Chapter 2, The Quest for Order, considers the significance of the fact that science finds that the physical world is explicable. Observed regularities can be codified in physical laws that can be described mathematically. This is an amazing thing! However, today it often is taken for granted, and its significance is not contemplated. Exceptions are the popular books written from a secular perspective by the physicists Paul Davies and Heinz Pagels. The universe could have been chaotic and/or incomprehensible to humans. However, when viewed from the perspective of the doctrine of creation, the order, regularity, and explicability of the world is not surprising.

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Chapter 3, The Investigation of the World, starts with the view that theology and science are fundamentally divergent in the way they acquire information about the world. Theology does it through revelation; science does it through experimentation. Yet McGrath points out that this is an oversimplification because even if an experiment is inconsistent with a theory, sometimes scientists will keep believing the theory. (A famous example is that from 1920 to 1960, scientists continued to accept Einstein's general theory of relativity despite the fact that the predicted gravitational red shift of light was not observed.) Furthermore, the simplistic model of science solely being a process of designing experiments to test hypotheses is historically wrong. Many significant discoveries were accidents! The relationship between experimentation (experience) and theory is not straightforward:

> The doctrine traditionally, yet misleadingly, known as the "Duhem-Quine thesis" asserts that, if incompatible data and theory are seen to be in conflict, one cannot draw the conclusion that any particular theoretical statement is responsible for this tension, and must therefore be rejected (p. 89).

McGrath is careful to point out that this idea has been inappropriately used by David Bloor and Harry Collins who study the "sociology of scientific knowledge" to justify relativism in science. Nevertheless, McGrath suggests that this principle is of fundamental importance to both science and theology. He suggests that experience often has relatively little impact on our world views.

Objections to natural theology (trying to obtain information about God directly from his creation, rather than from revelation) are considered from theological, philosophical, and historical perspectives. John Calvin's view was that a general knowledge of God can be obtained from the creation by anyone, not just Christians. However, this knowledge is marred by sin, and a knowledge of God the

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Redeemer can only be obtained through Christ. Differences over natural theology led to a famous debate between Emil Brunner and Karl Barth. Barth had a very negative view of natural theology, claiming that it suggested that God needed the help of humans to make himself known through revelation. McGrath suggests this debate was influenced by the historical context: it occurred the year that the Nazi party (which emphasized order in creation) seized power in Germany. Torrance was sympathetic to Barth's view but considered that it was focused on a natural theology which was detached from systematic theology based on revelation. Part of Torrance's argument is based on an analogy that just as Einstein brought non-Euclidean geometry into physics, natural theology needs to be brought into the realm of systematic theology.

A fertile area for the dialogue is the anthropic principle, which was considered by the astronomers Carr and Rees in a paper in *Nature* in 1979. They argued that the values of the fundamental physical constants (such as the charge and mass of an electron) are "fine-tuned" so that life can exist. If these constants had values that were slightly different by a few percent, the evolution of the universe would not have produced things such as stable stars, lots of carbon, stable atoms and molecules, and heavy elements that are essential for life. Atheistic scientists argue that this is not evidence for the existence of a Designer because if it were not true, we would not be here to observe it. McGrath clearly presents the objections of William Lane Craig and Richard Swinburne to this argument. Briefly, suppose that you survive facing a firing squad of one hundred expert marksmen. Is your reaction, (1) you are not surprised that you do not observe that you are dead, or (2) you are surprised that you do observe that you are alive?

McGrath then reviews Harman's work on "inference to the best explanation." This is the process of "accepting a hypothesis on the grounds that it provides a better explanation of the evidence than is provided by an alternative hypothesis." He concludes with pointing out the similarity among three imaginary people. The first person was someone who was committed to Einstein's general theory of relativity in the period 1920–1960, despite the fact that the predicted gravitational red shift of light had not been observed. The second is a person today who holds to Darwinian ideas about the origin of species, despite the fact that speciation has never been observed in the laboratory. The third is a Christian who holds onto her faith, despite the fact that she is puzzled by the existence of pain and suffering in the world. McGrath points out the common feature that all "hold on to" their view, "believing that its explanatory ability and coherence are sufficient to justify it, and that the difficulty will one day be resolved."

Chapter 4, The Reality of the World, identifies similarities in debates about realism in the theological and philosophy of science communities. The fact that some scientific theories are remarkably successful at explaining the results of past experiments and predicting the results of new ones suggest that they are describing an underlying reality. Furthermore, much of the modern technology (computers, drugs, radio, airplanes, …) that we regularly use is based on these theories. Some scientists hold to the view that there is a direct correspondence between the concepts in a theory and the reality to which they relate. Philosophers describe this position as "naive realism." Most scientists, however, would hold to a position of "critical realism": the theoretical concepts that scientists consider in their minds are some approximation (which is continually being improved) to the underlying reality. In contrast, postmodernists reject realism suggesting that these theoretical concepts are really a reflection of the "interpretative community" that produces them. Advocates of the "strong program" of the sociology of knowledge claim that "scientific truth" is purely a social construct. Advocates of philosophically similar positions can be found among those writing about theology. For example, McGrath considers a well-known advocate of such views, Don Cupitt, who asserts:

> We constructed all the world-views, we made all the theories … They depend on us, not we on them … the more realistic your God, the more punitive your morality (p. 152).

McGrath's response is:

> It might be argued that it is repressive and uncreative to suggest that the Compton wavelength of an electron is 2.424309×10^{-12} meters, or that DNA

> possesses the structure of a double helix. Each of these could be argued to be intransigent, representing the interests of the western male scientific establishment, and failing to respect creativity. The intense difficulty with such objections is that experimental research, often linked with theoretical considerations, shows that this is the way they are—and further asserts that these conclusions are independent of the gender, social status, religion, and sexual orientation of the observer (p. 158).

In contrast to Cupitt, Torrance advocates critical realism in theology (p. 158). It is constrained by who God is and his revelation in Christ and in the Scriptures.

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Chapter 5, The Representation of the World, points out that given the complexity of many concepts in both science and theology, humans must inevitably build models or analogies that allow them to visualize these concepts. This is particularly true if one wants to communicate these concepts to a wider audience that is not used to thinking in highly abstract terms. McGrath considers some of the problems associated with using analogies in science. The use of analogies in theology is explored briefly using the example of Christ's death, being a "ransom." The perspective of Ian Barbour on the similarities and differences between the use of models in science and religion is reviewed. McGrath points out that Barbour overlooks an important difference: whereas formulation and validation of models occurs in science, there is no direct parallel to this in classical Christian thought, such as advocated by Torrance (as in the quotation above). The basic concepts are given in God's revelation. This is in contrast to some liberal theology which develops new models of concepts such as God, sin, and redemption. A detailed discussion is then given of how the idea of "complementarity," advocated by the famous theoretical physicist Niels Bohr, may be relevant to theology. Previously, Torrance as well as Loder and Neidhardt have emphasized the philosophical similarity in the way that Barth approached theology and Bohr approached the description of quantum phenomena. Importantly, both advocated that the phenomena they were trying to understand (God's self-revelation and quantum physics, respectively) must be interpreted on its own terms. Specifically, Bohr tried to come up with a model based on classical thinking that could explain "wave-particle duality": in some experiments, electrons act like particles; whereas in a different class of experiments, electrons act like waves. McGrath discusses how one can draw an analogy to the problem in theology of Jesus having both divine and human character simultaneously.

Some concerns

The Treatment of Modern Physics

I feel it is worthwhile to point out how some theoretical physicists might respond with skepticism to McGrath's discussions of two specific aspects of modern physics, supersymmetry and complementarity. His treatment is not a good example of how to relate science and theology. First, some of the science he is discussing is far from being well established. Second, the connection to theology is forced and debatable. Nevertheless, along the way, some important issues are raised.

Supersymmetry

Chapter 2 contains a section (pp. 69–73) which discusses the fact that symmetry plays a major role in quantum theory. This might be of some theological interest because Aquinas argued that observed symmetries reflect the perfection of God. McGrath suggests that this interest has been offered a "new lease of life" because of the recent current interest in supersymmetry in theoretical physics. All known elementary particles are either fermions or bosons. Fermions have the property that any quantum state can be occupied by at most one particle. In contrast, any number of bosons can occupy a single quantum state. Examples of fermions are electrons, protons, and neutrons. Examples of bosons include photons (light particles and mesons). Supersymmetry theories propose that to each class of elementary particle which is a boson (fermion) there is a corresponding partner which is a fermion (boson). For example, as well as photons there should be "photinos" which are fermions. Later in the book, in the context of the use of analogies in theology, McGrath states:

> It is important to pause here, and note the importance of the way in which the growth of "supersymmetry" theories have posited a fundamental relationship between various aspects of modern physics. The doctrine of creation, puts such relationships on a secure intellectual footing, suggesting that a correlation exists within the created order prior to its being discerned through human investigation (p. 181).[7]

I have several concerns about this discussion of supersymmetry and this last point, in particular. My concerns are given in order of increasing importance.

1. It is not clear to me that this discussion will be understandable to most readers of the book. (The same can be

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said of the present article!) Terminology such as fermions and bosons are not defined.

2. It should have been pointed out that there is currently no experimental evidence for the validity of supersymmetry[8] or superstring theory. In his most recent book, Stephen Hawking states:

> There is no more experimental evidence for some of the theories described in this book than there is for astrology, but we believe them because they are consistent with theories that have survived testing.[9]

Furthermore, it is not at all clear that superstring theories will ever be tested experimentally because they would require particle accelerators bigger than the size of the earth. Hence, we may never know whether superstring theories really describe the created order rather than being just beautiful mathematical constructions. It should be stressed that this is quite different from the situation with general relativity between 1920 and 1960, mentioned earlier. Although the predicted gravitational red shift had not been observed several other predictions had been successfully tested.

3. If supersymmetry really is an underlying symmetry of the physical laws of nature, the universe itself would still have only exhibited perfect supersymmetry (equal numbers of photons and photinos) during some incredibly short time, like the first 10^{-41} seconds, after the beginning of the universe. However, in the world in which we now live the supersymmetry is "broken," i.e., that is far from perfect. There are an "astronomical" number of photons in the universe but so far we have not found a single photino. Will not such imperfection present problems to Aquinas' argument?

4. A statement by a theologian that theories based on symmetry are on a "sound intellectual footing" because of the doctrine of creation can be easily misinterpreted as an endorsement of a specific scientific theory and is problematic. Was that not the source of Galileo's problems?

Let me illustrate the problems with a concrete example from my own field of research. Currently, one of the greatest challenges in theoretical physics is understanding high temperature superconductors. These materials were discovered in 1986 by Bednorz and Muller, who were awarded the Nobel Prize in physics in 1987. (In contrast, some scientists have had to wait as long as thirty years after their initial discovery before they were awarded their prize.)

Over the past fifteen years, thousands of theoretical papers have been written on the subject focusing on two questions: (1) Why can superconductivity occur at such a high temperature? and (2) Why are the properties of the metallic phase so fundamentally different from elemental metals such as lead and copper? Yet despite all of this work by numerous distinguished theorists, including Nobel laureates Phil Anderson, Bob Laughlin, T. D. Lee, and Bob Schrieffer, we do not have clear answers to these questions. It is sometimes stated: "The only consensus is that there is no consensus." Yet in 1997, Shou Cheng Zhang, from Stanford University, published a paper in *Science* proposing that the electronic properties of high temperature superconductors could be understood in terms of an underlying symmetry associated with a set of transformations known as the symmetry group SO(5).[10] McGrath's statements could easily be misinterpreted as an endorsement of this theory over competing theories that are not based on symmetry. Though the SO(5) theory did initially create some interest, partly because of its aesthetic appeal, most theorists now consider that, in the real materials, this symmetry is so approximate that it is not a particularly useful concept.

Maybe the point worth making is just that the major role played in theoretical physics by symmetry is a concrete reflection of underlying order and explicability. A concrete example of this concerns the elementary particles known as quarks and the symmetry group SU(3). In the 1960s, a plethora of new particles were discovered and classifying them was like zoology. However, Gell Mann showed that many of them were related and developed a nice classification scheme in terms of SU(3).

In summary, trying to lend theological support to superstring theory or supersymmetry is contentious because these theories lack any empirical evidence. Furthermore, it is debatable whether theologians should ever lend support to any specific scientific theory.

Complementarity

The last chapter contains an extensive discussion of the concept of "complementarity,"[11] which was introduced by the theoretical physicist Niels Bohr to try to explain some of the puzzling features of quantum theory that emerged in the 1920s and 1930s. Some experiments involving electrons are most easily understood if we think of the electron as a particle. Other experiments are naturally interpreted if the electron is viewed as a wave. Complementarity refers to this ambiguity or "wave-particle duality." This idea was subsequently applied to a wide range of subjects including politics, economics, and religion. As discussed below, it also is used widely today by postmodern and New Age writers. A few points need to be made from the perspective of the theoretical physicist:

1. All physicists seem to agree that quantum theory predicts the outcome of specific experiments. Furthermore, many of its predictions have been tested to incredibly high precision, sometimes to within a factor of one part in a million. Nevertheless, physicists strongly disagree about the *interpretation* and *meaning* of the theory.[12] Besides the Copenhagen school (associated with Bohr), there are the Bohmian, many worlds, consistent histories, "no interpretation," and decoherence interpretations.[13] Complementarity is *not* a key component of quantum physics. Beller points out that several influential textbooks on quantum mechanics do not even mention complementarity.[14]

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2. Physicists are finally acknowledging that much of Bohr's writing was obscure rather than profound.[15] It was inappropriate of him and his contemporaries, such as Born and Pauli, to try and apply complementarity to a wide range of subjects such as politics and religion. Furthermore, an unfortunate consequence of their lack of intellectual discipline has been that it has helped inspire postmodern writing which misappropriates scientific concepts into the humanities, as discussed in the next section.

3. It is not necessary to invoke Bohr or complementarity to make two worthwhile points that McGrath[16] is concerned with:

a. The physical world must be interpreted on its own terms. It does not matter if the physical world presents us with concepts which we do not like because they are counterintuitive or go against our philosophical world view or favorite scientific theory. That is the way the world is and scientists are sometimes forced to revise their perspectives accordingly. There is a clear parallel to the approach of Barth and Torrance to theology:

> Christian theology arises out of the actual knowledge of God given in and with concrete happenings in space and time. It is knowledge of the God who actively meets us and gives Himself to be known in Jesus Christ—in Israel, in history, on earth. It is essentially positive knowledge, with articulated content, mediated in concrete experience. It is concerned with fact, the fact of God's self revelation; it is concerned with God Himself who just because He really is God always comes first. We do not therefore begin with ourselves or our questions, nor indeed can we choose where to begin; we can only begin with the facts prescribed for us by the actuality of the subject positively known.[17]

b. Even the best scientific theories sometimes present puzzles, paradoxes, and counterintuitive concepts which even the greatest scientific minds find hard to accept and cannot resolve to the satisfaction of most of their colleagues. Nevertheless, they "accept" those theories as the "best explanation" and continue to use them in their everyday scientific life. There is a clear parallel to theology. Despite the coherence of the biblical world view it does present issues such as suffering, free will versus predestination, and the human and divine natures coexisting in the person of Christ. Such issues challenge our preconceptions and our classical forms of reasoning.

In summary, complementarity is an ill-defined philosophical concept which has a long history of being abused. Since it is so contentious, I am skeptical that applying it in theology will be fruitful.

The Role of Postmodernism

I do not think that McGrath's treatment of postmodernism accurately reflects just how skeptical most scientists are about postmodernism. McGrath says one of the reasons for the book is the "inexorable rise of postmodernism." This is important for two reasons:

> Many discussions of the relationship between science and religion remain firmly grounded in a set of presuppositions which can only be described as "modern" …
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> The "postmodern" discussion to date of the methods and epistemic achievements of the natural sciences (especially the physical sciences) has seemed to some

I am concerned that McGrath has overlooked a whole body of literature associated with the problem that the ["postmodern" discussion to date of the methods and epistemic achievements of the natural sciences … has seemed to some to be somewhat hasty and superficial in its analysis]. This weakens some of his arguments and will cause others to be received with skepticism in the scientific community.

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I agree strongly with both these points. Furthermore, at various points, McGrath is critical of postmodern views. However, I am concerned that McGrath has overlooked a whole body of literature associated with the second reason above.[18] This weakens some of his arguments and will cause others to be received with skepticism in the scientific community.

Currently in universities, particularly in the USA, a major conflict sometimes known as "the Science wars" is occurring between natural scientists and postmodernists (mostly in departments of literature and "science studies" and "cultural studies"). This conflict was arguably started by the book, *Higher Superstition: The Academic Left and Its Quarrels with Science* written by Paul Gross (a professor of life sciences at the University of Virginia) and Norman Levitt (a professor of mathematics at Rutgers University).[19] It was a rather vicious attack on postmodern writing about science.[20] In 1996, the "editorial collective" of the postmodern journal *Social Text* produced a special issue dedicated to the "Science Wars." Unwittingly, they included in the issue an article, "Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity" written by Alan Sokal, a professor of physics at New York University.[21] Once the article was published, Sokal revealed that it was a hoax:

> For some years I've been troubled by an apparent decline in the standards of intellectual rigor in certain precincts of the American academic humanities. But I'm a mere physicist: if I find myself unable to make head or tail of jouissance and differance, perhaps that just reflects my own inadequacy.
>
> So, to test the prevailing intellectual standards, I decided to try a modest (though admittedly uncontrolled) experiment: Would a leading North American journal of cultural studies—whose editorial collective includes such luminaries as Fredric Jameson and Andrew Ross—publish an article liberally salted with nonsense if (a) it sounded good and (b) it flattered the editors' ideological preconceptions?
>
> The answer, unfortunately, is yes …[22]

The ensuing controversy was so big that it even was covered on the front page of the *New York Times.* It has stimulated numerous articles, both scholarly and at the popular level, and several books.[23] In particular, Sokal and Jean Bricmont, a professor of theoretical physics in Belgium, wrote a book in French which was a detailed critique of the writing of French philosophers about science.[24]

There has been some debate in the physics community as to what the hoax actually proved.[25] I do not claim to endorse Sokal's act. However, I think there are some important lessons here, especially for those who are interested in the dialogue between science and theology. Let me suggest that from the controversy we can draw the following modest conclusions:

- There are serious communication problems between scholars in the humanities and scientists.
- Many scientists are very skeptical about postmodernism, particularly its support for relativism and antirealism. They are skeptical because science and technology work so well.
- Many scientists consider that some postmodernists are misusing science to make their points. Particularly, concepts from quantum theory, relativity, and chaos theory are taken out of context and used to justify indeterminism and relativism.
- Some of the problems actually began with great theoretical physicists such as Bohr, Born, and Pauli, who wrote large amounts of obscure material containing highly speculative suggestions about the relevance of quantum theory, and especially complementarity to philosophy, politics, and religion.[26] Bohm and Prigogine have continued in a similar vein.

So, why are scientists "realists" who believe in "truth"? One reason is that due to advances in technology over the past few decades it has been possible to make experimental tests with incredibly high precision of the predictions of fundamental theories such as quantum mechanics, special relativity, general relativity, and quantum electrodynamics (QED). For example, QED predicts a value of the magnetic moment anomaly of electrons that agrees with experiment to within a few parts per billion.[27] When Schwinger, Tomonaga, and Feynman devel-

oped the theory of QED, they did not anticipate that it would be tested to such precision. In a similar vein, as emphasized by Weinberg[28] other theories have led to predictions that were not at all anticipated when the theories were originally developed. One hundred years ago, Planck introduced the concept of the quantum in order to explain the spectrum of black body radiation. He did not anticipate that this result would describe the spectrum of the cosmic microwave background, which is the remnant of the big bang, to an accuracy of better than 0.1%. When Einstein wrote down his field equations for gravity (general relativity), he did not realize that they would lead to the prediction of gravitational radiation which was subsequently observed (albeit indirectly) in binary pulsar systems to an accuracy of 0.4%.[29]

McGrath rightly points out that Einstein used his equations for general relativity to predict the gravitational red shift of light, yet experiments in the period 1920–1960 failed to observe the predicted effect. Some sociologists of science have made much of the fact that physicists still accepted the theory, in spite of the fact that it had been "falsified." This may be a just criticism but these sociologists use this problem to suggest that science is irrational and unreliable, neglecting to mention that the predicted effect has now been observed with a precision of seventy parts per million.[30]

Given such spectacular agreement between theory and experiment it is very hard for me to believe that these theories are just a social construct or that the equations developed in the minds of people like Einstein and Feynman do not in some sense represent an underlying reality that is independent of the mind and independent of the social context in which the theory was constructed.

It is rather disappointing that McGrath cites Pickering as having "demonstrated the perhaps unacknowledged significance of communal norms, traditions and approaches in the scientific undertaking" (p. 161). Citing Pickering is provocative to physicists familiar with his work. Although acknowledging the value of some of his contributions, physicists Kurt Gottfried and Ken Wilson have strongly criticized Pickering's work.[31] Their *Nature* article focuses on his unjustified and misleading conclusions that the standard model of elementary particles is just a social construct.

In summary, McGrath's book could have been strengthened by giving the views of scientists on postmodernism. Furthermore, given all of the above problems concerning the relationship of postmodernism to science, I fear McGrath's treatment of complementarity and suggestions that chaos theory "is pregnant with theological significance" (p. 59) will be greeted with skepticism by theoretical physicists because there are some similarities to postmodern writing.[32]

The Evangelical Perspective

McGrath is the author of several books on evangelicalism[33] and is the principal of Wycliffe Hall which has the stated aims of being " biblical, evangelical, Anglican, missionary, and contemporary." Hence, his views on how evangelicals have approached and should approach the dialogue are of particular interest. This appears to be only treated explicitly in the sections "Science as the Enemy of Religion" (pp. 26–27), and "Evangelicalism and the Natural Sciences" (pp. 129–31). In the first section, fundamentalism is defined as originally a cultural movement rather than a theological position. The Scopes trial and the associated fallout are briefly reviewed. The first section concludes with:

> The current attempt within conservative Protestantism to make sense of the biblical creation accounts in the light of evolutionary theories continues (Pinnock 1989; Santmire 1991), despite the polarizion [sic] of the debate through the deployment of "warfare" imagery.

The second section concludes with:

> The views of Packer and Warfield [who did not hold young earth and anti-evolution views] have not met with universal assent. "Creationists" such as Henry Morris have somewhat hastily dismissed the approach adopted by Warfield as a clear case of "pervasive theological apostasy" (Morris 1984, 39).

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I fully endorse the above statements but think that a much stronger case could have been made by including a more sustained interaction with the extensive evangelical literature that already exists on this subject. It is also important to make a distinction between microevolution, macroevolution, and Darwinism (a philosophy or world view). I do not think Clark Pinnock should be viewed as representative of conservative Protestant thought.[34] The past fifty years has seen a wide range of scholarly evangelical writing on science and theology by people such as Bernard Ramm,[35] Richard Bube,[36] Del Ratsch,[37] Malcolm Jeeves,[38] Walter Thorson,[39] Donald MacKay,[40] Howard Van Till,[41] William Dembski,[42] Edward Larson,[43] Phillip Johnson,[44] and Kirsten Birkett.[45] It would be unreasonable

McGrath suggests that the book develops the agenda set out by Thomas Torrance in his book, Theological Science. *However, I think the book differs from Torrance's agenda in two significant respects … the use of the term "religion" rather than "theology" … [and] it interacts little with the text of the Bible.*

to expect McGrath to interact with all this literature and I would not necessarily expect him to agree with any of it. (I do not agree with some of it). However, I find it disappointing and strange that none of this work (which is not just concerned with evolution) is even mentioned.

I am concerned that this lack of attention to evangelical views reflects a lost opportunity to undermine two of the "myths" in this field. The first "myth" is that if one takes the results of science seriously, the only intellectually respectable solution is to embrace liberal theology, and even worse process theology. The second "myth" is the one that McGrath is more concerned about: if you accept the authority of the Bible, you must reject significant portions of biology, geology, and astronomy. The evangelical authors cited above and the members of organizations such as Christians in Science in the UK and the American Scientific Affiliation stand in stark contrast to these views.

Fidelity to Torrance's Agenda

McGrath suggests that the book develops the agenda set out by Thomas Torrance in his book, *Theological Science.* However, I think the book differs from Torrance's agenda in two significant respects. The first concerns the use of the term "religion" rather than "theology" in the title and in much of the text. In his textbook, *Science and Religion: An Introduction*, McGrath states:

> Torrance draws a careful and critical distinction between "religion" and "theology." The distinction is important, as many discussions of the interaction of religious and scientific ways of thinking often treat the issues of "science and religion" and "science and theology" as synonymous—different ways of speaking about the same thing. Drawing partly on a Barthian perspective, Torrance insists that this is unacceptable. "Religion" is to be understood as concerning human consciousness and behavior. Religion is essentially a human creation. Theology, on the other hand, has to do with our knowledge of God.

Given the above, it is surprising that McGrath would use the term "religion." Besides this issue of consistency, McGrath's use of "religion" can lead to misinterpretation of what he is saying. For example, Chapter 3 begins with:

> In the previous chapter, we noted a high degree of convergence between the natural sciences and religion in relation to the critically important area of the ordering of the world, and its amenability to investigation and explanation.

This sentence makes sense if "religion" is replaced with "Christian theology." However, it is highly contentious if "religion" is replaced with "Hinduism" or "Buddhism." One of the reasons that many scientists so strongly object to the concept of a dialogue between science and religion is that they equate "religion" with superstition, magic, and mysticism, which reject the rationality and empiricism of science.

The second manner in which the book does not seem to advance Torrance's agenda is actually my biggest concern of all: it interacts little with the text of the Bible. Torrance has stated:

> A realist evangelical theology will go far toward healing the artificial gap that has opened up in modern times between kerygma and dogma, exegesis and dogmatics, and thereby toward restoring to Christian theology rigorous fidelity towards its proper subject matter, the self-communication and self-revelation of God in Jesus Christ his incarnate Word.[46]

Theological science is based on the data we have: the Bible. Furthermore, good theological science will take all of that data into account. I will use three examples to illustrate how McGrath has not done this.

First, Chapter 2 discusses in detail the doctrine of creation without interacting with the text of Genesis, nor how that might relate to New Testament passages such as John 1:1–18 or Col. 1:15–22. I can find no mention of the Fall nor how creation is now "frustrated" and awaiting redemption (Rom. 8:18–23).

Second, natural theology is discussed from a theological, philosophical, and historical perspective (pp. 98–118). I would have liked to see what the implications are of passages such as Gen. 11:19, Psalm 19, Acts 17:16–31,

Rom. 1:16–23, and 1 Cor. 1:18–31. Maybe such passages were some of the reason Barth was so opposed to natural theology; it was not just the rise of Nazism. In discussing Calvin's views on the subject, it would have been helpful to point out how Calvin used passages of the Bible, such as these, to develop his views.[47]

Third, as an example of the use of analogies in theology, McGrath discusses how the word "ransom" was used to illustrate the meaning of Jesus' death, as in Mark 10:45. The views of the early patristic writers on the "ransom" are then discussed (p. 182). This is interesting but I would have thought it best to first discuss how the concept of the ransom from the perspective of the Old Testament.[48] Barth provides a beautiful example of this in his exegesis of the "atonement" in Rom. 3:25.[49] Scripture itself provides the ultimate example of the use of analogies. Furthermore, the analogies of Scripture seem to be designed to be accessible and illuminating to all people, and also reflect the idea of God's accommodation to our limited minds. This is in stark contrast to some of the rather obscure analogies proposed in science and theology articles—a Ph.D. is a prerequisite to understanding them.

McGrath's treatment is in contrast to that of Calvin's discussion of natural theology.[50] Kirsten Birkett has given a nice treatment of how biblical theology can aid an understanding of the relationship between science and Christianity.[51] She explicitly looks at not just Genesis but also passages from Exodus, Job, Ecclesiastes, Proverbs, Matthew, Romans and Colossians. These say much about not just the order in the world but also the frustrated creation, the limitations of wisdom (and hence the limits of science), and Jesus as Wisdom Incarnate.

In concluding, I note that the same criticisms cannot be made of McGrath's latest book, the first volume of *A Scientific Theology*,[52] which is dedicated to Torrance. It contains a devastating critique of trying to relate science to the ill-defined concept of religion (pp. 50–60) and it does discuss natural theology from a biblical perspective (pp. 257–64).

The Way Forward

In a desire to be constructive, I conclude with five exhortations to all those interested in the dialogue between science and theology.

1. Assemble a multidisciplinary research team

While acknowledging the value of McGrath's contribution, I think some of the shortcomings of the book reflect that he has taken on an impossible task for any one individual. The subject is truly interdisciplinary, covering not just theology and several disciplines of science (mostly physics and biology), but also philosophy and history. The literature is vast and difficult to keep up to date with. Furthermore, I hope the above discussion of theoretical physics shows there are subtle issues involved, some of which will only be apparent to people actively doing research in the relevant disciplines. The humanities has a fine tradition of books written by single authors. Although, I think this is quite suitable for writing a biography of Plato, a commentary on Romans, or a survey of the novels of Jane Austen, I do not think it is the appropriate model for doing research in this field. The model of single authorship has now been essentially abandoned in science; people make up for their own lack of expertise by collaborating with others. Even Einstein had to get help from Grossmann with the mathematics of Riemannian geometry. When the biologist James Watson wanted to understand the molecular basis of genetics, he collaborated with a physicist, Crick. Furthermore, crucial to their discovery of the structure of DNA were the interactions that Watson had with chemists and X-ray crystallographers. Some of the most exciting scientific research today is being done in fields such as bioinformatics, materials science, nanotechnology, and quantum computing. It is almost all being done by teams of people comprising individuals from different disciplines.[53] In my own research in theoretical physics, I have found collaboration with experimental physicists, chemists, and mathematicians to be extremely fruitful, once the communication barriers are surmounted.

While acknowledging the value of McGrath's contribution, I think some of the shortcomings of the book reflect that he has taken on an impossible task for any one individual.

Working with a multidisciplinary team will make it much harder to drift from the real data (in this case, the Bible and well-established science) into unsubstantiated speculation. It also will make the research more likely to be accessible to a broader audience and to have a real impact. Michael Fisher was a professor of physics, chemistry, and mathematics at Cornell University. Apparently, he often said: "The problem with a lot of interdiscliplinary research is that it lacks a lot of discipline." Unfortunately, just as such a criticism can be made of the field of "science studies," which was the subject of Sokal's hoax, it also applies to much writing about science and theology.[54]

2. Engage the biblical text

For those such as evangelicals who might support Torrance's agenda, the Bible represents the real data that must be understood. I believe that any discussion

In a desire to be constructive, I conclude with five exhortations to all those interested in the dialogue between science and theology. 1. Assemble a multi-disciplinary research team; 2. Engage the biblical text; 3. Be more critical of what you read and what you write; 4. Write clearly; and 5. Acknowledge the limits and potential dangers of the dialogue.

of natural theology must first wrestle with Rom. 1:17–21:

> For in the gospel a righteousness from God is revealed, a righteousness that is by faith from first to last, just as it is written: "The righteous will live by faith." The wrath of God is being revealed from heaven against all the godlessness and wickedness of men who suppress the truth by their wickedness, since what may be known about God is plain to them, because God has made it plain to them. For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse. For although they knew God, they neither glorified him as God nor gave thanks to him but their thinking became futile and their foolish hearts were darkened.

This passage suggests to me that something can be learned about God from creation. Yet, it is something that will be evident to all and so cannot be based on modern science which is only accessible to an elite. However, that knowledge will be corrupted by sin and so may only be accessible to those who already know God through revelation and redemption. After all, this passage is arguably the starting point for the Barthian revolution[55] (and the Reformation!). To his credit, in his new book McGrath does discuss verse 18 and Barth's views (and their biblical basis) in more detail.[56]

As always, it should be stressed that it is particularly important to not just consider isolated verses or passages but to consider the major plot lines of the whole Bible.

3. Be more critical of what you read and what you write

Surely this is a lesson from the Sokal hoax. This does not apply just to postmodernism. Writers in the science/theology field also need to be more critical of the evidence for scientific theories, the scientific credentials of those writing on science and theology, and the use of scientific analogies in theology. Richard Feynman was one of the greatest theoretical physicists of the twentieth century. His advice to beginning scientists was basically: "The first principle is that you must not fool yourself, and you are the easiest person to fool."

4. Write clearly

Critiques of the rise of postmodernism (and of Niels Bohr) point out that it seems that sometimes people mistake obscurity for profundity.[57] This does not just happen in philosophy but also in theoretical physics. Sometimes, ideas that at best are trivial or simple (and at worst are wrong) are hidden behind a complicated mathematical formalism that presents a barrier to understanding. I worry that this is also happening in science and theology. Consider, for example, the following sentences:

> Crystalline formations embody a polycentric form of order which does not yield to physico-chemical analysis or logical construction. While we cannot get very far in explaining this kind of order through analytical methods, we are able to create certain conditions within which crystalline formations spontaneously become disposed into a distinctive order. In this event, useful recourse is made to group theory in developing appropriate modes of apprehension in the light of intuitively apprehended clues which press themselves upon us as we work with crystals …

Some readers may assume that they do not understand these sentences because they know little about crystal structures and group theory. However, I teach undergraduates about crystal structures and do research in theoretical solid state physics. Yet, I have no idea what the author is really trying to say. I would like to tell you that the author is Derrida, Lacan, Foucault, or at worst Bohr. However, I regret to acknowledge that the author is someone that both McGrath and I consider to be one of the best writers on science and theology: Torrance.[58]

5. Acknowledge the limits and potential dangers of the dialogue

Although, I have sometimes been skeptical about the value of a dialogue between the physical sciences and theology, McGrath, more than any other individual, has convinced me that the dialogue is worth pursuing. Yet I think there are potential dangers and pitfalls for theology. This is because at the heart of theology is the Cross. I fear that

too much focus on the dialogue and insights on theological method may not enlighten our theology but distract from, dilute, or obscure the content. For example, there are dangers of a subtle shift of focus from redemption to creation, and from revelation to natural theology. Consequently, it is appropriate to give the last word to Karl Barth:

> Everything shines in the light of His death, and is illuminated by it. No single passage of the Synoptic Gospels is intelligible apart from the death. The kingdom of God has its beginning on the other side of the Cross, beyond all that is called "religion" and "life," beyond conservatism and radicalism, physics and metaphysics …
>
> Christ died for us. For us—that is, in so far as by His death we recognize the law of our own dying; in so far as in His death the invisible God becomes for us visible; in so far as in His death is the place where atonement with God takes place (iii. 25, v. 9), and where we who have rejected our Creator, return to His love; and in so far as in His death the paradox of the righteousness and the identity of His holy wrath and His forgiving mercy becomes for us—the Truth."[59] ◈

Acknowledgments

This work was indirectly supported by the Templeton Foundation through their course award program. I thank K. Birkett, P. Bolt, R. C. Doyle, J. Ferreira, A. E. McGrath, B. MacPherson, and M. D. Thompson for their helpful comments.

Notes

[1]Alister E. McGrath, *The Foundations of Dialogue in Science and Religion* (Oxford: Blackwell, 1998).

[2]____, *Science and Religion: An Introduction* (Oxford: Blackwell, 1998).

[3]____, *Thomas F. Torrance: An Intellectual Biography* (Edinburgh: T & T Clark, 1999).

[4]____, *A Scientific Theology*, Volume 1: Nature (Grand Rapids, MI: W. B. Eerdmanns, 2001); and ____, *A Scientific Theology*, Volume 2: Reality (Grand Rapids, MI: W. B. Eerdmanns, 2002).

[5]The course "The Dialogue between Science and Theology: The Search for Meaning" was accredited by the Australian College of Theology. Other lecturers were Dr. Johan Ferreira (Bible scholar), Rev. Dr. Peter Close (pastor with a Ph.D. in microbiology), Dr. Peter Fung (obstetrician), Dr. Peter Ralphs (theologian), and Dr. Richard Brown (environmental engineer). The course received an award from the Templeton foundation.

[6]www.physics.uq.edu.au/people/mckenzie/

[7]The identical sentences also appear on p.151 of Alister E. McGrath, *The Foundations of Dialogue in Science and Religion*.

[8]For the latest experiment which fails to find evidence of supersymmetry see, Affolder, et al., "Search for Gluinos and Scalar Quarks in p–*p* Collisions at $\sqrt{s}$ = 1.8 TeV Using the Missing Energy plus Multijets Signature," *Physical Review Letters* 28 (2002): 041801. For a less technical description see, www.aip.org/enews/physnews/2002/split/574-1.html

[9]S. W. Hawking, *The Universe in a Nutshell* (London: Bantam, 2001), 103–4.

[10]S. -C. Zhang, "A Unified Theory Based on SO(5) Symmetry of Superconductivity and Antiferromagnetism," *Science* 275 (1997): 1089.

[11]In reviewing previous work that was critical of this, McGrath states: "It is not clear that Austin has understood that 'wave packets' were derived by Schrödinger from linear harmonic oscillator wave functions" (p. 196). This is technically incorrect. In order to discuss the relationship between waves and particles, wave packets should be written as a linear superposition of free-particle wave functions, not harmonic oscillator wave functions (see, for example, S. M. McMurry, *Quantum Mechanics* [Wokingham: Addison Wesley, 1994], 224–6). On one level, this may be a pedantic point since it is not crucial to McGrath's argument. On another level, it may be important because some scientists will react skeptically to theologians who make simple technical mistakes such as this.

[12]There are three things that polite physicists never discuss at dinner parties: politics, religion, and the quantum measurement problem!

[13]For an introduction, see J. Horgan, "Quantum Philosophy," *Scientific American* (July 1992): 94–103.

[14]M. Beller, *Quantum Dialogue: The Making of a Revolution* (Chicago: University of Chicago, 1999).

[15]Ibid.; and ____, "The Sokal Hoax: At Whom Are We Laughing?" *Physics Today* (September 1998).

[16]In a private communication, McGrath has stressed to me that he did not wish to give any priority to Bohr's views but rather "to make the more general point that assigning priority to observational evidence can lead us into thinking about—and representing—reality in ways that run counter to common sense."

[17]T. F. Torrance, *Theological Science* (Oxford: Oxford University Press, 1969), 26–7.

[18]To balance this criticism, I should point out that some of this work is briefly mentioned in McGrath, *A Scientific Theology*, Volume 1: Nature, 112. Sokal's hoax is discussed in McGrath, *A Scientific Theology*, Volume 2: Reality.

[19]P. R. Gross and N. Levitt, *Higher Superstition: The Academic Left and Its Quarrels with Science* (Baltimore: Johns Hopkins University Press, 1994).

[20]For a review, see R. H. McKenzie, "Postmodern Science," *kategoria* 1 (1996): 63–8.

[21]A. D. Sokal, "Transgressing the Boundaries: Toward a Transformative Hermeneutics of Quantum Gravity," *Social Text* 46/47 (spring/summer 1996): 217.

[22]____, "A Physicist Experiments with Cultural Studies," *Lingua Franca* (May/June 1996): 62.

[23]Numerous articles are available at: www.physics.nyu.edu/faculty/sokal/

[24]A. D. Sokal and J. Bricmont, *Intellectual Impostures: Postmodern Philosophers' Abuse of Science* (London: Profile Books, 1998).

[25]S. S. Schweber, "Reflections on the Sokal Affair: What Is at Stake?" *Physics Today* (March 1997): 73; S. Weinberg, "Sokal's Hoax," *The New York Review of Books* XLIII (13) (1996): 11; and Beller, "The Sokal Hoax."

[26]Beller, "The Sokal Hoax."

[27]P. J. Mohr and B. N. Taylor, "CODATA Recommended Values of the Fundamental Physical Constants: 1998," *Reviews Modern Physics* 72 (2000): 351. See appendix B.

[28]Weinberg, "Sokal's Hoax," 11.

[29]J. H. Taylor, Jr., "Binary Pulsars and Relativistic Gravity," *Rev. Modern Physics* 66 (1994): 711.

[30]R. F. C. Vessot, et. al., "Test of Relativistic Gravitation with a Space-Borne Hydrogen Maser," *Physical Review Letters* 45 (1980): 2081.

[31]K. Gottfried and K. G. Wilson, "Science as a Cultural Construct," *Nature* 386 (1997): 545.

[32]For a "classic" example of writing that looks to me just like Sokal's article, see E. L. Simmons, "Toward a Kenotic Pneumatology: Quantum Field Theory and the Theology of the Cross," *The Center for Theology and the Natural Sciences Bulletin* (Spring 1999). [This essay was one of the winners of the Templeton Foundations "Expanding Humanities Vision of God" essay contest in 2000. It is available on the Templeton Foundation Science and Religion Resource CD, 3rd ed.]. The essay reflects a very confused understanding of quantum physics based on reading popular books on

the subject. It mistakenly equates quantum field theory with Bell's theorem. It mistakenly claims that quantum field theory is nonlocal. The opposite is actually true. That is why the observation of EPR correlations is such a puzzle. As a regular user of quantum field theory, I would agree with Sokal that it provides absolutely no insight into psychology and human relationships. Similarly, I assert Simmons' essay provides no insight into the theology of the Cross, but rather confuses it because the Cross is primarily about interpersonal relationships (as in the relationship between humans and the personhood of God embodied in the Trinity). The essay does not mention sin or the substitutionary atonement. The best analogies for understanding the Cross are to be found in the Old Testament not in popular books about quantum theory.

[33]A. E. McGrath, *Evangelicalism and the Future of Christianity* (Downers Grove, IL: InterVarsity Press, 1995).

[34]See the extensive critique of his pluralist and universalist views by D. A. Carson, *The Gagging of God* (Grand Rapids, MI: Zondervan, 1996).

[35]B. Ramm, *The Christian View of Science and Scripture* (Grand Rapids, MI: Eerdmanns, 1954). This was reprinted in 1987, a testimony to its enduring influence. For a review of Ramm's legacy, see J. L. Spradley, "Changing Views of Science and Scripture: Bernard Ramm and the ASA," *Perspectives on Science and Christian Faith* 44 (1992): 2. Ramm has been highly influential in the USA; sometimes in ways he did not intend. Mark Noll has noted that the publication of Ramm's book was a catalyst to Henry Morris writing his first book on "creation science" (M. Noll, *The Scandal of the Evangelical Mind* [Grand Rapids, MI: Eerdmans, 1994], 188–92).

[36]R. H. Bube, *The Human Quest* (Waco, TX: Word, 1971); *Putting It All Together* (Lanham, MD: University Press of America, 1995). Bube is also the author of many articles in (and former editor of) the journal, *Perspectives on Science and Christian Faith*.

[37]D. Ratsch, *Science and Its Limits: The Natural Sciences in Christian Perspective*, 2d ed. (Downers Grove, IL: InterVarsity Press, 2000) (First published as *Philosophy of Science* [Downers Grove, IL: InterVarsity Press, 1986]); and ——, *The Battle of Beginnings* (Downers Grove, IL: InterVarsity Press, 1996).

[38]M. A. Jeeves, *The Scientific Enterprise and Christian Faith* (London: Tyndale, 1969).

[39]W. R. Thorson, "Realism and Reverence," *Journal of the American Scientific Affiliation* 38 (1986): 75.

[40]D. MacKay, *The Clockwork Image* (Downers Grove, IL: InterVarsity Press, 1974); *Science, Chance, and Providence* (Oxford: Oxford University Press, 1978).

[41]H. J. Van Till, D. A. Young, and C. Menninga, *Science Held Hostage: What's Wrong with Creation Science AND Evolutionism* (Downers Grove, IL: InterVarsity Press, 1988).

[42]W. Dembski, *The Design Inference* (Cambridge: Cambridge University Press, 1998).

[43]E. J. Larson, *Summer for the Gods: The Scopes Trial and America's Continuing Debate Over Science and Religion* (New York: Basic Books, 1997). This book won a Pulitzer Prize in 1998.

[44]P. E. Johnson, *Darwin on Trial* (Downers Grove, IL: InterVarsity Press, 1991); ——, *Reason in the Balance: The Case Against Naturalism In Science, Law, and Education* (Downers Grove, IL: InterVarsity Press, 1995).

[45]K. Birkett, *Unnatural Enemies: An Introduction to Science and Christianity* (Sydney: Matthias Media, 1997).

[46]T. F. Torrance, *Reality and Evangelical Theology: The Realism of Christian Revelation* (Philadelphia: Westminster, 1982; Downers Grove, IL: InterVarsity Press, 1999).

[47]J. Calvin, "The Knowledge of God Conspicuous in the Creation and Continual Government of the World," in *Institutes of the Christian Religion* Book 1, trans. H. Beveridge (Grand Rapids, MI: Eerdmans, 1989), chap. v.

[48]Compare, for example, J. Stott, *The Cross of Christ* 2d ed. (Leceister: InterVarsity Press, 1986), 175–82.

[49]K. Barth, *The Epistle to the Romans*, translated from the 6th ed. by E. C. Hoskyns (London: Oxford University Press, 1933), 104–5.

[50]Calvin, "The Knowledge of God Conspicuous in the Creation and Continual Government of the World."

[51]Birkett, *Unnatural Enemies: An Introduction to Science and Christianity*.

[52]McGrath, *A Scientific Theology*, Volume 1: Nature.

[53]Examples include the recent Bio-X initiative at Stanford University and the Bauer Center for Genomics Research at Harvard *Nature* 416 (2002): 256–7.

[54]See note 32.

[55]Barth, *The Epistle to the Romans*.

[56]McGrath, *A Scientific Theology*, Volume 1: Nature.

[57]Weinberg, "Sokal's Hoax."

[58]Torrance, *Reality and Evangelical Theology*, 44.

[59]Barth, *The Epistle to the Romans*, 159–60.

United States Postal Service

Statement of Ownership, Management, and Circulation

1. Publication Title	2. Publication Number	3. Filing Date
Perspectives on Science and Christian Faith	0 8 9 2 2 6 7 5	10/07/2004
4. Issue Frequency	5. Number of Issues Published Annually	6. Annual Subscription Price
Quarterly	4	$35

7. Complete Mailing Address of Known Office of Publication *(Not printer) (Street, city, county, state, and ZIP+4)*: PO Box 668, Ipswich MA 01938-0668 — Contact Person: Jonathan Chechile, Telephone: 978-356-5656

8. Complete Mailing Address of Headquarters or General Business Office of Publisher *(Not printer)*: American Scientific Affiliation, PO Box 668 Ipswich MA 01938-0668

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor *(Do not leave blank)*

Publisher *(Name and complete mailing address)*: American Scientific Affiliation, PO Box 668 Ipswich MA 01938-0668

Editor *(Name and complete mailing address)*: Dr. Roman J. Miller, PO Box 668 Ipswich MA 01938-0668

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PS Form **3526**, October 1999 *(See Instructions on Reverse)*

13. Publication Title: Perspectives on Science and Christian Faith	14. Issue Date for Circulation Data Below: September 2004 (Volume 56 Number 3	
15. Extent and Nature of Circulation	Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies *(Net press run)*	2348	2279
b. Paid and/or Requested Circulation (1) Paid/Requested Outside-County Mail Subscriptions Stated on Form 3541. *(Include advertiser's proof and exchange copies)*	2153	2064
(2) Paid In-County Subscriptions Stated on Form 3541 *(Include advertiser's proof and exchange copies)*	0	0
(3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Non-USPS Paid Distribution	29	25
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c. Total Paid and/or Requested Circulation *(Sum of 15b. (1), (2),(3),and (4))*	2187	2094
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(2) In-County as Stated on Form 3541	0	0
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e. Free Distribution Outside the Mail *(Carriers or other means)*	0	0
f. Total Free Distribution *(Sum of 15d. and 15e.)*	131	53
g. Total Distribution *(Sum of 15c. and 15f)*	2318	2147
h. Copies not Distributed	59	157
i. Total *(Sum of 15g. and h.)*	2377	2304
j. Percent Paid and/or Requested Circulation *(15c. divided by 15g. times 100)*	94%	98%

16. Publication of Statement of Ownership
☒ Publication required. Will be printed in the December 2004 issue of this publication. ☐ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Jonathan Chechile Membership Manager — Date: 10/07/2004

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