Christian Faith in a Scientific Age

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Introduction

The relationship between scientific inquiry and religious faith has been a subject of curiosity ever since the inception of science.[1] Indeed, one might date it as far back as ancient Greece, depending on one's definitions. However, in the last ten years it has attracted the broad interest of amateurs and specialists with an intensity hitherto unseen. Books are being written, conferences are taking place, public lectures are being given, debates held, research articles published, new organizations established and old ones experiencing new vitality, and the media have taken notice. Believers of all faiths and scientists from all disciplines are beginning to take part in the discussion.

What are the reasons for this veritable explosion of interest in religion and science? Certainly one significant factor has been the influence of the John Templeton Foundation, which has become quite well known for encouraging interdisciplinary work in science and theology through its prestigious Templeton prize and its Science and Religion Course Program.[2] However, other initiatives appear to be at work as well. The growth of the Internet in the past decade has given rise to a number of science/religion discussion groups, the best-known of which is the META listserver coordinated by William Grassie.[3] Post-secondary teachers have likewise been able to electronically network with one another to exchange ideas. Christian organizations of scientists interested in the relationship between their research, their profession, and their faith are now very active in Canada, the US, England, and elsewhere.[4] The creation-evolution debate in the US is ongoing, and its impact has been felt both in teaching guidelines in certain states and in the recent founding of the Discovery Institute,[5] a consortium of academics with a common interest in the possibility of empirically detecting intelligent design in living (and non-living?) things.[6,7]

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The relative significance of each of these factors could form the basis of doctoral work for a good number of sociology students, and it is not my purpose to consider this issue here. However, two background effects appear to be at work that at the least cannot be neglected and that I think would sooner or later have generated the sort of interest in the relationship between science and religion that we have now.

The first of these effects has been the persistence of religious faith worldwide. Although church attendance has been in decline in most industrialized nations (the United States being a notable exception), belief in God appears to remain important to most of the general population.[8] Furthermore, the education level of the overall population is higher than ever before in history, and more and more believers within various religious traditions are able to better articulate their faith and to appreciate the subtleties of difficult theological issues. Concurrently the roots of various faiths are under unprecedented levels of academic scrutiny, driven in part by advances in archaeology and Biblical criticism. The research on the historical Jesus provides an example of this,[9] a study that has gained media notoriety because of the Jesus Seminar.[10] Added to this mix is a growing level of religious pluralism in western nations; a near-instantaneous ability of news media to communicate internationally; and a growth of non-governmental peace, justice, and environmental groups whose concerns often dovetail with those of religious faith, especially Christianity.

The second effect has been the stunning advancement of science and technology in the twentieth century, particularly in the last decade. More than ever the results of science – whether from anthropology, physics, biochemistry, psychology, or any other subdiscipline – are raising questions about our most cherished beliefs at a dizzying rate. The pace of scientific progress is so rapid that even experts have difficulty keeping up with the latest developments. Consider just some of the new discoveries made in the past five years.[11] More than twenty new planets have been discovered outside of the solar system. Cloning moved from the realm of science fiction to science fact. Fermat's last theorem was finally proved, ending 200 years of mathematical speculation. Evidence has been collected that overwhelmingly indicates dinosaurs became extinct because of a comet that smashed into the Yucatan peninsula 65 million years ago. We have begun to unravel the mechanisms of how we age, offering

the prospect of radically extending human lifespans. Fibre optic cables now link our cities together in an information highway that will soon allow us to transmit the contents of an entire library in a matter of seconds. Genetically modified foods are now available in our supermarkets. The top quark – the last particle in the standard model of subatomic particles – was discovered. Animal intelligence has been shown to be far greater and subtler than was previously thought. Supergigantic black holes – 1,000,000 times heavier than our sun – have been found at the centers of most galaxies, and it is likely that our own galaxy has one at its core. The Human Genome project announced a preliminary blueprint of human DNA. Cosmology has provided us with a map of the detailed structure of the temperature of the night sky (the microwave background radiation, a remnant of the Big Bang) to such a high degree of precision that we can gain empirical information about the first instants of creation.

Such a rapid rate of discovery has a rather dazzling effect, both within and beyond the scientific community. We marvel not only at the technical expertise required to achieve these results but also at the very deep questions raised by the majesty and subtlety of nature. Such questions touch at the heart of religious faith. In a persistently religiously curious world it would seem inevitable that discussions of science and religion will arise.

My purpose here is to consider the broad impact of these discussions for Christian faith and theology. Such discussions typically are cast in either confrontational or conciliatory tones.[12] In the former case, the general presupposition is that the scientific and religious outlooks are two solitudes that inevitably conflict, or at best are independent of one another. In the latter case, the general approach is to articulate a theology that is integrated with a scientific worldview, or at least to open up a dialogue which attempts to find some common ground. I shall adopt an intermediate perspective between these two viewpoints, in which I shall raise some of the questions and implications for Christian theology that arise from modern scientific study. My purpose is to emphasize that the breadth and depth of scientific research is raising theological and practical concerns of relevance to the Christian community. I shall not attempt to provide specific responses to these concerns, although I will conclude with a brief proposal for a framework as to how they might be addressed. It is my hope that the Christian community will give these

issues the attention they merit, so that our faith can have integrity in a scientific age.

General Considerations

The differences between faith and science appear to be obvious. Most people regard science as being concerned with what is, whereas faith is interested in how things ought to be. Faith deals with "why" questions, whereas science deals with "how" questions. And whereas the experiences of faith are typically regarded as personal and private, science makes use of experimentation that yields a body of public data and knowledge.

The process of experimentation is at the heart of scientific inquiry and forms the framework by which its questions are addressed. Science begins with observations about something one might be interested in – the weather, the behavior of rabbits, the darkness of the sky at night. Next we make a guess – propose an explanation – about what might cause these observations. Then we carry out more observations and experiments that will test the proposed explanation or hypothesis. This process of improving hypotheses with experiments and then using the refined hypotheses to develop new experiments is repeated until we achieve genuine – albeit partial – understanding. The simpler and more elegant hypotheses are regarded as the most attractive, partly for aesthetic reasons but primarily because experience has repeatedly shown that they provide the best (i.e., maximally predictive) explanations of the phenomena. The scientific process is one that involves hard work, long hours, false starts, tedious computation, creative thinking, and psychological effort. However, most, if not all, scientists find it to be a very rewarding process – one that not only leads to the amazing results mentioned previously but also has enormous social, economic, and philosophical impact.

The process of science actually has a close relationship with the Judeo-Christian faith. Throughout the Bible we have testimony that the natural world is something that can be understood because it reflects the glory of a God who can be known. As we read in Psalm 19:

> The heavens declare the glory of God, and the skies proclaim the work of His hands. Day after Day they pour forth speech; night after night they display knowledge.[13]

For another example, in Proverbs 8 Wisdom (personified) was present before the creation and was intimately involved with its creation.[14] The universe is regarded neither as a place inhabited by capricious spirits, whose whims cannot be reliably known, nor as a place that God has abandoned. Rather, it is a creation reflective of its Creator's wisdom, yet distinct from its Creator. This same assumption – that the foundations of the earth, the laws of nature, reflect wisdom or reason – forms the underpinning of all scientific investigation. Simply put, if scientists didn't believe the universe could be understood with reason, they wouldn't bother to try.

John Polkinghorne has likened the relationship between Christian theology and scientific Inquiry to that between two cousins – beneath the differences there is a clear resemblance.[15] The common faith in the underlying wisdom of the universe is one example. Other examples include the common rationality, the common sense of awe at the majesty and intricacy of the natural world, the novelty present in scientific discovery and in coming to faith, and the incompleteness of understanding inherent in each discipline.

However, there is also an inherent tension between the two approaches, one that is often underappreciated by adherents on either side. Science regards the universe and its component parts as its own to be investigated. The relevant questions are objective in tone and character, with anything regarded as fair game for putting under the microscope of rational scrutiny. But faith – and especially Christian faith – views the world as an arena in which one seeks a relationship with God – the Great Other.[16] In this case the relevant questions are primarily concerned with personal involvement, whether to God, to family, to friends, to society, or to the natural environment.

The self-limiting objectivity which underlies the scientific method is chiefly responsible for its success. However, it also is at the heart of the tensions which are present in the science-faith dialogue because it raises the issue of what it means to explain something. From a faith perspective relational explanations (which include but are not restricted to the supernatural) are commonly viewed as sufficient. Explanation of a given phenomenon is in terms of either human or divine motivation: "God declared . . .," "I was called . . .," "It's enough to know God did it . . .," etc. The very nature of Christian faith encourages this relational perspective and its importance is central to

Christian theology. However, it is antithetical to a scientific approach, which seeks objective and impersonal explanations for (in principle all) phenomena. Explanation of a phenomenon through an assertion that "God did it" (effectively a supernatural explanation) is regarded as no explanation at all. To be satisfied with this kind of explanation is to effectively halt any scientific investigation into the subject. Conversely, to provide a scientific explanation for something suggests to many that no further motivational explanation is required – if earthquakes are explained by the shifting of tectonic plates, then what is meant by the assertion that God was somehow involved (or not) in the earthquake?

This is perhaps the chief question scientific research poses for theology. The more seamless the scientific description, the less relevant a theological explanation appears to be. This problem goes much deeper than the old "God in the gaps" conundrum, for it raises concerns that lie at the core of our understanding not only of God but of human freedom as well. Indeed, some scientists assert that theology has no epistemic content whatever but is at most a form of personal expression.[17] This perspective is not an acceptable one for Christianity, which claims an evidentiary basis for God's action in this world.

The challenge for modern Christian theology is to articulate the relevance of faith explanations in a culture where scientific explanations are so highly valued and effective. In sending out his disciples, Jesus advised them to be as wise as serpents and innocent as doves.[18] In proclaiming the Christian gospel in a scientific age, we likewise will find ourselves steering a careful path between skepticism and credulity.[19]

The traditional issues

The science-religion dialogue has traditionally been concerned with cosmology, evolution, and miracles.[1] This is no accident, since these subjects are rooted in some of our deepest questions of faith. Although the intellectual territory they present has been well travelled, each subject continues to raise profound questions for Christians in a scientific culture.

Cosmology is the subject devoted to addressing the question, Where did everything come from? Although born in antiquity, it remains one of the most exciting fields of science today.[20] The twentieth century revealed more about the structure and origins of the universe than humankind had learned in all the preceding centuries combined. We have learned that our universe has a

definite history, one that began about 15 billion years ago. The contents of our universe are the remnants of a gigantic explosion – the Big Bang – whose residual heat we detect in the form of the microwave background, a bath of radiation at a temperature of 3 °K. By human terms it is utterly immense, containing 100 billion galaxies, each of which has 100 billion stars. It is expanding, with the latest supernova data suggesting that (on average) all galaxies are receding from one another at ever-increasing rates of speed due to an overall expansion of space and time.

Cosmology presents us with a set of limit questions that provide fertile ground for theological reflection.[21] Did anything come before the Big Bang? If so, what? If not, what is the nature and significance of the initial instant of creation? What is the origin of the particular features of our universe? Is the physical description of the cosmos equivalent to an explanation of its existence, or is something more required? Is a Designer responsible for these features in some way, and if so, how? What level of influence (if any) is exerted by the Designer over the design? What is a theologically plausible balance between chance and necessity?

An intriguing feature of cosmological theories is that the equations of physics which underlie them depend upon physical constants that must take on very particular values in order for life as we know it to be able to exist. These constants, such as the strengths of the forces governing electromagnetism or radioactivity, the rate of the expansion of the universe, or the values of the masses of subatomic particle, are not determined by the equations themselves. There is no logical obstruction in their taking on any desired value, and so they must be determined by experiment. However, even very small adjustments in their empirically determined values yield logically possible universes that are uninhabitable (as determined from the equations). For example, if the relative mass of the neutron to the proton is adjusted by as little as one percent, stable stars would not exist, and stable molecular compounds such as water could not form. Further study of the equations indicates that of the possible universes one could obtain from the basic equations of physics by adjusting the physical constants of nature, only a very tiny fraction of them are inhabitable by carbon-based life. The numerical coincidences required for this to happen by chance are enormous.

Since we are living things, we can only live in a universe for which these numerical coincidences are satisfied, and the features of nature that we observe will at the least be constrained by this possibility. This idea is referred to as the Anthropic Principle.[22] At first sight it would appear to provide comfort to people of faith, for the many empirical coincidences required for life to exist are quite suggestive of the existence of a rational, purposeful, and intelligent creator who has an interest in life.[1,15] However, two alternate explanations are possible. One is that the constants take on the values they do because of some more fundamental physical theory of which we are currently unaware. The other is that any universe which can exist logically also exists empirically, and we happen to live in one of the very few conducive to life.[23]

Is all of existence simply the result of some grand cosmic accident? Or is it possible we are part of a creation? This is the principal theological issue that cosmology raises.

Evolutionary biology raises similar questions to that of cosmology, but in a more pointed way. It addresses the question, where did *we* come from? All religions attach significance to life, and Christianity particularly asserts that God has a special role and interest in the origin and development of life, especially human life. The relationship that humans have toward one another and their creator is central to both peace theology and salvation theology, and so whatever scientific information there is to bear on the nature of life will have at least indirect theological relevance.

As with cosmology, a great deal was learned in the twentieth century about the structure and development of life.[24] In the cells of all living things is a molecule called DNA, whose structure encodes all of the genetic information relevant to a particular organism. DNA has the property of self-replication, and this property forms the basis of evolution.[25] The basic idea of evolution is that, given a set of differing replicators, those that are most effective at reproducing in a given environment will be the ones that appear in succeeding generations. For example, if two equal-sized populations of green lizards and brown lizards are present in an environment which has predators that eat brown lizards but not green ones, then after a few generations there will be few, if any, brown lizards. The environment, by virtue of the presence of the predator, has selected out green lizards, and so has naturally selected out the

green lizard replicators. No replicating process is perfect, of course, and small errors (mutations) in the replicators will be selected (i.e., more likely to reproduce) by some environments and not by others. The evolutionary hypothesis is that this mechanism of natural selection through mutating replicators is sufficient to explain the complexity of all life: the forms of life we see today are here because their ancestors were the most efficient at reproducing in the environmental conditions they found themselves in.

So, evolution provides an answer to the origin of life question – but it is one that many of its proponents and opponents find theologically unattractive. The reason is the same: the process of natural selection through replicator mutation raises the question of God's role in at least the development of life, if not in its origins. Simply put, if the complexity of life arises from a process of environmental selection, what is left for God to do?

Much has been written about this subject, and feelings about it run intensely on both sides of the issue. I shall confine myself to a few brief remarks. The issue runs much deeper than the question of literalist interpretations of the opening chapters of Genesis. The Christian assertion of a loving God who has an interest in life faces a formidable challenge. If evolution is "God's mechanism," clarification is needed as to what this means. What exactly is it that God does that would allow someone to distinguish Him/Her from a deistic spectator? How are catastrophes (such as the comet that purportedly killed the dinosaurs) incorporated into the theological picture? If the structure of life provides evidence of intelligent design (as a growing number of researchers assert[6,7]), then by what means has the design been actualized? If evolution is wrong, then what is the mechanism underlying life's origin and development? To say "God did it" is no more adequate an answer than saying "Toyota did it" when asking about the construction of a car. Moreover, why has the evolutionary paradigm been so successful in other fields of biology if it is incorrect? An improved description would at least have to explain that.

I am not claiming that the above questions are fatal to the assertions of Christian theology, and indeed there is much ongoing work in this subject.[26] However, they present unique challenges to Christian faith that are not easily dismissed by an intellectually honest person. Unlike cosmology, whose foundations reside in equations of physics that appear to transcend the universe they describe,[21] evolution deals with extant structures within a particular system.

The challenge evolution presents is that of incorporating the logic of mutative self-replication in a changing environment with the claim of a God of love who finds humans much more valuable than the birds of the air.[27]

Miracles are the third traditional aspect of the science/religion discussion, one that is typically underappreciated.[28] Since (by definition) miracles are not repeatable under controlled conditions, this suggests to many that they are not legitimate subjects of scientific investigation. For skeptics this is sufficient reason to dismiss them, whereas for believers it is a comfort to think that there are perhaps limits to science. Miracles refer to phenomena that apparently lie outside of the (known) natural order yet are connected to it at least insofar as they are reportedly observable. In my opinion this makes them legitimate subjects for rational scientific inquiry. That the subject of investigation might limit the inquiry in some way ought not to dismiss them from consideration, for all scientific investigation encounters limits one way or another.

The foundations of Christianity are intimately connected with miracles, for the central assertion is that God was incarnate in the person of Jesus Christ. The New Testament buttresses this claim to no small extent by referring to a considerable number of miracles Jesus performed, such as walking on water,[29] healing the sick,[30] calming a storm,[31] converting water into wine,[32] and more. These miracles are described in a fairly concrete way, often noting the degree of skepticism on the part of the people who observed the phenomena. For example, Mary's first response to the announcement that she will give birth to a son[33] is to ask, How can this be, since I am a virgin? – an intriguing display of scientific curiosity in a prescientific culture. She at least knows that virgins don't have babies. Moreover, the gospel writer Luke knows this, and expects his readers to know it. Of course the most important miracle of all in Christianity is that of the resurrection of Jesus, and three gospels note the doubts held by the followers of Jesus concerning this phenomenon.[34]

In a modern scientific age the task for Christianity is to articulate the role and nature of the miracles that play such an integral part in its foundations. This is a difficult challenge. To assert that the miracles did not take place is to deny any special action of God in the manner described in the New Testament (as well as casting aspersions on the integrity of the NT writers). If miracles are simply poorly understood natural phenomena, then what special role does

God or Jesus play in their instantiation? For example, if Jesus' calming of the storm on the lake is only coincidence, what remains of the status of Jesus' authority and of the theological significance of the event? Conversely, if we affirm that miracles occur, what exactly is it that is being affirmed? Does the water change into wine instantaneously, or is there some interventionist sequential process by which it took place? If we assert a virgin birth of Jesus,[35] what is it that we are asserting? The New Testament does not provide us with sufficient data to fully answer these sorts of questions in detail. However, in my view our current levels of scientific knowledge and biblical criticism should lead to a reappraisal of the nature of miracles. At the very least we can outline what are and are not plausible scientific understandings of such events, and reassess our theological reflections of them.

Of course, an intellectually honest investigation of this sort would not stop at Christian miracles, but would go on to investigate miracles in other faiths and miracles which lie outside of sacred writings of the various religious traditions. Those miracles not judged as fabrications then present new material that must be incorporated into a Christian worldview. The task is made all the more difficult because of the widespread nature of poor reportage, false claims, and pseudoscience. Yet I believe it must be attempted if we are to maintain the integrity of the gospel message in a fresh way.

The subtle disciplines

Many scientific disciplines are not obviously connected to theology or a religious outlook on the world. These include subjects such as physics, mathematics, geology, and many of the applied sciences. However, further reflection indicates that these subjects also have a part to play in the science/religion discussion. Geology is perhaps the most obvious example. Indeed, it was Sir Charles Lyell's book *Principles of Geology*, in which the geographical features of the earth were portrayed as arising from slow-working natural process, that provided a formative influence on Darwin's ideas concerning evolution.[36] Although evolution has since tended to eclipse geology's role in the relationship between theology and science,[37] the earth sciences still have an ongoing part to play.

Geology is the only discipline outside of cosmology that provides us with an empirical window into the very distant past.[38] From it we have learned that the earth is a place in which natural processes operate gradually over very

long periods of time to yield rivers, mountains, valleys, islands, and canyons. By its methods, the earth has been determined to be about 4.5 billion years old. The earth is a dynamic object, in which the continents move on tectonic plates (occasionally giving rise to earthquakes and volcanic activity), and its interior has a multilayered structure whose details are still being understood. Catastrophism, in which the earth's observed features appeared due to a sequence of cataclysmic events, has been ruled out as the dominant formation mechanism. Nevertheless, more recent research has indicated that rare events, such as the earth's hypothesized encounter with a comet, can induce major changes over very short periods, as noted above. In the last twenty years extraterrestrial spacecraft have indicated that several of the moons of Jupiter and Saturn also have dynamic geological properties which are only just now beginning to be understood.[39]

Although geology raises challenges for theology similar to those provided by evolution in terms of the origin of the earth, it has its own distinctive set of questions. Since the earth is a place in which geological events can unexpectedly produce human disaster, in what sense can we attribute goodness to creation? Indeed, in what sense (if any) can we assert that creation has fallen from some state of pre-paradise, given what we now know about the earth's formation and its dynamic structure?[40] Seismic activity introduces a small element of randomness into everyday living in certain parts of the world that many find difficult to reconcile with a God in full control of events. The same can be said for the weather, in which lightning bolts occasionally strike. Yet we have biblical testimony that God's purported influence in the world extends to geological events, both apocalyptically[41] and historically,[42] including even the resurrection of Jesus. Geology raises the question of the degree and character of God's dominion over the planetary-sized phenomena that exert an influence over our lives that we so often take for granted.

Yet these same phenomena also induce within us a deep sense of awe and wonder, a sense which geological understanding can enhance. A trip to the Rocky Mountains or the Grand Canyon excites in people not only curiosity as to where they came from but also a sense of the finitude of existence and reverence for the natural order and what might lie beyond it. If our geological curiosity can in part be satisfied by the scientific method, perhaps our reverence

is indicative of a God who upholds the natural order. But the imprint of that God in geological processes remains obscure. Can it be clarified?

One possible means of clarifying God's role in the natural order is as the author of the laws and processes that geology – and all of science – describes. This is the domain of physics, that subject whose goal is to understand nature at its most fundamental level possible. Physics is the most exact of all the sciences. It deals with the deepest organizational levels, the most extreme of natural conditions, and uses the most exact mathematical equations, all of which seem remote from the human concerns of Christian faith.

However, physics has had a major impact on philosophy and theology,[43] and its methods are regarded as paradigmatic for the other sciences. The belief of Renaissance scientists in the existence of a Lawgiver led them to seek an interpretation of the natural world in terms of laws.[1] This conviction in an underlying wisdom of the natural order has been noted above, and it was something about which Newton was quite explicit[44]: *There exists an infinite and omnipresent spirit in which matter is moved according to mathematical laws*. Newton's conviction of the omnipresence of a God who is the ultimate causal agent led him to develop laws of physics which are taught worldwide today in high schools and universities, and on which all of the applied sciences and engineering disciplines rely.

These laws are now referred to as the classical laws of physics. They are deterministic (the future state of any system can be predicted from its present state), reductionistic (the behavior of an entire system is determined by the behavior of its constituent parts), and realistic (the laws of physics provide an objective description of the world in an absolute space and time, independent of any observer). To a high degree of numerical precision they describe the behavior of galaxies, planets, geological processes, fluids, gases, ballistics, light, heat, and sound. They naturally lead to a view of any natural system as a clockwork machine that operates according to knowable and reliable laws. The universe itself is regarded as the ultimate piece of clockwork, set in place by a deity who lets it run by itself.

The twentieth century witnessed a revolution in scientific thought in which all of these ideas were overthrown.[45] The experimental confirmation of Einstein's theories of special and general relativity indicated that space and

time were not absolute, but were instead an interconnected dynamical structure that both influences physical events and is influenced by them. For example, gravitation has the effect of slowing time down relative to distant observers for whom gravity's effects are weaker. Experiments carried out on matter at atomic and subatomic distance scales indicated that physical systems are not deterministic but instead must be described in probabilistic terms. More recent work on physical systems such as coupled pendulums indicate that very small changes in the initial state of a system lead to incalculably large changes in its subsequent development. Quantum mechanics and chaos theory respectively describe these phenomena, and they together challenge the classical notion of physical determinism. They also challenge classical reductionism, since in many circumstances it is not possible to meaningfully reduce a system to its constituent parts. All three together force considerable revision of the notion of realism, since the experimental contrivances used to explore a given system can have a non-negligible effect on its development.

Relativity, quantum mechanics, and chaos theory have indicated that the universe has a much richer structure than anyone imagined a century ago, one that provides fertile ground for theological reflection. They form reminders that our pictures of God ought not to be limited by our current understanding of the way things are. The inadequacies they point out in the clockwork universe provide some genuinely new possibilities for envisioning how God might act in a seemingly deterministic world. They raise anew the question as to what kind of God the God of modern physics is.[46]

The laws of physics describe with very high precision the natural world, by mathematical equations that go well beyond their original formulation. For example, the equations of the quantum theory of electromagnetism predict experimental outcomes to ten decimal places in accuracy, a level of empirical precision far greater than anything anticipated by the original practitioners of the theory. So effectively do the equations of physics work that Eugene Wigner commented that mathematics is an unreasonably effective gift that we neither understand nor deserve.[47] Is it indeed a reflection of the divine mind?[48]

The mathematical equations underlying physical law do not seem to need the natural world in order to exist. They have a highly transcendent character, one that seems to exist "out there" in a realm of abstract thought.[49] The ontological

status of mathematics is an intriguing question that continues to occupy the attention of philosophers. It is difficult to imagine that the truth of a mathematical theorem is dependent upon the existence of mathematicians, human life, or any other form of life for that matter.[50] Yet at the same time mathematics is constructed to serve purposes, not only for physics, but also for other fields such as finance, biostatistics, and circuit design.

The theological status of mathematics represents an avenue of study that is largely unexplored. Is mathematics discovered or invented? Did God invent it, or is it an intrinsic part of the mind of God? Why are some mathematical theories fruitful in science and others not? Is this fruitfulness somehow representative of the choice a Creator might make in designing a universe?

The frontier disciplines

Several areas of science raise concerns that are much more immediate and practical than those discussed above, and that occupy a considerable degree of public attention. They include genetics, psychology, ecology, and computer science as well as the applied sciences, whose technological character has a direct impact on our society and our lives. The territory is too vast to be covered here, so I shall confine myself to a few brief remarks.

Of all the sciences, psychology enjoys the greatest level of popularity among Christians. This is no surprise, given the relational character of religious faith noted above – psychology is the science pertaining to relationship and behavior, and so we should expect it to be of interest to people of faith. However, it is also the science for which it is most difficult to deal with effects of human bias, and underlying theological assumptions about human nature have an enormous influence on how clinical psychology is practiced. It is not my purpose to discuss these issues here.

A general theological question raised by psychology is the nature of the self.[51] What does it mean to be a conscious being? Do conscious beings have free will? If so, what are the limits to this free will? The very nature of these sorts of questions is simultaneously scientific and theological in tone. Only in recent years are neuroscience experiments being carried out to empirically determine (partial?) answers to them,[52] answers that, in my view, should have a profound impact on Christian thought. For the core of the gospel message is

to proclaim a God of love who has a special interest in humans and who calls them to right relationship with one another. It is difficult to understand how this message can be meaningful unless there exists genuine freedom of will to respond in love to actions of love.

Are we free to act? Or are we biological machines carrying out algorithmic instructions, our "sense of personal identity and free will . . . no more than the behavior of a vast assembly of nerve cells and their associated molecules"?[53] It is very difficult to see how to reconcile the latter viewpoint with a faith perspective. Indeed, the judgments we make concerning human personhood and the freedom to act in a lawlike world are analogous to those we make concerning divine personhood and God's freedom to act.[54] A naturalistic view of the world that would expunge it of a freely acting Creator might also be expected to expunge it of freely acting conscious entities as well.[51] Yet to assert free will is to assert a fundamental limit to either the domain of scientific inquiry or to the completeness of its descriptive power.[21] Will experimental work in this area inevitably be laden with theological presuppositions? Alternatively, can a theology of human freedom suggest new experiments that might be performed?

The information sciences provide related theological challenges. It is estimated that within twenty years a desktop computer will have the processing capacity of a human brain.[55] Efforts are in place now to develop a computer that will simulate human consciousness. What will it mean to have a machine that thinks, with opinions, emotions, ideas, and expectations? Will it be alive or conscious in some sense? If we judge it to be so, should we make it part of our human community? Should we make it part of our faith community? Do we preach the gospel to it?[56]

Genetics provides an alternate perspective on what it means to be human.[57] Upon completion of the human genome project, the entire nucleotide sequence of human DNA will be determined and we will know the blueprint of human life. Of course, it will be a further task still to interpret the blueprint – but obtaining the plans is a necessary first step. But a first step toward what? The prospects offered by this knowledge raise new questions for Christians (and indeed everyone) to wrestle with. Following the healing ministry of Jesus, it would seem reasonable to use this information to cure genetically based diseases. Yet this same knowledge faces us with the possibility of manipulating

human genetic information to achieve desired ends. But whose ends? Those of the parents or those of the government in power? And which desires? If we find ourselves able to engineer beauty, intelligence, muscular strength, and longevity in future generations – even to a limited extent – to what extent should we act on this knowledge? Where is God calling us?

Ecology provides us with yet a different perspective, one that calls into question our relationship to all other things.[40,58] We have learned that all life forms have a degree of interconnectedness that cannot be neglected in terms of human development. Species extinction, global warming, erosion of the ozone layer, pesticides, acid rain, air pollution, and nuclear waste are all issues of public concern rooted in scientific study. If we are to take seriously the call of God to be stewards of creation, then it will be necessary to take ecology into account. The question raised is one familiar to Christians: What does it mean to be stewards of creation? However, finding the answers to this question in the last twenty-five years has been very complex, due to the enormity of the problems and the interconnectedness of the issues. The challenge faced by the church is to articulate a call to stewardship of the earth that is scientifically sound and biblically well motivated.

Conclusion

Science raises questions for Christian believers that they ought not to ignore. These questions range from the practical to the abstract, touch upon both private and public spheres of influence, and impact on our notions of both God and humanity. While each topic merits far more attention than space permits here, I would like to propose a framework for theology that might be helpful in tackling these issues.

My proposal is that Christian theology become a much more corrigible discipline than it presently appears to be, by which I mean it should be open to revision as relevant new information becomes available and which ideally is cumulative in its insights. To do this with integrity would involve a clarification of the distinctions between its main assertions and its more peripheral aspects. Christian theology is predicated on a core set of beliefs that over the ages have been encoded in things like catechisms and statements of faith. Although many Christians have an intuition as to what these things are, in the development of theological perspectives relevant to scientific concerns it is essential to distinguish

the core beliefs from the peripheral ones, and to specify to what extent these beliefs can be corroborated or refuted by further experience. One expects the core beliefs to be much more resistant to revision that the peripheral ones, as is the case in scientific research.

An example might be helpful here. Christian theology assumes the existence of a personal God having particular characteristics, among them omniscience. Taking this to be a core assumption, one could then ask how God's omniscience might be manifest in this world, and develop certain auxiliary theological proposals concerning this idea. Along these lines, Polkinghorne[19] has suggested that the challenge posed to classical determinism from quantum theory and chaotic phenomena has potential implications for understanding God's omniscience, taken to mean that God knows everything that can be known. However, if the future is genuinely unknowable (as quantum theory and chaos imply), then even an omniscient God cannot know the future. It is a revision of a traditional understanding of God's foreknowledge that strives to be faithful to scripture while taking modern science into account. It is a corrigible picture, one that could be revised and cumulatively improved in light of further scientific developments and theological reflection. It also has wider implications for theodicy and free will that merit further study.

If theology and science are going to have any meaningful form of discourse, then the verisimilitudinous character of the scientific enterprise will have to be taken into account. My goal in sketching out the issues in this paper is to encourage Christian theology to become a much more corrigible discipline.[59] A gospel relevant to a scientific age demands nothing less.

Notes

[1] For an historical overview see I. Barbour, *Religion and Science*, (San Francisco: Harper San Francisco, 1997).

[2] Further information is available at the website www. ctns.org si

[3] See the website www.meta-list.org.

[4] In Canada the organization is the Canadian Scientific and Christian Affiliation; see www.csca.ca.

[5] See www.discovery.org.

[6] W. Dembski, *The Design Inference* (Cambridge: Cambridge University Press, 1999).

[7] M. Behe, *Darwin's Black Box* (New York: Touchstone,1998).

[8] For a detailed exposition of the situation in Canada, see R. Bibby, *Fragmented Gods: The*

Poverty and Potential of Religion in Canada (Toronto: Irwin, 1987) and *Unknown Gods: the Ongoing Story of Religion in Canada* (Toronto: Stoddart, 1997).

[9] M. A. Powell, *Jesus as a Figure in History* (Louisville: Westminster John Knox Press, 1998).

[10] R.W. Funk, R.W. Hoover, and the Jesus Seminar, *The Five Gospels: The Search for the Authentic Words of Jesus* (New York: MacMillan, 1993).

[11] For an overview of contemporary science and the upcoming challenges it faces, see J. Maddox, *What Remains to be Discovered* (New York: Touchstone, 1998).

[12] See I. Barbour, *Religion and Science*, for a detailed consideration of the different ways of relating science and religion.

[13] Psalm 19:1,2

[14] Proverbs 8:22-31

[15] J. Polkinghorne, *Serious Talk* (Valley Forge: Trinity Press International, 1995).

[16] *The Writings of Martin Buber*, ed. W. Herberg (New York: Meridian Books, 1956).

[17] The best known proponent of this view is Richard Dawkins, who contends, for example, that "faith is the great cop-out, the great excuse to evade the need to think and evaluate evidence. Faith is belief in spite of, even perhaps because of, the lack of evidence." (From a lecture extracted from the Nullifidian, 1994.)

[18] Matt. 10:16

[19] J. Polkinghorne, *The Faith of a Physicist* (Minneapolis: Fortress Press, 1996), 31.

[20] For a review of modern cosmology see J. Maddox, *What Remains to be Discovered*, ch. 1.

[21] For a discussion of cosmological issues from a theological perspective, see G.F.R. Ellis, *Cosmology Explained* (Boyers/Bowerdean, 1994)

[22] B.J. Carr and M.J. Rees, Nature 278 (1979): 605.

[23] For a detailed exposition on this point, see J. Leslie, *Universes* (London and New York: Routledge, 1989).

[24] For a review of current research in evolutionary biology see Maddox, *What Remains to be Discovered*, chapters 4-7.

[25] R. Dawkins, *The Selfish Gene*, 2nd. ed.(Oxford: Oxford University Press, 1989).

[26] P. Teilhard de Chardin, *Christianity and Evolution* (New York: Harcourt Brace Jovanovich, 1971); A. Peacocke, *God and the New Biology* (London: Dent, 1986); J. Templeton and R. Herrmann, *The God Who Would Be Known* (Templeton Foundation Press, 1998); J. Haught, *God after Darwin: A Theology of Evolution* (Boulder: Westview, 1999).

[27] Matt. 6:26

[28] A classic text on this subject is C.S. Lewis, *Miracles* (New York: Macmillan,1947).

[29] Mark 6:47-51

[30] Matt. 8:1-4

[31] Luke 8:22-25

[32] John 2:1-11

[33] Luke 1:34

[34] Matt. 28:17; Luke 24:38; John 20:25

[35] For a recent discussion of this subject, see R.J. Berry, *Science and Christian Belief* 8 (1996):101.

[36] C. Darwin, *The Origin of Species* (New York: Modern Library Paperback, 1998; first published

1859).

[37] An early attempt at reflecting on the relationship between geology and theology was made by W. Buckland, *Geology and Mineralogy Considered with reference to Natural Theology* (London: William Pickering, 1837).

[38] For an overview of modern geology and its relationship to Christian faith and to the other sciences, see Howard J. Van Till, Robert E. Snow, John H. Stek, and Davis A. Young, *Portraits of Creation: Biblical and Scientific Perspectives on the World's Formation.* (Grand Rapids: W. B. Eerdmans, 1990).

[39] A. McEwen et al. "Dynamic geophysics of Io," in *Time-Variable Phenomenon in the Jovian System*, NASA Special Publication 494 (1989): 11-46; P. Schenk et al. *Geophys. Res. Lett.* 24, (1997): 2467.

[40] A recent discussion of this issue is given by R.J. Berry, *Science and Christian Belief*, 11 (1999): 29.

[41] Rev. 6:12

[42] Matt. 28:2

[43] A recent treatise on work in this area is in *Physics, Philosophy and Theology*, eds. R.J. Russell, W.R. Stoeger, and G.V. Coyne (Vatican Press, 1988).

[44] J. Brooke, in *Let Newton Be!*, ed. J. Fauvel et al. (Oxford: Oxford University Press, 1988),169.

[45] For more detailed discussion of these issues see, I. Barbour, *Religion and Science*, ch. 7; J. Maddox, *What Remains to be Discovered,* ch. 2,3.

[46] For a detailed discussion of Christian theology from the perspective of a physicist, see J. Polkinghorne, *The Faith of a Physicist.*

[47] E. Wigner, *Comm. Pure & App. Math.* 13 (1960): 1.

[48] W. Pollard, *Am. J. Physics* 52 (1984): 877.

[49] For a discussion of this and other views of mathematics, see R. Penrose, *The Emperor's New Mind* (Oxford: Oxford University Press, 1989), ch. 3.

[50] P.C.W. Davies, *New Scientist*, 15 October 1988, 58.

[51] For a discussion of the various views of the self, see S. Blackmore, *The Meme Machine* (Oxford: Oxford University Press, 1999), ch. 17.

[52] For a recent overview see T. Beardsley, *Scientific American*, October 1997 issue; see also the section on Cognitive Neuroscience in *Science*, 275, (March 15, 1997): 1580-1610.

[53] F. Crick, *The Astonishing Hypothesis: The Scientific Search for the Soul* (New York: Charles Scribner's Sons, 1994), 3.

[54] For further discussion on this point see P. Clayton, *God and Contemporary Science* (Grand Rapids: Wm. Eerdmans, 1997), ch. 6.

[55] Ray Kurzweil, *The Age of Spiritual Machines* (New York: Viking, 1999).

[56] A. Foerst, *"Cog, a Humanoid Robot, And the Question of the Image of God,"* in *Zygon, Journal for Religion and Science* 33 (1998): 91.

[57] See T. Peters, *Playing God?* (New York: Routledge, 1997) for a thoughtful exposition on the promises and perils of genetic engineering.

[58] R.J. Berry, *Science and Christian Belief* 7 (1995): 21.

[59] See N. Murphy and G.F.R. Ellis, *On the Moral Nature of the Universe* (Minneapolis: Fortress Press, 1996) for a proposal to integrate scientific, ethical, and theological ideas in one framework.